Two mega-trends of modern culture, the rapid aging of the population and the inexorable advances in technology, have fueled the development of gerontechnology— the use of technology to sustain individual autonomy to an advanced age. This expansive book encompasses state-of-the-art research in gerontechnology and promising new technologies, products, and services that can improve activities of daily living, general health, and well-being of older individuals. It addresses current and future applications in such crucial areas as mobility and transportation, assistive devices, smart homes for senior citizens, in-home technologies, safety and privacy, and research and development highlighting— among others—design.

Topics include, but are not limited to, virtual environments as a research tool, sensation, perception, and cognition research advancements, novel accessibility challenges to information and communication technology, as well as the evolving characteristics of the elderly. These are among the welcome developments addressed in the book. Contributors from around the globe, including the UK, Germany, Japan, Canada, The Netherlands, Korea, the United States, and more, bring unprecedented cross-cultural insight to the intersections of aging phenomena and technology.

Key Features:

- Disseminates empirically proven findings and evidence-based theories, models, and concepts
- Written by world-recognized leaders in the field of technology and aging
- Reflects the global usage of gerontechnological applications
- Includes new technologies, research, and applications for virtual environments, smart homes, assistive technology care, and robotics
- Discusses computer-assisted social engagement, technology-facilitated caregiving, business case examples, and more
SECTION III

THE BIOPSYCHOSOCIAL ENVIRONMENT
CHAPTER SIXTEEN

TECHNOLOGY ACCEPTANCE AND AGING

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KEYWORDS

Asian perspectives  relevance theory
culture context  social inequality
environmental factors  social influences
facilitating conditions  social network size
gender gap  social status
household composition  technology acceptance
perceived ease of use  technology commitment
perceived usefulness

TECHNOLOGY ACCEPTANCE AND AGING

The modern world is becoming increasingly technical. The digital revolution has changed nearly all areas of daily life: banking, shopping, living, and healthcare, just to name a few. While today’s younger generations grow up with “technologized” products and services, the use of such can be a challenge to older ones. In addition, there are continuously more products especially designed to support and to meet the needs of elderly individuals. This includes,
in particular, domains such as active assisted living technologies as well as telecare and telehealth (see Chapters 11, 13, and 14).

The elderly do not represent a homogenous group. In fact, many aspects shape the diversity of age and therefore influence the willingness to adopt technologies and the capabilities to deal with them (Mollenkopf & Kaspar, 2005). Thus, the acceptance of technology by older persons—and hence its use—is affected by numerous factors, not only by physical and cognitive changes accompanying the process of aging.

To unfold its potential, technology needs to be adopted and used, which is influenced by a wide range of multilevel factors and determinants, summarized on three different levels:

- The product (or innovation) itself
- The user and his or her characteristics
- Environmental and contextual aspects

Several studies have highlighted such factors that led to different theoretical models helping to study and to predict the acceptance of technology. This includes most notably the technology adoption model (TAM) and its successors (TAM2 and TAM3), described by Davis, Bagozzi, and Warshaw in 1989, the theory of reasoned action (TRA) as published by Fishbein and Ajzen (1975), and the Unified Theory of Acceptance and Use of Technology (UTAUT, see Chapter 4 by Huber et al.). The UTAUT2 has been delineated by Venkatesh, Morris, Davis, & Davis (2003) and Venkatesh, Thong, & Xu (2012). Those models revealed multiple determinants that proved influential in the technology acceptance of older adults: perceived usefulness (PU) and perceived ease of use (PEOU), attitudes toward technology, cognitive abilities, social influences, self-efficacy, and facilitating conditions (Chen & Chan, 2013).

While the TRA tends to explain human behavior in general, TAM and its successors explicitly aim at predicting the use of technologies and usage behavior. PU and PEOU can be seen as the most important attitudinal factors. According to the original definitions of Davis and colleagues (1989), PU can be likened with “the degree to which a person believes that using the particular technology would enhance his/her job performance,” while PEOU is described as “the extent to which a person believes that using a technology is free of effort.” Both factors are also believed to be influenced by external variables like individual abilities or situational constraints affect (Davis et al., 1989).

