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Robot acceptance model for care (RAM-care):A principled approach to the intention to use care robots

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ABSTRACT

Robots are emerging in welfare services, and organizations require information on whether novel technologies are approved among staff. On the basis of technology acceptance theories, this study proposes a model that adds a principled approach to the intention to use care robots. Data of 544 professionals with care robot experience were collected. The use intention was predicted by usefulness, enjoyment, social influence, and attitude. Respondents who found robots useful and accepted by their colleagues were more likely to view robot use as consistent with their personal values. The care robot acceptance model supports consideration of the profession-specific context in robotization.

Keywords: healthcare, robot acceptance model, robotization, social robotics, technological change, therapy robots

1. Introduction

Promoting the robotization of everyday services has become one of the focal points of many government strategies [1–3]. However, this objective requires an in-depth understanding of the factors that influence the acceptance of robots and implementation processes in different fields of work. Robot assistance in industrial work has been commonplace for many decades. Now robotization seems to be gradually making its way to service fields. Service robots are viewed as providing possible solutions for relieving, renewing, and rearranging care work in a time of aging populations and increased needs for social and care services [4,5].

According to a common industrial definition, a robot is a programmable mechatronic device capable of moving in its environment [6]. Computers and robots are built on advanced information systems, but robots differ from computers in their ability to physically manipulate or interact with their environment. In contrast to industrial robots, which are typically used in manufacturing and other assembly applications, service robots work in the service sector, for example, in cleaning, customer service, and search and rescue. Care robots are service robots that are used in a care context. Today, care robots are almost entirely human operated, but robot autonomy is increasing with advancements in artificial intelligence (i.e., machine learning), artificial morality (i.e., coded ethics), and improvements in sensor technology [7,8].

Telepresence robots are mobile videoconference or consultation devices fully operated by, for example, a nurse interviewing a home-care customer from a remote location [9,10] or family members contacting a relative living in a residential care home [11]. So-called social robots (e.g., “Nao” or “Pepper”) are used to entertain and engage customers physically, cognitively, and emotionally [12,13]. Social robots are often humanoids, which means the robots have some physical characteristics similar to humans, such as arms, a torso, and a head with some facial features. Although these robots are seemingly interactive, the dialogue is almost always preprogrammed. Patient-lifting robots can be semi-autonomous (e.g., “RIBA bear”), which means they perform tasks independently, but only when safety is confirmed by a human operator [14]. Typically, the more autonomous the robot, the fewer functions it includes. For example, robotic animals designed for therapeutic purposes (e.g., “Paro seal”) have limited features and mobility, and hence, they have low maintenance and do not require constant management [15,16].

Theoretical and qualitative study results have implied that healthcare professionals may resist using care robots because using them would not be consistent with the way the professionals understand the principles of care work [17–20]. However, the significance and generality of this principled mindset, and its actual connection to the intention to use robots in care work, have not been investigated. Among the general population, however, fundamental concerns have been expressed about implementing robotics in social and care services. In the Eurobarometer data 2017 (*N* = 27,901) of adult (15+) citizens of the European Union, on average, 32% (ranging from 14% to 56% depending on the country; e.g., in Finland, 30%) would be comfortable with a robot providing services and companionship to infirm or elderly people [21].

In this study, we surveyed healthcare professionals' acceptance of robots and identified the factors that determine the intention to use robots specifically in the context of care for the elderly. We used the outcome variable repeat use intention that reflects the subjective probability that a care professional would continue to use the same technology with which he or she had firsthand experience. That said, we do not strive to explain the intention to use robots with yet another cluster of variables but widen the investigation with a principled approach to acceptance of robots. Possible principles underlying acceptance of robots are viewed as threefold: through instrumental, interpersonal, and ethical values.

Most technology acceptance models (TAMs) do not include motivational factors such as compatibility with moral or instrumental values, which lead to intention and behavior [22,23]. However, we expect that particularly moral evaluations of technology implementations in human-centered services significantly affect acceptance of robots. Virtue-ethical values of implementing new technology, in general, aim to assure people's privacy, distribution of welfare, and social inclusion [24]. Ethical values of nursing, then, include respectfulness, compassion, partnership, trustworthiness, competence, and safety [25,26]. Extending the previously suggested robot acceptance model by including a principled approach to the intention to use care robots, we propose a new robot acceptance model for care (RAM-care) to be used in academic and workplace studies with an aim to statistically model acceptance of care robots among employees.

2. Background

2.1. Acceptance of robots

Robot acceptance models are typically based on models developed for generic technology use. TAMs are applied to explain the intention to use and the actual use of a particular type of technology such as new information systems, automatons, and robots. Intention to use refers to behavioral intention as the measure of one's motive to perform a specified behavior or action [27 p. 288].

The systematic analysis of different TAMs, and emphasis on the differences between behavioral intention to use and the actual use of technology, led to the development of the unified theory of acceptance and use of technology (UTAUT) [28]. The UTAUT explains the actual use of and the intention to use technology by four core constructs—performance expectancy, effort expectancy, social influence, and facilitating conditions—and by moderators of weaker explanatory value (e.g., gender and experiences with technology) [28]. In the Almere model, the UTAUT was further developed to measure possible end users' (i.e., older adults) assistive social agent acceptance [29]. The Almere model explains the intention to use robots by factors of functional and social acceptance (Fig. 1), and in this model, intention to use is a strong predictor of the actual use of technology [29].

In the Almere model, social influence, attitude, perceived usefulness, perceived ease of use, perceived enjoyment, and trust have been found to predict intention to use [29,30]. Social influence is typically measured as a subjective perception of the opinions of important others [28] and understood here as parallel to interpersonal values [73]. Attitude is defined as the individual user's dispositional, positive or negative, feelings about performing the target behavior [27 p. 216], in this case, using care robots. Perceived usefulness has consistently been found to be a strong determinant of intention to use, whereas perceived ease of use has demonstrated a less consistent effect across technology acceptance studies [31,32]. Exceptionally high robot use self-efficacy (i.e., trust in one's ability to use robots in one's work) of Finnish nurses [33] confirmed that the ease of use is not one of the most critical factors influencing the intention to use new technology in a professional care context.

The Almere model is used as the base for the first hypothesis for a direct positive relation between the repeat intention to use care robots and favorable social influence (H1a), attitude toward use (H1b), perceived usefulness (H1c), perceived ease of use (H1d), perceived enjoyment (H1e), and trust (H1f) [29].

[FIG. 1 ABOUT HERE]

2.2. New model as an extension of the Almere model

The UTAUT is used to model technology acceptance in the workplace, but the theory is very general and does not consider a particular professional context [34]. By suggesting a new robot acceptance model for care, we believe that healthcare work has a distinct principled level affecting acceptance of robots. The constructs of intention to use, social influence, attitude, ease of use, perceived usefulness, perceived enjoyment, and trust stem from a model of robot acceptance [29]. As an expansion, we drafted a new model that includes a principled view of a technological change. We added perceived compatibility between the use of care robots and personal moral values and perceived technological unemployment caused by robots (Fig. 2).

