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Can care robots solve the shortage in nursing personal – an acceptance analysis

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Abstract:

The shortage of skilled labour leads to noticeable losses in the quality of care in Germany. The Federal Government wants to promote the mobility of international skilled workers with a current program. A different approach could be the introduction of care robots, which can relieve the professionals of onerous tasks, so that they can concentrate on their core tasks.

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1 Introduction

German health care and the health care system have changed and evolved over the past few decades as a result of numerous health care reforms. Hospitals have become more important for medical care, which manifests itself in rapidly increasing numbers of cases (Federal Agency for Civic Education 2012). In 2016, 19.5 million cases were recorded, around 35 % more than in 1991 (Federal Office of Statistics 2016). One reason for this is the demographic development in Germany. Life expectancy continues to rise, and the birth rate stagnates, leading to an increase in the old-age dependency ratio from 23.6 % in 2000 to 34.7 % in 2015. The forecast for the proportion of over-60s for the year 2030 is 52.3 % (Federal Office of Statistics 2018). In contrast to the increase in the number of cases, the number of hospitals has decreased. The number of beds set up in 2016 has decreased by about 25 % compared to 1991. The average length of stay has almost halved during this period (Federal Office of Statistics 2016). These facts mean that Germany already suffers from a shortage of nurses. Forecasts for the year 2030 point to a shortage of approximately 360,000 full-time nurses, assuming a stable full-time and part-time employment rate, retirement age and annual working time (PricewaterhouseCoopers 2012). Due to the same developments, care robots are already being used in hospitals in Japan to support the nursing staff and to compensate for the shortage of skilled workers. There are also few pilot studies in Germany that test and evaluate the use of these new technologies. Previous studies on the acceptance of robots by potential users are only available in the home environment and in nursing homes. For this reason, in this study the acceptance in the hospital context is investigated via a survey. From the research question “To what extend is the acceptance regarding the use of hospital robots in the hospital by residents of a residential community aged 60 years and above?” the first hypothesis emerges: “Acceptance regarding the use of care robots in the hospital by the residents of a residential community under 60 years is low or absent”. The second question “What is the difference in the level of acceptance between the various activities performed by a caring robot?” is also answered. Before the results are presented, a closer look is taken at the state of research.

2 Robots in Hospitals

Used in the industry for many years, they are now also spreading in the healthcare sector. In large hospitals today, precise medical robots are already being used as surgical assistants and transport robots transporting laundry, disposal material or food. However, most nursing robots that have been used in practice are only prototypes so far. In the next few years, however, these will be available for use, according to the Fraunhofer Institute for Production Technology and Automation (Fraun-

hofer IPA 2018). For this purpose, a joint project of the Fraunhofer IPA, the Institute of Sociology of the University of Duisburg-Essen and three other actors for the investigation of needs-based development of service robotics in the care sector was funded by the Federal Ministry of Education and Research (BMBF) (University of Duisburg-Essen 2014).

2.1 Pioneer Japan

In Japan, the demographic change compared to Germany is already well advanced, because Japan is the fastest-aging industrial nation worldwide. As of 2015, the birth rate is one of the lowest in the world at 1.4 children per woman, life expectancy at birth is 80.8 for men and 87.0 years for women (Federal Office of Statistics 2017).

As a result of these developments, Japan is expected to lose around 400,000 nurses by 2020, with the government responding, among other things, to robotic reinforcement (Nicolaysen 2014). In Asia, $ 587 million were spent on the robotics market in 2015, nearly twice as much as in 2014. About 61 % of Asian robot entities are owned by Japan and China (PricewaterhouseCoopers 2016). The reason for this is that Japan has a different understanding of technology compared to Germany. The technology helped Japan to change, to prosper and to modernise the country. Since the 1970s, Japan has had the worlds most industrial robots and is a leader in robotics (Schodt 1988). In the field of care robots, some models are already being used and accepted by people in Japan, e.g. the robotic seal Paro, the humanoid robots Pepper, and Paro for entertainment or as a means, which allows better access to the people. The nursing robot RIBA has also been used since 2015 to mobilise people. The robots, however, are an aid and relief, not a substitute, but can make the nursing profession more attractive in the future (Nikolaysen 2014).

