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EXPLORING GENERATIONAL DIFFERENCES IN ATTITUDES TOWARD HUMAN-LIKE ROBOTS

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Abstract: *The rapid advancement of robotic technologies and artificial intelligence (AI) has sparked widespread interest and debate regarding their integration into various aspects of daily life. As robots become increasingly capable of performing tasks traditionally carried out by humans, understanding public perception of these technologies becomes crucial. The objective of this paper is to explore the generational differences in attitudes toward robots. While younger generations may be more open to the integration of robots into daily life, addressing the concerns of older generations will be crucial for widespread acceptance. This analysis highlights the importance of considering generational perspectives when developing and implementing robotic technologies in various sectors.*

Keywords: artificial intelligence; robots; consumers; anthropomorphic; acceptance; generations.

JEL classification: M31

1. Introduction

In recent years, there has been a growing interest in researching and implementing robots in contemporary society. The interaction between human and robots has emerged as an important area of study within robotics, encompassing aspects such as consumer characteristics, the roles of robots, and consumers' perception of robots. Robots are no longer confined to traditional industries; instead, they are increasingly integrated into various occupations and are becoming more and more popular in everyday life and work environments (Shen & Koyama, 2022). This integration of robotics into various sectors has advanced technology, making robots more accessible and versatile, with service robots enhancing efficiency in healthcare, education, and hospitality, and social robots improving human-robot interaction research. People now expect robots to resemble and interact like humans, making it essential for robots to act reliably and transparently to gain human trust (Felzmann et al., 2019; Zörner et al., 2021; Maggioni & Rossignoli, 2023). Moreover, AI devices have become a common presence in our homes and in some cases even companions for people who suffer from loneliness (Broekens et al. 2009).

The aim of this study is to explore generational differences in perception towards robotics and AI applications across various age groups and is structured as follows: The first part covers the theoretical aspects of AI device acceptance, including innovation, anthropomorphism, and social interaction. The empirical part examines age-related reactions to AI devices and robots. The final part presents comparative research results on individuals' perceptions and preferences regarding AI devices and robots.

2. Literature review

AI-driven robotics continue to grow globally, being present across multiple sectors like retail, hospitality, banking, healthcare, and education, offering to all industries an important support by increasing productivity through human-AI collaboration, reducing labor expenses, improving customer experiences, and enabling precise inventory tracking automation. The acceptance and interaction of consumers with new technologies, particularly humanoid robots, are influenced by various factors including age, gender, and cultural background. Research highlights the role of anthropomorphism and social capabilities in shaping users' perceptions and trust towards robots, with human-like appearances and behaviors often enhancing acceptance and emotional engagement. In this context, the analysis of the reactions that different generations of individuals had towards the use of AI devices may help developers to build more user-friendly applications and to fulfill more adequately the user's needs and expectations (Pelau & Barbul, 2021).

2.1. *Innovation*

Consumers' acceptance of new technologies is influenced by multiple factors like age, gender, and cultural background, potentially reducing the influence of a robot's physical appearance. Research shows that older adults might view humanoid robots with skepticism, while younger people may find them appealing. Additionally, perceptions of a robot's look can differ by gender and culture, with some societies placing greater importance on humanoid designs (Shehawy et al., 2024; Pelau et al., 2024). These demographic differences not only impact how robots are perceived but also influence concerns about job loss and the evolving skill requirements driven by AI and technological innovation (Ban et al., 2024).

2.2. *Anthropomorphism*

Anthropomorphism has gained in last decade substantial attention in fields like psychology, computer science, marketing, information systems, and management and it can be defined as the attribution of human-like qualities or characteristics to non-human entities (Aggarwal and McGill, 2007; Epley et al., 2007; Kim and McGill, 2011, Pop et al., 2023). Previous research shows that anthropomorphism affects individuals' judgments, motivations, and behaviors (Kim & McGill, 2011; Puzakova & Aggarwal, 2018; Kim et al., 2018). Consumers tend to form rapidly their impressions during the interaction with a robot by evaluating its physical attractiveness, familiarity, and nonverbal behavior (Beer et al., 2011; Riegger et al., 2021) and they, usually, are more likely to anthropomorphize humanoid robots than mechanical, non-humanoid ones, as they view humanoids as more capable of completing tasks and fostering emotional interactions (Lu et al., 2021).

