

# A STUDY ON BEHAVIOURAL OUTCOMES OF PATIENTS TOWARDS HUMANOID SERVICE ROBOTS (HSR) IN HEALTH CARE SETTINGS

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## ABSTRACT

*Today, "robot" refers to humanoid robots that mimic human behaviour and have human-like traits rather than industrial robots. The feeling experienced by humans when robots start behaving like humans is known as the "Uncanny Valley." Some humanoid robots are so realistic that they can make humans very uncomfortable. The humanoid robot Pepper, created by the Japanese technology corporation Softbank and gaining popularity worldwide, is currently used worldwide. Now, Pepper, a humanoid robot, can be found in over 2500 locations, including shops, banks, hotels, museums, offices, airports, train stations, hospitals, and nursing homes. Technology experts have predicted that soon humanoid robots will become part of the family along with pets, children, and parents. Sophia, a humanoid robot created by Hanson Robotics in Hong Kong, is regarded as a rock star. This success of Sophia led to the development of domestic robots in many countries, including India. Ranjit Shrivastava, a programmer from Ranchi, India, developed Rashmi, the Hindi-speaking robot.*

**Keywords:** Healthcare Robotics, Patient Behavioral Outcomes, Patient Satisfaction with Robots, Robotic Caregivers, Perception of Healthcare Robots.

## INTRODUCTION

Generally, robots do not attract attention because they do not resemble humans. According to human genetics, every human is unique. Humanoid robots will occupy a substantial part of our lives when they are imbued with the same ethical and moral values (Sule Guner, 2018). Humanoid robots are classified as androids or gynoids. Android is a humanoid robot that resembles male characteristics, and Gynoid is a humanoid robot that resembles female characteristics.

The humanoids have started operating in the government and private sectors in India. Tech Mahindra has introduced an HR humanoid at its Noida special economic zone campus. The humanoid does the routine HR transactions and provides an enhanced employee experience. The humanoid robot at the Chennai airport greets passengers and responds to queries by deciphering the variances in accent. The humanoid robot at Canara Bank's head office in Bengaluru has an HD camera on its head, and it answers about 500 customer queries per day. Kerala police have introduced a humanoid robot called "KP-Bot". KP-Bot provides public interface and front office administration at police headquarters in Thiruvananthapuram (ET Bureau, 2019).

Many studies on human responses to humanoids have been undertaken in the robotics industry in various nations. Yet, there are not many studies that compare Humanoid Service Robots (HSRs) with suppliers of human services. Indian consumers' compensatory outcomes will be distinct from those of their counterparts in other nations.

There has been no research comparing HSRs and human service providers in India. Humanoid service robots are utilised in the healthcare industry for a number of activities, such as nursing assistants, senior carers, or even to ease the suffering of children. These robots, as opposed to industrial robots, can communicate with and act like people. As peers or consumers, humans must interact with other humanoids. Interaction between humanoids and humans will be uncomfortable and have a balancing impact. The outcomes might be favourable.

## LITERATURE REVIEW

The robots must master two key skills: first, they must comprehend the cues humans give about their emotional states or data gathered from social media about client preferences, cultural backgrounds, etc. Expressing one's emotional condition and influencing customers' purchasing decisions is the second skill. Combining social robotics and machine learning systems can accomplish this, which will increase the use of robots in practical applications (Francesca, Eleonora, and Pietro, 2017). The areas of education, health care, and interpersonal relationships will see the most influence from humanoid robots. When humanoid robots achieve a level of self-awareness resembling that of humans, human-robot interactions will change. The self-aware humanoids will participate in society and utilise brands to express themselves (Hector and Jimenez, 2018). Study participants responded well to HSR's creative customer service techniques. However, when compared to human contacts, HSR's innovative service behaviour is lower. HSR's customer service practises go above and beyond expectations, which results in happy and satisfied customers (Stock, et al., 2018). The expectations from a frontline service robot are based on what constitutes an ideal service, the expectations from a human front line service employee, and the expectations from self-service technology (Ruth & Mortiz, 2017).