2.2 Care robots

Nursing robots are machines that support or replace humans. They are learning and intelligent systems, some even have natural-language abilities. Their tasks are e.g. the bringing and serving of food and medicines, helping to lay down or straighten up or alert the emergency service (Bendel 2018). Nursing robots are to be classified in medical and service robots, since they can take on both medical tasks of care as well as customer service. They can be distinguished in assistance and companion robots. The former support the caregivers, the latter are also called social interactive robots and serve the patient as a companion (Triner et al. 2015). In the following, four models are presented, which are relevant for this work and about which the study participants were interviewed.

2.3 Nursing robot RIBA

The Robot for Interactive Body Assistance, abbreviated to RIBA, was developed by the RIKEN-TRI Collaboration Center for Human-Interactive Robot Research (RTC), launched in 2007, and has since been steadily improved. RIBA is 140 cm tall, weighs 180 kg and resembles a friendly teddy bear in appearance to increase patient acceptance. RIBA can lift people from bed to wheelchair and from wheelchair to bed. In addition, it can move independently on premises, shake hands, greet and say goodbye. Two cameras, two microphones, a large battery and almost 500 pressure sensors enable these precise movements. Its outer material is soft, and the position of the arms and hands can be manually changed by the caregiver, even during the movements, using special sensors to ensure the safety of the patients. It is designed for use in care facilities and hospitals and can be purchased for about 40,000 euros (RTC 2007).

2.4 Nursing robot Pepper

Pepper is 120 cm tall and weighs 29 kg. It is intended as a daily companion. Its most important ability is to recognise emotions. It was invented by the Japanese company Soft Bank Robotics and costs about 20,000 euros. Pepper can remember the faces of individual people, listen to them, talk to them, react with movements and facial expressions and move independently in premises. It remembers the preferences and habits of individual people. It has three cameras, four microphones, three 360° wheels, numerous sensors and a tablet usually connected to the Internet. It is already being used in Japan by more than 1,000 Nescafé branches and a large banking group to inform customers about the various products (Soft Bank Robotics 2017). In health care it has so far been tested only as a prototype, e.g. at the University of Halle in the “Future-care-lab” as an experiment in artificially created rooms such as ward rooms, family practice and an apartment (Walter 2017). At the University of Siegen, a research team with Pepper regularly visits the Marienheim in Siegen-Weidenau, a nursing home (University of Siegen 2017).

2.5 Nursing robot Care-O-bot

Care-O-bot, developed by the Fraunhofer IPA, is 145 cm tall, weighs 180 kg, and can be equipped with one, two or no arms alternately. It also has a rechargeable battery, three cameras, two microphones, a tablet with touch screen, a large database as a memory and many tactile sensors to fulfill its tasks. This includes e.g. the retrieval and delivery of items. It also serves entertainment and communication by using its tablet to play games, video calls or music and movies. For use in nursing homes or in the home of elderly people, it is equipped to recognise people who have fallen as an emergency and to automatically set up a video connection to the ward or emer-

gency center, which can communicate with people via Care-O-bot. It has already been used successfully in large office areas for floor cleaning and waste disposal (Fraunhofer IPA 2011). Care-O-bot can be purchased from 250,000 euros and is constantly being developed into new models (Gottwalt 2014).

2.6 Nursing robot Paro

Paro is a robot with the look of a harp seal baby, weighing 2.7 kg and is 57 cm long (Schulz 2006). The robotic seal has been in use since 1993 by the National Institute of Advanced Industrial Science and Technology (AIST) under the direction of Takanori Shibata developed in Japan. In 2001 Paro was presented to the public and has been available for sale since 2004. Today Paro is already in its ninth generation. The appearance has hardly changed, the functions have been steadily improved and adapted to the areas of application (AIST 2016). With its five types of sensors, Paro can detect and respond to touch, lighting, sounds, temperatures and position. The robot makes purring noises and imitates those of a real harp seal baby, moving the head, the eyes and all three fins. Paro remembers what reactions are returned to his movements. It repeats actions, followed by pats or avoided actions, followed by coarse reactions, such as fixed hitting. In the health sector, the seal is mainly used for therapeutic purposes in patients with dementia and residents or hospitalised children. It simplifies access and interaction with patients, reduces stress on both sides, and improves the relationship between patients and residents. A psychological effect on patients leading to more relaxation and motivation has been empirically proven (PARO Robots U.S. 2014). With approximately 4,000 copies of Paro, work is now carried out in over 30 countries worldwide (AIST 2016). In order to reinforce the impact of Paro and make professional use of it, the Danish Technological Institute has developed a training concept that trains and certifies users such as nurses and caregivers. In Germany the certification and the mediation of Paro is carried out by the company Beziehungen pflegen (2010). Paro is available for 5,700 euros (Gottwalt 2014).