Previous studies have been done on different range of robots and from this respect, findings on humanoid robots' physical appearance have varied. According to van Pinxteren et al. (2019), the perceived anthropomorphism, such as attractive facial features in Pepper robots, had a positive influence in users' trust and acceptance in public service settings. Similarly, Song & Kim (2020), found that the attractiveness of Pepper sale robots encouraged user adoption. However, Mende et al. (2019), noticed that interactions with humanoid robots in a restaurant, heightened consumer discomfort and compensatory behaviors, aligning with Mori's Uncanny Valley theory, where high human resemblance can evoke unease. Appel et al. (2020), also noted that humanoid robots' display of emotions like fear and embarrassment could induce eeriness. Conversely, Yoganathan et al. (2021), found that a human-like appearance in robots increased users' positive feelings and confidence in their competence compared to mechanical self-service machines.

2.3. *Social interaction*

De Ruyter et al. (2005), Song & Kim (2020) define social capability as a robot's ability to engage in interpersonal interactions, including skills like interactive communication, approachability, appropriate responses, and attentive listening without customer interruption while speaking. Consumers interacting with socially intelligent robots often feel that the robots care about them and are dependable (Song & Kim, 2020). Likewise, humanoid robots are frequently perceived as human-like, embodying qualities such as kindness, politeness, helpfulness and attractiveness (Haenlein & Kaplan, 2021; Ruijten et al., 2019).

All the characteristics mentioned previously, represent a motivational factor for users to engage with robots (de Graaf et al., 2015). In contrast, interactions with robots that lack social capabilities are often perceived as awkward, leading users to feel less trust and companionship with the robot (Mende et al., 2019). Recent studies indicate that robots with human-like appearances and social skills similar to those of humans tend to increase users' trust and acceptance of robot technology (Song & Kim, 2020; van Pinxteren et al., 2019). These interactions can also vary significantly across different age groups, with younger generations being more receptive to social robots due to their familiarity with digital communication and virtual interactions.

2.4. *Generational perspectives*

Generational perspectives play a crucial role in the acceptance and trust of robotic systems. Different generations exhibit distinct characteristics and attitudes towards technology based on their formative experiences. Other studies have shown differences in attitudes and perspectives toward AI and robots among different age groups (Pelau & Barbul, 2021). Generation Z, born from the mid-1990s to early 2010s, is notably familiar with digital technology from a young age (Turner, 2015). Millennials, born from 1981 to 1996, have witnessed the rapid evolution of technology and are generally tech-savvy (Bolton et al., 2013). Generation X, born from 1965 to 1980, experienced the transition from analog to digital and often balance traditional and modern views on technology (Prensky, 2001). Baby Boomers, born from 1946 to 1964, adapted to technology later in life and may have more conservative views on its integration (Czaja & Lee, 2007).

3. Research methodology

The present research paper investigates generational differences in attitudes toward robots by analyzing responses from 512 participants to 23 self-determined 7-point Likert scale questions, categorizing respondents into various age groups to identify potential generational variations. The questions were rated with values from 1 to 7, where 1 means that the respondents did not agree with the statement and 7 means that they fully agreed with it. The sample was selected using a stratified random sampling method to ensure representation across the different age groups. The questionnaire was administered online to reach a diverse and geographically dispersed population.

The research aims to uncover how familiarity with digital technology and varying levels of technological exposure influence perceptions of robotic capabilities, such as communication, emotional understanding, replacing human employees, and managing personal data. The findings provide valuable insights into the acceptance and trust of robotic systems across different generations, highlighting the need for tailored approaches in the development and communication of these emerging technologies.

To analyze the data, we employed various statistical tests using SPSS, including T-Test analyses, to identify significant differences between the generational cohorts. The use of the 7-point Likert scale was chosen to capture a wide range of responses and to enhance the reliability of the descriptive statistics. The following sections analyze the collected data with the aim of offering valuable insights and perspectives from different generational groups by splitting and comparing the responses and data collected across various age cohorts to seek significant differences.

4. Results

The following section will present and discuss the results of the comparison between age groups, initially by splitting the respondents into those under and over 25 years, and subsequently by dividing them into those below and above 40 years, also taking into account generational differences.

4.1. *Comparison under and over 25 years*

The initial analysis focused on respondents under 25 and those above to highlight the distinct differences in technology adoption and usage patterns between Generation Z and older age groups, who have varying levels of familiarity and comfort with digital advancements. Table 1 summarizes the results.

In terms of *perception of technological innovation* (Q1–Q2), both Generation Z (≤25 years) and older respondents (≥26 years) view robots' communication abilities and influence on the future of shopping as key innovations. Although Generation Z rated these features slightly lower, the difference was not statistically significant.

