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articles

Sociodemographic Impact on the Adoption of Emerging Technologies

Juan María González-Anleo[1a], Luca Delbello[1b], José Maria Martínez-González[1c], Andres Gómez[2d]

[1] ESIC University, [2] ESIC University - ESIC Business & Marketing School

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This study investigates the influence of gender and age on the acceptance of emerging technologies such as robotics and artificial intelligence (AI), Using the Spanish Sociological Research Centre's Science and Technology Perception Survey 2023. This is a representative sample of the Spanish population, comprising 2,384 responses. The results obtained using Ordinary Least Squares Regression reveal highly significant differences in acceptance and interest in technology, with women and older people showing less enthusiasm towards AI and robotics. The study also uncovers a nuanced perception of the socio-cultural impact of technology. While concerns about dehumanization were evident, fears related to elitism and inequality were not significantly supported. These findings highlight the need for inclusive and sensitive strategies in the development and implementation of new technologies by both corporate CSR policy and public policy.

Introduction

How is advanced technology, such as artificial intelligence (AI) and robots, transforming today's society and human perception? Recent reports from McKinsey (2023) and Deloitte (2023) clearly argue that advances in automation and AI will mark a turning point in global sectoral transformation. Consequently, in the age of digitization and automation, the social acceptance of technology, particularly robots and AI, has captured the attention of multiple academic disciplines. Researchers such as Venkatesh and Morris (2000) and Ajzen and Fishbein (1980) have provided a solid foundation for understanding technology adoption, using models such as TAM and UTAUT. These models have been instrumental in investigating how socio-demographic variables, such as gender and age, influence the perception and acceptance of technology. However, due to recent developments in this field, it is essential to understand the evolution of these perceptions in different markets.

In this study, 'acceptance' refers to the willingness to use technology, 'acceptability' refers to the perceived appropriateness of technology within a social context, and 'adoption' refers to the actual use and integration of technology into daily routines. These definitions will be used consistently throughout the manuscript.

Thus, the study of the interaction between demographic variables, such as gender and age, and their impact on the acceptance of emerging technologies such as AI and robots, is a field of growing interest in the business and digital transformation literature (i.e. Bouncken & Schmitt, 2022; Dörr et al., 2023; Gallego-Gómez & Vaquero-Frías, 2022). Despite the plethora of previous research that has addressed technology acceptance from multiple perspectives, there is a notable lack of understanding of how these specific variables interact with perceptions and attitudes towards technology. Research such as that of Venkatesh and Morris (2000) has highlighted gender differences in technology adoption, suggesting that these differences may be rooted in social behaviours and gender roles. However, the literature has yet to fully integrate these differences into a framework that fully considers how demographic and psychosocial dimensions affect technological acceptability.

a Juan María González-Anleo, juanmaria.gonzalezanleo@esic.university
ESIC University, Spain

b Luca Delbello, luca.delbello@esic.university
ESIC University, Spain

c José Maria Martínez-González, josemaria.martinez@esic.university
ESIC University, Spain

d Andres Gómez, andres.gomez@esic.university (corresponding author)
ESIC University - ESIC Business & Marketing School, Spain

The analysis of the relationship between gender and technology use, explored by various research (Gross, 2023; Hipólito et al., 2023; Newstead et al., 2023), has begun to shed light on how emerging technologies may perpetuate or mitigate gender biases. Despite these advances, a research gap persists regarding a comprehensive understanding of the role gender plays, not only in perceptions of and attitudes towards AI and robots, but also in how these perceptions translate into technological acceptance or resistance. Furthermore, some studies point to greater scepticism towards robots among women compared to men and suggest that gender-specific preferences and perceptions may be key factors in shaping interest and acceptance of the technology (Scopelliti et al., 2005). This scepticism and variations in motivation during communication (Siegel et al., 2009) underline the need for a more nuanced approach that considers gender differences in the design of robotic behavioural systems and the implementation of emerging technologies. Recently, it has been confirmed that sociodemographic dimensions, such as age and socio-economic status, moderate the relationship between innovation and robot/IA opinions (Méndez-Suárez, Monfort, et al., 2023). However, it seems necessary to narrow the analysis of perceptions to technology and robotics and AI in particular and focus it on specific markets.

Similarly, the influence of age on the perception and acceptance of emerging technology presents another underexplored area. Although some studies (LaRose & Eastin, 2004) have identified that age significantly affects attitudes towards new technologies, research on how ageing societies, and in particular individual differences within these age groups, perceive and engage with AI and robots remains limited. Evidence that older people may be more distrustful of these technologies (Scopelliti et al., 2005) and that there are significant differences in willingness to accept robots between older men and women (Stafford et al., 2014) suggests a complex intersection between age, gender and technology that has yet to be fully unravelled.

