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Social and societal issues in AAL

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Lutz, C., Miguel, C., Mujirishvili, T., Perez Vega, R. ORCID: https://orcid.org/0000-0003-1619-317X and Fedosov, A. (2025) Social and societal issues in AAL. In: Salah, A. A., Colonna, L. and Florez-Revuelta, F. (eds.) Privacy-Aware Monitoring for Assisted Living Ethical, Legal, and Technological Aspects of Audio- and Video-Based AAL Solutions. Intelligent Systems Reference Library. Springer, Switzerland. ISBN 9783031841576 doi: 10.1007/978-3-031-84158-3_13 Available at https://centaur.reading.ac.uk/123488/

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To link to this article DOI: http://dx.doi.org/10.1007/978-3-031-84158-3_13

Publisher: Springer

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Chapter 13
Social and Societal Issues in AAL

Christoph Lutz, Cristina Miguel, Tamara Mujirishvili, Rodrigo Perez-Vega, and Anton Fedosov

Abstract Active Assisted Living (AAL) systems use advanced technology to help older, impaired, or frail people live independently and stay active in society. These systems rely on automated data monitoring in home or care environments, processing video, image, audio, environmental, and motion data through artificial intelligence (AI), particularly machine learning. Thus, AAL systems offer considerable opportunities for efficient health monitoring, increased autonomy, and enhanced quality of life for older adults. However, AAL technologies also present ethical, legal, and social challenges, particularly around privacy due to the sensitive nature of the data collected and the vulnerability of the populations served. Beyond privacy, the broader social implications of AAL must be considered, including the potential reshaping of care relationships and work within the sector. This chapter provides an in-depth overview of the social and societal issues surrounding AAL, offering a comprehensive literature review that highlights the challenges in implementing these systems in everyday life. Specifically, the chapter discusses cultural differences, biases, the normalization of surveillance, the reshaping of care work and relationships, and matters of trust and adoption, alongside the opportunities AAL technology offers for prolonged independent living.

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A. A. Salah et al. (eds.), *Privacy-Aware Monitoring for Assisted Living*,
Intelligent Systems Reference Library 270,
https://doi.org/10.1007/978-3-031-84158-3_13

Keywords Active assisted living (AAL) · Society · Trust · Bias · Dataveillance · Cultural adaptation · Care work · Digital inequality

13.1 Introduction

Active Assisted Living (AAL) systems have emerged as a response to the aging populations in many countries and the corresponding increase in demand for long-term care [3]. These systems leverage sophisticated technology such as machine vision and natural language processing (NLP) to create environments that support older adults, individuals with disabilities, and those with chronic illnesses in maintaining their independence and quality of life. One example of AAL technology is the use of smart home sensors to monitor the daily activities and health status of older adults. For instance, the final evaluation report of the European Active and Assisted Living Research and Development Programme (AAL2) highlighted how integrated AAL systems "actively contributed to developing a positive perspective on ageing instead of considering ageing as a social and economic problem" [35, p. 41]. However, this deployment also brings to light significant potential for social issues, for example privacy infringements and caregivers' need for new skills to manage and interpret the data generated by these systems.

The rise of AAL technologies represents both a technological innovation and a societal challenge. While these systems promise enhanced autonomy and health monitoring for older adults, they also raise ethical, legal and social concerns (see [19, 29] in this volume). For instance, the pervasive data collection inherent in AAL systems can lead to a sense of constant surveillance among users, potentially impacting their sense of privacy and autonomy. Furthermore, the introduction of AAL technologies into caregiving environments can alter traditional care relationships, leading to shifts in roles and responsibilities among caregivers, patients, and their families. Addressing these issues requires a multidisciplinary approach that considers not only the technological aspects of AAL but also the broader social, cultural, and ethical implications.

The goal of this chapter is to provide a non-exhaustive overview of key social and societal issues in AAL technologies. We developed this overview of issues based on our involvement in the GoodBrother COST Action,[1] our own research on this and adjacent topics such as social robots [40, 64], smart speakers [63], and other AI systems and emerging technologies as well as constructive conversations in the author team, with the editors and with the authors of the chapters on legal issues and ethical issues in this volume. Our objective is to highlight the multifaceted nature of these issues, drawing attention to the complex interplay between technology, society, and individual users. We aim to foster a deeper understanding of how AAL systems impact various stakeholders and to promote informed discussions on how to address these challenges effectively.