[FIG. 2 ABOUT HERE]

Matters of principle play a part in ethical decision making when people have, for example, the opportunity to evaluate organizational changes [39 p. 1971, 40]. The principled mindset toward a technological change can be viewed as originating from the evaluation of justice. On the basis of the study by Cropanzano and colleagues, the causes of perceived workplace justice or injustice can be traced to instrumental, interpersonal, or ethical values. Instrumental values refer to self-interest (e.g., financial gains), interpersonal values refer to the thoughts of what is socially appropriate, and ethical values refer to the commitment to personal moral standards [73]. Interpersonal values are included in the Almere model as social influence that stands for subjective perception of the opinions of important others [28]. Thus, the additions to the new model are ethical values (i.e., compatibility between use of robots and personal moral values) and instrumental values (i.e., perceived technological unemployment caused by robots).

Perceived usefulness in TAMs refers to the functional value of using the technology, whereas personal moral values motivate change only if the change is compatible with existing values [37]. Steelman and Soror [38] state usefulness as an explanatory factor typically focuses on performance outcomes and less so on hedonic or affective values. Particularly in the service sector, people should carefully plan which tasks are suitable, safe, and appropriate for robotizing. The occupational ethics of nursing work emphasize this requirement. From this approach, measuring merely the usefulness of the technology falls short. Adding value-based consideration to the model acknowledges the distinctive nature of healthcare work compared to other less sensitive service work.

Personal moral values stem from virtue ethics: a humane worldview and moral acts promoting people’s well-being. Virtue ethics are written in, for example, the moral values of designing new technologies, which are safety, sustainability, distribution of welfare, universal usability, and trust [24,41]. Virtue ethics are also at the center of nursing ethics, which include respectfulness, compassion, partnership, trustworthiness, competence, and safety [25,26]. In artificial morality discussions, virtue-ethical values are viewed as a good starting point when coding ethical principles in a machine [41]. Although a robot is not genuinely capable of deliberating what is safe or unsafe, with programming, the robot can predict what a human would evaluate as such [41 p. 324].

An individual worldview defined as a view on life, the world, and humanity contains personal moral values of right and wrong and regulates thoughts and actions [35]. Values are considered socioculturally shaped, and even dictated, when it comes to laws and principles of certain fields of work. Ethical standards of nursing are principles that nurses are expected to commit to as individuals, and as a community [26 p. 6]. Changes in healthcare work can be seen as invariably reflected against these internalized moral principles, which, depending on perceived compatibility, either increase or decrease the enthusiasm to use new innovations [36].

Can virtue-ethically driven values and principles be supported by care robots? In the future, respectfulness may refer to the patient's or customer's right to choose robot care over human care or vice versa [42], but what about compassion and partnership? Compassion is considered to originate from human empathy, but it can merely be a performance. In some occupations, more than others, we are expected to express or suppress our emotions [43]. For example, nurses are required to signal their empathetic concern regardless of their genuine feelings [44]. Intelligent robots have the potential to present as compassion-simulating, ever-patient, and ever-friendly companions [45,46]. In a health coach robot study, an empathy-simulating robot was accepted as a friendly and trustworthy partner by users [47]. Trustworthiness, then, is a matter of consistency and reliability. Even though robots can be depreciated as truly compassionate actors, as reliability goes, the underlying assumption is that robots are expected to do exactly what and when they are told to do. Thus, the consistency of a robot's behavior has the potential to increase the feeling of safety in the healthcare context.

However, healthcare professionals may consider that robotization can lead to decreased quality of care. Some researchers have stressed the difficulty of implementing robots in care tasks because of the holistic nature of care work [48]. Healthcare professionals do have the right and the responsibility to define acceptable approaches in their areas of expertise, even in the midst of a technological change [49–51]. From the public perspective, to use care robots is to endorse them. The staff working at one of the first care facilities piloting the robot "Nao" in Finland received negative feedback from citizens, and instead of the management, the lower level staff had to justify the purchase and use of a care robot to the public [13].

In addition to ethical values, instrumental values may influence the acceptance of technology. Instrumental values of work include earning a living [52,53], and healthcare professionals sometimes view robotization as a threat to people's careers, income, or future employment [33]. Technological unemployment refers to changes in employment due to technical progress, such as new methods of production. The gradual integration of robots into service fields has brought technological unemployment back to public discussions. Most (72%) of the Eurobarometer respondents believed that robots would take people's jobs, and even a larger proportion (74%) thought that, because of robotization, more jobs would disappear than would be created [21]. Moreover, the fear of unemployment, in general, correlated with the fear of robots [54].

Deterministic views on technology state that advances in technology inevitably change societies and working life. However, more voluntaristic and dynamic views, such as Sabanovic's concept of mutual shaping of robotics and society, have been taking over [55]. Society shapes robots, and robotization shapes the society in a dynamic interaction [55]. As a counterview for technological determinism, social determinism states that technology is not considered inevitable but as rising from social needs [56 p. 15]. Again, the technologically determined view is that robots replace human work as artificial intelligence, and sensor technology reaches the required maturity levels, but according to social determinism, people have the means to decide which technology is actually usable in which context. However, in organizations, decision making is not always shared, and this raises questions about the mandatory use of technology as a source of cognitive dissonance—a conflict between an individual's beliefs and (expected) behavior. Compatibility with values represents an intrinsic motivation, without which people are expected to, for example, work in an environment that counters their own internal belief system [57]. An example of this cognitive dissonance [58] is a healthcare professional thinking that mandatory use of robots is not consistent with his or her personal values. Cognitive dissonance can also be viewed as a cause of technostress, which occurs when the worker is unable to adapt to using technology [59].

Overall, incompatibility with ethical or instrumental values can be a reason for rejecting new technology. In a study of information system acceptance, Karahanna et al. [60] found that compatibility with values predicted the perceived usefulness of technology, which again predicted the actual use of the technology. Following the innovation diffusion theory [36], however, the compatibility of personal values would directly explain the variation in the intention to use robots.

Thus, the competing hypotheses are as follows:

H2: Compatibility of personal moral values predicts a stronger intention to use care robots.

For example, this hypothesis would be true if those who feel that use of robots fits their worldview were more willing to use care robots than those who feel that the use of robots does not fit their worldview.

H3: Compatibility of personal moral values predicts the intention to use robots indirectly through perceived usefulness.

Viewing ethical and instrumental values from an experimental motivation psychology perspective, instrumental motives (e.g., financial) causally influence the virtue-ethical motives of right and wrong [52]. In addition, it is implied that the relation between values and behaviors is mediated by social influence [61,62].

Thus, we hypothesize the following:

H4: Perception of technological unemployment predicts lower compatibility between personal moral values and the use of care robots.

For example, this hypothesis would be supported if those who think robots are taking jobs from people assessed the use of robots as less fitting their values than those who do not think robots are taking people's jobs.

H5: Personal moral values predict a stronger intention to use robots indirectly through social influence.

3. Method

3.1. Participants

Data were collected from 544 healthcare, mostly nursing, professionals who reported firsthand experience with care robots in a larger survey of Finnish care workers (N = 3,800) between October and November 2016. The original random samples were collected in collaboration with two major trade unions in the field: the Union of Health and Social Care Professionals in Finland and the Finnish Union of Practical Nurses. Within an expected margin of error, the division between practical (64.9%) and registered (35.1%) nurses in the survey data complied with such a division of practical (64.7%) and registered (35.3%) nurses in the population [63]. The completion rate analysis did not note the differences in occupation or gender, but the respondents who dropped out were, on average, younger (M = 44.0 years) than those who completed the questionnaire (M = 47.3 years; $F(01) = 61.19$; $p < 0.001$).

