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What will it take to hire a robot? Views from health care personnel and managers in a rehabilitation hospital

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In the current work we explore the views of healthcare workers and managers towards including an android robot as an assistant in their daily routines. How employees perceive the technology can influence their behavior in ways that are highly instrumental for the innovation efforts. We investigate initial reactions, preferences, and expectations, exploring whether a robot can be used to assist health care personnel at this specific hospital. In this paper we ask: What will it take to hire a robot? We explore this question using mixed methods: interviews with health care staff after they had performed tasks with and without assistance from the robot; group interviews, one with managers of the hospital and one with staff from two different departments after seeing the robot and watching a video of how the robot can be used to assist health personnel; and questionnaires to personnel. The findings indicate that the healthcare personnel and managers are overall positive to a robot assistant, focusing mostly on the benefits of introducing a robot to assist at the rehabilitation hospital. However, it was emphasized that the robot needs to be reliable. If it stopped working, or if using the robot turned out to be cumbersome and time consuming, the staff would get frustrated, and rather perform the tasks themselves.

Keywords: *Healthcare, Robot assistant, Attitude, Trust, Technology acceptance, Empirical study.*

1 Introduction

Currently, policy makers try to cope with a continuous decrease of health care personnel, and an increase in health care expenses (Hjemås, Zhiyang, Kornstad & Stølen, 2019). Globally, WHO estimates a projected shortfall of 10 million health care personnel by 2030 (WHO, 2016). An additional challenge for the health care sector is a high turnover rate. Among nurses, this has been associated with high workload, time pressure, inconvenient working hours, and low pay (Beyrer, 2017). Furthermore, health care personnel daily perform time consuming tasks that they do not define as a typical health care task (Bergsagel, 2019).

In response to the existing shortage of nursing and caregiving professionals, along with the rising healthcare costs, the deployment of various technological solutions has been proposed. In the current work we explore the views of healthcare workers and managers towards including an android robot as an assistant in daily routines at a rehabilitation hospital. How employees perceive the technology can influence their behavior in ways that are highly instrumental for the innovation efforts. We investigate initial reactions, preferences, and expectations, exploring whether a robot can be used to assist health care personnel at this hospital in their daily tasks. In this paper we ask the following question: What will it take to hire a robot? We anticipate that several factors will contribute to answer this question, from service needs, task-technology fit, cost-benefit, other required competences, and safety and security.

In this work we present a qualitative study, based on individual and group interviews with hospital staff (both healthcare workers and management). To guide the analysis of the interviews we focused on findings from the literature, highlighting the following aspects as relevant in human-robot interaction for healthcare contexts (Fernandes, Bloch, Kaarstad, Eitrheim, & Reegård, 2021): acceptance (including usefulness and expectations), trust (including concepts of safety and reliability), and job design (including operational concepts and task identification and selection).

1.1 Acceptance of robots

Technology acceptance is a multidimensional construct, usually referring to the willingness of individuals to interact and use new technology (Davis, 1989). The Technology Acceptance Model (TAM), proposed by Davis (1989) has been an influential model in this area. The model has been developed and expanded, currently being framed within the unified theory of acceptance and use of technology (UTAUT, Venkatesh, Morris, Davis, & Davis, 2003). As seen by TAM, perceived usefulness and perceived ease of use will predict an individual's intention to use a system, which in turn will predict usage behavior. Perceived usefulness is commonly defined as «the degree to which a person believes that using a particular system would enhance his or her job performance" while perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). The usefulness of the robot, as in the matching between the robots' capabilities with the actual needs of the healthcare staff is another important factor. Perceived ease of use, linked to concepts of operation of and cooperation with the robot can also be of crucial importance, defining the boundaries for robot contribution and supporting the identification of tasks that the robot can be capable and allowed to perform.

In human-robot interaction (HRI) this model has been used and adjusted (e.g. Bröhl, Nelles, Brandl, Mertens, & Schlick, 2016; Turja, Aaltonen, Taipale, & Oksanen, 2020). Within this context, TAM has been criticized for being an information processing type of model, rooted in cognitive theory and often not integrating emotional components that are thought of as crucial within HRI (de Graaf, Allouch, & van Dijk, 2017). It is thus important to consider other components towards acceptance that encompass previous attitudes and emotions towards robots.