Table 1: Results of t-tests comparing age groups below and over 25 years

Question	x̄ ≤25 years	x̄ ≥26 years	x̄ diff.	t-talue	*p*-value
Q1: I consider the capacity of robots to communicate as an innovative element of technological evolution.	5.09	5.32	-0.233	-1.721	0.086

Question	x̄ ≤25 years	x̄ ≥26 years	x̄ diff.	t-talue	*p*-value
Q2: I believe that the use of this robot will influence the future of the shopping experience.	5.19	5.37	-0.179	-1.301	0.194
Q3: I believe this robot has the ability to explain requested information very well.	4.69	4.81	-0.120	-0.841	0.401
Q4: I believe that interaction with this robot can replace interaction with a human employee.	3.40	3.36	0.040	0.226	0.821
Q5: I believe this robot can manifest human emotions.	2.40	2.52	-0.120	-0.753	0.452
Q6: I believe this robot can understand human emotions.	2.64	2.53	0.106	0.658	0.511
Q7: I believe the empathetic behavior of this robot makes it seem human.	3.28	2.94	0.339	1.932	0.054*
Q8: I believe the responsiveness of this robot makes it seem human.	3.38	3.14	0.238	1.423	0.155
Q9: I believe the way this robot understands contexts makes it seem human.	3.34	3.19	0.148	0.882	0.378
Q10: I consider the ability of this robot to learn from mistakes as the element that makes it seem human.	3.69	3.46	0.226	1.350	0.178
Q11: I consider the ability of this robot to understand sarcasm as the element that makes it seem human.	3.61	3.21	0.400	2.270	0.024*
Q12: I consider the ability of this robot to hold a conversation as the element that makes it seem human.	3.76	3.47	0.291	1.710	0.088
Q13: I consider the ability of this robot to apologize as the element that makes it seem human.	3.48	3.46	0.027	0.158	0.874
Q14: I believe this robot has the capacity to be human through the answers it provides.	3.50	3.33	0.163	0.961	0.337
Q15: I believe this robot has the capacity to be human through its way of interacting with human consumers.	3.51	3.38	0.134	0.798	0.425
Q16: I have experienced confusing a robot with a human employee.	2.06	2.06	-0.001	-0.007	0.995
Q17: I feel uncomfortable when artificial intelligence systems seem too human-like.	3.76	4.10	-0.345	-1.993	0.047*
Q18: I believe our society is prepared to interact with a robot with human-like characteristics.	3.68	3.46	0.219	1.356	0.176
Q19: I believe our society is prepared to interact with a robot with human-like characteristics, even if it makes mistakes.	3.51	3.18	0.327	2.088	0.037*
Q20: I feel comfortable interacting with this robot.	4.11	3.90	0.206	1.294	0.196
Q21: I believe this robot can successfully replace human employees.	3.45	3.23	0.217	1.237	0.217
Q22: I intend to use the services of a company when I am assisted by this AI robot.	3.94	3.90	0.042	0.264	0.792
Q23: I trust the way this robot manages my personal data.	3.54	3.60	-0.061	-0.360	0.719

Source: Own research; **A significant difference was found at p < 0.05*.

Regarding the *robots' ability to explain and replace human interaction* (Q3–Q4), both age groups held similar views, showing no significant differences. This consensus suggests that neither Generation Z nor Millennials and above perceive robots as ready to fully replicate human explanatory skills or interaction capabilities. Also, when evaluating *robots' capacity to understand and express emotions* (Q5–Q6), both generations showed comparable levels of skepticism. This shared uncertainty reflects a broader perception that robots are currently limited in their ability to understand or demonstrate genuine human emotions.

With respect to *human-like behavior* (Q7–Q10), a minor difference emerged: Generation Z respondents were more likely to view empathetic behavior in robots as making them seem human-like, with this tendency nearing statistical significance (p_{Q7}=0.054). However, both groups demonstrated similar views on other aspects of human-like behavior, such as responsiveness and context-awareness. The general opinion of respondents shows they are not convinced about these aspects, as the average scores for both categories are around 3.5.

In *understanding sarcasm* (Q11), younger respondents showed a stronger tendency to value a robot's ability to recognize sarcasm as a human-like trait, a distinction that reached statistical significance (p_{Q11}=0.024). This finding may indicate that younger generations place greater importance on nuanced communication abilities. In contrast, regarding overall *conversational abilities* (Q12–Q13), both age groups responded similarly, showing no significant differences in their perception of robots' conversational skills, including the ability to apologize. This alignment suggests a shared understanding of the limitations in robots' ability to hold human-like conversations. Furthermore, in terms of *human-like interaction* (Q14–Q15), both groups also expressed similar perceptions of a robot's ability to emulate human responses in consumer interactions, showing no significant generational differences. Also, regarding *potential confusion between robots and human employees* (Q16), both age groups indicated that they can easily distinguish between robotic and human employees, suggesting that robots are not yet perceived as convincingly human-like.