### Humanoids in Health

Humanoid robots had greater acceptance when they were used for male African Americans and for the companionship of elders (Chang, Huff & Knox, 2019). Children and parents liked to interact with humanoid robots. Children preferred robots that were moderately realistic and when the robots displayed social cues (Tung & Fang-Wu, 2016). The three pillars of physical, psychosocial, and cognitive health are supported by assistive robots in the care of the elderly. The support roles assist both carers and patients, if necessary (Caic, Odekerken-Schroder & Mahr, 2018). The staff and seniors of a hospital were excited about a robot but were unwilling to share their workspace with the robot (Hebesberger et al., 2017). The elderly being cared for by robots was opposed by most people, but young males who are educated had a favourable attitude (Hudson, Orviska & Hunady, 2017). Robotic politeness has a negative impact on patients' perceptions of benefits and their willingness to comply (Lee et al., 2017). Humanoid robots have different areas of application such as tele-healthcare, pain relief, and for the ageing population (Azeta, J., 2017). The acceptance of humanoid robots among the ageing population is limited. Acceptance can be increased by matching the needs of the user with the role, appearance, and behaviour of the robots (Broadbent, E. et al., 2009). Robot therapy is a new method of mental healthcare for the elderly (Shibata T, 2011). When nursing and rehabilitative care of elderly patients were done by humanoid robots, positive changes were witnessed in relationships between patients, humanoid robots, and service providers (Tanioka, 2019). Robotic nursing assistants would increase the satisfaction of nurses, reduce injury due to lifting of patients, and extend the effective number of years a nurse would serve a hospital (Hu, J. et al., 2011).

Intelligent humanoid robots that perform the emotive function of empathy will be useful for nursing practise (Pepito, 2020).

### **Humanoids and Service Experiences (Patient Experience)**

When consumers interact with humanoid service robots, they exhibit compensating behaviours. When food is viewed as more nutritious, the customer has a strong sense of social bonding, and the robot is machine-made, these reactions can be reduced, attenuated, and buffered (Mende, M. et al., 2019). The customer experience with service robots revealed that the robot's function determines the experience and influences the interaction between robots and guests (Fuentes-Moraleda, L., 2020). The customer or shopper trip will be significantly impacted by new technologies like the Internet of Things, augmented reality, virtual reality, mixed reality, virtual assistants, chatbots, and robots that are powered by artificial intelligence. In order to produce experience value, this also affects the customer experience dimensions (Hoyer, W. D., et al., 2020).

*H<sub>1</sub>: HSR encounter would lead to improved patient experience.*

### **Humanoids and Customer Engagement (Patient Engagement)**

Artificial Intelligence Service Indicators, Service Quality Perceptions, AI Satisfaction, and Customer Engagement are all significantly correlated (Prentice, et. al, 2020). Robotic process automation (RPA)-based service interactions result in subpar and declining brand engagement over time. However, when observed, especially when it seems like there are limited options, improving Customer Engagement (CE) through RPA-based interactions will take on a less favourable valence. Higher (lower) positive brand-related CE will result from machine learning (ML) in transactional (relational) service interactions (vs. in human-to-human interactions). Deep Learning (DL)-based service interactions will result in a greater boost in brand engagement for customers that display very passive (as opposed to active) CE behaviours (Hollebeek, L. D., 2021). Customer engagement mediates the relationship between host trust and customer engagement as well as between customer engagement and loyalty, even if AI may have a negative moderating influence in these areas (Chen, et al., 2022).

*H<sub>2</sub>: HSR encounter would lead to improved patient engagement.*

### **Humanoids and Customer Loyalty (Patient Loyalty)**

Chatbots, avatars, virtual assistants, embodied virtual agents, and service robots are examples of anthropomorphized agents that foster emotional and intimate connections with clients (Keeling et al., 2010). Regardless of the specific robotic design, human orientation traits had a big impact on how functional people thought robots were. The study also showed that perceived robotic functionality has a significant beneficial impact on customer loyalty (Milman, et al., 2020). The results show that significant variances in customer satisfaction, brand loyalty, and overall service quality ratings can be attributed to both AI and employee service quality. However, only a small number of service quality factors led to noticeable changes in the relevant outcomes (Prentice, C. et al., 2020).

