

Technology and aging: the jigsaw puzzle of design, development and distribution

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The successful adoption and use of technology products and services for older adults remain limited. Although technological developments promise improved quality of life for older adults, ageism and access gaps impede their use. Implications and recommendations the design and distribution of new technologies for aging in place are discussed.

Globally, people are living increasingly technology-enabled lives. In some countries, new technologies such as artificial intelligence, sensors, advanced data transmission, cloud computing and naturalistic user interfaces are deeply integrated into everyday activities and routines. With the increased penetration and adoption of devices and services using digital technologies, boosted by the effects of the COVID-19 pandemic that propelled digital transformation in many different product and service categories (most notably in and around people's homes), it is likely that we will continue to see technology transforming how we get things done, interact with one another, care for ourselves as well as others, get around, search for information and find meaning in our lives. However, as evidenced by age gaps reported for internet use among American adults¹, the adoption and use of digital technologies remain lower among older adults. Furthermore, many solutions developed for older adults, such as emergency alert and monitoring technologies to support aging in place, remain unwelcomed and underused^{2,3}.

Population aging has unique implications for how technology-enabled products and services are used – and how they ought to be designed. Contrary to stereotypes that have traditionally framed older adults as unwelcoming of and unwilling to use digital technology, many older adults show positive attitudes and interest toward new technologies⁴. A growing number of older adults are active and adroit users of technology. At the same time, aging is often accompanied by changes in physical and cognitive capabilities that may affect one's ability to learn about and interact with new technologies. The environments and contexts in which technology is used also often shift with age and related changes in work, health and social connections. Furthermore, technology acceptance and use are not solely predicted by age, but also vary based on factors such as perceptions of usability and impact, self-efficacy and prior experience, affordability, conditions and contexts of use, and individual characteristics and abilities^{5,6}. These dynamics point to the need to consider the heterogeneity of abilities and experiences, to challenge assumptions characterizing older adults as a uniform group, and to address the uncertainties and gaps that lie at the intersection of population aging and technological advancement.

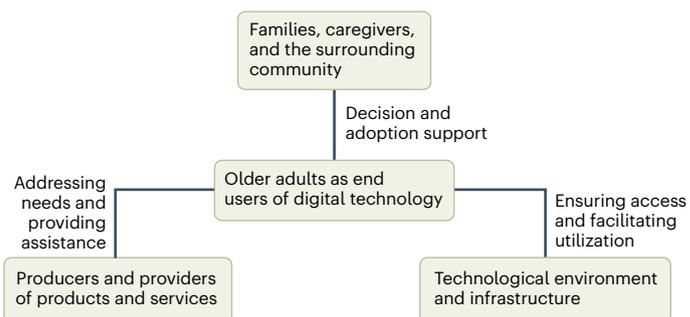


Fig. 1 | Multi-stakeholder dynamics supporting technology adoption by older adults. The successful use of technology-enabled products and services by older adults may be supported in various ways by multiple entities, including families, caregivers and social communities; technology providers; and the surrounding infrastructure.

Opportunities and promised benefits

New technologies offer capabilities that could address the emerging needs and changing lifestyles associated with population aging. Digital technologies are increasingly able to sense details and changes in the surrounding environment, able to process and analyze large quantities of data, and can easily be integrated with everyday objects. These characteristics may be used in home-based applications to support routine activities, ensure health and safety, and assist in the use of resources and services⁷. Technology for communication, education and entertainment can also bring benefits to older adults, as applications may be used in the home or another convenient setting to enhance social connectedness, support continued learning and contributions, and promote emotional well-being.

With these possibilities in mind, the proper use and integration of technology into everyday lives may help older adults to age in place (that is, continue to remain in their home and a place to which they are emotionally attached and that feels familiar, secure and meaningful to them⁸) more easily without having to relocate to fulfill changing needs. Increased automation of and technology-enabled assistance with everyday housework, home temperature control, energy management, safety and security monitoring, and other routine tasks may enable older adults to stay independent for longer and maintain a high quality of living, as well as provide their family and caregivers with peace of mind.

Challenges and barriers to successful technology use

Unfortunately, promise alone cannot guarantee the widespread adoption and effective use of technology to support the aging population. Although development investments and efforts have brought and will continue to bring rapid advances in technology, not all systems and applications have been readily welcomed and adopted by intended

users, especially older adults. Many older adults face unique barriers to using new technologies, which may include lower confidence and comfort, physical and functional challenges, and lack of access⁹.