Consequently, this research aims to fill these gaps by providing a detailed analysis of how demographic and psychosocial variables interact to influence the acceptability of AI and robots. This study aims to address these gaps by delving into the analysis of how demographic variables and attitudes towards technology shape the perception and acceptance of technology, particularly robots and AI. In this sense, new dimensions of the human-technology relationship are explored.

In this paper, the terms ‘robots’ and ‘AI’ are used interchangeably to reflect the overlapping nature of these technologies in terms of their applications and impact on society. Both robots and AI systems often utilize similar underlying technologies and contribute to automation and intelligent decision-making processes.

The structure of the article begins with a development of the hypotheses, subsequently setting out the sample and data analysis. It then presents the results, discussion and, finally, conclusions and future lines of research.

Theoretical Framework

In the field of technology acceptability research, such as mass exploitation of AI or robots, there has been extensive use of technology acceptance models (TAMs), originating from the theory of reasoned action (Fishbein & Ajzen, 1975) and extensively developed in subsequent studies (Crittenden et al., 2019; Hong et al., 2006; Rauniar et al., 2013; Venkatesh & Morris, 2000). These models assess users’ attitudes towards technology, focusing on perceived usefulness and ease of use, concepts that are fundamental to understanding users’ intentions towards technology (Montero-Guerra et al., 2023; Yen et al., 2010). Subsequent research has confirmed that perceived usefulness is a crucial factor in technology adoption (Pontiggia & Virili, 2010; Yen et al., 2010). A significant development in this field is Venkatesh et al.'s (2003) Unified Theory of Acceptance and Use of Technology (UTAUT), which integrates several preexisting models and has been applied in a wide range of technological contexts (Alaiad & Zhou, 2014; Heerink et al., 2010). This theory emphasizes four key drivers: performance expectancy, effort expectancy, social influence and facilitating conditions, and has been updated to include variables such as hedonic motivation, price value and habit (Venkatesh et al., 2012).

In these contexts, factors such as age, gender, experience and voluntariness moderate technology acceptance (Venkatesh et al., 2003). However, many models have not effectively incorporated demographic variables or personality differences (Gessl et al., 2019). The influence of these demographic factors on trust in robots has been an area of research interest (Scopelliti et al., 2005), highlighting the importance of analysing users’ age, gender, cultural background and other characteristics in understanding robot acceptance. In relation to robots, specific models have been developed, such as the Almere Model for the acceptance of social robots among elderly people (Heerink et al., 2010). Also, de Graaf et al. (2019) and Turja et al. (2020) have proposed models based on the Theory of Planned Behaviour and specific principles for the use of care robots. All this justifies the possibility of creating models as this paper proposes. In order to determine the best way to bring technology closer to potential users, it is also crucial to examine the set of effects of the socio-demographic characteristics of potential users.

In this regard, the relationship between gender and technology use has been widely explored from different perspectives. Newstead et al. (2023) discuss how AI can perpetuate or help mitigate gender bias in leadership. On the other hand, Gross (2023) notes that language models such as ChatGPT can amplify older, non-inclusive perceptions of gender. Hipólito et al. (2023) suggest a gender-inclusive approach to AI, stressing the importance of explainability and equity. In addition, research by Venkatesh and Morris (2000) highlights gender disparities in technology adoption, suggesting that such divergences may stem from differences in social behaviours and gender roles. In this framework, work by Ivanov and Webster (2019) highlights the need to understand the impact of gender on how tech-

nological devices, specifically robots, are perceived. It has thus been documented that there is a trend of greater scepticism towards robots among women compared to men, as indicated by numerous research studies (i.e. Gnambs & Appel, 2019; Hohenberger et al., 2016; Scopelliti et al., 2005).

This scepticism has been explained by evidence that women may show less interest in emerging technologies such as AI and robots due to differences in perceptions and preferences towards anthropomorphic-looking devices (Pelau et al., 2021). Additionally, it has been found that there are variations in the motivations of men and women during communicative interaction, which is crucial for the design of robotic behavioural systems, as pointed out by some studies (Siegel et al., 2009). Such findings suggest that the particular preferences and perceptions associated with each gender play an important role in interest in robots and AI (Pelau et al., 2022).

Regarding the impact of age on interest in robots, research has shown that older people tend to trust robots and automated processes less than younger people, and have more negative emotions towards robots (Oksanen et al., 2020). Furthermore, a study on robotics education for young children found differences in robotics knowledge in different age groups, indicating a possible correlation between age and interest in robots (Jung & Won, 2018). As for age, recent studies have found that it significantly affects attitudes towards new technologies (LaRose & Eastin, 2004). Although ageing societies may have a more positive view of robots, at the individual level, older people show more negative attitudes (Gnambs & Appel, 2019).