*H<sub>3</sub>: HSR encounter would lead to improved patient loyalty.*

## Empirical Overview

We put our theories to the test in a trio of experiments. In terms of three possible compensatory studies 1, 2, and 3 provide a preliminary examination of how consumers respond to HSRs in the context of medical services. These studies show that HSRs motivate customers to engage in compensating behaviours such as enhanced patient engagement, enhanced patient experiences, and enhanced patient loyalty. These studies all focus on consequential decisions or real behaviour.

### Experimental Studies - Do HSRs Lead to Outcomes of Compensatory Consumer Behavior?

The three studies offer a preliminary analysis of how consumers react to HSRs across the compensatory behavioural outcomes of patient experience, patient engagement, and patient loyalty to test H1, H2, and H3. In the one-way between-subjects design of the investigations, two service provider tiers (HSR and human) are used (Andtfolk, et al., 2022). In order to develop service scenarios where the provider delivers directions to customers, we produced videos utilising a genuine HSR (or human). The study's video was specifically set in a medical environment. We investigate if consumer behaviour that results in improved patient experience, better patient engagement, and improved patient loyalty occurs in response to the HSR. In all of our research, we control for gender, age (McCrory et al. 1999; Romero & Craig 2017), and the perceived novelty of the service experience, all of which have an impact on compensatory behaviours, in order to rule out the possibility that robots have merely novelty effects (Roehrich 2004).

#### 3.1.1 Study 1: Video-Based Encounter with an HSR and patient experience.

A total of 103 COVID patients took part in the study. There were 48 women, and the average age was between 26 and 35. The participants watched a video depicting a medical service encounter with either a human provider or an HSR while sitting at a computer station. This was done at random. When the HSR or human medical service provider entered the exam room, participants were expressly told to envision themselves there for a planned routine medical examination. Please take a seat so that I may take your temperature, pulse, and blood pressure, the service provider remarked in the video. Participants gave a brief description of their impressions of the experience after seeing the video. As a manipulation check, they reported how much the service provider appeared robotic (1 "strongly disagree," 5 "strongly agree") and novel (2 "I have not been to a medical practise like this before," and "This medical practise is unusual," random presentation; 1 "strongly disagree," and 5 "strongly agree").

Using the Generic Short Patient Experiences (10-question) Questionnaire (GS-PEQ) by Sjetne et al. (2011), the patient experience was assessed in the second portion of the study. Participants included their age and gender.

##### 3.1.1.1 Results

Check for manipulation. The major effect of service provider type was found in an analysis of variance (ANOVA) for the robot manipulation check ( $M_{\text{HSR}} = 3.59$ ,  $M_{\text{human}} = 2.82$ ,  $F(1, 101) = 17.654$ ,  $p < 0.001$ ). Therefore, the manipulation worked because people thought the HSR was a robot.

### **Compensatory Behavioural Outcome: Patient Experience**

We used an analysis of covariance (ANCOVA) to see how the type of provider affected the patient experience. Patient experience was more focused on HSR than a human provider of services ( $M_{\text{HSR}} = 3.97$ ,  $M_{\text{human}} = 2.39$ ;  $F(1, 101) = 11.803$ ,  $p < .001$ ,  $\eta^2 = 0.107$ ).

#### **3.1.2 Study 2: Video-Based Encounter with an HSR and patient engagement.**

The study included 103 COVID patients in total. The participants watched the same video that was shown earlier while seated at a computer terminal that showed a medical service interaction with either a human provider or an HSR. It was carried out at random. When the HSR or human medical service provider entered the exam room, participants were expressly told to envision themselves there for a planned routine medical examination. The novelty of the video was also checked.

The second part of the study examined patient engagement using the "Engagement with Health Care Provider (13-item) questionnaire by Bakken et al. (2000). The participants also indicated their age and gender.

##### **3.1.2.1 Results**

The manipulation check was not carried out again as the same video was used.

