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# The Potential of Using Social Service Robots in the Healthcare Environment

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***Abstract***

*This study investigates the perceived value of social service robots within simulated healthcare settings, focusing on the TEMI robot. Utilizing Likert scale questionnaires, based on previously created scales, 25 diverse participants (16 female, 9 male; average age 41 with a minimum of 23 and a maximum of 65) engaged in scenarios involving the robot's interaction in a hospital context. The research aimed to understand adults' perceptions of service robots' value in healthcare and the factors influencing this perception. Results revealed overwhelmingly positive assessments across various facets of perceived value, indicating significant interest in integrating service robots into healthcare practices. Notably, gender and age variations influenced specific aspects of perceived value, with males showing more interest in utilization and females valuing comprehensibility and interaction positions. However, concerns arose regarding learning challenges and physical dimensions, particularly for taller individuals. To enhance the study's reliability, future research should replicate the experiment in real hospital environments, focusing on a larger sample of hospital workers, and include healthcare college teachers and medical students as participants to enrich the study's scope.*

***Keywords:*** *Social Service Robots; Perceived Value of an Innovation; Healthcare Technology; TEMI Robot; Hospital Simulation.*

## 1. Introduction

Modern semi-autonomous, socially adept service robots are positioned as a promising solution (Weinstein et al., 2014) for addressing the challenges posed by an aging population, particularly in the realm of telehealth, crucial for bridging healthcare access gaps and enhancing health

outcomes. A service robot is often defined as "*a freely programmable kinematic device that performs services semi- or fully automatically*," that provides useful services but is not an industrial automation application (Schraft, 1993). When used in human-centric environments, these robots need to be able to navigate uncontrolled environments (Wirtz et al., 2018) of public spaces, utilizing AI and natural communication skills (Bieber et al., 2019) to engage with people and follow social norms, including choosing the correct communication distance (Kim et al., 2013). Some service robots designed for semi-autonomous telepresence, such as the TEMI robot (Temi USA, 2023; see Figure 1), are capable of acting as autonomous social assistants (Holland, 2021), interacting with individuals, accompanying them, or facilitating direct communication between physically present and remote participants through telepresence.

The introduction of service robots into healthcare has presented a range of innovative applications, each tailored to specific healthcare needs, with the potential to transform patient care and support for medical professionals. Firstly, service robots could facilitate remote patient monitoring, offering continuous surveillance for elderly patients without the need for physical presence. Using mobile video monitoring, these robots could enable swift responses to health disorders or risk factors, lessening the workload for medical staff and ensuring timely intervention in cases of falls, congestive heart failure, or other health issues (Sather et al., 2021). They could also assist homebound patients in measuring vital signs like pulse, blood pressure, and oxygen saturation levels, allowing for health assessments, medication administration, and remote oversight by healthcare providers and family members (Sather et al., 2021). Additionally, service robots could serve as an immersive platform for remote consultations, enabling healthcare providers to engage in face-to-face interactions with patients or family members, particularly beneficial in remote areas (Vaughn et al., 2015). Moreover, these robots could play a crucial role in alleviating social isolation among elderly patients by physically being present in the same room. They can create a profound sense of social belonging and intimacy, positively influencing the patient's well-being and potentially reducing their reliance on healthcare services (Koceska et al., 2019). Finally, service robots are invaluable in medical education, granting students remote access to educational settings, medical rounds, conferences, and demonstrations, ultimately enhancing learning opportunities and providing wider access to expert knowledge (Wong et al., 2021).

However, the acceptance of service robots in healthcare involves inherent complexities, and practical issues encountered during implementation could potentially impede their utilization. A pivotal factor in promoting the deployment of service robots in healthcare is introducing them through medical education. This not only enhances learning opportunities but also expands access to expert knowledge (Wong et al., 2021), possibly increasing the perceived value of the technology. In the summer of 2023, we conducted an experiment with 25 participants utilizing the social service robot TEMI in two simulated hospital scenarios at CITY Health Care College. Post-test Likert questionnaires were employed to assess how participants perceived the value of

using the robot in these scenarios. Our methodology involved engaging a heterogeneous sample comprising individuals with diverse backgrounds, including those in medical, university, and robotics fields. The guiding research inquiry driving our study was "*How do adults perceive the value of social service robots within the hospital environment?*"

