Social Robots: Applications, Challenges, and Future Directions - literature review

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***Abstract**. The integration of AI, robotics, and digital connectivity is transforming various sectors, enhancing operations, reducing costs, and enriching customer interactions. Social robots, equipped with AI and advanced sensors, are prominent in fields such as healthcare, education, and entertainment, offering human-like interactions. This review examines the potential, challenges, and future directions of social robots by analysing experimental studies across diverse domains where social robots have been applied: healthcare, mental health, care for the elderly, psychology, hospitality industries, and other services such as the financial sector, cultural heritage, and retail. It identifies key issues and provides recommendations for effective and ethical implementation.*

Keywords. social robot, healthcare, industry

1 Introduction

The synergy between the evolution of artificial intelligence (AI), the advancement of robotics, and the proliferation of digital connectivity is profoundly reshaping every sector. Businesses are eagerly integrating these state-of-the-art technologies to streamline operations, cut costs, enrich customer interactions, and pioneer innovative products and services. Undoubtedly, the technological dimension is at the heart of service innovation. Robots, leveraging AI and sophisticated sensors, have permeated diverse industries, spanning manufacturing, search and rescue, entertainment, education, research, assistance, and healthcare. Among these, social (humanoid) robots stand out as a category designed to engage with individuals, enrich interactions, and elevate overall experiences (Spekman et al. 2020). With AI-driven capabilities and sensory awareness, these robots can perceive and respond to their environment, engaging with people in a manner akin to human social dynamics.

Characterized by their humanoid resemblance, featuring recognizable elements such as a head, torso, arms, and legs, social robots hold tremendous promise, particularly in the field of social robotics. Their goal is to seamlessly integrate into human interactions, exhibiting behaviours that foster communication, collaboration, and companionship (Perez-Zuniga et al. 2024). Robotics stands as a technological facet ingrained across diverse life domains (Kalaitzidou & Pachidis (2023)).

The main aim of this paper is to explore the transformative potential of social robots across various areas of life. Therefore, this review will assess the support for claims regarding the potential of social robots in everyday life through an analysis of experimental studies. It will also address the applications of social robots in different domains of human activity: healthcare, mental health, care for the elderly, psychology, hospitality industries, and other services such as the financial sector, cultural heritage, and retail, identify problems and limitations, and provide recommendations.

The paper outlines the general objective and research questions, details the materials and methods utilized, presents the search results, explores the application areas of social robots with significant examples, identifies key issues and provides future recommendations, as well as includes a thorough discussion and conclusion.

2 General Objective and Research Questions

This study aims to explore the deployment of social robots across various sectors such as healthcare, psychology, hospitality, and other services. It seeks to identify key research challenges, constraints, and provide recommendations. By understanding

technical, ethical, and societal issues, the study aims to offer insights and strategies for effective and ethical implementation, enhancing the functionality and acceptance of social robots in diverse environments.

The following research questions are at the centre of interest:

RQ1: In which areas of activity are there examples of using social robots in interaction with humans?

RQ2: Which research problems, recommendations and limitations have been identified in the selected papers?

3 Material and Method

The literature review process was divided into four stages: identification, screening, eligibility, and inclusion, according to Boland et al. (2017) and the complete process is illustrated in Fig. 1.

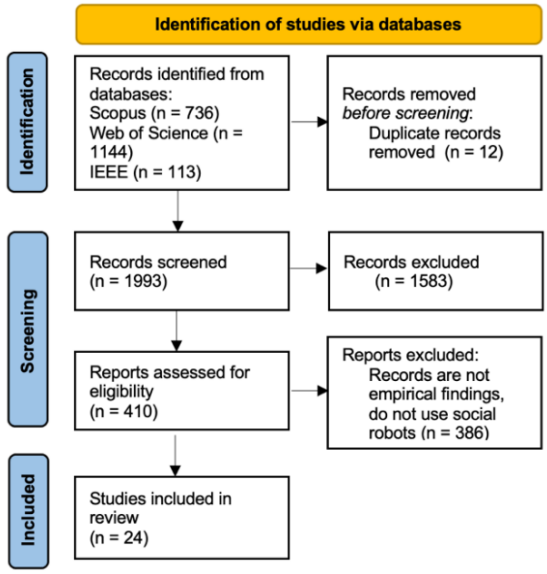

Figure 1. The literature review process

In the first identification stage, a structured search strategy was created to be used on the scientific databases IEEE, Scopus and Web of Science. Keywords: social, robot, healthcare and industry were used for database search. The literature review process was conducted using the following search strings:

TS = (social OR humanoid) AND robot* AND healthcare

TS = (social OR humanoid) AND robot* AND industry.