3 Method

Due to the aspects of population development in Germany and the changes in the health care system, as well as the current state of technology acceptance research in the field of caring robots, the following main questions arise:

Question 1: To what extend is the acceptance regarding the use of care robots in hospitals by residents of a residential community aged 60 and above?

Hypothesis 1 (H1): There is little or no acceptance of the use of care robots in the hospital by the residents of a residential community aged 60 or above.

This question refers to the evaluation of the attitude acceptance of all obtained results. A positive attitude speaks for acceptance, a negative attitude for no acceptance or rejection. As a decision rule, the limit of 50 % is set. H1 is therefore verified when less than fifty percent of all results speak for the acceptance of care robots.

The second question examines the individual results in more detail and questions the acceptance of the individual activities that a care robot could perform in the future:

Question 2: What is the difference in the level of acceptance between the different fields of application or the activities performed by the caring robot?

Hypothesis 2 (H2): The acceptance of care robots in the hospital by the residents of a residential community aged 60 years and above is different for different uses or activities that the care robot performs.

H2 is verified if the results show percentage differences in the level of acceptance for the different areas of application or activities.

To answer the two questions, a paper and pencil survey has been conducted. The questionnaire is standardised and has an exclusively closed question structure with a total of 30 items. This should allow a systematic and concrete evaluation of the results of the questioned constructs (Ritschl, Weigl, and Stamm 2016). The 30 items are subdivided into six sections with their own headlines for overview and orientation. The first four sections refer to a specific model of the four selected care robots. This is described and presented first by name, description of its functions and two pictures each. On the next side are the five questions about the model. The last two sections are not related to concrete models but capture the “general curiosity, interest and usefulness” or “general anxiety and scepticism”. To answer the individual questions an ordinal scaling method was used. In the ordinal “Likert scale”, the answer options should be constructed in such a way that the distance between them is perceived to be as equal as possible. In order to obtain a concrete tendency of the answer, a four-level scale was used, thus dispensing with a middle category.

The four response categories of the questionnaire are “fully true”, “more appropriate”, “less likely to apply” and “not true”. Before the questionnaire was distributed among the study participants, a pre-test was conducted with six persons representing the future population and its characteristics. During the pretesting phase, three questions regarding their comprehensibility were adopted. The font size and the images of the care robots have been enlarged.

Residents of a serviced residential complex in the north of Hamburg were selected as the study population, who, according to the responsible management, fulfilled both the two following criteria:

- age equal to or higher than 60 years,
- at least one experienced hospital stay.

There is a total of about 160 people living in the condominium, of which about 120 are cognitively and physically able to participate in the survey. The questionnaire was distributed to these 120 residents along with the mailbox management. In order to increase the response rate, the questionnaire was previously announced at the bi-annual resident meeting as a voluntary questionnaire by the managing director. In the three-week survey period from 03/19 to 04/09/2018, 102 of the 120 distributed questionnaires were handed over to a box set up in the entrance hall of the living area. Three of these questionnaires were not filled out completely so that 99 out of 120 questionnaires could be used for the evaluation. This corresponds to a return rate of 82.5 %. The questionnaires were evaluated by Excel.

Underlying Theory and Quality Criteria

The questionnaire used for this study was compiled by the authors based on the Technology Usage Inventory (TUI) by Kothgassner and Felnhofer (2013), which founds on the Technology Acceptance Model (TAM) 3 by Venkatesh and Bala (2008). The quality criteria for the TUI were calculated in the study by Kothgassner and Felnhofer and rated as good, gender- and age-specific reference values are available. Reliability was assessed by internal consistency and validity by factor analysis.

In order to focus the questionnaire used in this work on the two research questions, the TUI was adjusted accordingly. The user-friendliness, immersion and accessibility scales were not considered since no real interaction with the care robots could take place. For each robot model, the attitude to two specific activities was additionally investigated.

4 Results

First, the individual models of the care robots and their different activities are presented. Second, the general acceptance or scepticism is discribed. For most items, the results are dichotomised. The answer options “fully applies” and “more likely to apply” are considered as a positive attitude towards care robots. The answer options “does rather not apply” and “does not apply” are considered as a negative attitude. Depending on the question, some of the answer options had to be evaluated the other way round. For the acceptance of a caring robot model or a single activity only a

result counts, in which more than 50 % of all responses of the residents show a positive attitude.