[1] https://goodbrother.eu/, last accessed 02.09.24.

The chapter is structured into five sections, each describing a relevant social or societal issue, in addition to the Introduction and Conclusion. In the first section, we will review aspects of cultural adaptation and cross-cultural differences in readiness and openness towards AAL systems. While some cultures tend to be more ready to embrace AAL, others are more reluctant. We elaborate on how and why such cultural differences occur. In the second section, we will spotlight the important issue of bias, discussing how AAL technologies can have biases embedded that disadvantage certain population groups such as ethnic or gender minorities. In the third section, we address the issue of dataveillance, power asymmetries between different stakeholders in the AAL eco-system, and associated concerns about the normalization of surveillance. In the fourth section, a perspective on the roles of those involved in care services is taken, as their practices, responsibilities and expectations might be shifting due to AAL technologies. Thus, we reflect on changing roles, including de-skilling or re-skilling. In the fifth section, we look at trust in AAL systems and barriers to adoption. Finally, the conclusion provides a quick summary and sets forth an outlook for future research interested in the social and societal issues in AAL technologies.

13.2 Cultural Adaptation and Differences

The way technologies are perceived and adopted can vary based on several factors. Although a significant amount of research has focused on elements directly related to the use of the technology, such as how useful and easy to use the technology can be [7, 45] there is also strong evidence that these perceptions can also be determined by different cultural values [99]. For instance, one of the largest studies that examined how new technologies like self-driving cars elicit attitudinal and moral questions of users around the world [6] found that geographical and cultural proximity can lead to large groups of territories to converge on shared preferences and attitudes towards this technology. There is increasing evidence that AAL technologies are also influenced by cultural norms, values, and beliefs, affecting their perception and adoption. For instance, research has shown that the acceptance of AAL technologies is influenced by factors such as perceived motives, barriers (e.g. invasion of privacy, concerns about personal data, attitudes towards the replacement of human care), benefits (e.g. reducing dependency on others, increased autonomy, enabling fast reactions of emergency services), individual care preferences, and the properties of the technology itself [100, 102]. However, other studies have also highlighted the importance of cultural differences when designing and implementing assistive technologies. For instance, a study comparing German and Turkish participants found that cultural influences significantly affect the acceptance of video-based assistive technology in private environments, with Turkish users having more positive perceptions of the benefits that these technologies bring [100]. Similarly, research on older adults in continuing care retirement communities emphasized the need to understand cultural perspectives to enhance the quality of life and safety through smart home

technologies [30]. In a similar vein, the work of Chung et al. highlights that even where cultural similarities exist within diasporas, the views on the roles that different stakeholders have towards enabling older users to use these technologies change between apparent similar groups, as it would be the case of Korean and Korean American older adults [25].

The acceptance of assistive technologies can vary widely across different cultures. For example, a study on the acceptance of a socially assistive robot by older adults showed positive attitudes towards the technology among a group of older adults [61]. Attitudes towards the use of AAL technologies might not only be determined by cultural values, but also by drivers that affect specific populations. For instance, [73] found in their feasibility study of older adults in Puerto Rico that the use of these technologies would be particularly embraced by the population due to the prevalence of disabilities among this population for independent living. Furthermore, the cultural context can impact the design and implementation of assistive technologies. A framework has been proposed to outline how culture influences perceptions and expectations of individuals with disabilities, leading to implications for assistive technology design [13]. Understanding the cultural nuances and preferences of older adults is important for the successful adoption of assistive smart home technologies [50].

In summary, while factors like perceived usability and utility are considered important to the adoption of these types of technologies, cultural norms and beliefs, together with macro-level factors (e.g. lifestyle affecting the prevalence of certain morbidities) can also shape attitudes towards AAL technologies, and should be considered when designing interventions to help with the adoption of these technologies. It is worthwhile noting that while shared attitudinal elements between cultural diasporas can be maintained through the use of communication technology [84], elements of cultural assimilation will end up shaping attitudes in the long run [9].

13.3 Socio-Cultural, Ethnic and Linguistic Biases

As AAL technologies become more integrated into healthcare and personal use, it is necessary to recognize and address the biases they may perpetuate. Biases can disproportionately affect ethnic and gender minorities, leading to unequal access to and outcomes from these technologies and the digital divide in healthcare [60]. Bias in AAL technologies primarily stems from the data used in their development, the design of the technologies themselves, and the societal norms and values embedded by the designers [68].