The acceptance of robots within healthcare settings has been studied before resulting in mixed findings (Naneva, Gou, Webb, & Prescott, 2020). Factors such as robot appearance, user expectations, and matching between user needs and robot capabilities (Broadbent, Stafford, & MacDonald, 2009) influence its acceptance. Robot appearance, especially when considering humanoid or android robots can be a crucial factor for acceptance, with human-like features being contributing to likability (Li et al., 2010), but at the same time increasing the risk for eeriness (Kätsyri, Förger, Mäkäräinen, & Takala, 2015). Appearance has also been found to module expectations and seems to be important to match expectations and capabilities to potentiate acceptance and satisfaction (Klüber & Onnasch, 2022). Considering this knowledge, in the current work we explore initial expectations and hopes from healthcare staff that might influence the acceptance of the robot and its successful integration in the workflows at the hospital.

1.2 Trust in robots

Some researchers have pointed out that a main challenge for successful integration of advanced technological systems, like robots, is trust (e.g., Beer, Fisk, Rogers, 2014). Ghazizadeh, Lee and Boyle (2012) claim that trust in automation or technological systems is a factor that helps to determine acceptance, attitude, intention to use and thus also the actual use of the system. However, too much trust in robots may lead the human to always depend upon them. Overtrust was demonstrated in a study by Booth et al. (Booth, Tompkin, Pfister, Waldo, Gajos, and Nagpal, 2017) where people willingly ignored an emergency exit sign to follow an evacuation robot taking a wrong turn during a (simulated) fire emergency. On the other hand, if the humans trust the robots too little, this may lead to disuse of the technology, which may result in high workload and decreased system performance (Lee & See, 2004; Kok & Soh, 2020). Therefore, for the interaction between humans and robots to be reliable, it is important that humans develop a calibrated level of trust.

Rempel, Holmes, and Zanna (1985) studied trust in a human-human context. They proposed a model of trust where they looked upon trust as a dynamic attitude consisting of three dimensions: predictability, dependability, and faith. They found that predictability, the anticipation of future behavior, forms the basis of trust early on in a relationship. Then, dependability, whether the behavior of the trustee is consistent, develops. The last step in the trust formation process in Rempel et al.´s model, is faith, which is considered as a more general judgment whether a person can be relied upon. This model was later applied to trust in

automation. Muir found that trust in technology often follows an opposite pattern, starting with faith to the system followed by dependability and predictability (Muir, 1994).

Although empirical findings show an initial trust or faith towards technological systems, it has been found that if users are not aware of the limitations of the system before they start using it, trust will be significantly weakened when and if they experience system failures (Beggiato, Pereira, Petzoldt, and Krems, 2015; Balfe, Sharples, Wilson, 2018). Based on the above, we argue that trust in robots, how it is formed, developed, lost, and regained, will be an important research area in the years to come.

1.3 Job design

The introduction of new and increasingly advanced technologies tends to constitute changes in job design as it frequently implies changes in task allocation and work processes and may result in new skill requirements for human workers (Parker & Grote, 2020). Research has shown that technology has no predetermined effect on work design. Both positive and negative effects are possible. This is determined by the technology itself, higher-level factors at the organizational and societal level, individual factors, and the interaction between all these (Parker & Grote, 2020; Wang, Liu, & Parker, 2020). Hence, studying aspects such as work characteristics, job autonomy, and relational aspects of work are equally important to studying task-technology fit (Schwarz & Watson, 2005; Wang, Liu, & Parker, 2020). These are aspects that concern people's motivation and are influential in outcomes such as job insecurity, turnover intentions, organizational commitment, and stress. It is necessary to consider how introduction of new technology could enhance pre-existing work processes and procedures, while not disrupting processes humans wish to preserve. Anticipating and experimenting with different ways of working and simulating best-case and worst-case scenarios could be a way to support the design of new ways of working that can efficiently promote team performance.

2 Method

When exploring what it would take to hire a robot, we used a mixed methods approach, using data from individual and group interviews and a questionnaire.

2.1 Individual interviews

Individual interviews were performed during an empirical study focusing on how the robot Eve was perceived by health care personnel at a rehabilitation hospital (Eitrheim, Kaarstad, Sørensen, Berg, 2023). The study took place in a training apartment in a separated area within the facilities of the rehabilitation hospital. Each participant was introduced to the researchers, the robot Eve, the purpose of the study and data to be collected prior to signing an informed consent.