For the second stage, screening, 113 results from IEEE, 1144 results from Web of Science and 736 results from Scopus were identified. The following additional selection criteria were used:

- Published in English,
- Published within the time frame 2020-2024,
- Document type was article,
- Full text was available.

As a result, 47 studies were obtained from IEEE, 118 from Scopus and 257 from Web of Science. 12 duplicates were detected and excluded, and 410 studies were reviewed by titles and abstracts.

In the next stage, the final eligibility criterion was applied – studies should have included empirical findings on the use of social robots in the fields of healthcare and industry. All the studies that research humanoid hands and heads, robot design and performance, frameworks and recommendations have not been included. 386 studies were removed because they did not meet the required criteria. A total of 24 studies were included in the fourth stage of the literature review.

4 Results

The research results are presented in Table 1 and they show the type of robot used, the number of participants and their age, the field (healthcare, cultural heritage, psychology, services in commerce and tourism, financial sector, etc.) and the duration of the activity.

Table 1. Presentation of the research results

Authors	Robot	Participants	The field of application	Duration
		No / Type		
Perez-Zuniga et al. (2024)	Qhali	17 /university students	mental health	1 session
Cantucci et al. (2023)	NAO	84 / adults	cultural heritage	1 session
Karunarathne et al. (2020)	Robovie	20 / adults	healthcare	2 sessions
Andtfolk et al. (2022)	Pepper	264 /patients, relatives, professionals	healthcare	30 min
Fan et al. (2021)	NAO	26 / adults	care for elderly	1 session
Nertinger et al. (2022)	GARMI	166 / museum visitors	healthcare	2 months
Kasimoglu et al. (2020)	iRobiQ	200 / children	healthcare	-
Robinson & Kavanagh (2021)	NAO	18 / adults	healthcare	2 sessions (60 min)
McIntosh et al. (2022)	Pepper	993 / adults	healthcare	12 weeks (5 min)
Tanioka et al. (2021)	Pepper	2 / adults	mental health	-
Yoshii et al. (2023)	Pepper	94 / patients and adults	mental health	-
Liu et al. (2021)	-	120/university students	psychology	1 session
Leung et al. (2023)	Ka Ka	4 / adults	care for elderly	2 weeks
Spekman et al. (2020)	NAO	211/university students	psychology	1 session
Plotkina et al. (2024)	social robot	429 / adults	financial sector	-
Mingotto et al. (2021)	Pepper	- / customers	hospitality industries	22 sessions (1 hour)
Zhang et al. (2023)	Pepper	280 / customers	hospitality industries	6 months

Okafuji et al. (2022)	Sota	5000+ / pedestrians	mall	3 weekends (6 hours)
Roozen et al. (2023)	Pepper	537 / customers	store	-
Zhu & Chang (2020)	-	221 / customers	service	-
Lo et al. (2022)	Zenbo	77 / adults	sustainability	-
Spekman et al. (2020)	NAO	101/university students	psychology	-
Krakovski et al. (2021)	NAO, Poppy	26 / adults	psychology	-
Ko et al. (2023)	NAO, Pleo	20 /university students	psychology	2 sessions