Like other artificial intelligence (AI) systems, AAL technologies often suffer from biases that can affect their performance across different ethnic and gender groups. The design of the majority of algorithms ignores the sex and gender dimension and its contribution to health and disease differences among individuals, resulting in flawed results and mistakes as well as discriminatory outcomes [26]. Moreover,

medical devices that monitor health parameters may not be as accurate for all types of skin tones [37, 52], due to variations in physiology and skin reflectivity that were not adequately considered in their design. Biases are not limited to skin tone. Human factors and cultural practices can also contribute to the performance of health technologies [21]. For example, Choy et al. demonstrate how certain cultural and ethnic groups might need to change their customs (e.g. change their hairstyle by removing cornrows or braids) to join the research studies, which may result in lower participation of certain groups during data collection [24]. This can lead to biases in the development of the technologies, ending up with misdiagnosis or delayed treatments for certain groups. In line with this, Kim et al. demonstrated that facial emotional expression recognition systems are most effective at identifying emotional expressions in images of young adults, and their accuracy diminishes when analyzing images of older adults [51].

Language is a critical component of many AAL technologies, particularly those involving voice-activated systems and communication aids. If these systems are primarily designed for certain dominant languages or dialects, non-native speakers or people who use regional dialects may find these technologies less responsive or accurate. This not only limits the usability of the device but can also isolate individuals linguistically, potentially exacerbating feelings of exclusion. Despite the recent expansion of research in NLP fairness, there has been little examination on how AI models represent disability [46], and age-related disability that can impact speech [34, 97]. Age influences user interactions with speech technology systems [14], differences which are not accounted for in the technology [82]. Research demonstrates that voice technologies exhibit unfairness due to disparities based on race and age. For instance, these technologies may show lower accuracy in recognizing the speech of Black older adults, highlighting biases in speech recognition systems [15, 44]. In addition to racial biases, studies also reveal gender biases in Automatic Speech Recognition technology, with female speakers being particularly affected [38, 98].

AAL technologies can also reflect and reinforce socioeconomic biases. High costs associated with the latest technologies can prevent lower-income individuals from accessing these potentially life-enhancing tools. Cost is among the main determinants and facilitators of older adults' adoption of technology [55, 86]. Additionally, designs that do not consider diverse living conditions may result in products that are less effective or irrelevant for those in different socioeconomic settings [57, 69].

Although technological solutions for elderly care are often praised as cost-efficient means to promote independence, safety, and health, research suggests that these positive views might ignore underlying issues of social inequality, ageism, and the exploitation of gendered care labor [33]. Dalmer et al. argue that technologies themselves are based on ageism, that the designers of Age Tech, frequently base their perceptions of aging on clichéd notions of frailty, disability, and decline, and tend to exhibit a restricted comprehension of older adults and their interactions with technology. They often fail to adequately account for how factors like gender, class, ethnicity, and ability can influence the usage of technologies—or whether they are used at all [33]. In the same article, together with other critical discourse, Dalmer

et al. discuss that the success of smart home environments, residences, and private care settings often relies on the caregiving labor traditionally performed by women. This gendered labor, essential to the operation and maintenance of health and care technologies, is frequently overlooked.

Importantly, when we speak about audio- and video-based monitoring solutions with an emphasis on privacy protection, we can not omit the sociodemographic stance on privacy and the imbalances around it. Toward the close of the last century, Anita Allen was already making the case that privacy rights were originally designed with men in mind, not women, and in cyberspace, women do not experience the same degree or types of privacy as men [4]. Additionally, a systematic review of 37 studies found that women on social media sites exhibit greater concerns and behaviors regarding privacy compared to men [95]. Notably, studies have also highlighted the constrained privacy experienced by certain demographics; for example, people of color have historically been subjected to privacy infringements through surveillance practices [16], while those from lower socioeconomic backgrounds often face reduced privacy rights [43].

While AAL technologies hold significant promise for enhancing the lives of many, it is imperative to address the biases that may undermine their effectiveness and accessibility. By taking proactive steps towards inclusive design and evaluation, we can utilize the full potential of these technologies in a way that benefits all members of society. This requires ongoing research, diverse data representation, and collaborative efforts across disciplines to ensure that AAL solutions are equitable and responsive to the needs of all users.