In the subsample used in this study, participants were aged 19–70 years (M = 46.8; SD = 11.46), and 95.0% were native speakers of Finnish. Most were practical nurses (62.4%) or registered nurses (33.9%), while the rest (3.7%) were physiotherapists, instructors, and assistants. The most common places of work were an assisted living facility (53.8%), home care (17.0%), or a hospital (15.2%). A considerable portion of the participants (80.1%) worked with patients with dementia.

An online questionnaire included multiple-choice questions about personal and occupational details, experiences with care robots, and attitudes toward technology in general, and robots specifically. Participants who reported using a particular kind of care robot were directed to additional questions concerning this type, and only the type of robot with which they had experience. The four types of robots presented were 1) a telepresence robot (example picture of "Double"), 2) an entertaining or activating robot (example picture of the humanoid "Nao"), a therapy animal robot (example picture of "Paro seal"), and a patient-lifting robot (example pictures of "RIBA bear" and a robotized bed).

3.2. Measures

Each robot type reported to have been used opened up seven additional questions, including the dependent variable of the intention to use the robot in the future and its six explanatory variables from the Almere model: social influence, attitude, ease of use, perceived usefulness, perceived enjoyment, and trust [29]. Responses were given on a 5-point Likert scale ranging from *totally disagree* to *totally agree*, and after the scales were standardized, a higher reading indicated a more positive view of the robot. The reliability of the six explanatory variables of the original Almere model was highly acceptable ($\alpha = 0.939$).

Three statements of personal moral values were modified and translated by professionals into the Finnish language from the information system acceptance questionnaire validated by Karahanna et al. [60]. The response scale ranged from 1 (*totally agree*) to 5 (*totally disagree*). Thus, the composite variable ranged from 3.0 to 15 ($\alpha = 0.929$); a higher score indicated care robots' compatibility with personal moral values. The statements about the Almere model and personal moral values are presented in the Appendix.

To measure the perceived technological unemployment, we used a repeated and validated Special Eurobarometer [21] question about whether participants believed that "Robots steal people's jobs," with the response scale ranging from 1 (*totally disagree*) to 5 (*totally agree*). Interest in technology was used as a control variable. It was measured with a question modified from the Special Eurobarometer [21]: "Are you very interested (3), moderately interested (2), or not at all interested (1) in technology and its developments?"

3.3. Statistical analysis

Preliminary analysis included percentages, means, modes, standard deviations, and correlations measured with Spearman's rho (r_S). Differences between groups were tested with chi-square (χ^2) and t-tests.

To test the theoretical model, we found that the multidimensional construct of technology acceptance and values is best modeled as a multivariate structural equation model (SEM). SEM is an extension of regression analysis involving simultaneous regression models and rendering one variable to be a dependent and an independent variable. Because some of the measures were ordinal, a generalized SEM was applied. All of the variables were observed (none latent), and they are reported as unstandardized coefficients. The McFadden's pseudo-R-square indicates a good fit of generalized SEM if results are above 0.2. Using Stata 15 for the analysis, the pseudo-R-square was calculated using an additional ordinal logit model.

The model was based on a cross-sectional study design; however, causality between the dependent and independent variables has been theoretically supported [64]. Only direct paths to intention to use were taken from the Almere model [29] to prevent complexity in case of a small sample inadequate for a generalized SEM [64].

4. Results

Most of the participants had used only one type of care robot. A therapy animal was the single most recognized robot type and was familiar to 52% of the participants. A patient-lifting robot was familiar to 20%, a telepresence robot to 16%, and an entertaining or activating robot to 15% of the participants. The responses also indicated that these experiences originated from trials rather than everyday use. Of the participants, 68% had used a therapy animal once or twice and 32% had used one more than that. A similar distribution was found for telepresence robots (65% had used one once or twice) and entertaining or activating robots (64% had used one once or twice). Patient-lifting robots were statistically significantly more frequently used (46% had used one once or twice, and 54% had used one more than that; $\chi^2(1) = 4.41$, $p < 0.05$).

Table 1 presents the descriptive statistics of the intention to use separately between different robot types. The difference between the intention to use patient-lifting robots and therapy animal robots was statistically significant ($t = 6.02$, $p < 0.001$).

[TABLES 1 AND 2 ABOUT HERE]

Descriptions of all the variables are given in Table 2. Most of the participants (60.3%) found the use of care robots compatible with their personal moral values. The compatibility with values correlated with the intention to use telepresence robots ($r_S = 0.44$, $p < 0.001$), entertaining or activating robots ($r_S = 0.54$, $p < 0.001$), and therapy animal robots ($r_S = 0.37$, $p < 0.001$) but not patient-lifting robots ($r_S = 0.16$, $p = 0.115$).

Examining the original Almere variables, therapy animal and patient-lifting robots were perceived as the most useful types of care robots. Therapy animal robots were also evaluated as more enjoyable and easier to use than the other three robot types. Attitude correlated the most with the intention to use telepresence robots ($r_S = 0.63$, $p < 0.001$), patient-lifting robots ($r_S = 0.60$, $p < 0.001$), and therapy animal robots ($r_S = 0.68$, $p < 0.001$).

Differing from the rest, perceived enjoyment correlated the most with the intention to use entertaining or activating robots ($r_S = 0.73$, $p < 0.001$).

We analyzed the intention to use care robots in a generalized SEM with age, gender, and interest in technology-controlled care (Fig. 3). After the control variables were added, the model fitness deteriorated (the AIC from 5481.71 to 8692.47 and the BIC from 5555.99 to 9125.79) but did not alter the statistical significance of the relations in the model. The pseudo-R-square was 0.285. Thus, the RAM-care model explained approximately 30% of the variance in the intention to use care robots. The pseudo-R-square used in the generalized SEM was much more stringent than is expected of R-square statistics in linear models; hence, this was considered a very acceptable level of explanatory power.

[FIG. 3 ABOUT HERE]

5. Discussion

Because of the sensitivity and novelty, the intention to use robots in care may involve alternative, and even stronger, predictors than existing models of technology acceptance. In addition, previous robot acceptance models are general and do not consider particular professional contexts [34,35]. We consider healthcare a field with distinct, value-based characteristics and, therefore, in need of a unique model for explaining the intention to use robots. We proposed a model of robot acceptance RAM-care that, by an extension of established factors [29], has a principled approach to the intention to use robots. Acceptance of robots is explained by ethical, interpersonal, and instrumental values [73]. In this analysis, interpersonal values (i.e., social influence) predicted directly the intention to use care robots, while personal moral values along with instrumental values (i.e., perceived technological unemployment) emerged as otherwise notable factors in the acceptance of robots.

Hypothesis 1a–1f addressed direct explanatory factors of intention to use defined in the Almere robot acceptance model [29]. These hypotheses were partially supported by these data. The results confirm that social influence (H1a), attitude (H1b), perceived usefulness (H1c), and perceived enjoyment (H1e) predicted higher intention to use care robots. However, these data differed from the Almere model by not supporting the influence that trust (H1f) or ease of use (H1d) has on the intention to use robots. Two possible explanations are the specificity of care work and the level of technology maturity with which care workers have firsthand experience.

