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Impacts of robot implementation on care personnel and clients in elderly-care institutions



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ABSTRACT

Background: Digital technologies, including robots, are being increasingly used in elderly care. Their impact on users carries implications for successfully integrating technological innovations into care. This study aims to identify the impacts of care-robot implementation on elderly-care service stakeholders.

Methods: Impacts of care-robot implementation on users – care personnel and elderly clients – are identified from the data collected during a 10-week field study of the implementation process of the care robot 'Zora' in municipal elderly care services in Finland. The data were obtained from semi-participatory observation (27 sessions) of the robot engaging in rehabilitation efforts in two care homes and a geriatric rehabilitation hospital, and focus-group interviews conducted with 40 care workers and clients.

Results: Robot use in elderly care is associated with multiple types of impacts with positive, negative, and neutral dimensions. These include impacts on interaction and activity for clients, and impacts on the work atmosphere, meaningfulness of work content, and professional development for care personnel. Impacts on personnel were related to the need for orientation, problems of time usage, and overall attitudes toward novelty and renewing of care service. The robot's presence stimulated the clients into exercising and interacting. The care workers perceived the clients' well-being both as a motivation to learn how to use robots as well as a justification for negative views.

Conclusions: Care-robots like Zora have the potential for multi-faceted rehabilitative functions and can become part of care service with careful systemic planning with a specific focus on orientation. Many of the identified impacts were related to how the robot fits into the service processes. Distinguishing between positive, negative, or neutral dimensions of different impacts is important.

1. Background

Digital technologies, including service robots, are being increasingly used in elderly care. Their influence on clients and care-service personnel holds implications for integrating technological innovations into care [1,2]. Assistive technologies have been evaluated positively by elderly clients, health care professionals, family members, and the broader society; however, more studies are needed regarding their outcome and effectiveness [3]. The market for *care robots* for elderly or disabled people is still small, but the segment's growth is expanding rapidly, as robot applications develop further and become more user-friendly [4]. Care robots are defined as partly or fully autonomous machines performing care-related activities for people with physical and/or mental handicaps related to age and/or health restrictions [2, p. 115]. Care robots may simplify activities of daily life for elderly and/or

handicapped people, increase quality of life by enhancing their autonomy [5], and provide protection [2]. Currently, in Finland, more typical uses include various types of rehabilitation and support for interaction. Disruptions arising from care robotics can lead to organisational and social impacts, some of which are already reported in research studies [22,24], while others will take time and more usage to become visible.

This study focuses on 'Zora', a care robot for personal cognitive and social assistance [4]. Specially developed for elderly rehabilitation and recreational purposes, it has also been successfully used with children. Previous research by van den Heuvel, Lexis, and de Witte [14] showed a positive contribution of Zora in achieving therapy and educational goals among children with severe physical disabilities. Zora's most promising domains of application included movement, communication, and cognitive skills. Furthermore, Zora can contribute towards

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enhancing motivation, concentration, attention span, and taking initiatives. Görer, Salah, and Akin [15] found that elderly people can successfully exercise with the assistance of the robot demonstrating fitness exercises; while staying engaged with the system over multiple sessions. Lotfi, Langensiepen, and Yahaya [16] discussed and implemented a different type of Socially Assistive Robot (SAR) that coaches older adults in exercises. The study participants reported high satisfaction and willingness to recommend the SAR to others.

Discerning the impacts of care robot use requires a multidisciplinary and holistic approach in both research and practice. Additionally, the uptake of new services requires the study of ethical issues and stakeholder participation. Users' adjustment is crucial in implementing disruptive technologies because the introduction of new technologies and innovative practices entails more than mere adoption. Users – elderly clients and care-service personnel – need to integrate novelties into their practices, organizations, and routines [9,10]. Reasons for confrontations between technologies and elderly care practices may include technical incompatibilities; professional identities and roles; usability and accessibility problems; the hard pace of care work; lack of orientation or training; wide variety of available technology; and fears and ethical problems [11]. Dealing with clients, who experience dysfunctions such as memory disorders can be particularly challenging [3]. To date, there is insufficient evidence to support the use of assistive or socially intelligent robots that are feasible and effective for use in unstructured care environments [12,13]. For a detailed understanding of robots as care companions, better-informed human perspectives on robotic technologies are needed.