13.4 Dataveillance and Normalization of Surveillance

In the literature on the social implications of Internet-of-things technologies, the increasing normalization of surveillance is sometimes mentioned as a social issue on the macro level. [39], for example, discuss such a risk in the context of smart connected toys (SCTs), which are targeted at children and thus address a particularly vulnerable and protected group. Empirical research on SCTs, for example by [78], problematizes how these products "introduce surveillance in playful and uncritical ways with potentially powerful, wide-ranging ramifications" [39, p. 138]. A similar issue emerges in the context of AAL. Given that AAL systems are frequently developed for vulnerable groups such as older adults or people with disabilities and mobility constraints, there tends to be a stark power imbalance between these groups and other individuals in their network such as caretakers and healthy friends or family members. Even if these other individuals have benign intentions, they still might see it as desirable to keep more control than needed, for example by engaging in

intimate surveillance,[2] thus restricting the privacy or autonomy of the vulnerable users. Over time, a habituation to such intimate surveillance could lead to shifting norms around surveillance and lower the thresholds for practices we see as problematic today, for example watching live video streams or listening to live audio within a relative's or friends' home through AAL systems when someone gets unauthorized (or authorized) access.

An adjacent risk in that regard, which has received increasing attention in the privacy and surveillance literature [17, 18, 77, 90, 91], are chilling effects. They are defined as "the self-inhibition of (legitimate) behaviors, such as expressing one's opinion online […] or searching the web for (sensitive) information" [17] due to surveillance—and in the digital age especially dataveillance. The literature on chilling effects stresses the democratic and participatory risks when chilling effects occur, but existing research in this area has focused more on government surveillance than corporate surveillance [17], despite important adjacent literature on surveillance capitalism [103] and dataveillance [96]. Thus, we have a limited understanding if and how sustained monitoring through AAL systems leads to behavioral change and chilling effects–and under what conditions.

13.5 Re-shaping of Care Relationships

As AAL technologies become more prevalent, they inevitably impact the roles, identities, tasks, and routines of healthcare professionals such as doctors and nurses, as well as the dynamics of care relationships between caregivers and care recipients. This transformation encompasses both opportunities and challenges for formal caregivers (e.g., doctors, nurses, personal support workers, rehabilitation specialists, etc.) [53, 58], informal caregivers (e.g., family members, relatives) and end users. This digital transformation, as observed by Colnar et al., could potentially also contribute toward the configuration of new care models more individual-centered "to move away from traditional hospital-centered systems to more desirable community based and integrated care structures" [28, p. 17133]. This section will present the challenges and opportunities of AAL technologies in the context of care relationships and how these technologies re-shape care relationships between caregivers and caretakers, as well as healthcare roles and tasks.

AAL technologies including sensors assist with the analysis of patient behaviors, help with early illness detection, prevent risks (e.g., falls), and support nursing

[2] The concept of intimate surveillance has been developed in the context of parenting in the digital age, describing how parents use technologies such as location-tracking, dedicated apps or security cameras in the children's room to monitor their children [62]. The key motive for this intimate surveillance is safety and security but it has been criticized as problematic because the children are often unaware of these practices, and if they are, they remain unable to consent or resist this surveillance due to the power imbalances at play.

decision-making in patient care. Following [23], Ahmad et al. argue that AAL technologies are already playing a key role in supporting caregivers, who mainly believe that "technology can help them to make care giving more efficient, effective, safer and less stressful" [1]. In particular, AAL technologies for people with dementia help nurses to reduce their worry and anxiety and increase the length of the rehabilitation activities [79]. AAL solutions, such as telehealth and remote activity monitoring, allow taking care of older adults, as well as an efficient communication between them and health care professionals and informal caregivers in a cost-effective way to enhance independence, security, and health [1, 33]. For instance, remote patient monitoring, as observed by [1], offer helpful alternatives to "track the user's healthcare conditions outside of traditional health care settings, such as hospitals and care units". These technologies can empower individuals to manage their own health and well-being more effectively, therefore, reducing their reliance on formal caregivers. For example, remote monitoring systems and wearable devices allow users to track vital signs, medication intake, and activity levels, enabling them to take a more proactive role in managing their health [5, 93].