For the participants, the most familiar robot type was the plush therapy animal Paro. This and other robot types (e.g., the Nao humanoid and the telepresence robots) that participants reported being familiar with in these data do not appear particularly intimidating or difficult to use. Furthermore, their functionalities are limited, and the tasks these robots are designed for do not require high reliability and caution, which can explain why the influence of trust was not significant. Considering that the care robots of today are not complex, this study of care workers and robots adds to the previous findings that ease of use does not always predict the intention to use new technology, particularly in the healthcare context [31,32], or at least have predictive power similar to other explanatory factors [31,32,34]. We chose to present the ease of use and trust in the suggested RAM-care model even if they do not contribute statistically significantly in these data samples (Fig. 3).

We next hypothesized that the intention to use care robots depends on compatibility with personal values, or that the relation is mediated by perceived usefulness. Personal values did not directly predict the intention to use but predicted the perceived usefulness of the robot, which predicted the intention to use. Thus, H2 was rejected, while H3 was supported. This result is in line with Karahanna et al.'s [60] study where the relation between compatibility with values and technology use was mediated by the perceived usefulness. The result did not support the innovation diffusion theory's presumption of a direct relation between compatibility of personal values and the intention to use robots [36].

Results showed that the intention to use patient-lifting robots did not correlate with personal values, unlike the other robot types. Value assessments may have different underlying objectives, depending on the robot type. For example, patient-lifting robots may be viewed as more essential in terms of improving nursing work. They are instrument-like, and perhaps for that reason, their acceptance is less dependent on whether care workers find them compatible with their personal worldview. Of all the robot types, the intention to use entertaining or activating robots correlated the most with compatible personal values. These humanoid robots are typically used in older patients' physical, cognitive, and emotional stimulation. In this context, robots are not essential but can be viewed as supplementary to care work. Thus, the intention to use this kind of new technology is dependent on how the care worker thinks care robots fit into his or her worldview.

In support of H4, the less the participants felt that robots would cause technological unemployment, the more they felt that the use of robots would be compatible with their personal values. This relation emerged as the most statistically significant correlate in the model. This relation implies that in addition to personal and interpersonal ethical values, instrumental values such as earning a living affect the way people are willing to see robots in care [73]. Brynjolfsson and McAfee [65] view technological unemployment as a matter of supply and demand and believe education policy should drive the reduction of practical nurses and increase the supply of registered nurses. The authors argue that once professionals receive advanced education and robots do the physically demanding work, more people will see and understand the values of robotization. This, of course, comes across as a technologically deterministic prediction of the future, as well as a very limited view on the motives for approving of or declining robotic assistance. In another perspective, Stahl and Coeckelbergh [74] suggest development where education would be reformed by taking into account the ethical and social concerns of robotization.

The compatibility between use of care robots and personal moral values was significantly associated with views on technological unemployment caused by robots. In this study, the fear of technological unemployment is understood as an instrumental value where the fear stems from uncertainty about career and income and results in lower acceptance of robots. In addition to financial aspects, people also strive to maintain their occupational identity (i.e., who you are and wish to become as a professional). If one's occupational identity is strongly connected to the idea of being a multiskilled trustworthy nurse, robotizing even a part of that job might be too controversial of an idea. The core of nursing ethics includes positive and safe interaction between a nurse and a patient [25], and any work-related changes are reflected against these occupational standards and principles. The present results are in line with previous findings that decision making in nursing work is considerably influenced by identity, including professional and personal values, and shaped by social influence [75].

In support of H5 and previous motivation studies [61,62], compatibility between personal values and robot use predicted the intention to use robots through social influence. First, the participants who found their worldview compatible with using robots in care thought more likely that care robots are approved in the workplace in general. Second, the participants who thought care robots are approved in their workplace and found care robot use to be compatible with their own personal values had higher intention to use care robots in the future. Again, personal values did not predict the intention to use robots directly, but the interaction between compatible personal values and compatible interpersonal values toward use of care robots leads most likely to higher repeat use intention.

After rejecting the hypothesis that personal values predict the intention to use robots, the direct link between them was excluded from the suggested model (Fig. 3). It may be challenging for care workers to consider their personal values and potential future use of robots because the development of care robots is in such an early stage. Therefore, it is easier to compare personal values with perceived usefulness and interpersonal values about robotization. Most of the participants had used a care robot once or twice at work. If robots gained more ground in everyday care work, users would perhaps have more of a perspective to approve of or reject the use of robots. Then the intention to use might also be more significantly explained by personal values.

Intention to use the same robot type again was relatively high among all robot types. Robot assistance can be appealing if it holds a promise of allowing nurses more time to interact with patients [25,26]. Intention was lowest regarding entertaining or activating robots. Melkas et al. [13] found that using the humanoid robot “Nao” in a care home can be perceived as laborious and time-consuming by nurses. An entertaining robot can also be perceived as demeaning because of its toy likeness, and when used in rehabilitation, the robot can be viewed as reducing human contact [42]. Patient-lifting robots were used more regularly than the other robot types, and respondents who had firsthand experience with these robots reported the highest repeat use intention. This result may indicate the physical demands of care work and how new technology is welcomed to assist with this [66]. Sharkey and Sharkey [42], however, questioned the objectification of patients when using such technology. Objectification is more distinct in scenarios where an autonomous robot is assisting a patient without any care personnel present. Patient-lifting robots are perhaps acceptable only when robots are not autonomous.

Although new technologies often create tensions concerning prevailing norms, the technologies also present opportunities for developing new practices [67]. First, the present study results show that the occupational context is important when a new technology is implemented. Second, the results imply the advantages of including employees in organizational robotization plans. Participating staff is engaged not only as a democratic management strategy but also to enrich assessment and decision making [68]. Nurses have opinions on, for example, which tasks they see robot assistance is suitable for [67,70]. Personal moral values along with instrumental values are important motivational factors [23], and if the objective is retaining committed employees in an understaffed field of work, it is best to consider potential contradictions between employees’ values and technological implementations, or any other organizational changes [57]. Incompatible values at work are found to be an even more substantial stressor than the perceived workload [70].

When using a robot as a part of the job is not consistent with an employee’s own view of the world, he or she may experience cognitive dissonance [58]. The outcome of this inner conflict is twofold when the individual is striving to reduce the discomfort of the dissonance. The first mental option is to change one’s behavior, in this case to use the robot or to stop using the robot. This behavior outcome is not always possible because use of the robot may be a mandatory part of performing the job. The second option is to change one’s cognitive assessment, in this case reevaluate the compatibility between values and use of robots. Individuals experiencing the most cognitive dissonance have the greatest motivation to relieve the dissonance by adjusting their attitude [71]. To find justification for robotization, an individual might be drawn to adjust his or her value-based evaluations by viewing the change as creating opportunities, rather than threats (instrumental values), and as supporting the principles the individual is committed to in life and work (personal and interpersonal values).

Although we measured the intention to use robots, we do not propose that the ideal situation is an unconditional acceptance of robots. On the contrary, we strived to demonstrate how value-based consideration is important when implementing robots in new contexts. If the rejection of the use of robots is explained by deeper motivational mechanisms, such as basic principles in life, there is not much sense in dealing with this variance by setting up the mandatory use of robots covering the whole staff. We propose that robotization be managed with the knowledge and consideration that individual differences in accepting robots at work may also have an essential principled side.