Limitations to successful use of new technologies among older adults and other users may stem from challenges at several stages in the design and delivery process. When ideas are conceived and concepts for products or services are generated during the early stages of design, technology solutions for older adults often get winnowed down to systems for safety and medical care needs – a short-sighted reduction of the design landscape that can be at least partly attributed to ageism. Older adults are often characterized using negative stereotypes (that they are frail and dependent) and their needs are framed as health and care problems to be corrected¹⁰. It is true that many older adults experience age-related functional decline. For example, severe mobility limitations are significantly more prevalent among older adults aged 80 years or older as compared to those who are 79 or younger¹¹, which could translate to a heightened need for medical support and safety monitoring. However, assumptions regarding frailty and dependence that apply only to a subset of older adults have often been overly generalized to what is actually a heterogeneous group. Although fall detectors and emergency alarm systems address fundamental needs of survival and safety, a narrow focus on basic activities of daily living¹² prevents technology from addressing other important aspects of independence and quality living. Everyday task and lifestyle needs that correspond to instrumental¹³ or enhanced¹⁴ activities of daily living – such as social interactions, communication, education and information seeking, entertainment, finance, retail and more – are often perceived as of lower priority, although these needs are frequently experienced by a larger group of older adults as well as their families and caregivers. The design and development of lifestyle technology solutions largely focus on considering the needs of younger groups, leaving the needs of much of the older adult population unaddressed.

The next stage of detail design – in which decisions are made about specific features of a system's form and functions, including the user interface – is also easily affected by assumptions and stereotypes. For example, beliefs regarding user-experience design needs for younger users may be focused on both aesthetics and ease of use, whereas beliefs surrounding the needs of older users are centered around accessibility only, introducing the possibility that other design aspects desired by older adults may easily be overlooked¹⁵. Many systems targeting older adults use overly large text labels and buttons that are optimized only for simplicity and readability, sometimes sacrificing aesthetics and desirability. Although ease of use and understanding is a critical factor, a more holistic design approach – one that considers both needs and wants, marries usability with desirability, and uses options to customize when applicable – may help to improve adoption.

Difficulties also lie in the distribution stage and in the methods through which technologies reach their older end-user, including finding effective and trusted channels to deliver technologies and related information. A better understanding of how various channels – including online sources (for example, news websites and social media), print media (for example, newspapers and magazines) and interpersonal networks (for example, community groups and online forums) – are accessed and trusted by older adults and their families may be key to raising awareness and delivering messages regarding the availability and capabilities of new technology systems. The advertising and promotion of technology products and services often use vocabulary that reflects stereotypes of old age and portray fearful images of lives being at risk. These are messages that may not resonate

BOX 1

Terms commonly used in aging-in-place technology discussions

Digital technology includes electronic computer systems and devices that can record, create, store, transport and process data. Examples of new digital technologies and their applications include artificial intelligence, cloud computing, blockchain, mobile communication and social media.

Artificial intelligence describes machines that mimic cognitive functions that humans associate with human minds, such as learning and problem solving. Artificial intelligence is able to make predictions and decisions when presented with novel information within a defined task setting.

A smart home (or connected home) may collect and analyze data about the environment within and around the home to help to manage and automate tasks, devices and services. It may communicate information to users and service providers.

Naturalistic user interfaces are interfaces that use natural modalities such as speech or motion and require little-to-no learning curve for an individual to achieve proficiency in use.

Universal design refers to designing products and environments to be usable by all people, to the greatest extent possible, without adaptation or specialized design. Key principles include designing for equitable, simple, flexible and intuitive use regardless of preferences, abilities, skills, experience, knowledge, body size, age and other characteristics²⁰.

with older adults who are seeking a healthier lifestyle, and which they may actually try to avoid. Further, information about new technology products and services does not always reach other members who are involved in adoption and purchasing, such as family, close friends and community groups.

In addition, emerging technologies and systems (such as the smart home and the internet-of-things) increasingly use and rely on other 'foundational' technologies, such as broadband access, cloud computing and artificial intelligence. For example, in the USA, an absence of internet use is already more prevalent among older adults, rural residents and socioeconomically disadvantaged groups¹, and access and knowledge gaps may remain for future systems and applications that use existing technological infrastructure. Finally, infrastructure-related challenges to aging in place also lie in the physical built environment in which we live. The seamless integration of technologies into our homes and communities is conditional on compatibility between a technology and the physical setting, in addition to the interoperability with underlying technological infrastructure.

