A Need for Service Robots Among Health Care Professionals in Hospitals and Housing Services

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Abstract. We explored a need for service robots in hospitals and housing services. The methods consisted of a literature review and a cross-sectional survey among health care professionals (n = 224). The survey data was analyzed with a logistic regression model and a factor analysis. The literature review showed that there are only few papers, which discuss service robotics in nursing. The results presented that service robots are needed as co-workers for decreasing mental workload of workers and for activating the patients. Physical workload and age of respondents were non-significant factors in assessing a need for service robots.

Keywords: Service robots · Health care · Nursing · Attitude · Perception · Workload

1 Introduction

Robotics is well researched among the industrial settings but studies regarding the usage of service robots as co-workers is still scant [1–4] but an emerging topic. Service robots can be used as co-workers in industry but an interesting topic is how to use robots in service sectors, e.g. in health care [5]. A pressure to develop a new robot application in a service sector is based partly on policy and partly on cost effectiveness. The Strategic Research Agenda for Robotics in Europe, SRA2020 [6] has identified healthcare as a significant sector for the applications of robotic technologies, and during the last few years, European Union has allocated €50 million for robotics development in elderly care [7]. Another trend, the restructuring of the health care services in Europe, will force us to rethink how to produce and deliver the cost-effective care [8].

There are many different classifications of robotics available [9] but usually robots are classified into two main categories, industrial robots and service robots, and further service robots can be divided into personal and professional robots [10]. We consider that personal robots are social or semi-social because of a human robot interaction (HRI) [11] but professional service robots also can be non-social such as manipulators if those are assisting e.g. industrial processes without any HRI.

Social robotics has been defined more than decade ago [12–14] but still it seems to be unclear what robot applications can be addressed under the social robotics definition. A good example of difficulty of the classification and the variety of sub-groups of

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robots are presented by Heerink et al. [15] who studied assistive robots and classified those in two main categories: (1) non-social assistive and (2) social assistive with sub groups of (2a) companion robots and (2b) service robots. In this study we consider a service robot as an entity, which would be able to collaborate with workers and to provide services [3].

Despite the diversity of robotics definitions, the need for service robots is evident [16, 17] but a question is from whose point of view a decision to employ robots are made. From the end users' point of views there are three different perceptions regarding the use of service robots in workplaces: How robots are able to provide benefits to workers, customers and organizations. The service robot development in a health care sector has focused on patients and emphasized assistive technology for the elderly [18, 19]. Some countries, for example Japan, have reported a need for more nurses and care workers for securing high level health services and that strives companies to develop new service robot applications which are able to assist nurses and increase productivity [20]. However, studies regarding the attitudes towards service robots at workplaces are still scant [3] and therefore we have focused on health care professionals.

A framework of this study consists of service robotics and working life. The aim of the study was to explore the need for service robots among workers in health care organizations, such as hospitals and housing services. The objectives were to assess the benefits for robots for care workers and patients at work. Our hypotheses were that workers who state that their work is physically strenuous as well as older workers (age $\geq$ 50) might need robots.

2 Methods

The study was part of the *PALROB* project, which focuses on developing the open web- based innovation platform for service robotics in health care sector [21]. This study was based on a literature review and a cross-sectional survey questionnaire conducted among health care workers (registered and practical nurses, head nurses, physiotherapists, managers and directors) in Finnish hospitals and housing services. The number of respondents was 224 (206 women and 15 men) and they represented 6 organizations (1 hospital and 5 housing service organizations). Because numbers of women and men differed a lot, we did not compare women and men between. Respectively, the number of workers in hospital and housing service organizations differed and thus we did not compare them between. All the participated organizations gave their consent to the survey. The survey was carried out with help of directors and head nurses who activated staff members to participate. The response rate varied from organization to organizations but was on average about 30%. The mean age of respondents was 38.7 (Md 38.0, SD 11.7). We offered three web-link to respondents from where respondents were able to meet service robots. We analyzed 148 scientific articles in a literature review and evaluated articles where the associations between robots and health care workers were studied. Unfortunately, we are not able to present the entire list of the articles in this paper.