In addition to ensuring the role of personal values in technological changes, we must consider how new technology influences the norms in our society. If we do not want to commit to the “values first principle” [76] in which autonomous robots perform only tasks humans are incapable of doing, we must dilute contemporary ethical standards, such as respectfulness, compassion, and partnership, between a nurse and a patient.

5.1. Limitations

The collected survey data suggest that instrumental, interpersonal, and ethical values have a part in the acceptance of care robots. However, the results also raise further questions for investigation. A follow-up study is needed to identify the contents of the care workers’ values which are compatible or not compatible with the intention to use robots. Sharkey and Sharkey [42] expressed concern about the ethics of using care robots in care for the aged specifically. These concerns included potential reduction of human contact, feelings of objectification, loss of privacy, deception, and infantilization [42].

As a limitation of the study, we did not categorize the participants based on the voluntariness of their use of robots or consider the breadth of technology use as an explanatory factor. The sample size did not allow us to apply a generalized SEM to each robot type separately. The preliminary correlative analysis, however, showed the relevance of the type of robot in the acceptance of care robots.

These data are representative of care workers to a certain extent, as the subsample is based on a large, random sample of Finnish care workers. The fact that the sample includes Finnish-speaking nurses confines the generalization of the results. Attitudes toward robots at the population level differ considerably even among countries of the European Union [21]. Moreover, care work culture and technology use differ between countries, and some of this variance may also be associated with employees' ethnic background. However, the model RAM-care is not restricted to specific cultures or even professional care work but should be tested with other end users as well, such as informal caregivers and care receivers from different cultural backgrounds. A recent study, for example, showed that employees in cultures with higher power distance and masculinity values than those in Finland are more likely to experience technostress [72]. Without comparative studies, we are not able to say, for example, whether the high intention to use care robots is distinctive to Finnish care workers, who have substantial professional autonomy and relatively downplayed hierarchy [77].

5.2. Conclusion

Implementing robots and other advanced information systems in new fields of work requires an in-depth understanding of the factors associated with technology acceptance among groups of professionals. A new model, RAM-care, is proposed to measure the acceptance of care robots. The intention to use robots is traditionally explained by functional and social factors stemming from TAMs. In addition, we emphasize context-dependent value-based principles behind the acceptance of robots.

In the model, personal moral values predict intention to use, not directly but through social influence and perceived usefulness. Dispositional attitude and perceived enjoyment were the most significant predictors of the intention to use robots, but two original factors from the robot acceptance model, namely, ease of use and trustworthiness, did not reach statistical significance. In total, the RAM-care model explained approximately 30% of the variance in repeat intention to use care robots. Arguably, the predictive power of RAM-care will increase with developments in robotics and artificial intelligence. First, more complex robots will require more expertise from their users, and second, more autonomous robots are likely to test people's trust more than the currently available automatons.

CONFLICT OF INTEREST:

Tuuli Turja declares that she has no conflict of interest.

Iina Aaltonen declares that she has no conflict of interest.

Sakari Taipale declares that he has no conflict of interest.

Atte Oksanen declares that he has no conflict of interest.

References

[1] European Commission, Horizon/2020, Robotics. http://ec.europa.eu/programmes/horizon2020/en/h2020-section/robotics, 2016 (accessed 25 May 2018).
[2] D. Huber, M. Hebert, National robotics initiative, PI Meeting Report. http://nri2015.ri.cmu.edu/wp-content/uploads/2016/02/2015-NRI-workshop-report.pdf, 2015 (accessed 26 September 2016).
[3] RRI Council, Action Plan for FY. https://www.jmfrri.gr.jp/content/files/20150925_plan_eng.pdf, 2015 (accessed 26 September 2016).
[4] M. Baer, M. Tilliette, A. Jeleff, A. Ozguler, T. Loeb, Assisting older people: From robots to drones, Gerontechnology 13 (2014) 57–58.
[5] T. Sorell, H. Draper, Robot carers, ethics, and older people, Ethics Inf. Technol. 16 (2014) 183–195.
[6] ISO 8373, Robots and robotic devices—Vocabulary, International Organization for Standardization. http://www.iso.org/iso/home/store/catalogue_ics/catalogue_detail_ics.htm?ics1=25&ics2=040&ics3=30&csnumber=55890, 2012 (accessed 25 May 2018).
[7] F. Alaieri, A. Vellino, Ethical decision making in robots: Autonomy, trust and responsibility, in: A. Agah, J.J. Cabibihan, A.M. Howard, M.A. Salichs, H. He (Eds.), Proceedings of 8th International Conference of Social Robotics, Springer, Kansas City USA, 2006.
[8] J.A. Cervantes, L.F. Rodríguez, S. López, F. Ramos, F. Robles, Autonomous agents and ethical decision-making, Cogn. Comput. 8 (2016) 278–296.
[9] S. Koceski, N. Koceska, Evaluation of an assistive telepresence robot for elderly healthcare, J. Med. Syst. 40 (2016) 121. https://doi.org/10.1007/s10916-016-0481-x.
[10] C.I. Schulman, A. Marttos, J. Graygo, P. Rothenberg, G. Alonso, S. Gibson, J. Augenstein, E. Kelly, Usability of telepresence in a level 1 trauma center, Telemed. J. e-Health 19 (2013) 248–251. https://doi.org/10.1089/tmj.2012.0102.
[11] M. Niemelä, L. Van Aerschot, A. Tammela. I. Aaltonen, A telepresence robot in residential care: Family increasingly present, personnel worried about privacy, in: A. Kheddar, E. Yoshida, S. S. Ge, K. Suzuki, J.-J. Cabibihan, F. Eyssel (Eds), Proceedings of International Conference on Social Robotics, Tsukuba Japan, Springer, 2017, pp. 85–94.
[12] D.O. Johnson, R.H. Cuijpers, K. Pollmann, A.A.J. van de Ven, Exploring the entertainment value of playing games with a humanoid robot, Int. J. Soc. Robot 8 (2016) 247–269.
[13] H. Melkas, L. Hennala, S. Pekkarinen, V. Kyrki, Human impact assessment of robot implementation in Finnish elderly care, in Proceedings of International Conference of Serviceology, 2016, pp. 202–206.
[14] T. Mukai, S. Hirano, H. Nakashima, Y. Kato, Y. Sakaida, S. Guo, S. Hosoe, Development of a nursing-care assistant robot RIBA that can lift a human in its arms, in Intelligent Robots and Systems (IROS), IEEE/RSJ International Conference, 2010, pp. 5996–6001.
[15] M. Niemelä, M. Ylikauppila, H. Talja, Long-term use of Paro the therapy robot seal: The caregiver perspective, in 10th World Conference of Gerontechnology, 2016.
[16] K. Wada, T. Shibata, Social and physiological influences of living with seal robots in an elderly care house for two months, Gerontechnology 7 (2008) 235.
[17] K. Beedholm, K. Frederiksen, A.M. Skovsgaard Frederiksen, K. Lomborg, Attitudes to a robot bathtub in Danish elder care: A hermeneutic interview study, Nurs. Health Sci. 17 (2015) 280–286. https://doi.org/10.1111/nhs.12184.
[18] A. Carnevale, Will robots know us better than we know ourselves?, Rob. Auton. Syst. 86 (2017) 144–151.
[19] B. Hofmann, Ethical challenges with welfare technology: A review of the literature, Sci. Eng. Ethics 19 (2013) 389–406. https://doi.org/10.1007/s11948-011-9348-1.
[20] J. Parviainen, J. Pirhonen, Vulnerable bodies in human–robot interactions: Embodiment as ethical issue in robot care for the elderly, Transformations 29 (2017) 104–115.
[21] Special Eurobarometer 460, Attitudes towards the impact of digitalisation and automation on daily life, https://publications.europa.eu/en/publication-detail/-/publication/89e6e8e4-6777-11e7-b2f2-01aa75ed71a1, 2017 (accessed September 24, 2018).
[22] R.J. Holden, B.T. Karsh, The technology acceptance model: Its past and its future in health care, J. Biomed. Inform. 43 (2010) 159–172.
[23] J.L. Szalma, On the application of motivation theory to human factors/Ergonomics motivational design principles for human–technology interaction, Hum. Factors 56 (2014) 1453–1471. https://doi.org/10.1177/0018720814553471.
[24] J.W. Schot, A. Rip, The past and future of constructive technology assessment, Technol. Forecast Soc. Change 54 (1997) 251–268.