The results show that NAO and Pepper are the most popular social robots, with each used in seven studies. The robots Pleo, Poppy, Zenbo, Sota, Ka Ka, Robovie, Qhali and iRobiQ were used in one study each. In three studies, it was not specified which social robot was used. The number of participants who actively participated in the research ranges from 2 to as many as 5000. In one study, the number of participants was not specified. Studies are most often conducted among adults: university students, customers, pedestrians, museum visitors, older adults, patients, relatives, and care professionals. Only one study was conducted among children. When we observe the application areas of social robots, we can notice that six studies are from the field of healthcare, five studies are from the field of psychology, three studies are from the field of mental health, and two studies each are from the fields of care for the elderly and hospitality industries. Other services such as the financial sector, cultural heritage, and retail are represented by five studies. Considering the duration of interactions with social robots, both short-term and long-term studies were conducted. Nine studies involved interactions with the robot once or twice. Five studies conducted activities with the robot over several weeks up to 6 months, while in nine studies, the duration of the interaction with the robot was not specified.

4.1 Application Areas of Social Robots with Examples

The application of social robots and their interaction with humans has been extensively researched across various contexts, highlighting their significant potential. Below, we outline some cases documented in the literature based on the domains where social robots have been applied: healthcare, mental health, care for elderly, psychology, hospitality industries and other services such as financial sector, cultural heritage, and retail.

4.1.1 Healthcare

Karunarathne et al. (2020) conducted an empirical study on older adults, comparing their experiences walking alone and with a robot. Attitudes towards social robots in healthcare among various stakeholders, analysing correlations with demographic characteristics, were investigated by Andtfolk et al. (2022). Nertinger et al. (2022) used a social robot to explore acceptance of caregiving tasks, considering socio-demographics, user beliefs, and robot autonomy. The application of a social robot to reduce children's anxiety during dental treatment was in the centre of interest by Kasimoglu et al. (2020). Robinson & Kavanagh (2021) evaluated a social robot designed to promote health behaviour change related to food intake and weight loss. The impact of a social robot on knowledge of influenza prevention and attitudes toward vaccination were the focus of the research by McIntosh et al. (2022).

In the experiment conducted by Karunarathne et al. (2020) results indicated that participants gave significantly higher ratings to the intention of walking with the robot compared to walking alone. In their research, Andtfolk et al. (2022) found that the majority of participants expressed favourable views on the use of social robots in healthcare, with only a minority holding negative opinions. Among other stakeholders, including healthcare service providers, politicians, individuals with higher education levels, and older adults, attitudes towards social robots were predominantly positive. Nertinger et al. (2022) compiled all pertinent factors regarding acceptance to guide the user-cantered design process of assistive robots. Their findings indicate that, among other factors, trust in the robot and utilitarian variables like perceived usefulness are the most influential factors in robot acceptance. Kasimoglu et al. (2020) demonstrated that the use of robotic technology holds promise in effectively addressing dental anxiety and stress, resulting in improved behaviour among children in dental settings.

Study conducted by Robinson & Kavanagh (2021) indicates that the robot-delivered intervention was found to be helpful and user-friendly, particularly after users became accustomed to interacting with a social robot and experienced initial benefits. Social humanoid robots seem suitable as health coaches for adults, especially for behaviour change. The study conducted by McIntosh et al. (2022) has shed light on the effectiveness of a social humanoid robot in enhancing individuals' understanding of influenza prevention and influencing their attitudes toward influenza vaccination. Following interactions with the humanoid robot, participants experienced immediate increases in knowledge and shifts in attitudes, suggesting that social robots could play a significant role in health promotion efforts related to influenza prevention.

4.1.2 Mental Health

Perez-Zuniga et al. (2024) reviewed the expressive social robot Qhali, focusing on its design, components, and validation for telepsychological interventions. The experiences of older patients with schizophrenia and dementia interacting with healthcare social robots and intermediaries were explored by Tanioka et al. (2021). Yoshii et al. (2023) who studied early detection of mild

cognitive impairment through patient-robot conversations, bypassing neuropsychological exams.

The study conducted by Perez-Zuniga et al. (2024) indicates that participants not only experienced improvements in their emotional well-being but also held positive perceptions regarding the psychological intervention facilitated by the social robot. The robot is highly efficient in delivering telepsychological interventions, minimizing the sense of threat, and ensuring engagement with users (Perez-Zuniga et al. (2024). Research findings conducted by Yoshii et al. (2023) indicate the potential to detect patients with mild cognitive impairment through their everyday conversations with a social robot, thereby enhancing the effectiveness of a simple dementia screening test. The study results conducted by Tanioka et al. (2021) suggest that interactions with robots can bring moments of joy to older individuals with schizophrenia and dementia, highlighting the value of healthcare robots in these settings.