This study aims to identify the impacts of care-robot implementation on elderly-care service stakeholders. It is based on empirical research on the implementation process using the care robot 'Zora' in elderly care in Finland. The qualitative Human Impact Assessment (HuIA) approach is utilised to assess the impacts of care-robotics implementation on clients and care personnel [for its previous use, refer 6]. Identification of early impacts can provide the information and context needed for orientation and planning.

2. Methods

This field study focuses on the real-life implementation process of the care robot Zora in municipal elderly care services in the City of Lahti in Southern Finland. Zora was their first acquired robot, and the first Zora robot used in public elderly care services in Finland. Zora is a 57 cm-tall humanoid robot (see [Photo 1](#)). It can be used for rehabilitation and recreational assistance with exercise, playing music, performing dances, story-telling, and playing interactive memory and guessing games. Softbank Robotics produced this Nao robot called Zora with software developed to enable application in the healthcare field (www.zorarobotics.be). For additional information on Zora, see Box 1



Photo 1. The robot in action during an exercise session. (photo: Satu Pekkarinen).

in the Supplementary Material.

The implementation period lasted from December 2015 to April 2016. The robot was first introduced in two care homes and a geriatric rehabilitation hospital. The sites were the only public service care homes with 24 h services and the only rehabilitation hospital in the city. The city's selection was also based on the perceived potential of the robot in such sites; availability of competent key persons; and a physical environment in the facilities that enabled the robot use. The robot was used for two weeks in the first care home; four weeks in the second; and for a month at the hospital (see an overview of the implementation process in [Fig. 1](#)). In the care homes, a group of two to four physiotherapy or nursing students operated the robot, in collaboration with the staff. In the hospital, the permanent nursing staff operated the robot. The robot facilitated exercises ([Photo 1](#)), played music, told stories, performed dances, and played interactive memory and guessing games with elderly clients. The robot also approached the clients by walking towards them and shaking their hands while they sat in a circle. The robot could also be held in one's arms. The types of activities depended on the participants as all types of physical exercises are not suitable for every client.

In all, 5–20 clients and 2–10 staff members attended each group activity session that was observed. About 60 clients were involved in the sessions with Zora in the three units during the 10-week implementation period. About 50 care workers participated in the use of Zora. Some clients participated in multiple sessions if allowed by their health condition. Care workers' participation in the sessions and the subsequent interviews depended on work shifts, clients' health conditions, daily activities, and unexpected events in the ward. The selection criteria for the clients to be interviewed included willingness to participate and being in a relatively good cognitive condition. Purposive sampling was thus utilized. The data collection process is shown in [Fig. 1](#).

The research questions are:

- How does a robot (in this case, Zora) impact care work, services, and interactions between stakeholders in a care environment?
- What are the various impacts on care personnel when Zora becomes a part of their work?
- What are the various impacts on clients when Zora becomes a part of their services?

Ethical standards were maintained during the research. Both the care personnel and clients provided informed consent for participation and subsequent interviews. Leaving mid-session was permitted. The care workers assisted clients with mobility problems. To ensure safety, the robot was used with clients only under appropriate, competent control and supervision of at least one care worker. The clients were never left alone with the robot. A research permit was obtained from appropriate authorities and participants' confidentiality was maintained.

The semi-participatory observation consisted of 27 sessions of about an hour each, in which the robot was either introduced to the clients in a special session or acted as part of regular group activities (exercise or literature groups, inter alia) at the care homes or the hospital. One researcher typed all the verbal information while the other two took photographs and notes of the non-verbal action. All the notes were combined into a single document after each session.