[25] NMC, The code, Professional standards of practice and behaviour for nurses and midwives. https://www.nmc.org.uk/globalassets/sitedocuments/nmc-publications/nmc-code.pdf, 2015 (accessed January 2018).
[26] M. Benjamin, J. Curtis, Ethics in Nursing, third ed., Oxford University Press, New York, 1992.
[27] M. Fishbein, I. Ajzen, Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research, Addison-Wesley, Reading, 1975.
[28] V. Venkatesh, M.G. Morris, G.B. Davis, F.D. Davis, User acceptance of information technology: Toward a unified view, MIS Q. 27 (2003) 425–478.
[29] M. Heerink, B. Kröse, V. Evers, B. Wielinga, Assessing acceptance of assistive social agent technology by older adults: The Almere model, Int. J. Soc. Robot 2 (2010) 361–375. https://doi.org/10.1007/s12369-010-0068-5.
[30] N. Ezer, A.D. Fisk, W.A. Rogers, Attitudinal and intentional acceptance of domestic robots by younger and older adults, in C. Stephanidis (Ed.), Universal Access in Human-Computer Interaction. Intelligent and Ubiquitous Interaction Environments. Lecture Notes in Computer Science, Vol. 5615, Springer, Berlin, 2009, pp. 39–48. https://doi.org/10.1007/978-3-642-02710-9_5.
[31] V. Venkatesh, F.D. Davis, A theoretical extension of the technology acceptance model: Four longitudinal field studies, Manag. Sci. 46 (2) (2000)186–204. https://doi.org/10.1287/mnsc.46.2.186.11926
[32] L.D. Chen, A model of consumer acceptance of mobile payment, Int. J. Mobile Commun. 6 (2008) 32–52.
[33] T. Turja, S. Taipale, M. Kaakinen, A. Oksanen, Care workers’ readiness for robotization: Identifying psychological and socio-demographic determinants, Int. J. Soc. Robot. https://doi.org/10.1007/s12369-019-00544-9.
[34] P.Y.K. Chau, P.J.H. Hu, Investigating healthcare professionals’ decisions to accept telemedicine technology: An empirical test of competing theories, Inf. Manag. 39 (2002) 97–311. https://doi.org/10.1016/S0378-7206(01)00098-2.
[35] J.W. Sire, Naming the Elephant: Worldview as a Concept, InterVarsity Press, Downers Grove, 2004.
[36] E.M. Rogers, Diffusion of Innovations, The Free Press, New York, 1983.
[37] N.T. Feather, Values, valences, and choice: The influences of values on the perceived attractiveness and choice of alternatives, J. Pers. Soc. Psychol. 68 (1995) 1135.
[38] Z.R. Steelman, A.A. Soror, Why do you keep doing that? The biasing effects of mental states on IT continued usage intentions, Comp. Hum. Behav. 73 (2017) 209–223.
[39] M.G. Edwards, D.A. Webb, S. Chappell, N. Kirkham, M.C. Gentile, Voicing possibilities: A performative approach to the theory and practice of ethics in a globalised world, in Leadership and Personnel Management: Concepts, Methodologies, Tools, and Applications, IGI Global, Hershey PA,2016, pp. 1955–1981.
[40] W. Wallach, C. Allen, I. Smit, Machine morality: Bottom-up and top-down approaches for modelling human moral faculties, AI Soc. 22 (2008) 565–582.
[41] A. Laitinen, What principles for moral machines? Envisioning robots in society–power, politics, and public space, Proc. Robophilosophy (2018) 311–319.
[42] A. Sharkey, N. Sharkey, Granny and the robots: Ethical issues in robot care for the elderly, Ethics Inf. Technol. 14 (2012) 27–40. https://doi.org/10.1007/s10676-010-9234-6.
[43] D. Holman, P. Totterdell, K. Niven, Emotional labor at the unit-level, in: A.A. Grandey, J.M. Diefendorff, D.E. Rupp (Eds.), Emotional Labor in the 21st Century, Routledge, New York, 2013, pp. 121–144.
[44] A.C.H. McQueen, Emotional intelligence in nursing work, J. Adv. Nurs. 47 (2004) 101–108.
[45] L. Damiano, P. Dumouchel, H. Lehmann, Towards human-robot affective co-evolution overcoming oppositions in constructing emotions and empathy, Int. J. Soc. Robot 7 (2014) 7–18. https://doi.org/10.1007/s12369-014-0258-7
[46] B.C. Stahl, N. McBride, K. Wakunuma, C. Flick, The empathic care robot: A prototype of responsible research and innovation, Technol. Forecast Soc. Change 84 (2014) 74–85.
[47] T. Bickmore, L. Caruso, K. Clough-Gorr, Acceptance and usability of a relational agent interface by urban older adults, in: Proceedings in the Conference on Human Factors in Computing Systems, Portland USA, 2005.
[48] A. van Wynsberghe, Designing robots for care: Care-centered value-sensitive design, Sci. Eng. Ethics 19 (2013) 407–433. https://doi.org/10.1007/s11948-011-9343-6.
[49] A. Abbott, The System of Professions, University of Chicago Press, Chicago, 1988.
[50] D. Badcott, Professional values in community and public health pharmacy, Med. Health Care Philos. 14 (2011) 187–194.