4.1.3 Care for the Elderly

Leung et al. (2023) studied humanoid social robots in nursing homes and their interactions with older adults. The socially assistive robot designed to enhance activity and social engagement in older adults were researched by Fan et al. (2021).

Findings from a laboratory-based study involving older adults demonstrate the capabilities of socially assistive robotic, revealing that this system can enable one or multiple older adults to engage in multidomain activities while receiving dynamic guidance; facilitate their participation in robot-mediated tasks and promote human-to-human interaction, and assess their social and activity engagement using multiple sensory modalities (Fan et al. (2021)). In their study, Leung et al. (2023) highlighted the benefits of social robots, including offering emotional support to older adults living alone, adding variety to their daily routines, and strengthening family bonds. The voice of the robot, described as female, soft, and soothing, was perceived as bringing a sense of comfort to older adults.

4.1.4 Psychology

Spekman et al. (2020) examined how emotions and emotional coping influence perceptions of social robots. The impact of human-robot proxemics on concentration-training games with social robots was investigated by Liu et al. (2021). Ko et al. (2023) explored user perceptions of robots in conversational tasks, varying their voice types, appearances, and expressions. The focus of the research conducted by Krakovski et al. (2021) were social robots and how they can fulfil the physical and cognitive training needs of older adults.

The study results conducted by Spekman et al. (2020) revealed an interaction effect between prior emotions and the manipulated coping potential on robot perceptions, contrary to the expected effects from previous studies. Interacting with a robot elicited different reactions, overriding any emotional effects. The findings of Liu et al. (2021) indicate that a distance of 2 meters and a left-front orientation between a human and a robot are optimal for interactive concentration training between humans and robots. Furthermore, females demonstrated superior performance compared to males in human-robot interaction imitation games.

Research findings conducted by Krakovski et al. (2021) revealed that acceptance of the robotic system was influenced by age, attitude, and education. This underscores the significance of tailoring the system to diverse user needs and the value of meaningful feedback. The system exhibited robustness and reliability, showcasing its potential as a personal trainer and a source of motivation for older adults. The research findings conducted by Ko et al. (2023) suggest that accuracy in perceiving emotions varied depending on the emotions presented; participants preferred a regular human voice for its naturalness; however, a characterized voice was more effective in conveying emotions with significantly higher accuracy in emotion perception, and participants exhibited significantly heightened emotion perception.

4.1.5 Hospitality Industries

Mingotto et al. (2021) focused on the evolving roles of frontline employees and customers due to technology adoption, particularly AI-powered conversational agents and robots in tourism companies. In their research Zhang et al. (2023) examined consumer responses to service failures by social versus non-social robots, and how these responses affect brand forgiveness and revisit intentions, considering performance expectations across genders.

The research results conducted by Mingotto et al. (2021) indicate that conversational agents and robots in tourism can serve as an augmentative force, leading to the evolution of frontline employees (FLEs) primarily into enablers - both for customers and technology - as well as innovators and coordinators. Meanwhile, customers may primarily assume the role of enabling the technology. Zhang et al. (2023) in their study demonstrated that consumers exhibit higher performance expectations for non-social robots. These expectations lead to brand forgiveness and revisit intentions among male consumers, while they do not significantly impact forgiveness and revisit behaviours among female consumers.

4.1.6 Other Services

Cantucci et al. (2023) examined user satisfaction during interactions with a robot guided by a computational cognitive model incorporating adjustable social autonomy principles. In the financial sector, Plotkina et al. (2024) investigated how the anthropomorphism and gender of robo-advisors influence social presence, allowing consumers to assess personality traits like competence, warmth, and persuasiveness, thereby contributing to trust. Okafuji et

al. (2022) explored the use of a robot as a social service provider in a shopping mall, examining various robot behaviours. In their research, Roozen et al. (2023) compared perceived service quality in human-robot and human-human interactions in a retail store through hypothetical scenarios, also considering the moderating effects of participants' attitudes towards robots, age, gender, and education level. Zhu & Chang (2020) studied how the anthropomorphism of robotic chefs affects the perception of food quality based on warmth and competence. In their study, Lo et al. (2022) examined the effectiveness of robots in persuading people to recycle through education and encouragement.