4.1 Nursing robot RIBA

A comparison of the first two questions shows that although 73 of the residents (73.7 %) could imagine beeind mobilised out of the bed in the presence of a nurse of RIBA, only 26 (26.3 %) would like to be without the presence of a caregiver. Here, the residents clearly differentiated, which application of RIBA is conceivable for them. In the third question, 37 residents (37.4 %) say that they have difficulty trusting RIBA. Slightly more than half of the residents believe that the use of RIBA brings dangers for them, just the other half does not think so. The idea that the presence of RIBA could make their stay in hospital more comfortable was rejected by 54.5 %. If the absolute frequencies of all five questions are added up in order to arrive at an overall result, there are 234 responses that reflect a positive and 261 responses that reflect a negative attitude towards RIBA. Overall, 47.3 % have a positive and 52.7 % a negative attitude.

4.2 Nursing Robot Pepper

The use of the robot as part of a conversation or socialising was rejected by 66 residents (66.7 %) and rated negative. In contrast, 53 residents (53.5 %) would like to be enlightend and informed by Pepper. Here is a clear distinction in the perceived benefit of the individual activities. About half of the residents would have difficulties to trust Pepper, the other half does not. However, most people (69.7 %) do not see any danger in using Pepper, but they do not (58.6 %) think that they would benefit from this care robot during their hospital stay. In summary, 246 answers have been given that indicate a positive attitude towards Pepper and 249 responses that show a negative rating. By this result, neither a clear rejection (50.3 %), nor clear acceptance (49.7 %) of the nursing robot Pepper can be determined. The opinions and attitudes of the inhabitants differ widely here.

4.3 Nursing robot Care-O-bot

Nearly three-quarters of residents (74.7 %) would have had their food or groceries delivered by Care-O-bot. However, only 28.3 % would accept and take medication from the grooming robot. Again, the acceptance obviously depends on the activity performed or the field of application of the robot. Although only 35 residents (35.4 %) have problems trusting Care-O-bot, 56.6 % think the robot could pose a threat to them. When asked whether Care-O-bot could make hospitalisation more enjoyable, opinions differ widely, with 48.5 % answering yes and 51.5 % disagreeing. Since 254 of 495 responses given (51.3 %) to the questions about Care-O-bot

reflect a negative attitude, it can not be assumed that the robot will be accepted widely.

4.4 Nursing robot Paro

The residents can not imagine Paro either to calm down before surgery (66.7 %) or for entertaining purposes (62.6 %). However, 70 of the residents (70.7 %) think that the application on people with dementia poses no dangers. This shows that the usefulness of Paro is more likely to be therapeutic for the treatment of people with dementia. The residents who took part in the survey and did not suffer from dementia would have difficulties getting into Paro (53.5 %). Accordingly, only 33 % think a robotic seal would make hospitalisation more comfortable.

The sum of all responses that reflect a positive attitude is 219, that of the negative is 276. Since the negative attitude outweighs 55.8 %, a rejection of the care robot Paro is to be assumed. However, in further studies, the acceptance of people suffering from dementia would have to be tested in practical situations.

4.5 General acceptance or scepticism

The results so far already at first glance verify the hypothesis (H2). The level of acceptance of care robots in the hospital differs depending on the activity of the care robot. There are both, differences in the level of positive attitude towards the individual models per se, as well as between the two activities of a caregiver robot. The acceptance of Care-O-bot and RIBA is the highest. This is followed by Pepper and Paro. Care-O-bot and RIBA, however, also have the largest differences between the two surveyed activities. The residents show that they would only accept the following activities in the hospital through a caring robot:

- mobilisation by RIBA with caregiver,
- drinks and food brought by Care-O-bot, and
- Pepper informing and explaining.

In order to answer the main question “What is the acceptance regarding the use of care robots in hospital by residents of a residential community aged 60 and above?”, in addition to the specific care robots, the general curiosity, interest and usefulness and the general timidity and scepticism are evaluated.

The answers show that 80.8 % of the residents have not yet dealt with the topic of care robots, so this survey is their first contact on the subject. It is exciting that nevertheless 56 of the 99 inhabitants (56,5 %) are anxious to learn more about care robots, now. Of the participants, 60.6 % would even be curious about an interaction with a nursing robot in the hospital. However, as an integral part of a hospital, only 43.4 % would like to have access to robots. Regarding the shortage of nurses, al-

most 80 % think that they would be useful for relieving caregivers physically and in terms of time. Overall, 257 out of 495 responses reflect a positive attitude towards caregivers, which is around 52 %.