[51] C. Gallegos, C. Sortedahl, An exploration of professional values held by nurses at a large freestanding pediatric hospital, Pediatric Nurs. 41 (2015) 187.
[52] C. Christensen, The Innovator's Dilemma, Harvard Business School Press, Cambridge, 2000.
[53] K. Toode, P. Routasalo, M. Helminen, T. Suominen, Hospital nurses' work motivation, Scand. J. Caring Sci. 29 (2015) 248–257. https://doi.org/10.1111/scs.12155.
[54] P.K. McClure, "You're fired," says the robot: The rise of automation in the workplace, technophobes, and fears of unemployment, Soc. Sci. Comput. Rev. 36 (2018) 139–156.
[55] S. Sabanovic, Robots in society, society in robots. Mutual shaping of society and technology as a framework for social robot design, Int. J. Soc. Robot 2 (2010) 439–450. https://doi.org/10.1007/s12369-010-0066-7
[56] L. Green, Technoculture: From Alphabet to Cybersex. New South Wales, Allen & Unwin, 2002.
[57] R.J. Vallerand, Toward a hierarchical model of intrinsic and extrinsic motivation, Adv. Exp. Soc. Psychol. 29 (1997) 271–360.
[58] L. Festinger, A Theory of Cognitive Dissonance, Stanford University Press, Stanford, 1957.
[59] M. Tarafdar, Q. Tu, B.S. Ragu-Nathan, T.S. Ragu-Nathan, The impact of technostress on role stress and productivity, J. Manag. Inf. Syst. 24 (2007) 301–328.
[60] E. Karahanna, R. Agarwal, C.M. Angst, Reconceptualizing compatibility beliefs in technology acceptance research, MIS Q. 30 (2006) 781–804.
[61] A. Bardi, S.H. Schwartz, Values and behavior: Strength and structure of relations, Pers. Soc. Psychol. Bull. 29 (2003) 1207–1220.
[62] Y. Shoda, A unified framework for the study of behavioral consistency: Bridging person × situation interaction and the consistency paradox, Eur. J. Pers. 13 (1999) 361–387.
[63] A. Virtanen, Health care and social welfare personnel, National Institute for Health and Welfare. http://www.julkari.fi/bitstream/handle/10024/135915/TR_01_18.pdf?sequence=1, 2016 (accessed 19 March 2018).
[64] R.B. Kline, Principles and Practice of Structural Equation Modeling, Guilford Press, New York, 2011.
[65] E. Brynjolfsson, A. McAfee, The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies, WW Norton & Company, New York, 2014.
[66] T. Turja, L. Van Aerschot, T. Särkikoski, A. Oksanen, Finnish healthcare professionals' attitudes toward robots: Reflections on a population sample, Nurs. Open (2018). https://doi.org/10.1002/nop2.138.
[67] D. Stemerding, T. Swierstra, M. Boenink, Exploring the interaction between technology and morality in the field of genetic susceptibility testing: A scenario study, Futures 42 (2010) 1133–1145.
[68] G. Rowe, L.J. Frewer, Evaluating public-participation exercises: A research agenda, Sci. Technol. Hum. Values 29 (2004) 512–557.
[69] A. Alaiad, L.N. Zhou, The determinants of home healthcare robots adoption: An empirical investigation, Int. J. Med. Inf. 83 (2014) 825–840. https://doi.org/10.1016/j.ijmedinf.2014.07.003.
[70] M. Leiter, C. Maslach, Nurse turnover: The mediating role of burnout, J. Nurs. Manag. 17(2009) 331–339. https://doi.org/10.1007/s10916-016-0481-1111/j.1365-2834.2009.01004.x.
[71] A.J. Elliot, P.G. Devine, On the motivational nature of cognitive dissonance: Dissonance as psychological discomfort, J. Pers. Soc. Psychol. 67 (2009) 382–394.
[72] S. Krishnan, Personality and espoused cultural differences in technostress creators, Comp. Hum. Behav. 66 (2017) 154–167.
[73] R. Cropanzano, D.E. Rupp, C.J. Mohler, M. Schminke, Three roads to organizational justice, in: J. Ferris (Ed.), Research in Personnel and Human Resources Management, Vol. 20, Anonymous Emerald Group Publishing, Greenwich, CT, 2001, pp. 1–113.

[74] F. Kalengayi, A-K Hurtig, C. Ahlm, BM Ahlberg, "It is a challenge to do it the right way": An interpretive description of caregivers' experiences in caring for migrant patients in Northern Sweden, BMC Health Serv. Res. 12 (2012) 433.
[75] B.C. Stahl, M. Coeckelbergh, Ethics of healthcare robotics: Towards responsible research and innovation. Robot. Auton. Syst. 86 (2016) 152–161.
[76] V.J. O'Keeffe, K.R. Thompson, M.R. Tuckey, V.L. Blewett, Putting safety in the frame: Nurses' sensemaking at work, Global Qualit. Nurs. Res. 2 (2015). https://doi.org/10.1177/2333393615592390..
[77] J. Seibt, M.F. Damholdt, C. Vestergaard, Five principles of integrative social robotics. Envisioning robots in society–power, politics, and public space, Proc. Robophilosophy (2018) 28–42.
[78] A. Olakivi, Unmasking the enterprising nurse: Migrant care workers and the discursive mobilisation of productive professionals, Sociol. Health Illn. 39 (2017) 428–442. https://doi.org/10.1111/1467-9566.12493.

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Table 1

Intention to use the robot types (scale, 1–5).

	n	Mean	Mode	Std. deviation
Intention to use a telepresence robot	93	3.69	4	1.02
Intention to use a therapy animal robot	239	3.96	4	1.10
Intention to use a patient-lifting robot	100	4.37	5	0.75
Intention to use an entertaining or activating robot	112	3.66	4	1.10
Total	544	3.93	4	1.10

Table 2

Descriptions of the variables in the analysis.

Variables	Mean	Std. deviation	Range	%
Intention to use robots	3.93	1.10	1–5	
Robots’ compatibility with personal moral values	8.46	3.55	3–15	
Perceived technology unemployment	3.14	1.13	1–5	
Social influence	2.81	0.90	1–5	
Attitude	3.89	1.06	1–5	
Ease of use	3.71	1.13	1–5	
Perceived usefulness	3.51	1.13	1–5	
Perceived enjoyment	3.42	1.01	1–5	
Trust	3.26	1.08	1–5	
Gender				
Female				94.1
Male				5.9
Interest in technology				
Very				23.8
Moderate				70.3
Not at all				5.9