TAM has been extended by adding age-related health and ability characteristics of older persons (Chen & Chan, 2014a). The so-called “senior technology acceptance model” (STAM) was tested with elderly people in Hong
Kong; results showed that the model could explain 68% of the variance in the elders’ technology use. The authors came to the conclusion that “personal characteristics (age, education, gerontechnology self-efficacy and anxiety, as well as health deficiencies) and environmental facilitating supports (accessibility, assistance, and guidance) had more predictive value than attitudinal factors (usefulness and ease of use) for predicting gerontechnology usage behavior” (Chen & Chan, 2014a, p. 648).

While TAM and related models focus mainly on motivational reasons for the use or nonuse of technology (by older persons), qualitative studies provide additional insight beyond statistical relations. This is of particular relevance when barriers to the adoption and use are studied. For instance, Chen and Chan (2013) conducted interviews with elderly persons in Hong Kong. Participants were asked about their experiences with technology, including benefits (“What do you like and dislike about technology?”) and negative attitudes (“What are the difficulties/barriers when you are using technology?”). Results showed that use was affected mainly by outcome expectations and social influence, supported by facilitators such as training, which was the most frequently mentioned aspect, timely help, or encouragement. Barriers were conceptualized as follows: situational (e.g., lack of assistance or lack of time), dispositional (e.g., beliefs, values, attitudes), and technological (e.g., complexity or privacy issues; Chapter 5). Considering assistive technologies (Chapter 12), stigmatization and restrictions of autonomy are also important aspects within this context, because users feel constantly reminded that they are dependent and need technology to deal with everyday life issues (Barrett, Thorpe, Goodwin, 2014; Sander et al., 2012).

In a systematic literature review covering mostly qualitative studies and conducted by Peek et al. (2014), the authors identified 27 factors divided into six themes that affected the acceptance of technology for aging in place: concerns regarding technology (e.g., high costs or stigmatization), expected benefits of technology (e.g., PU or increased independence), need for technology (perceived need or subjective health status), alternatives to technology (e.g., help by family or spouse), social influence (e.g., use by peers), and characteristics of older adults (e.g., cultural background or familiarity with electronic technology). Moreover, the authors distinguish between factors in the pre- and postimplementation phase. While several concerns of the participants proved irrelevant after adoption and implementation, others became reality and new ones emerged (Peek et al., 2014).

Qualitative approaches provide explanations beyond the key constructs of TAM or UTAUT. For instance, the study conducted by Peek et al. (2014) showed that the participants described more benefits of technology than just PU. However, the authors noted that increased safety or increased independence
could be antecedents to PU. Another explanation could be the fact that TAM and comparable models (except UTAUT2) are usually employed within an organizational setting but not regarding individual consumers (Kim, Chan, & Gupta, 2007).

Unsurprisingly, the age of the user also affects the attitude toward new technologies. Someone who was not very tech-savvy during his or her life course probably will not use ICT-based products in old age. Moreover, a person’s perceived obsolescence can reinforce or weaken the effect of age as a predictor of technology acceptance: People who think that it is not worth buying a new product anymore are unlikely to do so (Mollenkopf & Fozard, 2004; Mollenkopf, personal communication, January 9, 2016).

THE ENVIRONMENTAL CONTEXT

A variety of factors contributes to the use/nonuse of everyday technology by older people. In addition to the personal characteristics such as age-related decline of functional abilities and socioeconomic status, the environmental context in which individuals are embedded, such as social norms, supports, training, and culture, also plays an important role in influencing older adults’ technology acceptance and its usage.