Despite the identified benefits that AAL can provide to improve older adults' care, many professional caregivers are reluctant to the introduction of these technologies due to ethical considerations, fear that technology will have a negative impact on building relationships, as well as lack of skills to operate these devices [28, 32]. Chaharsoughi et al. explain that also formal carers, such as nurses, must catch up with the workings of AAL technologies adding more stress and workload, thereby decreasing job satisfaction, which limits the potential benefits these new technologies may bring to nursing practice and patient care [20]. As Crawford also discusses, AI may paradoxically involve an increased workload for humans as well as a restructuring of how the work is performed [31]. In addition, from a Feminist perspective, Dalmer et al. argue that use of AAL technologies also involve "social inequality, agist bias, and exploitative gendered care labour" [33, pp. 77–78]. According to them, informal carers, often women who "are already burdened with the bulk of caregiving", are now expected to operate and fulfill the competencies necessary to understand the workings of care technologies to track bodily activities (e.g., eating, sleeping, and medication schedules, bathroom use) "including discerning deviations in data patterns or moments and responding to emergency calls and alerts". Technologized gendered older age care labor is intertwined with the broader political economy of health, yet it remains largely invisible in the design of AAL technologies that claim to reduce the need for paid or unpaid care providers [33, 67, 80]. Milligan acknowledges that although AAL technologies are part of a strategy from Western governments to reduce the number of older adults entering residential care and hospitals, they also need resources to operate [67]. Despite AAL technologies being perceived as cost-efficient for society, they also involve (invisible) labor needed for tracking the routines of older people and managing the extensive data requiring interpretation, which pushes caregivers to integrate physical and online worlds, becoming on-call data intermediaries [33]. Building on [41]; Dalmer et al. argue that tracking actions or routines creates a situation that brings to light the myriad of actors and activities

involved in care, often unnoticed, underscoring the need to consider the materiality of data, laboring bodies, and social relations involved in care practices [33].

The introduction of AAL technologies also transforms the tasks and routines performed by healthcare professionals in clinical and home-based care settings. In particular, remote patient monitoring (RPM) devices powered by AI allow doctors and nurses to track patients' health parameters in real-time and design of personalized care plans: "AI-enabled RPM architectures have transformed healthcare monitoring applications because of their ability to detect early deterioration in patients' health, personalize individual patient health parameter monitoring using federated learning, and learn human behavior patterns using techniques such as reinforcement learning" [83]. However, following [80], Dalmer et al. highlight that AAL technologies introduce an artificial division of care in three separate tasks: monitoring, physical care, and social-emotional care, thereby "undermining the complexities of care work and oversimplifying both the care experience and the complexities of social-spatial relations of care" [33, p. 88]. Moreover, AAL technologies imply that both formal and informal care providers are skillful in the use of these devices, therefore, intensifying inequalities between technically-skilled and "unskilled" non-technical labor. In order to face these challenges and prepare for the future, Chaharsoughi et al. suggest that "nursing must begin the immediate transformation into a digitally enabled profession that can respond to the complex global challenges facing health systems and society" [20, p. 149].

13.6 Trust in (AAL) Technologies and Barriers to Adoption

In 2016, Yusif and colleagues conducted a systematic literature review across disciplines and identified a set of potential barriers to the adoption of Assistive Technologies (AT) in domestic settings [102]. The most critical barriers were related to privacy concerns of the end-users (34% of surveyed articles). It was followed by factors linked to (the lack of) trust in AT as well as value-added functionality, with 27% and 25%, respectively, of the total examined empirical studies. Those concerns were followed by high costs of the deployment, maintenance, and use of the AT at home, as well as their ease of use and suitability for everyday tasks (23% each). The other factors were related to the perception of 'no need' for such technologies in domestic settings (20%), associated stigmas related to their use (18%), fears of dependence (16%) as well as limited opportunities for training, specially tailored to older learners (16%). Finally, the authors identified related feelings of embarrassment of using such technologies, loss of dignity and autonomy, and overall lack of accessibility and social inclusion as contributing factors that impede the adoption and use of AT at home.

When it comes to trust, it serves as the foundation for numerous human interactions and relationships [36, 59]. Furthermore, trust can be transferred to institutions, organizations, and technologies [11, 12]. Cheshire conceptualized this as "system trust" [22]. With the automation and complexity of digital technologies, trust is

especially important as it is a prerequisite for successful technology use and adoption [42, 48]. Scholars examined the importance of trust in AAL technologies and their acceptance using various methodologies [88] and in the different contexts [10, 71, 72], including, most notably, medical applications [47, 75], advisory services [10], domestic technologies [27], and care institutions, such as AT centers (e.g., [69, 70]).