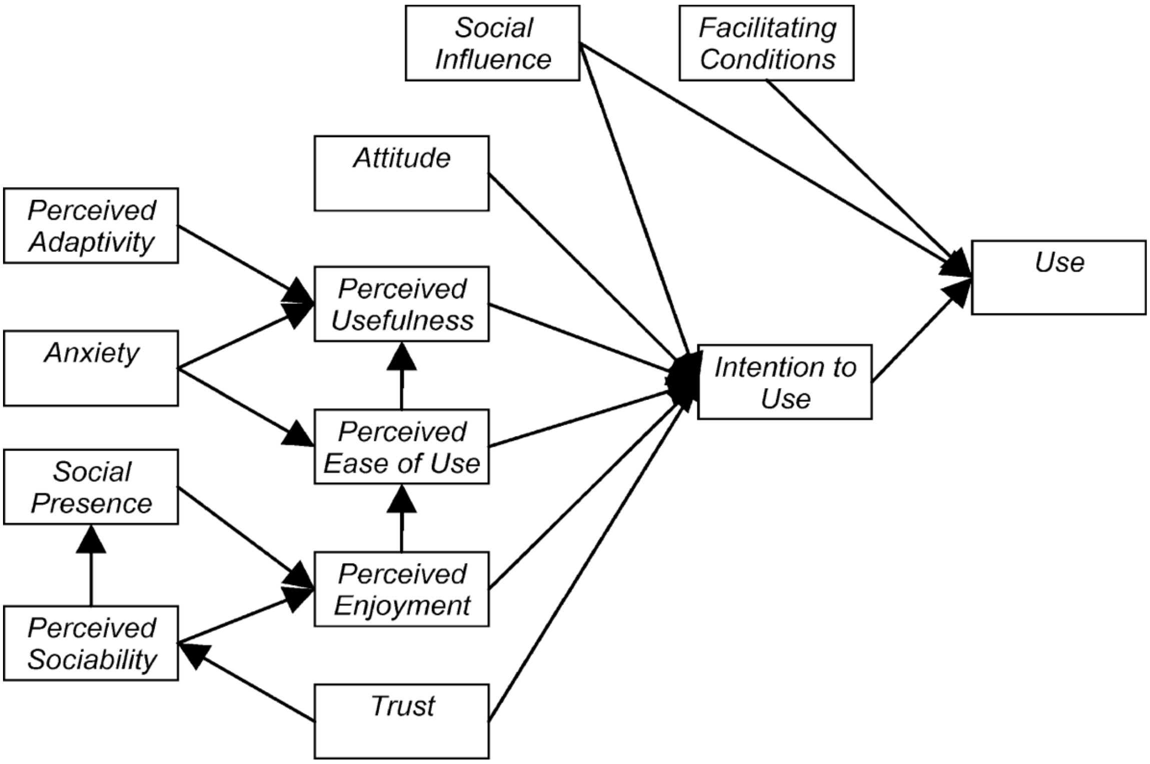

Fig. 1. The Almere model of robot acceptance among older adults [29].

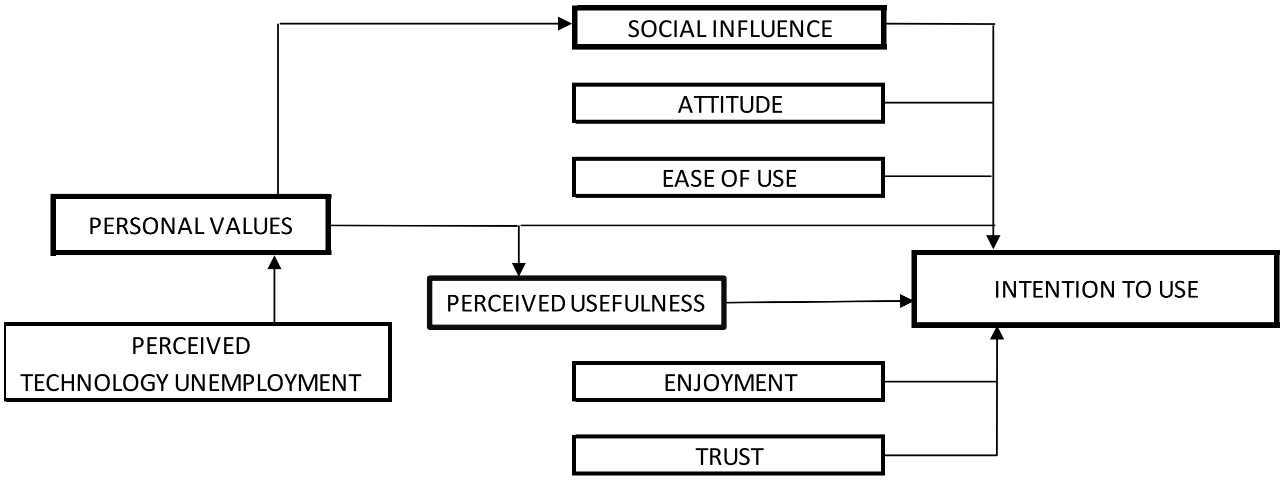

Fig. 2. Draft model of care robot acceptance.

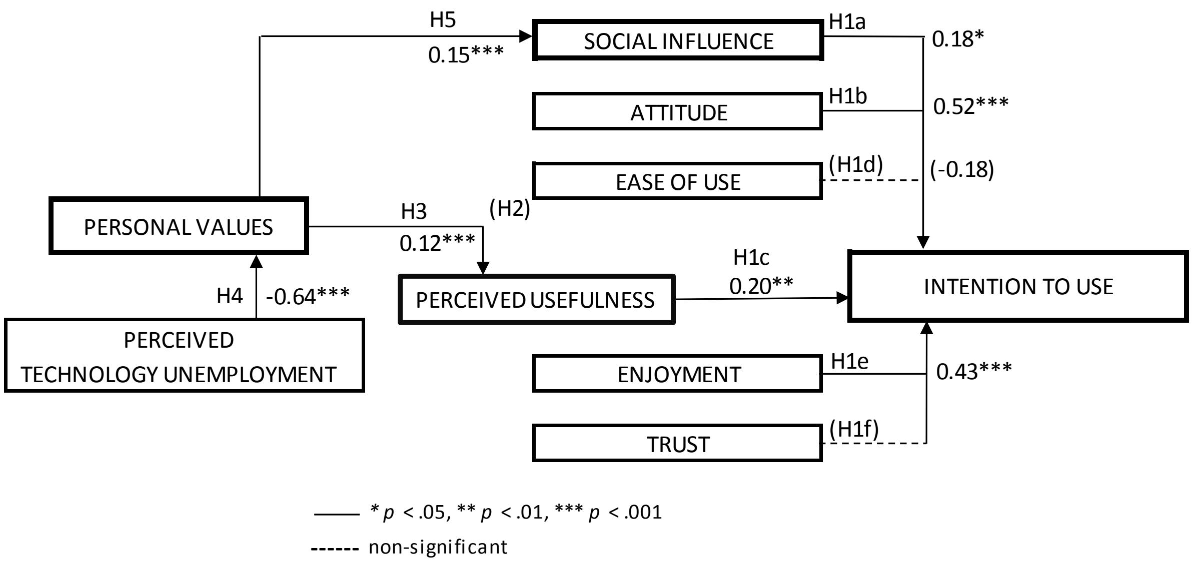

Fig. 3. RAM-care model: Coefficients reported in cases of statistically significant results; the direct path from personal values to intention to use removed from the model.

Appendix

Variable	Items
Intention to use robots	○ If the telepresence robot were available, I would use it. ○ If the robot used for entertaining or activating were available, I would use it. ○ If the therapy animal robot were available, I would use it. ○ If the patient-lifting robot were available, I would use it.
Attitude	○ I think it's a good idea to use the telepresence robot. ○ I think it's a good idea to use the entertaining or activating robot. ○ I think it's a good idea to use the therapy animal robot. ○ I think it's a good idea to use the patient-lifting robot.
Ease of use	○ I think I can use the telepresence robot without any help. ○ I think I can use the entertaining or activating robot without any help. ○ I think I can use the therapy animal robot without any help. ○ I think I can use the patient-lifting robot without any help.
Perceived usefulness	○ I think the telepresence robot is useful in my job. ○ I think the entertaining/activating robot is useful in my job. ○ I think the therapy animal robot is useful in my job. ○ I think the patient-lifting robot is useful in my job.
Perceived enjoyment	○ I enjoy doing things with the telepresence robot. ○ I enjoy doing things with the entertaining or activating robot. ○ I enjoy doing things with the therapy animal robot. ○ I enjoy doing things with the patient-lifting robot.
Trust	○ I would not trust that the telepresence robot is safe. ○ I would not trust that the entertaining or activating robot is safe. ○ I would not trust that the therapy animal robot is safe. ○ I would not trust that the patient-lifting robot is safe.
Social influence	○ Using care robots is mainly considered a positive thing among my colleagues.
Robots' compatibility with personal values	○ Using care robots runs counter to my own values. ○ Using care robots does not fit the way I view the world. ○ Using care robots is not appropriate for a person with my values when thinking about the role of robots.