Focus group interviews are particularly suited to the study of attitudes, perceptions, and experiences. The interaction within the groups can help people explore and clarify their attitudes in ways that would be less accessible in individual interviews [18]. This study focused on interviewing care workers. The topics of the semi-structured interviews with the professionals (35) at the end of the implementation phase included primary reactions, experiences during the implementation and familiarisation phase, experienced (and expected future) benefits and challenges, impacts on work practices, perceptions concerning

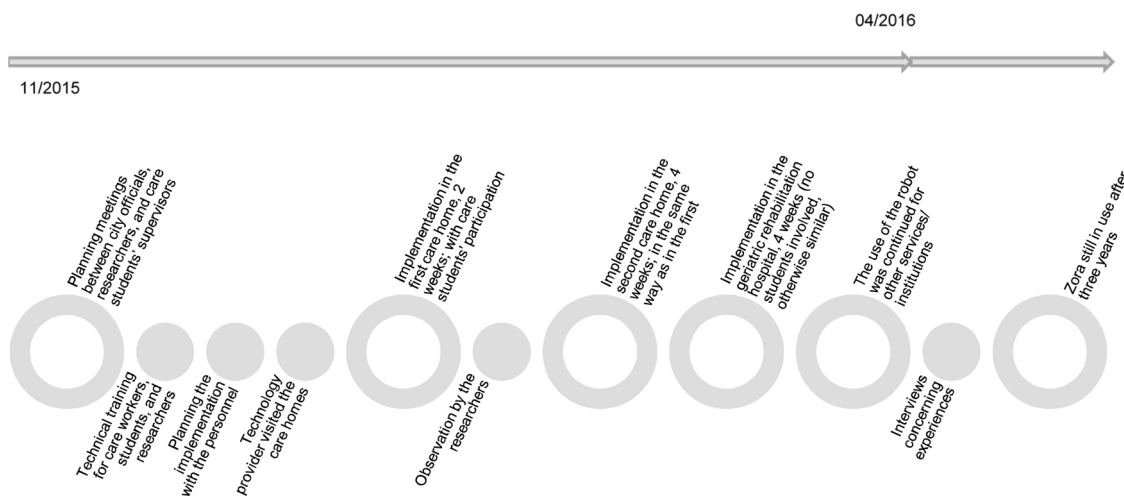


Fig. 1. The implementation process of Zora in 2015–2016 (and subsequently) and the data collection.

Notes: After the implementation period in 2016, Zora is still in use in these original (as of Spring 2019) as well as in some other elderly care environments. The robot can be booked from the technology unit of the current joint authority of municipal social and health care services, for a few weeks at a time, and the care units have occasionally used this opportunity over the past three years.

suitability, and applicability of the robot for elderly clients. The interviews with the five clients focused on their initial thoughts about the robot; nice, surprising or irritating characteristics; differences in recreational sessions with and without the robot; and their willingness to participate in future sessions with the robot. (For additional information on the interviews, see Box 1 in the Supplementary Material.)

The data were analysed using the qualitative HuIA approach to identify the impacts of care-robot implementation on users, i.e., care personnel and elderly clients. This user-oriented approach aimed to identify the various impacts on humans without following any pre-determined framework. HuIA identifies the impacts of different actions and options, providing information for decision-making and resolving conflicts [19]. It has been used to assess the impacts of ‘traditional’ elderly care technology, such as safety alarms [1,6]. Its essence is to identify positive, negative, and neutral impacts on different groups of people involved holistically. Confrontations between technologies and practices due to, for example, the hard pace of work, various fears, or lack of orientation [11] may surface with the help of HuIA.

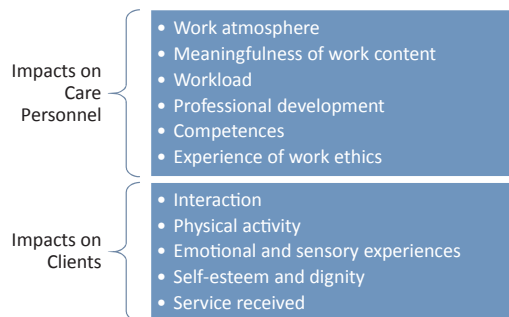
An inductive thematic analysis [20] of the data consisted of six phases: becoming familiar with the data, generating initial codes, searching for themes, defining themes, naming them, and producing the report. Accordingly, the transcribed text and notes were thoroughly read to capture the features associated with the research topic. The sentences and paragraphs from the interviews or notes from observations, assessed as interesting or meaningful about the phenomenon under study, were identified and marked, and initial codes were generated across the data set. The codes were grouped into potential themes (impacts) which were checked with the codes and the entire data set for relevance. Finally, each theme was named. The analysis resulted in six themes for care personnel and five themes for clients.