Scopelliti et al. (2005) highlight that older people are often distrustful of new technologies, although this can be mitigated by personalized education and mentoring (Mitzner et al., 2010). In addition, older men are more willing to accept robots than women of similar ages (Stafford et al., 2014). Thus, evidence suggests that both gender and age are important factors affecting robot acceptance. While some studies have not found a clear impact of gender on robot acceptance (Shibata et al., 2009), most support the idea that women and older people are more reluctant to adopt this technology (Gallimore et al., 2019).

In summary, while existing research offers valuable insights, it also presents a complex and sometimes contradictory picture of how gender and age influence the perception and acceptance of technology, particularly in the context of AI and robotics. This complexity and diversity in findings underscores the need for deeper and more nuanced analysis, leading to the formulation of the following hypotheses for our research:

> **H1.** Gender and age affect interest in robots and AI.
> **H1a.** Women have less interest in emerging technology, such as robots or AI.
> **H1b.** As age increases, interest in robots decreases.

The relationship between technology and its associated risks to society is an area of growing academic interest (i.e. Méndez-Suárez, de Obesso, et al., 2023; Troilo, 2023; Wu & Monfort, 2022). For example, the fear of job loss due to automation is a prominent concern in the discourse on technological risks. Rampersad (2020) addresses this fear, noting that innovations in robotics could supplant numerous occupations. Similarly, Frey and Osborne (2017) quantify this risk, projecting that around 47% of jobs in the United States could be automated. This trend is corroborated by Bogliacino et al. (2013), who note how technological innovation precipitates job losses in traditional sectors such as retail, banking and manufacturing. Cirillo et al. (2018) extend this analysis, linking these job losses to more vulnerable occupational groups, while Dachs and Peters (2014) identify process innovation as a catalyst for layoffs stemming from productivity gains. These findings suggest that technology can act as an agent of social differentiation, exacerbating existing inequalities.

Research by Hertog et al. (2023) introduces an additional dimension to this debate by estimating that automation of domestic work could reduce up to 60% of time spent on domestic work, implying a significant shift in the gender division of labour and underlining the complexity of the social implications of technology. Nomura (2017) and subsequent studies, in addition to delving deeper into gender differences, highlight concerns about the social impact of these innovations. However, other studies have explored assistive technologies and remote monitoring, highlighting their potential to mitigate inequalities in healthcare and improve the well-being of ageing populations (Sapci & Sapci, 2019). This research, along with other work that has addressed similar issues (i.e. Adam et al., 2020; Zafrani & Nimrod, 2018), reflects the changing role of technology in society and its ability to influence social interaction, customer care and well-being of older adults.

Critical analysis of the existing literature reveals a complex intersection between technology, social risks and the transformation of social dynamics and well-being. This body of work underscores the need for a rigorous assessment of how technology can perpetuate elitism, deepen inequalities and contribute to dehumanization. Schwab (2017) extends this discourse by considering how the fourth industrial revolution may reshape not only our activities, but also our identity and relationships, pointing to the challenges inherent in the increasingly close relationship between humans and technology.

Bernard Stiegler, whose work on new media had a great influence on the ways in which academics perceive and analyze communication and information, famously argues that the role of technology has never been more crucial due to its new status as an ever-present human and social interaction (Stiegler, 1998). Following Heidegger's intuition (Heidegger, 1977), his analysis emphasizes how technology is directly and dialectically tied to the ways in which human beings create their consciousness. For the first time in the history of technology, everyday objects become "alive," with their own ontology (Stiegler, 1998; Turner, 2016). According to Stiegler, the constant and fast pace at which technology reinvents itself leads to a generalized feeling of anxiety and to a reduced span of attention in the Western population, which fails to grasp its underlying significance (Turner, 2016). Moreover, his study focuses in particular on how the spread of technology undermines community and

symbolic creation (Stiegler, 2016). His work has been explored and extended by Byung-Chul Han, who argues that the main difference between old and new objects rests on the absence of "sameness" in the latter. In other words, the constant change in technology makes it so that human beings cannot find a sense of stability which previous objects conferred, leading to a sense of loss of orientation and direction (Chul-Han, 2020).

In conclusion, academic evidence argues for a holistic approach to understanding the social implications of technology. This approach should consider how technological innovations affect social structure, economics, gender relations and human interaction, highlighting both the challenges and opportunities presented by the digital age. This detailed analysis provides the basis for formulating specific hypotheses about the social risks associated with technology.