2.1 Survey Data

Data on a need for service robots was based on a question: "How much do you need a service robot at health care work?" We also asked the respondent to assess the benefits of service robots for patients and health care work. The questionnaire included also questions regarding workers' perceived physical and mental workload as well as an open-ended question where we asked the respondents to tell in which tasks robots could be recruited in their organizations. The response options were on a five-point scale: (1) "Not at all," (2) "Little" (3) "Some extent," (4) "Much," (5) "Very much." The quantitative survey results were analyzed with SPSS 23 software (Statistical Package for the Social Sciences).

2.2 Variable Design

Workers' need for service robots at work was selected as a dependent variable. The main independent variable was a robot's ability to help at work. We asked them the following questions: "How much a service robot may (a) increase the quality of work, (b) save time, (c) increase meaningfulness at work and (d) lighten work load?" We analyzed also the following variables: Age, perceived mental and physical workload. Regarding a factor analysis, we selected 13 factors that may have an association between and impacts on a need for robots.

2.3 Statistical and Qualitative Analyses

First, we analyzed data with a logistic regression model. The variables were classified and dichotomized for assessing the odds ratios (OR). Chi-square ($\chi 2$) test was performed and p-values were assessed with the 95% confidence intervals (95% CI). Second, we analyzed data with a factor analysis. We checked also validity and reliability of the factors. Third, we analyzed the selected articles from a literature review and responses to an open-ended question "In which tasks robots could be recruited in your work or organization?" with a content analysis method. Responses were coded according to the type of tasks mentioned.

3 Results

3.1 Survey

Table 1 presents the background characteristics of respondents. The majority of the respondents worked at housing services. All together 88 (39%) of respondents claimed that they may need service robots at work. The need for service robots at work was almost equal among nurses in a hospital and housing services.

Table 2 presents that robots' abilities to lighten a work, increase meaningfulness at work, save time and increase quality of work had significant associations with need for robots. In addition, perceived high mental workload had a significant association with a need for robots, whereas high physical workload did not. We tested also if age 50 or over would have associations with a need for robots but that factor was non-significant.

Table 1. Characteristics of respondents (n = 224)

Organization type	Participants			Need for service robots			
	n	%	Age (Mn)	Yes	%	No	%
Hospital	58	25.9	38.6	24	41.4	34	58.6
Housing services	166	74.1	38.8	64	38.5	102	61.5
Sum	224	100		88		136	

Table 2. Associations between selected variables and a need for a service robot using a logistic regression model (n = 221)

Variables	OR	95% CI	$\chi 2$	p
Robot may lighten my work***	18.9	8.4–42.4	68.4	<0.001
Robot may increase meaningfulness***	26.1	11.5–59.4	84.3	<0.001
Robot may save time at work***	18.5	8.4–40.3	70.4	<0.001
Robot may increase quality***	17.3	8.6–34.7	77.9	<0.001
Age 50 or over	1.3	0.7–2.5	0.8	0.38
High physical work load	1.2	0.7–2.1	0.6	0.46
High mental work load***	3.0	1.7–5.3	15.4	<0.001

*p < 0.05; **p < 0.01; ***p < 0.001

Because the number of male respondents was only 16, we did not analyze the difference between men and women.

Table 3 presents the mean values and standard deviations of selected variables in a factor analysis. The scale was from 1 to 5 and the mean values of the greatest part of the variables are close to 3 which means that a service robot would be useful to some extent. The highest mean values were regarding a robot's ability to activate a patient's

Table 3. Descriptive statistics of selected variables regarding a robot's function (n = 200)

Variables	Mn	SD
Activate a patient's cognitive skills	2.95	1.16
Activate a patient's motoric skills	2.92	1.12
Connect a patient to relatives	2.85	1.39
Provide joy to patients	2.77	1.05
Support work tasks	2.70	1.04
Motivate a patient	2.66	1.15
Save time concerning routine work	2.65	1.12
Increase of meaningfulness of work	2.52	1.05
Increase the quality of work	2.49	1.13
To be a discussion companion	2.22	1.28
Assist patients in eating	2.19	1.16
Assist patients in toilet visits	2.15	1.14
Assist patients in bathing	2.02	1.12

cognitive and motoric skills. Please, note that mean values of variables are presented in a factor analysis even if the scale is ordinal. That is common and allowed in a factor analysis.