## 2. Method

### 2.1. Sample

The sample for the study ($N$ = 25) consisted of teaching staff ($n$ = 18) and administrative employees ($n$ = 1) from different STATE1 and STATE2 universities (CITY University of Technology, CITY Health Care College, CITY2 University of Technology and CITY 3 University), employees from STATE1 East-CITY Central Hospital ($n$ = 4) and from the service robot companies COMPANY1 and COMPANY2 ($n$ = 2). The sample encompassed both male ($n$ = 9) and female ($n$ = 16) participants from diverse cultural backgrounds, with varying ages (minimum 23, maximum 65, average 41). The individuals in the sample possessed diverse experiences with social service robots: some had no prior encounters, some had encountered them briefly, and a few had briefly used them in their professional capacities. The participants are collaborative partners of CITY University of Technology and were invited to participate via email in the experiment. Their involvement was voluntary, based on their interest in studying the behavior patterns of a social service robot. As this area aligns with the research interests of the participants, the experiment was conducted on a regular working day. Written consent was obtained from all participants before the experiment, acknowledging that personalized data would not be collected. The form also outlined that all photos would be blurred for research purposes, and videos would be deleted after analyzing observational data.

### 2.2. Procedure

The service robot used in the experiment was an autonomously operating personal AI assistant robot TEMI V3 (Temi USA, 2023; see Figure 1), designed with an additional focus on video interaction. It is able to recognize and follow commands, save preset locations, and seamlessly navigate both home and office environments. It can also be used for telepresence communication with friends, family or professional connections.

The experiments with the social service robot TEMI took place at the CITY Health Care College, following two scenarios typically encountered in a hospital setting. The experiments were conducted on a single floor, and the rooms provided adequate space for the trials. Each experiment lasted for 10 minutes, with 5-7 minutes dedicated to the experiment itself and 3-4 minutes for discussion, totaling 60 minutes for transitioning between rooms. The robots and their controlling computers were connected to an independent Wi-Fi network operating at a 5

GHz frequency, ensuring a minimum speed of 10 Mbit/sec. The sample comprised five groups, each consisting of five members, intentionally designed to be as heterogeneous as possible, encompassing diverse genders, nationalities, institutions, and levels of experience. Each participant was assigned a unique code for data collection purposes. While two groups concurrently conducted experiments with the social service robot, the remaining three groups engaged with telepresence robots, which are not elaborated on in this article. All five groups participated in two scenarios with the social service robot, each overseen by an observer.

*Figure 1. The setup for the scenarios. Left: a robot-mediated nurse contacting a patient (Scenario 1); right: a robot-mediated nurse guiding a patient (Scenario 2).*

*Scenario 1* (Figure 1, left). In the first scenario, the TEMI robot, guided by a researcher operating a computer, assumed the role of a hospital nurse in a pre-mapped room. The room layout included designated areas for the nurse's station, patient room, and rest area. The "robotemi" user interface and room map were displayed on the robot's screen. A participant played the role of a bedridden patient interacting with the nurse through the robot, while another participant acted as the patient's relative. Observers assessed the realism, naturalness, comfort, and functionality of the scenario, evaluating its success in a real-life hospital-like context. During the experiment, the TEMI robot navigated to the patient's location using the pre-created room map. The patient contacted the nurse through the robot's interface, requesting a newspaper. The nurse received the call on her computer, confirmed the delivery through the robot, and ended the call. The nurse then directed the robot to fetch the newspaper, delivered it to the patient's room, and communicated with the patient again via the robot. After the scenario, a brief 3-4 minute discussion followed, exploring participants' experiences.

*Scenario 2* (Figure 1, right). The second scenario involved the TEMI robot, directed by the researcher, placed in a pre-mapped corridor with indicators for three doctors' offices. The researcher acted as a receptionist, and the robot's screen displayed the "robotemi" environment

and room map. A participant, playing the patient, sought directions to a doctor's office. Observers assessed realism, naturalness, comfort, and functionality, including communication flow, audibility, and intelligibility. The patient interacted with the robot-mediated nurse, who guided them to the doctor, engaging in conversation along the way. Observers could join as passersby. After reaching the destination, the nurse bid farewell, ending the communication and directing the robot back to its initial position. A 3-4 minute discussion followed, focusing on participants' experiences

### 2.3. Data Collection and Analysis

The experiments aimed to assess participants' perceptions of the value of using service robots in a hospital environment, relying on both individual experiences and observations. After the experiments, participants completed a questionnaire, including the option to write notes, while observers documented their observations on separate sheets. The collected surveys were digitized and analyzed using Excel.

To evaluate the perceived value of social service robots in healthcare, we drew on the works of Pütten & Bock (2018), Pinto et al. (2022), and Sánchez-Fernández & Iniesta-Bonillo (2007), along with the expertise of our authors from CITY Health Care College and East-CITY Central Hospital. We constructed a questionnaire to gain insights into participants' perceptions of various aspects of robot-mediated communication, such as complexity, comprehensibility, physical comfort zone, safety, reliability, and pleasantness. It also explored participants' inclination to learn to interact with the robot and their interest in incorporating it into their work. The survey, consisting of eight Likert scale questions allowing respondents to rank perspectives from -3 to +3, included supplementary inquiries about the sample's demographics.