Cantucci et al. (2023) found that as the robot's autonomy in task adoption rose, users' satisfaction with the robot declined, yet their satisfaction with the tour itself enhanced. These results underscore the promise of adjustable social autonomy as a framework for creating autonomous adaptive social robots that can enhance user experiences across various real-world domains of human-robot interaction. Plotkina et al. (2024) observed that humanized avatars instil greater trust compared to both gender-neutral cartoonish and anthropomorphized cyborg robo-advisors. This trust is attributed to higher perceived competence and persuasiveness, particularly significant for male robo-advisors, confirming the significance of gender in financial digital services, as hypothesized. Additionally, findings revealed an uncanny valley effect for anthropomorphized cyborg representations of robo-advisors, unlike gender-neutral cartoonish ones. Moreover, highlighting the gender-neutral personality of the robo-advisor "de-humanizes" it and diminishes the positive effect of anthropomorphism on trust.

The findings of Okafuji et al. (2022) suggest that robots' performance in providing information tasks is comparable to humans in controlled environments, indicating their potential effectiveness as labour-support technology in real-world settings. In the study conducted by Roozen et al. (2023) participants rated service quality higher in human-human interactions compared to human-robot interactions. Among those with positive attitudes towards robots, there was no significant difference in perceived service quality between the two interactions. However, participants with lower positive attitudes towards robots rated service quality lower in human-robot interactions. Age, gender, and educational level did not significantly influence participants' perceived service quality in either interaction.

Zhu & Chang (2020) demonstrated that anthropomorphism of robotic chefs influences food quality prediction, mediated sequentially by perceptions of warmth and competence. Age is included as a significant control variable. The results of the study conducted by Lo et al (2022) suggests that due to their anthropomorphic features, robots are more capable of eliciting empathy than tablet computers, potentially making them more effective in encouraging pro-social behaviour.

4.2 Identified Issues and Future Recommendations

In their empirical studies, the authors identified key issues and considerations regarding the deployment and integration of social robots. They provided detailed recommendations and outlined plans for future research to address these challenges. Their findings aim to guide further development and ensure effective, ethical, and practical use of social robots across various sectors, enhancing their functionality and acceptance in real-world applications.

4.2.1 Identified Issues and Considerations

There is concern about the generalizability of research findings due to potential variations with different robots, contexts, and communication abilities (Karunarathne et al., 2020; Andtfolk et al., 2022; Zhang et al., 2023; Roozen et al., 2023).

Future research should involve participants from diverse age groups, socioeconomic statuses, and cognitive levels across various countries, considering cultural differences in attitudes toward technology and gender (Leung et al., 2023; Plotkina et al., 2024).

Several authors highlight the significant cost of social robot systems as a primary drawback. Damage to these robots, whether hardware or software-related, requires examination by qualified specialists, and maintaining extensive robotic systems demands substantial budgets (Kasimoglu et al., 2020; Leung et al., 2023; Plotkina et al., 2024; Mingotto et al., 2021).

Concerns also include issues related to data privacy, increased intrusiveness, biases among users, and the use of unregulated mechanisms. It is essential to investigate these potential negative aspects of robot services (Plotkina et al., 2024).

4.2.2 Recommendations and Plans for Future Research

Andtfolk et al. (2022) underscore the need for further research into the root causes of negative attitudes that could hinder the integration of social robots in healthcare.

Future plans include integrating measures of activity engagement and social interaction to enhance real-time interpersonal interactions and task engagement, thereby improving the adaptive behaviours of robots (Fan et al., 2021).