3. Results

The data consisted of (i) semi-participatory observation [17] of the robot used for rehabilitation purposes at the two 24-h-service care homes and the geriatric rehabilitation hospital (27 sessions, about an hour each), (ii) focus-group interviews with 35 care workers (nurses, assistant nurses, physiotherapists, and occupational therapists) and (iii) focus-group interviews with 5 clients. Clients’ health-related information was neither sought nor obtained. However, the clients’ general health conditions can be characterized based on the nature of the study environments. Two of them were care homes with client entry criteria of low functional abilities and requirement of round-the-clock care. A

majority of the clients had different degrees of memory disorders. The third unit was a ward in a geriatric rehabilitation hospital specifically designed for people with memory disorders. In Finland, the public authorities determine the entry criteria and needed services, assessed during special assessment visits.

Six types of impacts on care personnel and five types of impacts on clients were identified concerning robot use (see Tables 1 and 2 in the Supplementary Material for additional information):



3.1. Impacts on care personnel

The impacts on care personnel are described below with descriptive quotations from the interviews. The operation of the robot was reported to be easy, but workflow integration was challenging. For example, meaningful usage of the robot requires time and personnel resources: two caregivers are needed – one concentrating on the robot usage and the other one on the client. A caregiver described the challenges for busy schedules presented by robot use:

‘If I take the robot into use here, 15 min is not enough for it, and somehow I always felt that this is not the moment for it, and I will take it later’.

It thus led to less frequent and efficient use. No positive impacts on time were mentioned during the implementation phase. Personnel require dedicated time to use the robot. One instructor noted:

‘This daily work is pretty tough; working time should be marked out for us for this’.

The caregivers highlighted the importance of knowing the clients and their needs well in advance when planning to use the robot. They emphasised that ample time for training and orientation for all

personnel is needed. As a practical detail, the robot also requires an Internet connection and an easily accessible place for storage and battery charging.

The small size of the robot provided a cute and sympathetic persona; however, the size also caused problems for elderly people with poor eyesight or when the robot was used in a large group. Likewise, the robot's voice was too low for those with hearing problems, and lip-reading was not possible. This caused some confusion when clients did not understand who was talking and what was expected from them. Therefore, caregivers' special context sensitivity is necessary when using the robot to ensure that the clients know what is happening, especially when there are technical problems or other confusing situations.

Care personnel reported both positive and negative impacts on meaningfulness of work including coping at work. An occupational therapist noted that the robot could be useful for those care workers who are not comfortable instructing clients on exercise moves and performing publicly. One instructor felt good about the exercise sessions conducted by the robot:

'It doesn't matter that the machine shows the way; it is great to "outsource" oneself sometimes'.

Some of the caregivers had a personal or professional interest in novelties for care work to provide better services and improve work ethics. For other caregivers, they felt it important to maintain a sense of control in their work and believed that the robot posed a threat. Those employees wanted to withdraw from any contact with it. An occupational therapist pointed out:

'The caregivers said that this is just a waste of money and causes additional work, when work is already so busy'.

Some condemned the robot as 'modern nonsense' or degrading toward elderly clients, while others who had seen the clients' positive reactions considered the robot more beneficial for the clients' well-being. According to a physiotherapist:

'Robot use requires supervision and work, but do we depart from what we give to clients? I cannot tolerate technology, but still, I have a positive attitude if I see that the client gains something good out of it. You have to reach beyond your attitude'.

In general, various kinds of prejudice often abated after gaining personal experiences of using the robot with clients.

Impacts on participation and perceived opportunities to participate in the decision to purchase the robot also varied. An important user-oriented point was raised by an occupational therapist:

'Is the grassroots level taken into account when purchasing such robots? Have the needs of the house been considered?'

Some caregivers viewed the city's strategy in elderly care services to be technologically pioneering and they showed support by agreeing to use the robot. Negative impacts were caused by publicity and negative public reactions towards the purchase of the robot for public elderly care [see also [21]]. Care personnel had to justify the purchase and use of the robot to the public.