Table 4 presents a rotated factor matrix for tested variables. There were two factors which support the use of service robots in hospital and housing services. One is related to health care work and another to assisting patients. The correlations between variables were high ($p < 0.01$) and Kaiser-Meyer-Olkin Measure was 0.93. The Chi-Square value for the test was 331.4 ($p < 0.01$) and Cronbach's Alpha was 0.94.

Table 4. Rotated Factor Matrix[a] for tested variables

	Factor	
	1	2
Provide joy to patients	.385	***.716***
Activate a patient's cognitive skills		***.814***
Activate a patient's motoric skills	.385	***.786***
Motivate a patient	.379	***.831***
Support work tasks	***.824***	
Increase of meaningfulness of work	***.767***	.409
Save time concerning routine work	***.856***	.309
Increase the quality of work	***.833***	.388
Assist patients in toilet visits	.640	.384
Assist patients in bathing	.642	.426
To be a discussion companion		***.663***
Assist patients in eating	.533	.573
Connect a patient to relatives	.301	.533

Extraction Method: Maximum Likelihood.
Rotation Method: Varimax with Kaiser Normalization.
[a]Rotation converged in 3 iterations.

3.2 Literature Review

According to several studies, health care professionals believe that robots are useful to nursing practice in different nursing environments. In home care for the elderly, robots can report the results of body functions of a patient and alert emergency services if necessary [22–24]. A quick assessment of the patient's situation is crucial [23]. Falls in particular are a major problem, and the ability to manage such emergencies is essential in service robotics [25–27].

Aiding patients' communication with family and professionals is one of the key benefits of robots. Monitoring patients' well-being [22–24], and location [27], assessing their medicine use, promoting exercises and providing assurance [28] are also remarkable advantages of using robots from nurses' point of view.

According to Cohen-Mansfield and Biddison [29], nurses prefer robots that can aid them in the most physically demanding parts of their jobs, such as bathing, toileting and transferring residents.

Service robots often face initial resistance, but nurses tended to accept them as one possible tool and see them as beneficial to their work, particularly if patients also accepted them. Having robots has even strengthened their professional values such as caring for the user's well-being, integrity and open-mindedness [24].

Important benefits of robots for people who live in isolated locations include increased safety and help with maintaining social contacts [23]. The use of robots may lead to fewer visits to patients [24], but robots could help maintain the users' independence [28] and strengthen the relationship between users and their family [25]. Specialized robots could also be a useful tool for patients' rehabilitation [23] and pharmacy operations [30]. Some studies have also reported positive effects on nurses' job satisfaction, safety, working conditions and stress recognition [31, 32].

The technology's usability is highly important [33] and nurses expect robots to be safe [29], funny, exciting and easy to interact with patients [27]. Nurses claim that even with the help of robots, a human-to-human contact is paramount in nursing [30]. Robots cannot replace nurses, but they can be excellent tools.

The size of the robot is important [25] because in home environments users might stumble on a robot that takes too much space. Size is less of a problem in a hospital environment, as long as a robot does not prevent patients' movement and transport or interrupt unit rounds [30].

Health professionals have some concerns regarding robots. One fear has been a robot's unreliability in the clinical situations [27]. In addition, several studies have highlighted nurses' worries about the privacy of patients [23, 27, 28]. Constant monitoring may cause anxiety in the elderly [25] and design flaws could increase the risk of falling for the elderly [23]. Professionals also pointed out that using robots in nursing may increase unemployment and decrease face-to-face contacts [23, 27].

3.3 The Results of an Open-Ended Question

"Which tasks could a robot be used for in your work or in your organization?"