For this context, social influence is defined as “a perceived social pressure to perform a behavior” (Venkatesh & Brown, 2001, p. 75). In the age of technological revolution, new technologies define the society we are living in (Selwyn, Gorard, Furlong, & Madden, 2003). For instance, electronic and computer systems of various forms are pervasive in almost every aspect of daily life, such as cooking appliances, mobile devices, electronic banking, automated telephone menu systems, and online ticket booking. It is impossible for older adults to ignore these technologies and, hence, they should be motivated for adherence to prevailing social norms and values in order to fit in with current and future societal contexts. Elders also need to avoid being seen as isolated, because social engagement plays an important role in determining life satisfaction and well-being (Erber, 2010, p. 265). Through retirement, older adults lost work and social roles. Maintaining connections with the changing world—contemporary ideas and development—and social involvement within the community are reported as the motivation to use new technology (Rosenthal, 2008). However, studies also show that older people have ambivalent feelings toward modern technology. At the time of this writing, senior citizens recognize that it could bring progress and support daily activities. Nevertheless, particularly older age cohorts are not sure whether they can really benefit from it because they consider themselves as not possessing the knowledge, skills, and resources.
necessary to use high-technological applications (Karahasanović et al., 2009; Mitzner et al., 2010).

Technology acceptance and usage are also influenced by “significant persons,” including family members, friends, and peers in an individual's social network. Moreover, previous research has identified the influence of the mass media, including newspapers, television, radio, and other secondary resources, on older individuals’ beliefs and behaviors (Rogers, 2003). During the mid-1990s to the mid-2000s, the existence of a digital divide between younger and older generations has generally been acknowledged (Cutler, Hendricks, & Guyer, 2003; Czaja et al., 2006). Yao, Qiu, Huang, Du, and Ma (2011) found that Chinese older adults expressed negative feelings toward technology because they were afraid of being seen as following new fashions at an old age and being laughed at as a result of potentially poor performance. This indicates that older people are—currently—described by the mass media and the public as “technophobic” or “disadvantaged.” It could be believed that all elders are not supposed to understand or be equipped with the latest technology. However, if the information and message conveyed by the media promote the belief that seniors have the physical and mental capabilities to use new technology, they become more confident, more positive, and more likely to try it out (Broady, Chan, & Caputi, 2010; Lin, Tang, & Kuo, 2012).

Studies have found that the desire to gain status or power within social groups is an important reason for technology usage. If perceived to be associated with the enhancement of favorable social outcomes—that is, one’s image or status within social systems—it is fairly obvious that individuals are more likely to accept a technology. Older adults had been found to place a high value on public recognition in their social system, that is, the way they are viewed and treated as a result of technology adoption (Chen & Chan, 2013). Smartphones and tablet computers are technological innovations and, thus, older individuals who are owners/users may have highly valued power, knowledge, and/or status for being early adopters (Venkatesh & Brown, 2001). However, elders might reject usage of assistive technology products such as hearing aids or monitoring devices if their utilization is associated with the impression that they are designed for frail and vulnerable people (Steele, Lo, Secombe, & Wong, 2009).

There are three mechanisms explaining the impact of social influence on individual behavior (Venkatesh & Davis, 2000): compliance, internalization, and identification. Compliance refers to the direct change of an individual’s behavior in response to social pressure or reference groups’ expectations. As opposed to the direct compliance effect, in the cases of internalization and identification, social influences indirectly impact behavior by altering an individual’s belief structure, such as the PU of a given technological product. The
subsequent practical implication: It is important to create an elder-friendly, favorable, and supporting environment for lifelong learning and, also, for the usage of technology.

In the macro-environmental context, facilitating conditions are other important contributors predicting technology acceptance and usage. These refer to the perception of objective factors in the environment that support technology usage (Venkatesh, Morris, Davis, & Davis, 2003) and include adequate knowledge, guidance, assistance from others, financial support, accessibility, leisure time, hardware/software capacity, and compatibility (Pan & Jordan-Marsh, 2010; Ryu, Kim, & Lee, 2009). All of those reflect the perception of external constraints on usage behavior.