### **Compensatory Behavioural Outcome: Patient Engagement**

We used an analysis of covariance (ANCOVA) to see how the type of provider affected patient engagement. Patient engagement was more focused on HSR than a human provider of service. ( $M_{\text{HSR}} = 4.26$ ,  $M_{\text{human}} = 2.36$ ;  $F(1, 101) = 52.163$ ,  $p < .001$ ,  $\eta^2 = 0.345$ ).

#### **3.1.3 Study 3: Video-Based Encounter with an HSR and patient loyalty**

There were 103 COVID patients in total in the research. The participants sat at a computer terminal and saw the same video that they had seen earlier, which depicted a medical care interaction with either a human provider or an HSR. It was executed arbitrarily. Participants were specifically instructed to picture themselves in the exam room having a routine medical examination when the HSR or human medical service provider entered. The video's novelty was also examined.

The second part of the study examined patient loyalty using the patient loyalty (three-item) questionnaire developed by Zeithaml et al., 1996. The participants also indicated their age and gender.

##### **3.1.3.1 Results**

The manipulation check was not carried out again as the same video was used.

## Compensatory Behavioral Outcome: Patient Loyalty

We used an analysis of covariance (ANCOVA) to see how the type of provider affected the patient loyalty. The results were not significant.

### DISCUSSION

Technology and artificial intelligence are seen as valuable tools in nursing for the patient in order to promote learning and replace the understaffing of humans with robot resources (Soriano et al., 2022). The theory of heterophily (Kwon, 2018) was applied to users' experiences with healthcare robots based on three factors: empathy, professionalism, and personality with user satisfaction. The results showed that the higher the level of user satisfaction with the humanoid-style healthcare service, the smaller the difference in empathy between a user and robot, and there was a positive heterogeneity association between healthcare and user satisfaction. With the use of a humanoid robot and nurse administration of the annual flu vaccination, Beran et al. (2015) developed a non-pharmacological approach to child diversion. According to the study's findings, children and their parents respond well to a humanoid robot by the child's bedside. According to a qualitative study by (Tanioka, 2019), who used the Transactive Relationship Theory of Nursing (TRETON) to examine ageing and rehabilitative patient care, the human and the robot got along well with the patient, the humanoid, and the healthcare professionals. Andtfolk et al. (2022) reviewed the potential advantages and difficulties of older people interacting with humanoids. As advantages and technological issues were identified, four major domains were recognised, including: supporting everyday life, providing interaction, facilitating cognitive training, and facilitating physical training. Using a modified version of the Robot Attitude Scale, a cross-sectional study was conducted to understand attitudes towards the use of humanoid robots in healthcare among patients, relatives, care professionals, school actors, and other relevant actors in healthcare, which produced the following findings: Other key players, such as healthcare workers and legislators, participants with higher educational levels, and older adults had more favourable attitudes towards the use of humanoid robots.

In this study, the findings suggest that hypotheses  $H_1$  and  $H_2$  are correct. However, hypothesis  $H_3$  is rejected. This demonstrates how HSR improves patient experience and engagement. However, HSR has not been shown to boost patient loyalty. Patients with HSR believe that doctors accurately diagnose their conditions, communicate with them in a cordial manner, and involve them in treatment decisions. The patients also stated that they were pleased with the hospital's overall level of care and that the hospital's treatment was well organized. Additionally, the doctor gives the patient information, gives the patient enough time, respects the patient's decisions, and attends to their requirements.

### MANAGERIAL IMPLICATIONS

Top management and administrators can engage their patients consistently in a nice manner during their treatment with their healthcare services by implementing humanoids in the health care industry (hospitals).

### LIMITATIONS AND FURTHER RESEARCH

One of the disadvantages of this study was the limited sample size. Participants were interested in the study, but they were unable to remain unaware of its objectives because it was not feasible to imagine robots conversing with and caring for patients. Another drawback was that the study's emphasis was on practicality rather than generalizability. The study can also be conducted with a large sample size among Indian cancer patients, paediatric patients, elderly patients, and particularly bedridden patients in order to engage them throughout the treatment process and analyse how their health and the adoption of technology interact.

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