Further research could explore customers' negative experiences with service robots and measure outcomes (Roozen et al., 2023). Zhu & Chang (2020) emphasize the importance of investigating how anthropomorphism in social robots influences perceptions of their competence.

Longitudinal studies could provide insights into the ways customer attitudes and perceptions of service

quality evolve over time as they become more familiar with service robots (Roozen et al., 2023).

There is a need to enhance technical robustness and individualize robot-delivered interventions, which includes improving the robots' communication abilities to paraphrase sentences, respond to interpersonal cues, and emulate client-centred counselling techniques (Robinson & Kavanagh, 2021).

Future research aims to enhance the linguistic capabilities of robots. Several studies are constrained by robots' challenges in natural interactions with pedestrians in noisy environments, often due to low speech recognition accuracy—a common issue in real-world robot operations. Overcoming these challenges requires improving the robot's ability to accurately recognize speech amidst noise (Yoshii et al., 2023; Okafuji et al., 2022).

Additionally, future experimental designs should incorporate more interactive experiences with real applications. While their study confirmed a significant positive relationship between trust in social robots and intention to use them, exploring other consumer perceptions such as confidence in their decisions and intentions to act on recommendations would provide further insights (Plotkina et al., 2024). Although the intention to use typically predicts actual usage, this relationship needs validation through direct user studies. Given that some functionalities are not fully developed for implementation, these findings will guide future research on user readiness (Nertinger et al., 2022).

The potential influence of novelty is challenging to mitigate. Further research is needed to determine whether this persuasive effect persists over time, beyond the initial decline in user curiosity (Lo et al., 2022).

5 Discussion

The study identified several areas of activity with significant examples of using social robots in healthcare, mental health, care for the elderly, psychology, hospitality industries, and other services. Additionally, the study highlighted research problems, provided recommendations, and stated limitations found in the selected papers. Here it should be noted that NAO and Pepper are very popular social robot in the context of interactions with humans (e.g. Cantucci et al. (2023), Fan et al. (2021), Andtfolk et al. (2022), Tanioka et al. (2021), Yoshii et al. (2023), etc.). The range of participants varied widely, and the predominant focus was on adults. In terms of research issues, the centre of interest for researchers was human-robot interaction.

Many papers (11) confirmed the positive relationship between human-robot interaction, behavior and attitudes. For example, Andtfolk et al. (2022) found that the majority of participants expressed favorable views on the use of social robots in healthcare. The study by Perez-Zuniga et al. (2024) indicates that participants experienced improvements in their emotional well-being and had positive perceptions of the psychological intervention facilitated by the social robot. Leung et al. (2023) emphasized the benefits of social robots, such as providing emotional support to older adults living alone, introducing variety into their daily routines, and strengthening family bonds.

Successful interaction between humans and robots is significantly influenced by the characteristics of both the humans and robots, as well as their spatial relationship. The acceptance of the robotic system was influenced by factors such as age, attitude, and education what underscores the importance of tailoring the system to diverse user needs and the value of obtaining meaningful feedback (Krakovski et al. (2021)). Liu et al. (2021) indicate that a distance of 2 meters and a left-front orientation between a human and a robot are optimal for interactions between humans and robots. The voice of the robot also plays a significant role; Ko et al. (2023) found that participants preferred a regular human voice due to its naturalness, while Plotkina et al. (2024) highlighted that the gender-neutral personality of the robo-advisor "dehumanizes" it and diminishes the positive effect of anthropomorphism on trust.

In terms of main findings, it should be noted that most of the research had relatively small samples, which means that some results should be confirmed by others. Additionally, most studies are short-term, with participants interacting with the robot for a short period or even just once.

We can note that authors highlight concerns about research generalizability due to robot, context, and communication variations persist (Karunarathne et al., 2020; Andtfolk et al., 2022; Zhang et al., 2023; Roozen et al., 2023). Future studies should diversify participants by age, socioeconomic status, and cognitive level across cultures (Leung et al., 2023; Plotkina et al., 2024). Additionally, high costs, maintenance demands, privacy risks, and biases are significant drawbacks emphasized by Kasimoglu et al., 2020; Leung et al., 2023; Plotkina et al., 2024; Mingotto et al., 2021.