## 3. Results

Our research question focused on understanding how adults perceive the value of social service robots within hospital settings. The findings illustrated that, barring the learning dimension, all other aspects of perceived value garnered predominantly positive assessments (Figure 2), with participants expressing significant interest in integrating service robots into their work. Across each aspect of perceived value, only 1 to 2 individuals out of the 25 participants held negative perceptions. However, regarding the learning aspect (phrased as, "*To what extent do you think using a tele-robot at work requires separate learning/training?*" in the questionnaire), the scenario differed significantly: 80% of the participants either expressed uncertainty regarding potential difficulties or perceived the learning process as rather challenging.

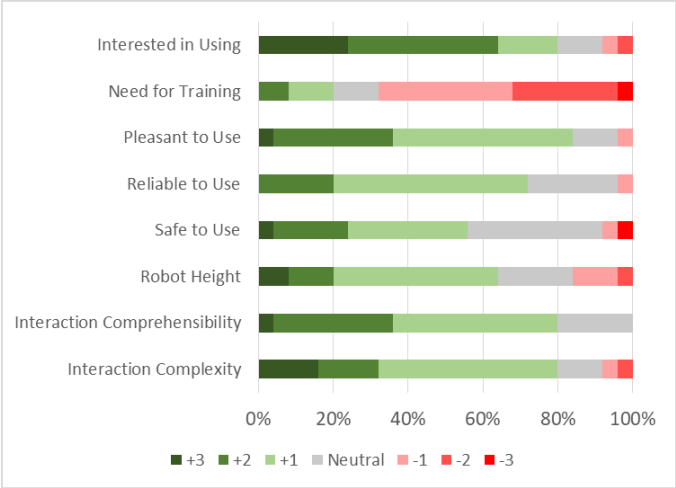


*Figure 2. Facets of perceived value of using service robots in healthcare.*

Gender variations in perceiving the value of social service robots were not notably distinct. Nevertheless, male participants were slightly more interested in utilizing the robots in their work (mean value 5.89 vs 5.37) – whereas female participants assigned higher rankings to the robots' comprehensibility (mean value 5.44 vs 4.78) and interaction position or robot's height (4.97 vs 4.33). The median age within our sample stood at 41, creating two distinct age brackets: (a) 23-41 years old, and (b) 41-65 years old. Notably, the younger subgroup rated the robot as more complex (mean value 5.46) and also found it more interesting for their purposes (mean value 5.92) compared to the older subgroup (scoring 4.77 and 5.15 respectively).

## 4. Discussion

In this study, we explored the perceived value of the TEMI social service robot within a simulated hospital environment, enacting scenarios ranging from aiding in patient interactions to guiding individuals in clinical settings. Our study suggests that healthcare workers have the personal readiness to adopt social service robots; however, successful implementation necessitates appropriate training to alleviate fears and equip staff with effective strategies. It is essential to recognize that initial optimistic biases towards unfamiliar technology might obscure uncertainties (Clark et al., 2016), especially regarding the perceived risks of using the novel technology (Calandrillo et al., 2021). These concerns could already be addressed in medical higher education through specialized courses.

The high interest among participants in integrating service robots into their work likely stems from the burden faced by healthcare workers due to staff shortages (as pointed out in Christensen et al., 2009), prompting them to seek relief through robot assistance. Notably,

gender and age differences revealed that males and younger participants were more interested in using the robots for their purposes. These variations may stem from distinct preferences, experiences, or comfort levels with such technology. Addressing these divergences in perception is vital for tailoring robot functionalities and interfaces to meet diverse user needs. Concerns were raised regarding the robot's short height, potentially posing a challenge for taller individuals. Overall, it appears imperative to test service robots thoroughly in complex healthcare settings to understand their value in demanding situations. This includes considerations such as battery life, reliability during peak hours, among others.

In harnessing the potential of service robots in healthcare, it is crucial to focus on targeted training, adaptable designs, and ongoing research to address demographic-specific challenges. Efforts should center on easing learning challenges and enhancing the comprehensibility and interactive capabilities of these robots for successful integration into healthcare practices. Furthermore, the integration of service robots into medical education holds promise, serving as a valuable tool to familiarize future healthcare professionals with emerging technologies like telehealth and robots (also indicated by Wong et al., 2021). Medical education should embrace these technologies to empower future doctors to adapt to evolving healthcare landscapes.

The limitations of the study presented include the need for increased reliability through replication in an actual hospital environment with a larger sample consisting solely of hospital workers. Additionally, expanding the research to incorporate healthcare college teachers and medical students as participants would enhance the study's comprehensiveness and relevance.

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