Training is the most critical factor in facilitating technology used by older people (Wagner, Hassanein, & Head, 2010). In the previously mentioned study by Chen and Chan (2013), older people from Hong Kong indicated that they would not be able to use computers without the necessary knowledge and skills, unless formally trained. If older people were required to use a new technology or to learn the operation of a new function unfamiliar to them, they had to rely on other people instead of self-learning. Besides acquiring adequate knowledge and skills to use technology, researchers have found that attending training programs or workshops can help older individuals to build self-confidence and to reduce anxiety in using technology; thus, more favorable attitudes, which further increase usage intention, are induced (Lagana, 2008; Lam & Lee, 2007). On the other hand, it has also been found that the traits of a tutor determine the successfulness of the teaching and learning process to a great extent. Given age-related deteriorations such as in cognitive abilities (e.g., reduced working memory capacity and declines in information-processing speed), older people are slower in the acquisition of new knowledge and skills than younger adults and they require more assistance, as well as hands-on practice (Czaja, Sharit, Charness, Fisk, & Rogers, 2001). Therefore, the “patient” and “slow-paced” instruction approach is highly recommended for and valued by older learners.

Technology usage is also embedded in the culture or country-specific contexts. Social influences and facilitating factors may take on a greater significance for countries sharing similar characteristics. Collectivistic cultures, such as those of China, Korea, or Japan that advocate group conformity, tend to weigh influences of social norms and the public’s recognition more than in individualistic societies (Schepers & Wetzels, 2007). In addition, older age cohorts before the baby-boomer generations in Asia usually do not have a good knowledge of the English alphabet, and, hence, they encounter more difficulties when interacting with foreign-language device interfaces, such as remote controls and keyboards. However, language as a frequently reported barrier
that needs to be overcome will likely become an obsolete issue in the not-so-far future. Moreover, older users up to the 2000s had been found to be very concerned about technology usage costs (Steele et al., 2009), but this problem is also anticipated to vaporize according to market forecasts. It is known that more than half of Hong Kong’s and China’s older people have been financially supported by their family members, whereas in regions with well-established pension and social security systems such as North America or Britain (International Labour Organization, 2011), the governments take primary responsibility for supporting senior citizens. Consequently, those from developing countries or nations with lower pension and social security coverage have more financial concerns and the cost may outweigh the perceived benefits in technology usage (Chen & Chan, 2014b).

In another study by Chen and Chan (2013), Chinese older adults expressed their objections to being taught by their children about technology usage. This may be due to the nature of the culture which has been greatly influenced by Confucian values that emphasize family status and authority increasing with age: Children learn from their parents and have to obey them (Yan & Sorenson, 2004). When it comes to technology usage, the situation is often reversed: Older-than-baby-boomer elders are at a disadvantage in comparison to younger age groups. Being lectured or taught by younger people would be perceived to weaken an older person’s status or authority (Xie, 2007).

Overall, technology acceptance and usage within the social context are complex issues. They are influenced by a number of factors in different disciplines. In order to have a better understanding, a holistic approach should always be kept in mind, because the process involves the person and technology through interactions with the environment.

TECHNOLOGY USE AND ITS ACCEPTANCE AGAINST THE BACKGROUND OF SOCIAL INEQUALITY

There is often a lack of technology acceptance especially among the socially weak who have only limited financial and educational resources. An increasing uptake and use of gerontechnological products therefore bears the risk of an unequal distribution among members of the society. If this occurs regularly between the same social groups, it could be perceived as inequity and hence it becomes a social problem (Hoffmann, 2008). Against this background, Pelizaues-Hoffmeister (2013) argues that the use of technology could be seen as a dimension of social inequality. Evidence for this in old age is found—among others things—in the income situation, comfort of housing or living arrangements, social integration, access to social and health services, and in a longer
life expectancy (Heinze & Naegele, 2012). According to Hradil (2001, p. 30), “social inequality exists when people frequently receive more of a society’s ‘valuable goods’ than others owning to their position in the social network of relationships.” He distinguishes four basic dimensions of social inequality: material wealth, power, prestige, and education. Also, he distinguishes four new dimensions: working, housing, environmental, and leisure conditions (Hoffmann, 2008). Following the thesis of Pelizaeus-Hoffmeister (2013), the use of technology can also be considered as such a “new” dimension.