When it comes to *comfort and trust in robots* (Q17–Q23), a few differences emerged. Older respondents expressed more discomfort with robots that appear overly human-like (p_{Q17}=0.047), while Generation Z showed stronger confidence in society's preparedness to engage with human-like robots, even those prone to errors (p_{Q19}=0.037). Across other measures of comfort, trust, and the potential for robots to replace human workers, no significant differences were observed. Overall, the average scores for both age categories are around or higher than 3.5 except Q17 and Q18 (the mean of older respondents) and Q21 (average results of both groups). This shows that interviewees are generally eager to interact with AI robots, but regardless of age, they do not fully trust robots to replace humans.

In summary, while both Generation Z and Millennials and above generally agree on the capabilities and limitations of robotic technology, younger respondents are slightly more receptive to human-like robots and value traits like sarcasm. Older respondents feel more discomfort with highly human-like robots. Younger respondents (≤25 years) are more optimistic about society's readiness to interact with human-like robots, even if they make mistakes. Despite these differences, there is broad consensus across generations on many aspects, such as the robot's ability to communicate, explain information, replace human interaction, and manage personal data. These insights suggest that while younger generations may be more open to integrating robots into daily life, addressing older generations' concerns about human-like behavior will be crucial for widespread acceptance. This split between age groups below and above 25 years revealed some generational differences in perceptions of robots, but many views are shared.

4.2. Comparison over and under 40

A second split in the data, this time between generations below and over 40 years, reveals new insights and uncovers some significant differences, highlighting how generational experiences and attitudes towards technology vary markedly between these age groups. The findings provide a deeper understanding of the unique perspectives and behaviors of individuals in these distinct generational cohorts. Table 2 summarizes the results. Notably, younger respondents (≤40 years) generally exhibiting more favorable views on the capabilities and acceptance of robots in various roles compared to older respondents (≥41 years). Table 2 summarizes the results. Specifically, younger respondents were more likely to believe that interaction with robots could replace interaction with human employees (p_{Q4}=0.012), and that robots have the capacity to understand human emotions (p_{Q6}=0.019). They also perceived empathetic behavior (p_{Q7}=0.037) and the ability to understand sarcasm (p_{Q11}=0.012) as significant factors contributing to the human-like qualities of robots. However, when the sample was split into interviewees below and over 25 years, the differences were less pronounced, suggesting that Generation Z's familiarity with digital technology from a young age shapes positive perceptions of robots.

Table 2: Results of t-tests comparing age groups below and over 40 years

Question	x̄ ≤40 years	x̄ ≥41 years	x̄ diff.	t-talue	*p*-value
Q1: I consider the capacity of robots to communicate as an innovative element of technological evolution.	5.147	5.368	-0.222	-1.282	0.200
Q2: I believe that the use of this robot will influence the future of the shopping experience.	5.255	5.319	-0.064	-0.367	0.714
Q3: I believe this robot has the ability to explain requested information very well.	4.736	4.747	-0.011	-0.061	0.951
Q4: I believe that interaction with this robot can replace interaction with a human employee.	3.486	2.915	0.571	2.511	0.012*
Q5: I believe this robot can manifest human emotions.	2.500	2.232	0.268	1.323	0.186
Q6: I believe this robot can understand human emotions.	2.681	2.200	0.481	2.344	0.019*
Q7: I believe the empathetic behavior of this robot makes it seem human.	3.216	2.747	0.468	2.096	0.037*
Q8: I believe the responsiveness of this robot makes it seem human.	3.334	3.011	0.324	1.522	0.129
Q9: I believe the way this robot understands contexts makes it seem human.	3.317	3.105	0.211	0.990	0.323
Q10: I consider the ability of this robot to learn from mistakes as the element that makes it seem human.	3.623	3.432	0.191	0.896	0.371