Robot use impacted the integrity of the entire workplace community. There were some tensions in the workplace between robot users and non-users, and between 'puttering about robot use' (as seen by others) and 'real care work'. A care professional who used the robot in the activity sessions noted:

'I felt that it was wrong for the workmates to be playing with a machine when you could do the real work which is really busy. [...] There was passive resistance among the personnel: The patients were not taken into activity sessions (where the robot was). We got comments like "Isn't the patient more important?"'

These research results led to an important finding: the orientation (referring to training and learning) related to care robots should not only include an explanation of technical issues. It should also cover issues related to time usage and task divisions. The managers also recognised the need for orientation, a major issue that needs to be highlighted and dealt with skilfully.

'I asked the importer to give training when I saw the fear, distress, and diffidence about the robot coming here' (an instructor).

3.2. Impacts on clients

The impacts on clients are described below with descriptive quotations from the interviews. Impacts on clients as well as their relatives centred around an awakening of different kinds of feelings and promoting activity and interaction. One instructor commented:

'I was surprised that the clients had such positive attitudes. They wanted to be engaged and hold the robot. They were open-minded and felt that someone had come here for them'.

She also highlighted the positive aspects that the robot, as a technical creature – being always persistent and emotionless – can have in care work:

'The robot doesn't get tired, but always responds in a friendly way and repeats things. And she doesn't take it personally if someone doesn't want to hold her'.

The clients considered the robot entertaining, funny, and interesting. They talked to the robot using its name. The robot stimulated movement and led to reminiscing because of its child-like character. An occupational therapist noted:

'When people were supposed to raise their feet, someone who never does that, did it because the robot calmly demonstrates exercises'.

Robot use not only created various kinds of interactions between the clients and the robot but also between the clients and care personnel (and within these two groups). These types of interactions are important and relieve some of the concerns related to the maturity of the technology for interaction. A caregiver commented:

'Interaction was generated, as the operators of the robot could answer questions at the same time. People started to talk to a doll like this quite well'.

Negative reactions included irritation, reserve, and fear. 'Go away, this is silly', as one client reacted. A client also noted:

'This goes too technical. It is the human contacts that I miss. Human to human – that is important and not any toys'.

It was highlighted that clients should not be misled; the role of ethics is of key importance. Another key issue during the session was interactions between the care personnel and clients: to explain what the robot is doing throughout the sessions, how clients can address and interact with it, and the role of the robot operator. A caregiver said:

'Elderly clients are grown-ups, even if they suffer from memory diseases. They are not stupid. The user of the robot should tell them what is done and why'.

It was noted that those with memory problems did not necessarily perceive the robot as a conversation companion, but the interaction was still positive. The care personnel needs specific sensitivity and knowledge of clients when introducing the robot to the clients with memory-eroding conditions.

The robot's impacts on clients are essentially related to ethical questions concerning robot use. The caregivers were especially concerned about the possibility of the robot replacing humans as caregivers. They cited the following concerns:

'If it is used as a substitute for humans... and if the robot entertains people all day long'.

'If a robot is given to a person living alone and she/he has to cope alone'.

'It is, after all, always a machine; it can malfunction without saying anything'.

These issues need to be considered through responsible planning and orientation [e.g., [22]] and in future research [e.g., [6,8]] in the context of care robotics.

4. Discussion

Our research findings suggest that while there is potential for

rehabilitative work and activities with the help of the Zora robot – multi-faceted rehabilitative work, combining mental, social, and physical aspects of rehabilitation, there are also substantial barriers. To be successful, the robot's use must be well-planned with an understanding that the robot's usefulness varies and may increase over time. Realizing a robot's full potential may depend on providing staff with a proper orientation, usage time, and clear motives for use. With commitment by organizational leadership, benefits may increase for the clients and personnel in the establishment phase (e.g., from the viewpoint of meaningfulness of work). However, benefits may remain negligible if the use is not well-planned and led. Inadequate information on the purpose and meaningful tasks of the robot may lead to unrealistic expectations and unmet needs.