Leitner et al. [56] employed contextual design and technology acceptance modeling and evaluated 20 real-world household installations of their AAL prototype, and reported on the gender differences when it comes to access to AAL technology. In turn, Otten et al. [74] used a scenario-based approach to identify the acceptance criteria focusing on video-based AAL technologies. They have concluded that data protection, information, and communication flow, as well as associated trust criteria, consisting of health and emotional aspects, play a role in the acceptance of video-based AAL technologies. Additionally, they emphasized the role of context as a contributing factor for acceptance, specifically honoring interactions among technicians, caregivers, and caretakers. They concluded: "It is important to remember that people still place their trust to a large extent in humans and by extension, on their recommendations of said technologies" [74, p. 133].

Similarly to [74], Offermann-van Heek and Ziefle employed realistic case scenarios to identify perceived benefits and barriers to the adoption of AAL technologies at home surveying 140 individuals [71]. Potential users reported that privacy, perceived control, attitudes towards AAL, medical necessity, and the added value to their daily routines contribute to AAL acceptance. They have also highlighted the differences between those new to caregiving and those with caregiving experience in their reasons for using AAL technologies in the home setting. For the former group, the reasons to opt in for AAL technology are the increase in process efficiency and medical safety, while for the latter, the most important considerations are the emotional relief and the felt safety for a person in care. As for the barriers, they have examined the access to personal data from third parties and the handling of processed or recorded data as impeding factors for the adoption of AAL in the domestic context.

Human-computer interaction scholars have also investigated the aspects of trust and barriers to the adoption of AAL technologies, especially for older populations [87, 89, 101]. For example, Steinke et al. [87] conducted a survey among older adults aged between 60 and 90 years old in Germany and distinguished two stratification criteria, i.e., gender and housing situation, that influence trust within (sensor-based) AAL technologies. Specifically, the authors demonstrated that people living in a single household showed lower levels of trust in sensor technology than the ones who lived in a shared household. Furthermore, similarly to [56], gender played a role in forming trust in sensor technology: men had distinctly higher levels of trust than women. Finally, they have concluded that key factors to trust AAL systems among older adults are perceived reliability and ease of use (also corroborated in a subsequent experimental setup [89]); when it comes to the form factors of such technology, they deemed that stationary AAL setups (e.g., fixed sensors in the home environment) were more reliable than the wearable ones.

13.7 Conclusion

In this chapter, we discussed important social and societal issues in AAL, making sure to deal with implications that are as distinct as possible from the ethical and legal [19, 29] aspects. However, social, ethical and legal issues are intertwined and not always clearly separable. For example, privacy is a topic that can be approached from a social perspective [81], from a legal one [85] and from an ethical one [66]. Social and societal issues refer to the development and use of these technologies in context and in real-life settings, rather than in the lab. They also capture historical dynamics and cultural perceptions of the technology. As such, the social and societal issues in AAL are conducive to be approached from multiple disciplines spanning the humanities and social sciences and using different methods such as quantitative (e.g., surveys, experiments), qualitative (e.g., ethnographies, interviews, focus groups, discourse analysis), mixed methods (any combination and integration of qualitative and quantitative methods), as well as conceptual, archival and desk research approaches (e.g., scoping reviews, historical analysis of development and implementation of specific systems). Cross-disciplinary projects and a critical perspective, for example informed by science and technology studies [76] or critical data studies [8], are particularly conducive to studying the social and societal issues in AAL, because they allow for a holistic understanding of the underlying dynamics at play.

Specifically, we discussed five critical social or societal issues, dedicating a section to each. We first highlighted cultural adaptation and differences. The review showed how cultural factors such as country of residence can affect people's acceptance of and attitudes towards AAL solutions, but demographic aspects and physical status, for example disability, matter too. In a second step, we dealt with the key issue of socio-cultural, ethnic and linguistic biases. The overview of extant literature showed biases in terms of gender, age and race, as well as the importance of an intersectional perspective. Linguistic biases are a topic that requires further attention when systems are voice-activated. Large language models (LLMs) that are more and more incorporated into AI analysis pipelines are known to perpetuate systematic racial prejudices [49]. Then we described the issue of dataveillance and the potential for normalizing surveillance among vulnerable groups such as older adults or individuals with psychiatric disorders. AAL technologies rely on sensitive data, for example audio and video recordings of people in their private home, and the normalization of increasingly private data collection could carry risks such as power abuse, function creep or chilling effects, which we discussed.