> **H2.** Technology is perceived with a higher risk to society.
> **H2a.** Technology is perceived with elitism.
> **H2b.** Technology is perceived with inequality.
> **H2c**. Technology is perceived with dehumanization.

Data and methods

This research is based on a secondary analysis of the Science and Technology Perception Survey (Centro Investigaciones Sociologicas, 2023), carried out through in-person interviews among Spanish citizens aged 18 and older; the survey sampling was representative of the national population. It covers a wide area of questions related to innovation and robotic applications and includes a set of attitude measures towards innovation. Although the database contained a sample of 2,924 observations, after removing all the answers corresponding with 'do not know' or 'do not answer', the number of valid observations was reduced to 2,384, 47% women and 53% men with average ages of 48.2 and 48.4 respectively. The analysis was based on Ordinary Least Squares Regression.

The questionnaire was designed to capture a wide range of attitudes and perceptions towards technology. It included sections on demographic information, technology usage habits, and specific questions related to the acceptance of AI and robots. The survey was distributed through in-person interviews conducted by trained interviewers, ensuring a representative sample of the Spanish population.

This study examines the factors that influence interest in robots using a sample of 2384 participants. The dependent variable was "Interest in Robots" and is measured on a scale of 1 to 5, where after inverting the values, 1 is Not at all interested and 5 is Very interested. The final measure is a 5-point Likert scale.

Results

This study examines the factors that influence interest in robots using a sample of 2384 participants. The dependent variable was "Interest in Robots" and is measured on a scale of 1 to 5, where after inverting the values, 1 is Not at all interested and 5 is Very interested. The results of the linear regression revealed several significant findings which are shown in Table 2.

First, the coefficient for "Woman" was -0.459 ($p < 0.001$), indicating that, on average, Spanish women show a significantly lower interest in robots compared to men by almost 0.5 points out of 5, i.e., almost 10% less interest than men. Furthermore, age has a negative effect on interest in robots, with a coefficient of -0.005 ($p < 0.001$), suggesting a decrease in interest of 0.005 for each additional year that the person has, for example, for a person aged 40, their degree of interest in robots would have decreased by 0.2 points out of 5 and in the case of a person aged 80 this decrease would have been 0.4 points or almost a 10% loss of interest.

On the other hand, people who have a good perception of robots also think that in the next 20 years AI may come to represent a danger (coefficient = 0.085, $p < 0.001$). On the other hand, "Association of technology with dehumanisation" reduced interest (coefficient = -0.072, $p < 0.001$). However, the variables "Association of Technology with elitism" and "Association of Technology with inequality" are not related to the perception of robots.

Discussion

The present research falls within the framework of technology acceptability, drawing on technology acceptance models such as the TAM and UTAUT (Ajzen & Fishbein, 1980; Venkatesh et al., 2003; Venkatesh & Morris, 2000). These models have been instrumental in understanding how factors such as perceived usefulness and perceived ease of use influence attitudes towards technology (Davis et al., 1989; Yen et al., 2010). The results support and extend these theories, highlighting the influence of demographic variables such as gender and age on the acceptance of emerging technologies such as AI and robots.

To address the varied acceptance levels across different demographic groups, it is essential to develop customized training programmes and awareness campaigns. These programmes should cater specifically to different age and gender profiles. Additionally, integrating inclusive design features in technology can significantly enhance user engagement across a broader spectrum.

Our results corroborate previous studies that have identified significant differences in technology acceptance based on gender and age (Gross, 2023; Hipólito et al., 2023; Newstead et al., 2023; Venkatesh et al., 2003). Specifically, it was observed that women and older people tend to show less interest in emerging technologies such as robots and AI, which aligns with previous research (Gnambs & Appel, 2019; Scopelliti et al., 2005). This trend underscores the need to address cultural and educational barriers to promote more equitable adoption of these technologies.

On the other hand, the results revealed that while technology is associated with an increase in perceived risk, particularly in terms of dehumanization, no significant association with elitism or inequality was found. This contrasts with concerns about job loss and social inequalities that are often associated with technology (Bogliacino et al., 2013; Cirillo et al., 2018; Frey & Osborne, 2017; Rampersad,

Table 1. Questions related to opinions about "Interest in Robots".

Variable	Question
Association of technology with progress	I would like to know to what extent you associate or relate each of these words to science: Progress
Hazards of AI in the next 20 years	Looking ahead to the next 20 years, in your opinion, will the development of science and technology bring many benefits, few benefits or no benefits at all?
Association of technology with dehumanization	I would like to know to what degree you associate or relate each of these words to science: dehumanization
Association of technology with elitism	I would like to know to what extent you associate or relate each of these words to science: elitism
Association of technology with inequality	I would like to know to what extent you associate or relate each of these words to science: inequality

Table 2. Ordinary least squares regression, dependent variable: Interest in Robots.