Impacts on work appeared to depend on whether the 'novelties' were perceived as motivating, an extra burden, or a threat. After their own experiences of using the robot and witnessing the elderly clients' positive reactions, many caregivers who were suspicious at first changed their views. While most of the elderly clients welcomed the robot with curiosity and even became emotionally attached to it, we observed that some clients perceived it as nonsense or became irritated. Like in the Görer et al. study [15], we found that the clients could successfully exercise with the robot's help. Additionally, we observed promising signs concerning movement skills, communication skills, and cognitive skills; consistent with those found by van den Heuvel et al. [14] using Zora, albeit with children.

The care personnel perceived the clients' well-being not only as a motivation for learning to operate the robots but also as a justification for negative views. Our finding that residents had a more positive attitude toward robots than care personnel is also consistent with other studies, such as Broadbent et al. [23]. This study provides directions and a strong emphasis on the need for impact assessment in each environment, but detailed responses to when, how and for whom a Zora robot can be useful are too early. The above-mentioned details may even depend on changes in the client's daily health condition.

By examining the robot use in real elderly-care environments, this research also revealed some unexpected and unintended impacts, such as negative impacts on the workplace community. Robotic research has so far focused on technical implementation, technology development, and clinical applications, but there has been limited discussion on social and managerial issues that might be equally important for successful robot use [7,24]. This study strived to contribute to filling this gap. As the study involved people from one city in Finland, its results are context-specific, yet consistent with previous literature.

The findings should be interpreted while considering certain limitations. This study was conducted in an organisation with a strong willingness to adopt new technologies for elderly care and provide new services to the clients. It was one of the first elderly-care providing organisations in Finland to use a robot. However, grassroots-level employees expressed criticism toward its adoption. The decision concerning robot purchase and the actual start of the implementation phase took place quite quickly, with an open-minded and experimental attitude that might have caused a situation in which not enough support was put into training and informing all employees. The low number of client interviews is a limitation in this study. Yet, about 60 clients were involved in the sessions that were observed by the researchers.

The use of Zora in various types of care continues due to satisfactory experiences during implementation. During the implementation phase, the robot mainly functioned as recreation for clients; it was a pastime and routine breaker as well as, to a certain extent, a multi-faceted stimulator of social and functional abilities among clients. The study's sole focus on the implementation phase is also a limitation in terms of studying the long-term impacts, but along with HuIA, various important issues can be revealed for subsequent use in planning.

The study brought up useful avenues for future research. Aspects of rehabilitation and encouragement in stimulating physical and cognitive skills require long-term follow-up. Possible novelty effects should be

investigated; the question of how the impacts found here change with future use and implementation, and the related question of whether the interest wanes once the personnel and clients become familiar with the robot. Addressing these questions fully entails a new study that is outside the scope of this paper. However, the researchers have been in contact with the case organizations over the three years of using Zora; and the discussions have confirmed the importance of the starting phase such as orientation, in subsequent use. Generally, due to the relatively short-term experience with such activities, the starting phase of long-term robot use in elderly care has rarely been studied thoroughly.

Author contributions

The authors confirm that the manuscript has been read and approved by all named authors and that there are no other people who satisfied the criteria for authorship, but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us. Author contributions are as follows:

HM: Contributed to data collection and analysis and manuscript preparation

LH: Contributed to data collection and analysis and manuscript preparation

SP: Contributed to data collection and analysis and manuscript preparation

VK: Contributed to data interpretation and critical revision of the manuscript

Summary Points

- Impacts of care-robot implementation on users – care personnel and elderly clients were identified from the data collected during a 10-week field study of the implementation process of the care robot 'Zora' in municipal elderly care services in Finland.
- Impact assessment ensures the comprehensive identification of positive, negative and neutral impacts.
- Crystallising the multiple impacts associated with the use of the Zora robot in elderly care properly and making them visible to those concerned is vital for finding and addressing weak spots.
- The issues highlighted as impacts indicated a need to ensure proper orientation. Skilful leadership is also needed to avoid and handle conflicting attitudes.
- Zora seems to have the potential for multi-faceted rehabilitative work, combining mental, social, and physical aspects of rehabilitation – with careful systemic planning.
- Inadequate information on the purpose and meaningful tasks of the robot may lead to unrealistic expectations and unmet needs.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.ijmedinf.2019.104041>.

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