The robot Eve, developed by 1X, is built on a flexible platform, has a head with a face (eyes and mouth), movable arms, and can move on three wheels, see Figure 1. The robot is 180 cm tall and has humanlike manipulation capabilities through its arms and a selection of hands. Eve was remotely operated from another room at the hospital by an experienced engineer using a virtual reality (VR) headset. The participants were informed that the robot was being teleoperated in the current study, but the expectation would be that it could perform the tasks autonomously in the long-term.

Figure 1: The robot Eve

In the empirical study, the participants were asked to carry out some tasks in two different settings, one with and one without the robot. The tasks performed were selected in a previous analyses of health staffs' daily tasks, needs and preferences, and matched to current robot capabilities (Eitrheim et al., 2023).

In the scenario without the robot, the participants picked up equipment needed for the

tasks themselves, while in the scenario with the robot, the participants called Eve, which spent the same time to perform the pickup tasks as the health care personnel. In the scenario with assistance from Eve, the participants had therefore more time available with the patient. The scenarios involved picking up equipment and patients (tasks that were identified as a lot of time from the staff). In the trials with support from the robot, the participants would use a tablet interface with a push of a button to request the necessary equipment. The robot was always successful with the task. When Eve performed the pick-up tasks, it placed the equipment on a table inside the training apartment and left the room. Thus, there were no required interaction between the staff and the robot in this study. In this study we were only interested in the views from the health care staff, therefore, two members of the research team alternated to play the patient, simulating a spinal cord injury.

When both conditions were completed, a semi-structured interview lasting for about 20 minutes was conducted. One researcher asked the questions, and another took notes. The interviews were videotaped and transcribed after the study was completed.

Five female and three male health care workers at the rehabilitation hospital participated. Four of the participants were nurses, two occupational therapists, and two physiotherapists. Their average age was 40 years, and average work experience within the health sector was 16,5 years. The participants had worked at the rehabilitation hospital between 1 and 21 years, with an average experience of 9,3 years.

2.2 Group interviews

Two group interviews were performed. One group interview was conducted with managers of the rehabilitation hospital and one with staff from two different health care departments. There were approximately 20 participants in each group. A meeting with each group was called in advance. The total duration of both meetings was one hour. Both group-interviews were performed after seeing the robot and watching a video of how the robot can be used to assist health personnel. The two group-interviews were performed by gathering the participants so that everyone could see and hear each other while answering the questions. The research team introduced themselves, informed about the purpose of the study, and how the information they provided during the group-interview would be used. One researcher asked questions, while another took notes. The group interviews lasted for about 15-20 minutes.

2.3 Questionnaire

Trust was measured through a short version of "The Halden Trust Scale" (Skjerve et al., 2001; Strand, 2001; Skjerve et al., 2005). This is based on the three dimensions of trust: predictability, dependability, and faith, as suggested by Rempel, et al. (1985). The original questionnaire includes two items for each dimension. In the current version, we shortened it to one item per dimension. Three items were then used to assess the participants' level of trust in their colleagues, and the same three items were used to assess their trust in the robot, Eve. This questionnaire was distributed to the health care staff performing tasks with and without the support from Eve, after they had been through both scenarios. The participants were asked to mark with a number from 1 to 10 (1=strongly disagree and 10=strongly agree) whether they agreed to the following: *1) My colleagues / the robot is dependable; 2) My colleagues / the robot is predictable; 3) In general, I have confidence in my colleagues / the robot.*

3 Findings

A deductive analysis approach was applied for the interview data (Bingham & Witkowsky, 2022). A total of 144 statements were made in the interviews (both the individual and the group interviews). The statements were categorized into *acceptance* (including usefulness, expectations, and emotional components, 51 statements), *trust* (including concepts of safety and reliability, 26 statements), and *job design* (including operational concepts and task identification and selection, 67 statements).

The content of the statements made in the different interviews were similar and are therefore not distinguished during the presentation of results. However, the statements were distributed slightly differently in terms of number in the various categories. Figure 2 present the distribution of the statements in each category for the individual interviews, the group interview with managers and the group interview

with health care personnel. As can be seen in the figure, the topics discussed during the group interviews focused mostly on job design aspects, while the individual interviews had more focus on acceptance of the robot.