Of the 224 respondents belonging to various nursing staffs, 97 wrote suggestions on robot use to the open-ended question (Table 5). Of these statements (n = 210), 57% concerned indirect nursing care, which is work in which a patient is not present. Logistics related tasks were seen as the most important area of robot use. According to the respondents, filling shelves, cleaning, especially floors, and managing food and laundry services via robots would allow the nursing staff to focus more on direct nursing care. To aid record keeping, respondents wished for speech recognition software that could add the text directly to the patient's medical record.

In direct nursing care, in which a patient is present, 37% felt that the presence of a robot could aid in tasks being related to patient safety such as monitoring, alarm raising and giving reminders. Respondents believed that robots could be used in motivating and activating patients via stimulating activities. Lifting and transferring patients, in

Table 5. Nursing staff's suggestions on the use of robots in nursing and/or in their own organization (210 statements)

Category	Percentage
Indirect nursing care	57%
Laundry service	
Tasks related to food distribution	
Cleaning	
Shelving	
Maintaining and transporting	
Empty patient beds	
Distributing medicine	
Speech recognition and record keeping	
Direct nursing care	37%
Monitoring and raising alarms	
Companionship	
Guiding and advising	
Transferring and lifting patients	
Giving the patient reminders	
Motivation and activation	
No need/no possibilities	6%
No use	
No information about robots' capabilities	

particular, were seen as tasks that could benefit from a robot assistance. Robots could also guide patients through twisting hospital corridors.

Only 6% of the respondents saw no use for robots in their work. They viewed that nursing is based on a human interaction, which cannot be replaced by a machine. Some respondents wrote that they did not know enough about the possibilities of robots to suggest uses for them.

4 Discussion

We assumed that health care workers whose work is strenuous might favor service robots as assistants at work. In addition, we hypothesized that those workers who are age 50 or over might be the possible end-users of service robots. However, our hypotheses did not match with the results of the study. We found that physical workload and age were non-significant factors in assessing a need for service robots, even if Cohen-Mansfield and Biddison [29] reported that robots are needed for physical tasks. We found that workers' perceived mental workload had an association with a need for service robots. The reason for that might be that care work is mentally strenuous due to multiple routine tasks and a lack of time. Service robots are needed to carry out some basic tasks, not necessarily to assist nurses in patient lifts or material handling. The results of a factor analysis supports that finding and presents that service

robots are needed to increase meaningfulness at work and to cut time-consuming routine work.

The results of the literature review presented that there are some studies which have focused on the benefits of robots in health care but a number of studies regarding robots as co-workers is still scant [1–4].

The responses to open-ended question emphasized that service robots are needed for indirect nursing care where a nurse-patient interaction is not prevalent. The responses regarding the direct nursing care emphasized patients' safety and lifting and transferring patients, which are common arguments for robot usage in health care.

We also found that service robots are needed for motivating patients and activating their cognitive and motoric skills. These might be related to nurses' workload, which would be lighter if patients would be independent and motivated. Another emerging issue was robots' function as a discussion companion and a communication aid [23, 25] which are traditional functions of social robots [11–15].

The strength of the study was that it employed both quantitative and qualitative methods and presented the relevant factors, which supported the use of robots. In addition, a survey was conducted among 6 organizations and 97 participants suggested 210 issues on functions for robots. That number was adequate in assessing the need for robots.

The limitation of a study was that it was based on respondents' expectations and preconceptions but not the field tests of robots. Some respondents argued that it is difficult to answer because they had a lack of information on possibilities of robots' functionalities. As far as we know, the participants and their organizations have not used service robots but some of them have seen some demos such as a demo of a Zora robot [34]. Even if we offered an option (web links) to meet service robotics, we were not able to confirm that the respondents visited those pages before replying a questionnaire. However, it might be challenging to organize a field test of service robots in a large scale because many robots would be needed and an introduction of robots should be organized before the implementation [20, 33].

As a conclusion, this study presented that service robots with social features are needed as co-workers or assistants from respondents' point of view in order to decrease mental workload and for motivating patients.

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