Question	x̄ ≤40 years	x̄ ≥41 years	x̄ diff.	t-talue	*p*-value
Q11: I consider the ability of this robot to understand sarcasm as the element that makes it seem human.	3.543	2.979	0.565	2.511	0.012 *
Q12: I consider the ability of this robot to hold a conversation as the element that makes it seem human.	3.712	3.298	0.414	1.906	0.057
Q13: I consider the ability of this robot to apologize as the element that makes it seem human.	3.490	3.394	0.097	0.437	0.662
Q14: I believe this robot has the capacity to be human through the answers it provides.	3.489	3.147	0.342	1.581	0.114
Q15: I believe this robot has the capacity to be human through its way of interacting with human consumers.	3.526	3.137	0.390	1.829	0.068
Q16: I have experienced confusing a robot with a human employee.	2.101	1.895	0.206	1.137	0.257
Q17: I feel uncomfortable when artificial intelligence systems seem too human-like.	3.794	4.411	-0.617	-2.805	0.005 *
Q18: I believe our society is prepared to interact with a robot with human-like characteristics.	3.661	3.232	0.429	2.103	0.036 *
Q19: I believe our society is prepared to interact with a robot with human-like characteristics, even if it makes mistakes.	3.483	2.874	0.609	3.065	0.002 *
Q20: I feel comfortable interacting with this robot.	4.153	3.421	0.732	3.650	0.000 *
Q21: I believe this robot can successfully replace human employees.	3.465	2.884	0.581	2.606	0.009 *
Q22: I intend to use the services of a company when I am assisted by this AI robot.	4.019	3.484	0.535	2.689	0.007 *
Q23: I trust the way this robot manages my personal data.	5.147	5.368	-0.222	-1.282	0.200

Source: Own research; **A significant difference was found at $p < 0.05$*.

Generation Z, having grown up with digital technology, demonstrate the highest comfort levels in interacting with robots and trusting them with personal data. Millennials, who witnessed the rapid evolution of technology, also show a strong belief in the innovative potential of robots and their ability to influence the future shopping experience. In contrast, Generation X and Baby Boomers, who experienced the transition from analog to digital and adapted to technology later in life, respectively, exhibit more conservative views. They seem more likely to feel uncomfortable with human-like AI (Q17, p=0.005) and less convinced of society's readiness to interact with human-like robots, even if they make mistakes (p_{Q19}=0.002).
Interestingly, while younger generations are more inclined than older respondents to accept that interactions with robots could replace interactions with human employees (Q4) and that robots could successfully replace human employees (Q21), they still exhibit some reluctance towards the latter scenario. As regards the intention of making recourse to the services of a company when there is the possibility of being assisted by an AI robot (Q22), younger respondents seemed more eager to this scenario (p_{Q22}=0.007). Even though the older generations are not that influenced by

this possibility, their average score was close to 3.5, which reflects that even them might be enthusiastic about such a circumstance.
These generational differences can be attributed to varying levels of exposure to and comfort with digital technologies. Younger generations, being more tech-savvy and accustomed to rapid technological advancements, tend to have a more optimistic view of robots' capabilities and their integration into daily life. In contrast, older generations, who have had to adapt to these changes later in life, may harbor more skepticism and discomfort towards the increasing human-like qualities of robots.
These findings suggest that while there is a generational divide in the acceptance and perceived capabilities of robots, particularly in emotional and empathetic contexts, both age groups recognize the broader technological advancements represented by robotic communication and functionality.

5. Conclusions

The decision to split the sample of respondents into those below and above 40 years of age was based on the distinct life experiences and technological exposure characteristic of these age groups. Those below 40, including Generation Z and Millennials, have grown up with rapid technological advancements, leading to greater comfort with emerging technologies like robotics and AI. In contrast, those above 40, including Generation X and Baby Boomers, have experienced a more gradual integration of technology, balancing traditional and modern views. The insights gained from this classification are particularly relevant as they highlight generational differences in the acceptance and perceived capabilities of robots. Younger respondents (≤40 years) demonstrated significantly more favorable views towards the potential of robots in various roles, including their ability to replace human interaction and understand human emotions, as evidenced by the statistical results. This generational divide underscores the importance of tailoring technological developments and communication strategies to address the distinct expectations and comfort levels of different age groups.
The split between respondents below and above 25 showed fewer significant differences, suggesting Generation Z's early exposure to digital technology fosters positive perceptions of robots. In contrast, the broader 40+ age division captures a wider range of technological adaptation, offering deeper insights into generational differences. Understanding these perspectives helps stakeholders address diverse age groups' needs, easing the integration of advanced robotics across sectors.

6. Research limitations

The study has several limitations. The sample size of 512 participants may not fully represent the broader population, lacking diversity in geographical location, socioeconomic status, and cultural background. Self-reported data from Likert scale questions introduce potential biases. The cross-sectional design captures perceptions at a single point in time, missing changes over time. Age group classifications may overlook individual experiences, and Likert scale questions might not cover all aspects of robotic capabilities. Contextual factors like media coverage and personal experiences with robots were not considered. Rapid technological advancement means perceptions may quickly become outdated. The focus on generational differences may overlook other demographic factors. Lastly, the study does not address economic implications, job displacement, or ethical considerations.

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