Determinants of social inequality are, for instance, gender, place of residence, or age, with the time of birth per se being more than a determinant of social inequality. One has to distinguish between social inequality of age and social inequality within age (Pelizaeus-Hoffmeister, 2013). The first describes the inequality between groups, the second expresses the heterogeneity of aging—so, belonging to the same age cohort does not necessarily imply the same social status. According to the cumulative advantage/disadvantage hypothesis, social inequality accumulates over the life course and can therefore be seen as a product of lifelong processes (Dannefer, 2003; Merton, 1968).

As previously shown, the technology acceptance of older persons is influenced by various factors. The fact that social inequalities play a role within the context of acceptance and use of technologies by older persons has been underlined in previous studies. According to determinants of social inequality, besides age itself, the literature generally highlights three: gender, education, and social network/household size.

Regarding the factor of gender, it is assumed that women tend to have more problems related to the use of technologies than men (Pelizaeus-Hoffmeister, 2013). This “gender gap” has been—for instance—confirmed by statistics for the population aged 60 and older in Germany: When asked about their Internet activity, 28.5% of men stated daily use, in contrast to only 12.9% of women (authors’ own calculation based on the European Quality of Life Survey, 2012). The situation was similar in Japan: Among the “younger elderly” (60–64 years), more men (62.9%) used the Internet than women (39.5%). The differences are even more evident in the group of people aged 80 years and older: 28.3% of men used the Internet but less than 10% of women (8.3%) (Statistics Japan, 2014).

Educational level is positively correlated with the adoption and implementation of technology, and this has shown strong empirical evidence. An explanation can be found in relevance theory (Sackmann, 1993): People who experience modern technology during their working life tend to develop a higher technology commitment. This fact is documented by many studies: In Europe, highly educated older persons are much more active on the Internet.
than lower-educated ones. Nearly every second German with a degree in higher education was active on the Internet (49.0%) as opposed to 19.3% of the persons with a medium education level. In comparison, there are lower rates in Poland (highly educated persons 34.8%; persons with a medium education level 7.5%) demonstrated that there were also differences among European countries (authors' own calculation based on the European Quality of Life Survey, 2012). In the United States, a similar situation was found: 87% of the seniors with a college degree went online, as contrasted to 40% who had not attended college (Smith, 2014).

Though it is assumed that social networks and household size play a crucial role considering technology acceptance, not many studies seem to have dealt with this topic. Nonetheless, as mentioned previously, it is presumed that elders show more involvement with ICT if they can count on social support, for example, by their families or relatives. Of special relevance within this context is whether older persons have children or grandchildren who can introduce them to and explain new technologies (see Chapter 4). A survey in Germany confirmed this assumption: Nearly every second elderly individual who lived alone rated his or her handling of technical products as poor (47.6%) compared to every fourth who resided in a two-person household (25.7%; Enste et al., 2014).

Still, little is known about how social inequalities affect technology commitment, and not much emphasis has been put on explaining the reasons behind and the implications of the development and design processes (Pelizaeus-Hoffmeister, 2013). Technology has emerged as an essential access point to societal goods—most notably health care. The digital divide can lead to a societal divide if the use of technology tends to be taken more and more for granted. Moreover, social inequalities will play a role in future scenarios: Although it is certain that coming generations and, hence, future older persons will have a different way of dealing with technology, the dimensions of social inequality are going to remain relevant even if it can be assumed that they will lead to different outcomes. A low educational status will no longer negatively correlate with the use of technology, but it may have an effect on how technology will be used.