Figure 2: Distribution of statements in each category

3.1 Acceptance of Eve

Several comments provided in the interviews concerned the quality of work tasks. The personnel stressed that in situations where they had support from the robot, they had "more time freed up to make human contact with the patient, could have conversations with them, which is an important part of the profession, and is especially important in a rehabilitation hospital". Furthermore, in situations where they needed to leave the patient room to get equipment, the flow and the concentration in the treatment was interrupted. One participant explained: "If you must interrupt a training session to get something, you must start the relationship a bit anew when you are back, and at the same time you may be a little out of breath. You can then appear a little stressed even if you are not, which can be unfortunate for the patient". All the participants in the individual interviews would appreciate if the robot could perform simple, time-consuming tasks and run errands to enable them to have more time with the patient. They appreciated that, with a robot in the hospital, the work could be performed more efficiently, and in all interviews the participants stated that the health care personnel would probably save a lot of time if supported by a robot.

Another aspect relevant for acceptance, is perceived ease of use. The health care workers expressed that it was easy to call and use the robot in this study: "It was very easy to perform my work when I could call the robot for help. I just needed to press a button, and the robot came with the equipment".

The participants had also different expectations for a robot in the rehabilitation hospital. Some suggested that it should be designed to support a few predefined tasks: "If it is to support patients when they walk or exercise, it needs to be designed so that it does this in a safe way. If it is to perform more fine-motorically tasks, it needs to be designed in a different way. There are many tasks that healthcare personnel may need help with, and it is important to choose some relevant tasks, and to design the robot for such purposes". Furthermore, it was stressed that the interaction with the robot needs to be simple. Several participants suggested to call for it through an app on their phone and that it would be useful to be able to supervise the robot through this app., e.g., to see where it is, and how it proceeds with the task it has been assigned.

Another important aspect related to acceptance of new technology, are emotional and individual components like attitudes towards this technology. During the interviews, some participants expressed that the robot looked friendly, and that they appreciated that it waved to them when it left the room after bringing the equipment. Others mentioned that the patients, and particularly children, may think it is a bit intimidating, due to its height. Most participants believed that their colleagues in general would be positive towards a robot. They thought it might be some initial challenges when and if it is implemented, and that some staff members may need some time to adapt to it. They also mentioned that some colleagues may be worried that the robot will replace them at the hospital. However, they considered that if the health care personnel experienced the robot to reduce their work pressure and make the everyday work easier, most colleagues will find it useful.

3.2 Trust in Eve

In the interviews, there were several concerns raised among the participants regarding

the robot´s reliability. The participants expressed that they would appreciate to get support from a robot if it is reliable, and if they can trust that it performs the tasks it is expected to do within a reasonable timeframe. “If the robot takes longer than me, I will do it myself”, one participant stated. They also stressed that it is important that the robot can solve potential problems that can occur (be able to get around barriers, finding the equipment it is asked to pick up, etc.). In addition, concerns were raised related to battery time and breakdowns that may create frustration. It was also mentioned that the robot does not get sick and is not mentally affected by different moods and state of mind, and in this respect, it may be more reliable than a human.

When looking at the self-reported trust after performing tasks with and without the support from Eve, the participants seemed to trust Eve similarly to their colleagues (see Figure 3). We should highlight that Eve was 100% successful in all trials of the study – no failures were tested.

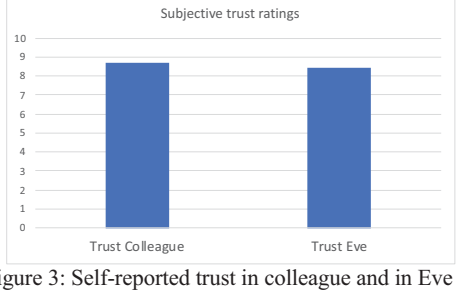

Figure 3: Self-reported trust in colleague and in Eve

3.3 Job design with an android

Tasks identified in the interviews that could support the staff in addition to collecting equipment, were for instance: delivering samples to the laboratory, clean and sterilize equipment, tidying, wash linen, making beds, deliver mail, replenish stock items, administer medications, measuring patients weight, height, and blood pressure, support patients with dressing and training, picking up and bringing food, welcoming patients at the reception and escorting them to their room, fetch items located too high/low to reach, meet and follow patients to appointments, helping with transfers from bed to chair, or prepare room for a new patient.