The fact that the inhabitants previously had little contact with the topic is reflected in question 27, because 79 of the 99 residents would be sceptical at first, if they should use a care robot in the hospital. One reason could be that 53.5 % are afraid of doing something wrong. Of the participants, 37.4 % think that they would be overcharged by an interaction, and 39.4 % think that using a care robot would bring them more benefits. This presence of curiosity and scepticism means that just over half (53.5 %) of the residents would accept the help of a robot and the other half (46.5 %) would refuse the help. In the overall result of general scepticism and anxiety, 257 responses (51.9 %) are negative and 238 (48.1 %) positive.

To answer the main research question, all answers to the individual models and the general questions, are evaluated together. In total, 1,574 of the 2,970 responses given reflect a negative attitude towards care robots, or 53 %. Accordingly, 47 % of the respondents accept care robots in hospitals. The first hypothesis is also verified, as the value is less than 50 %. The result is, however, less clear than expected.

5 Discussion

The two questions could be answered by evaluating the returned questionnaires. If the result of the first question is examined, it is noticeable, however, that positive and negative attitudes towards caring robots or the acceptance and rejection with 47 % and 53 % are not very different in their proportions. This makes it difficult to make a statement as to whether nursing robots in the hospital would be accepted and used by the study participants or not. The attitude seems to be very different between individuals, as well as depending on the robot model and field of application. This confirms the clear result of the second research question. One reason is certainly that 80 % have never dealt with the topic of care robots before. It also fits that 80 % would be sceptical if they were to use a nursing robot in the hospital. The questions about timidity were not so obvious, so that the aspect of scepticism seems to be playing a bigger role than the fear of technology. After the participants had first contact with the topic through the questionnaire, 70 % are curious about the use of a care robot and would like to know more about it. This could mean that with a growing importance of the topic, e.g. in the media, and the first contacts to robots, e.g. in stores, acceptance in the hospital area could also increase. This requires further studies.

In the evaluation of the questionnaires, three statements that were supplemented by hand could not be evaluated. But these are interesting to include in the discussion.

One participant wrote: “The most important thing about caring for me is humanity and interpersonal care, which must not be lost”. The other two comments were “The robots must not replace people, but only support them.” and “An interesting topic that I've never thought about before. I think that robots in addition to nurses would be a great thing”. These statements underline the results, because on the one hand they express scepticism, but on the other hand also interest. The results of the research work only apply to the residents of the residential complex in Hamburg and can not be generalised. For more extensive studies on the acceptance of care robots, the questionnaire should be revised and standardised, and the quality criteria should be scrutinised and tested in more detail. It certainly makes sense in more extensive studies to show the results according to several characteristics, e.g. age or generation or male and female to differentiate and to check the correlations of the individual scales to each other.

6 Conclusion

The questionnaire was suitable for answering the research questions in the scope of this work. It is therefore particularly suitable for the survey of older people from 60 years, since the response rate was very high. The reference to the TUI and the TAM increased the degree of standardisation and made a quantitative survey possible. However, asking only closed questions did not allow the participants to better explain their positive or negative attitude. Thus, the added open answers to three questionnaires of the participants could not be included in the overall evaluation, but only in the discussion. The research question, how high the acceptance of care robots in the hospital by older people above the age of 60 is, could be achieved. However, the result was not as clear as expected. Of all responses, 47 % show a positive attitude towards nursing robots in the hospital context, i.e. for the acceptance of robots.

However, according to the decision rule of the first hypothesis, this result assumed that there is no acceptance of care robots in the hospital by the residents, as the result is below 50 %. This leads to the assumption that the decision rule for confirming or rejecting the hypothesis should have been chosen differently. Because the proportion of answers that stand for acceptance and the proportion of answers that stand for rejection are almost equally distributed. For the authors of the work, this result was unexpected, as greater rejection was expected. The research results to answer the second question, whether there are differences in the level of acceptance in different activities of care robots, are clear. RIBAs mobilisation, caregiving and groceries by Care-O-bot, and Peppers information and education are accepted. A mobilisation without a caregiver, the bringing of drugs and the company and entertainment of a robot are rejected. The seal Paro is completely rejected by the inhabit-

ants but is seen as a good way to treat people suffering from dementia. The research shows that the issue of care robots for older people is not yet present and that scepticism and anxiety, as well as curiosity and interest, exist. In actual use of care robots in hospitals in the future, patient acceptance will depend on the nature of the care robot and its areas of use.

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