Implications and recommendations

Developments and advancements in enabling technologies must be paired with the appropriate design of products and services that address older adults' needs and wants, support for improving awareness and availability, efforts to create effective messaging regarding potential benefits, and the development of education and technical support programs.

A more complete and holistic understanding of the decision-making processes of older adults may help to facilitate awareness and the adoption of new digital technologies and their applications. Characterizing older adults using stereotypes and assumptions has led to gaps in truly understanding users, and prevented designers, developers and marketers from fully considering the breadth and dynamic nature of various factors that drive adoption and use. Design efforts and research focus have been centered around the needs of physical health, safety and simplicity, and older adults have often been categorized as a single user group without a full description of the social settings and environments in which technology products and services may be used. Although target end-users may be older adults, designers and producers of technology can also consider reaching family caregivers and community members, as these individuals often act as intermediaries who obtain necessary information, support technology adoption decisions, and assist in decisions related to home and housing (Fig. 1). Understanding such social dynamics may also help to uncover untapped distribution and delivery channels. Furthermore, better outcomes will follow from increased efforts to include older adults and related decision-makers in the design process for an improved understanding of needs, idea generation, concept validation and design evaluation. These efforts can take many forms, including facilitating the direct inclusion of older adults in describing needs and goals, creating solution ideas, developing and prototyping product concepts, conducting pilot user experiments, and more¹⁶.

In the area of public policy, governments, businesses and non-profit organizations should support universal access to platform technologies and systems such as broadband and smartphones or tablets, as these serve as enablers and channels for services and applications (Fig. 1). Equity and inclusion should be a goal for the development and distribution of new technologies to ensure that benefits are delivered to older adults and families in different areas and situations. The digital divides that exist between generations, socioeconomic groups and geographical communities may persist and even expand without commitments to improving technological infrastructure and facilitating the inclusion of older adults and other groups who are less likely to be digitally connected¹⁷. Equitable and universal access to adequate technology platforms and reliable connectivity is not only an enabler to facilitate technology use, but should also be a key consideration for infrastructure development as it could serve as a public health requirement.

Education is an important element for producers of technology and providers of related services, as well as for consumers and end users. Although few studies provide recommendations to incorporate technologies and accommodate related services (for example, ref. ¹⁸), many commercial guidelines and practical principles for aging in place focus on architectural design and elements of the physical environment (for example, doors, floors and handles) to ensure safety. Similarly, design guidelines for creating age-friendly user interfaces have traditionally been centered around improving readability and efficiency in graphical and menu-based interfaces, many of which may not be readily applicable to technologies that are embedded into the home. As new technologies continue to enter our aging society, design principles and requirements need to evolve and expand to be compatible with different possibilities such as naturalistic interfaces (for example, using speech or motion), increased automation, and integration with everyday products and services. Caregivers – both formal and informal – are also not equipped with the necessary knowledge to recommend and use technology products and services that may be helpful for their job, as well as for the well-being of the recipient of their care. Possibilities for

technology use and integration, as well as the implications of potential benefits and risks, need to be considered in more detail.

Lastly, the standardization of key terminology and definitions (Box 1) may help to facilitate communications among designers, across stakeholders, and between producers and users. For example, although the concept of the ‘smart home’ has received popular attention and promises benefits to improve safety and convenience in the home, many older adults as well as much of the public cannot easily define what constitutes a smart home, and inconsistencies are found even among practitioners and researchers in related fields¹⁹. Effective communication to improve understanding of new technologies and their capabilities among older adults as well as other population groups will help to reduce knowledge gaps between users of different demographic, socioeconomic and experiential characteristics, and will help future consumers to easily incorporate technologies into their everyday lives.

A technology-enabled future has the potential to improve convenience, connectivity and care for older adults and families in a rapidly aging world. But for new technologies to truly aid older adults in remaining in their homes for longer, a holistic approach to address current and anticipated challenges – with support from public and private sectors, efforts from multiple industries and disciplines, and considerations that span technical and social dimensions – will be necessary.

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Competing interests

The author declares no competing interests.

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