A fourth social issue is the re-shaping of care relationships, with AAL systems re-configuring tasks and responsibilities in the care sector, for example for nurses. The literature shows both opportunities, where certain aspects of AAL systems are welcomed, but also challenges, for example additional burdens and responsibilities, especially for women, and a necessity for re-skilling. Finally, we looked into trust and barriers to AAL adoption. User-oriented research in the area shows the importance

of privacy concerns and a lack of trust as barriers to adoption of AAL systems. Trust seems gendered, with men reporting higher levels of it.

Together, these five social and societal issues show the complexity of the technology and the plurality of stakeholders involved. Thus, approaching AAL technologies from an ecosystem perspective might prove fruitful, with actor-network theory as a promising theoretical lens to better grasp the social and societal issues and their interplay [65]. The issues discussed point to implications for different stakeholders, including developers, users (where different user groups have to be distinguished depending on the context and use case, for example patients vs. care personnel, see [2]), policymakers and researchers.

For *developers*, there is a need to design AAL systems in a way that minimizes social issues and societal harms. Of course, developers cannot foresee all the downstream consequences of the technology, but having a keen eye for these issues, including conversations with ethics experts and social scientists, as well as a strong consideration of user needs in the vein of participatory design, are good starting points. For *users*, it is advisable to develop a solid level of AAL literacy, which includes not only knowledge of technical aspects such as a basic understanding of how the technology works, but also contextual knowledge, for example about the benefits and risks and about the technological implications more broadly. However, such a literacy will not be developed on its own, so that institutions, including industry, civil society, academia and policy, are encouraged to come together to implement suitable literacy programs, for example through understandable info materials and targeted workshops. For *policymakers*, a strong awareness of the social and societal issues of AAL is necessary to appropriately govern this technology, so that regular consultation with technical and social AAL experts should take place.

In terms of existing regulatory tools, the European Union AI Act, which went into force recently, provides a comprehensive framework to regulate AI-based technologies such as AAL (see for example [29] in this volume). It uses a risk-based approach and classifies AI technologies into four risk groups with specific regulatory demands: unacceptable, high, limited, and minimal risk, respectively. Aiming to foster trustworthiness [92], the AI Act prohibits systems with unacceptable risks, while high-risk applications come with many obligations for developers, for example regarding risk management, cybersecurity, documentation and human oversight. AI technologies that process biometric data and use profiling are considered high-risk. Thus, many AAL systems (which need to identify a person in the care environment to monitor their data) are likely to fall within the high-risk category. Kuźmicz discusses the importance of balance in the governance of AAL, with both the AI Act and the General Data Protection Regulation (GDPR) referencing the concept [54]. He specifies that "to achieve balance, it is crucial to identify aspects or situations where one party is disadvantaged and empower more vulnerable stakeholders" (p. 22). Thus, law and policy, technology and user needs (see [94] in this volume) must go hand in hand for a socially-aware and successful implementation of AAL technologies. Finally, *researchers* should intensify the study of the social and societal issues of AAL.

Future research should study the social issues we discussed here empirically and through a range of social science methods, both quantitative and qualitative ones. Observational methods are fruitful to investigate, for example, the normalization of surveillance, chilling effects and issues of bias and trust. However, given the sensitivity of AAL data such methods are subject to higher ethical requirements and scrutiny than self-reported data from interviews, surveys or media coverage. Theoretical contributions that situate the social and societal issues we discussed within existing theories or develop new theories are also very much welcome.

Acknowledgements This publication is based upon work from COST Action GoodBrother—Network on Privacy-Aware Audio- and Video-Based Applications for Active and Assisted Living (CA19121), supported by COST (European Cooperation in Science and Technology). We would like to thank the editorial team, Albert Ali Salah, Liane Colonna and Francisco Florez-Revuelta, for their helpful feedback on our chapter and their tireless efforts that went into editing this book. Christoph Lutz was partly funded by the Research Council of Norway, project number 299178 "Algorithmic Accountability: Designing Governance for Responsible Digital Transformations", while writing the chapter. Rodrigo Perez-Vega dedicates this chapter to Sofia and never ending adventures.

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