In the interviews, it was also commented that with a robot, the healthcare personnel will have more time freed up to make human contact with the patient, and to have conversations with them. Conversations were considered an important part of their profession and particularly important in a rehabilitation hospital. The health care personnel also pointed out that “With a robot, the work could be more directed towards our profession, what we are educated to do”, and “If the robot can perform general, time-consuming tasks, I can do more of my nursing tasks and spend more time with the patient”.

4 Discussion

The findings indicate that the healthcare personnel and managers are overall positive to an android robot assistant, focusing mostly on the benefits of introducing the robot to assist at the rehabilitation hospital.

There is a shortage of personnel, and they often experience time pressure. Our findings suggest that there is a potential value of a robot to alleviate the health personnel in daily work, enabling them to focus more on patient care which they consider the core of their profession.

If a robot is to be employed to support personnel in a hospital, it will be important for acceptance and use that it is useful. It is then relevant to identify some of the specific time-consuming or cumbersome tasks that fall within a robot’s capabilities and regulatory and legal boundaries on safety and security aspects. Such a robot should be developed iteratively with potential users to ensure its usefulness and that it is not perceived as threatening to the staffs’ role. An iterative design approach could furthermore mitigate potential pitfalls and challenges that are difficult to foresee in advance, which will be particularly important in a such context as the current rehabilitation hospital with vulnerable patients. Incremental testing in a controlled environment will ensure that a robot is capable to handle or avoid potential challenges.

Regarding trust, the participants who took part in the study where they performed tasks with or without assistance from Eve, were very optimistic regarding the robot assistant. They seemed to have high trust in the robot in the tested scenarios, and their self-reported trust ratings were equally high in their colleagues as in Eve. This finding is consistent with the empirical finding of Muir (1994), who found that trust in technology starts with a high degree of faith. It is important to highlight, however, that we did not include failure scenarios in our test, that could have impacted the perceived trust and

reliability of the robot. To avoid potential over-trust to a robot, the healthcare personnel should be able to familiarize with the robot and experience failures and errors and ways to handle them. Testing it in situations where errors are introduced and testing it in "worst case scenarios" could support more realistic expectations from the staff. In future work, it will be necessary to explore situations where the robot is less reliable, for instance by failing to complete a task accurately (e.g. bringing the wrong item, failing to find an item) or by malfunctioning (sudden shutdown, not responding to request, etc.).

Despite the high score on the trust scale, most participants emphasized in the interviews that the robot needs to be reliable. If it stopped working, or if using the robot turned out to be cumbersome and time consuming, the staff would get frustrated, and rather perform the tasks themselves. Nonetheless, the assistant android clearly supported the staff by enabling them to increase the time spent with the patients. This leaves us to wonder what would be the concessions in time and efficiency the staff would be willing to make to gain that extra time, i.e., does the robot really need to be "as fast as a human", or could it be slower given the time gained by working with it?

The current findings suggest a positive and perhaps over-confident perception of the contribution that an android robot could have at the hospital. This is relevant information to guide, shape and design a successful and sustainable implementation project.

5 Conclusion and future work

The healthcare staff was overall positive to the integration of a robot in their workflows – it seems like the acceptance threshold for the integration of robotics might be rather low in the study case. The staff mostly highlighted advantages in using the robot as an assistant for their daily tasks. Few concerns were presented by the participants, and of these, most focused on the robots' reliability and ease of use. The robot seemed to elicit a high usefulness perception, possibly reflecting the fact that the proposed tasks in the demonstration and simulated scenarios were suggested based on a needs analysis and prioritization done previously with staff representatives. The current paper focused essentially on the acceptance and trust from the staff. Further work will need to emphasize job design aspects, including the practicalities of deployment including the study of concepts of operation and control of the robot, as well as legal and ethical constraints that will shape the integration of the robots. We expect that our findings will be useful for ongoing efforts to identify user needs across diverse stakeholders and work contexts to alleviate health care staff (through technological interventions) in their daily work.

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