**CONCLUSION**

In summary, it becomes clear that technology acceptance and use of older persons is affected by many determinants and factors beyond age-related physical and cognitive changes. This includes characteristics of the (older) user like age itself (age negatively correlates with technology use), gender (women tend
to have more problems in dealing with technology compared to men), or education (e.g., higher-educated people use the Internet more). But also environmental factors such as household size and composition (social contacts play a crucial role for technology acceptance) must be taken into account. However, it has to be noted that factors change within different contexts. How people age depends on the historical, cultural, and technological environment (Mollenkopf & Fozard, 2004). Gerontechnology covers a plethora of different devices and products, ranging from “simple” nondigital technologies to more complex telecare or telehealth systems. In addition, those factors will, without doubt, change with the next generations. People who are more used to electronic and digital technologies will approach technology in a different way. For example, the feeling of stigmatization or the lack of competences in dealing with ICT-based devices will no longer be regarded as barriers to the adoption and use of technology. However, it can be assumed that most of the impediments discussed previously will still be prevalent in the future. All of the mentioned factors will play a role in future generations. It can be seen that social inequalities (especially socioeconomic inequalities) tend to increase and not to decrease. Arguably, this will also be true for technology use as a dimension of social inequality. Those who could benefit most from modern technologies (e.g., because they are living alone and/or are dependent) often have no access to products and services or are not capable to use them. If technology should help the elderly, this asks for continuously adapted theoretical and empirical models, as well as other approaches to fully understand acceptance and use. As shown, quantitative and qualitative research needs ought to go hand in hand to fully understand reasons for acceptance and nonacceptance of technology.

**Recommendations**

1. From the developer’s point of view, the highlighted factors—facilitators or barriers to the use of technology by older persons—should be addressed from the very beginning of the innovation process.

2. There is no such thing as the target group of older persons; age is very heterogeneous. Hence, products should not only be easy to use and adapted to physical aspects of older persons, but their benefits should be clear and they should fit into the cultural and/or country-specific context. Also, not a single individual should be forced to use products if he or she does not want to.

3. Moreover, there are also aspects beyond the technology itself that have to be kept in mind. Teaching is a critical aspect and includes training of the users, but there is a need also to “train the trainer.”
To better understand the users’ needs as well as their concerns, the integration of older persons into research and development has proven to be a suitable way to facilitate technology acceptance. For instance, within the Active and Assisted Living Programme (www.aal-europe.eu) launched by the European Commission, users have to be part of the projects.

Overall, we have demonstrated the complexity of factors involved in technology adoption. We opt for not only using various methods in research, but also to scrutinize the most important issue of technology acceptance from a variety of different disciplines angles to do it justice. For instance, Huber and colleagues (Chapter 4) cover the UTAUT and UTAUT2 models; Charness (Chapter 13) addresses the field from the viewpoint of supporting aging populations with the use of telehealth; Schmidt, Claßen, and Wahl (Chapter 18) focus on benefits of assistive technologies for older persons with cognitive impairments; and Kutzik (Chapter 14) writes primarily from a care provision business perspective. One overarching factor that we found is the need to have a clear benefit as a result of adopting a technology, and the common denominator is to increase ease of use as an aid to promoting technology acceptance to those who need the aid of advanced devices and gerontechnological services the most.

Concretely, as researchers, we advise that the models described can be used to better understand the user’s perception of a certain technology and should be integrated into the development processes. However, the frameworks need to be further tested with emerging technologies and within new contexts.

Lastly, if there is adherence to our recommendations and summary statements, we trust that an optimal level of technology acceptance can be achieved, not only for healthy and frail elderly themselves, but also for all who are looking after them, caring for them, and/or are concerned about the well-being of elders now and in the future.

REFERENCES


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hands: An international view on senior citizens’ utilization of ICT (pp. 41–58). Copenhagen, Denmark: DJVF Publishing.


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