Dependent variable Interest in Robots	Coefficient	Std. Error	T-Stats
Intercept	2.697	0.177	15.225***
Women	-0.459	0.049	-9.465***
Age	-0.005	0.001	-3.534***
Association of technology with progress	0.269	0.029	9.144***
Hazards of AI in the next 20 years	0.085	0.019	4.481***
Association of technology with dehumanization	-0.072	0.021	-3.485***
Association of technology with elitism	0.023	0.020	1.172
Association of technology with inequality	-0.023	0.021	-1.081
n	2,384		
R^2	0.089		

Sig. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

2020). However, it reflects a growing concern about the impact of technology on fundamental aspects of humanity, such as social relationships and empathy (Schwab, 2017).

These findings have significant implications for CSR and sustainability by highlighting the issues that companies should be concerned about in the design and implementation of emerging technologies. It is essential that technology developers and policymakers consider demographic differences and strive to humanise technology. They should also pay attention to social and ethical concerns related to technology adoption to mitigate the risks of dehumanization and ensure a harmonious integration of these technologies into society.

This study has several limitations that should be acknowledged. The sample is limited to the Spanish population, which may affect the generalizability of the findings to other cultural contexts. Additionally, the methodology relies on self-reported data, which can be subject to biases. Future research should aim to include more diverse samples and utilize mixed-method approaches to validate the findings.

Conclusions

This study has provided a comprehensive view on how gender and age influence the acceptance of emerging technologies, particularly in the field of AI and robotics. Based on established models of technology acceptance, such as TAM and UTAUT, clear patterns have been identified that indicate a lower inclination of women and older people towards these technologies. The study underlines the need for inclusive and demographically sensitive strategies in the development and implementation of advanced technologies. In addition, the research reveals that while technology is associated with risks of dehumanization, concerns about elitism and inequality are not as prominent as anticipated, suggesting a shift in public perception about the socio-cultural effects of technology.

In conclusion, the adoption of inclusive design features and the implementation of tailored educational strategies are crucial for enhancing user engagement. These approaches are particularly important for addressing the diverse needs of different demographic groups, thereby improving the overall effectiveness of technology adoption.

At the same time, these findings emphasize the importance of addressing the dehumanization risks associated with technology. Growing concerns about how emerging technologies may affect fundamental aspects of the human experience, such as social interactions and empathy, pose critical challenges for developers, policymakers and educators. It is therefore crucial that future technological innovations focus not only on efficiency and utility, but also on how they can enrich and complement the human experience, while preserving and promoting ethical and social

values. This is an aspect that should be integrated into companies' sustainability and CSR policies.

Future lines of research

While our current study takes a global perspective on technology acceptance, future research should focus on specific sectors of interest to the global economy. By examining technology acceptance in particular market contexts, we can provide a more detailed analysis that addresses the unique characteristics and challenges of each sector.

An important future line of research focuses on further exploring the cultural and educational barriers that influence the perception and acceptance of technology by different demographic groups. It would be valuable to investigate how specific interventions, such as educational programmes and awareness campaigns, can improve technology acceptance among women and older people. In addition, studies examining how cultural and media representations of AI and robotics affect the attitudes of these groups could provide critical insights for the development of more effective communication strategies.

The findings of this study have additional implications for future research. Researchers should explore the impact of technology acceptance in specific sectors, such as healthcare, education, and manufacturing. Additionally, investigating the role of cultural factors and cross-national comparisons can provide deeper insights into the global dynamics of technology adoption. Finally, integrating qualitative methods will offer a more nuanced understanding of the motivations and barriers to technology acceptance.

Future research should also incorporate qualitative methods such as interviews, focus groups, and case studies. These approaches will enrich our understanding of the underlying attitudes and motivations that influence technology acceptance or resistance. By providing a more detailed perspective on the ways different sociodemographic groups perceive and interact with technology, qualitative methods will complement the quantitative data gathered in this study.

Another promising area for future research is the study of the ethical and emotional aspects of human-technology interaction. Given the increasing focus on the risks of dehumanization, it would be beneficial to investigate how different designs and approaches to interaction with AI and robots may influence empathy, trust and social skills. This line of research should include the exploration of technologies that foster positive interaction and the development of social skills, as well as the study of the long-term impact of these technologies on society. Such research would not only contribute to technological development, but also to the understanding of the evolution of society in the digital age.

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