We observe that the authors emphasize the need to investigate barriers to robot integration (Andtfolk et al., 2022), the need to improve real-time interactions and task engagement, which could enhance robot adaptability (Fan et al., 2021). Additionally, several authors mention the negative experiences of users interacting with robots and the need to understand these experiences, as well as the importance of exploring the impact of anthropomorphism on the perception of robot competence (Roozen et al., 2023; Zhu & Chang, 2020).

It can be observed that several authors highlight the importance of conducting longitudinal studies to track evolving attitudes and user perceptions of the quality of services provided by robots (Roozen et al., 2023).

These studies could also address novelty effects and provide more information on the long-term impact and intention to use robots (Lo et al., 2022; Plotkina et al., 2024; Nertinger et al., 2022). Additionally, the authors emphasize the importance of improving the technical capabilities of robots and personalizing robot interventions, including enhancing linguistic abilities, especially in real-world and noisy environments (Robinson & Kavanagh, 2021; Yoshii et al., 2023; Okafuji et al., 2022).

While the integration of social robots into various aspects of human activities offers promising opportunities, it also brings significant ethical and data privacy challenges. A major concern is that none of the analyzed papers address these issues, even though some acknowledge their importance. For example, Boch et al. (2020) identified several risks, including lack of transparency, data privacy issues, robot dependency, diminished human interaction, and potential job displacement, all of which require careful consideration. These challenges underscore the need for the responsible and safe deployment of social robots. Data privacy is a critical concern, as noted by Boch et al. (2020), necessitating clear protocols for data collection, processing, storage, and informed consent. Newton & Newton (2019) emphasize the importance of evaluating the appropriateness of the assumptions, values, and beliefs embedded in robots' instructional methods. Proper management and secure disposal of collected data, whether handled by robots or humans, are essential for maintaining privacy and safety. The creation of specific regulations to address new technological features that facilitate enhanced data collection highlights the need for ongoing policy development. These issues point to the necessity for developing regulations and public policies for social robots, a topic that will be crucial for future study and research (Subramanian, 2017). Collaboration among policymakers, developers, and privacy experts is essential to establish clear guidelines and policies that prioritize human well-being and rights (Boch et al., 2020).

6 Conclusion

The synergy between the evolution of artificial intelligence (AI), robotics, and digital connectivity is profoundly reshaping numerous sectors. Businesses are integrating these technologies to streamline operations, reduce costs, enhance customer interactions, and innovate products and services. A key facet of this technological transformation is the rise of social robots, designed to engage with individuals, enrich interactions, and elevate experiences across various domains. These robots, equipped with AI-driven capabilities and sensory awareness, can perceive and respond to their environment, engaging with people in a human-like manner. Social robots, characterized by their humanoid features such as heads, torsos, arms, and legs, hold significant promise, particularly in social robotics. Their design aims to seamlessly integrate into human interactions, exhibiting behaviors that foster communication, collaboration, and companionship.

The transformative potential of social robots is being explored in various sectors, including healthcare, mental health, care for the elderly, psychology, hospitality, and other services like the financial sector and cultural heritage. In healthcare, social robots have been used to reduce children's dental anxiety, promote health behavior changes, and enhance influenza prevention knowledge. Mental health applications include facilitating telepsychological interventions and early detection of cognitive impairments. For elderly care, robots offer emotional support and engage older adults in multidomain activities. In psychology, research focuses on robots' influence on emotional coping and concentration training. In the hospitality industry, robots serve as conversational agents, influencing consumer responses to service failures and shaping frontline employee roles.

Despite their potential, social robots face several challenges, including high costs, maintenance requirements, data privacy concerns, and issues related to user biases and unregulated mechanisms. Future research should address these challenges, explore the root causes of negative attitudes towards robots, and enhance robots' technical robustness and communication abilities. Longitudinal studies are needed to understand how user perceptions evolve over time, and interactive experiences with real applications should be incorporated to validate findings. Addressing these challenges and recommendations will ensure the effective and ethical integration of social robots, enhancing their functionality and acceptance in various environments.

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