JYX
JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

This is a self-archived version of an original article. This version may differ from the original in pagination and typographic details.

Author(s): Vilpponen, Hannu; Leikas, Jaana; Saariluoma, Pertti

Title: Designing Digital Well-being of Senior Citizens

Year: 2020

Version: Accepted version (Final draft)

Copyright: © IEEE, 2020

Rights: In Copyright

Rights url: http://rightsstatements.org/page/InC/1.0/?language=en

Please cite the original version:

Vilpponen, H., Leikas, J., & Saariluoma, P. (2020). Designing Digital Well-being of Senior Citizens. In Proceedings of the 13th International Conference on Human System Interactions (HSI) (pp. 40-44). IEEE. https://doi.org/10.1109/hsi49210.2020.9142655

Designing Digital Well-being of Senior Citizens

Hannu Vilpponen
City of Kerava
University of Jyväskylä
Kerava, Finland
hannu.vilpponen@kerava.fi

Jaana Leikas
VTT Technical Research Centre of Finland Ltd
jaana.leikas@vtt.fi

Pertti Saariluoma
University of Jyväskylä
Jyväskylä, Finland
pertti.saariluoma@jyu.fi

***Abstract*—In this paper, we illustrate a concrete case to apply the Life-Based Design approach to identifying human goals for technology to achieve. We focus on a form-of-life method of design, which seeks to reach a mental state of "digital well-being." Digital well-being aims to facilitate digitalization and changes in the digital environment, and to maximize the availability and accessibility of services. We evaluate the target group of senior citizens, who are facing an accelerating pace of digitalization of the services in their daily lives. This increases their sense of anxiety and undermines their well-being.**

Keywords—Life-based design, digital services, service design, digital well-being, ageing

I. Introduction

Technology design is becoming increasingly multidimensional. In the 1960s, the idea of using psychology to improve computer use or people as models of intelligent programs was in its earliest stages. Today designers can integrate all kinds of knowledge, ranging from nanotechnology to sociology, to construct working products—i.e. those that people can adopt and apply to their daily lives [1,2,3].

All too often, people have to try to use non-intuitive information systems. Information systems are frequently considered ready when they are technically *operational*, but still cause major worries to end users—or are incomprehensible to them. These systems may lack the necessary knowledge or be unable to use the knowledge they should use. In any case they do not work properly or do not meet the needs of users, despite their high price tags.

Digitalization is a social process, which makes it complicated to design. Communal software for public digital services is often acquired by people who are unfamiliar with the complexity of the requirements. Even full-time professionals may find it difficult to keep up to date in this field. Thus it is hard to develop rational design processes for communal software. For various technical reasons, some systems which are designed for a particular purpose may be hard—or impossible—to adapt to other practical uses. Finally, these problems highlight the need to integrate all necessary expertise into a rational design system instead of battling with systems that are outdated when adapted to practical applications.

The average age throughout the world is increasing due to improvements in health care. This rise in life expectancies is a positive development, but it also leads to problems that should be solved using information technology and emerging technologies, such as artificial intelligence (AI). The rational adoption of intelligent technologies calls for a multidisciplinary approach to managing complex systems with various kinds of expertise.

In this paper, we investigate how such expertise should be used to develop new types of digital systems in the field of gerontechnology. Gerontechnology concerns technology that directly impacts the daily lives of people aged 65 or over [4]. Our goal is to define the main user-related design problems and the kinds of expertise required to create communal information systems for older people.

II. Digitalization and the use of Internet by the elderly

The population of elderly people in Europe will almost double from 87.5 million in 2010 to 152.6 million in 2060. The share of those aged 80 and over is expected to rise from 5% to 12% during this period [5]. In countries with the highest percentage of elderly people, Internet adoption in the 65–74 age group ranges from 4–61% [6].

In Europe, the traditional multi-generational family structure has changed [5] and the elderly people are increasingly living alone or as couples without help from the younger generation to access new technologies and digital services. The public sector aims to improve access to digitalized services through legislation and support for digitization projects through various forms of grants. Digitization has led to an increase in the number of services available, the speed of transactions and location-independent operations. Yet during this rapid technology change, the needs of special groups have not been adequately addressed before services are brought into production. Many older people lack the necessary equipment and ability to use modern technology and digital services. Data protection legislation restricts the development of seamless digital services. Many digital services require strong authentication procedures, which is an overwhelming task for many older people.

Finland's society is strongly based on information and its utilization, and digital services are considered the fastest and easiest way for citizens to interact with the authorities. When the use of digital services becomes more widespread, public service provision becomes more efficient, which helps to conserve public resources.

More than 500,000 of Finland's population over the age of 55 does not use the Internet or digital services [7]. One-fourth of Finnish people over 65 (242,000) have never used the Internet. Most of them have challenges using digital devices such as computers or smart phones [8]. A study by the Finnish Institute for Health and Welfare shows that there is a great

discrepancy between age groups. An estimated 78% of men and 81% of women aged 55–74 use the Internet for e-services, but only 48% of men and 38% of women over 75 do so [9].

III. DIGITAL WELL-BEING AS A FORM OF LIFE

Most studies on human–technology interaction are focused on how efficient such systems are. The Life-Based Design (LBD) approach to design thinking, however, starts by considering human beings and their life conditions. The main tenet of LBD is that the purpose of technology and services is to improve the quality of life [2]. LBD aims to seek explanations of the "why's" and "what for's" related to technology use on human research grounds. According to LBD, this information (produced in a form-of-life analysis) should guide the entire design process. Form-of-life analyses of a specific user group should generate the human requirements that define how a product or service will improve a particular aspect of people's lives. The human requirements are based on the methods and results of human life sciences and create the basis for the design by introducing the design theme and the requirements for achieving the design goal—i.e., the technology's impact on the lives of the target users. This article evaluates digital well-being as a form of life and human requirements for digital services for the elderly. The human requirements pave the way for technological concepts, which define design goals for the specific form of life.

According to the LBD approach, exploring the nature of the form of life of older people is necessary in order to understand how technology can be harnessed to help them achieve the emotional state of "digital well-being." The goal of form-of-life analysis is thus to help define a design problem by contextualizing and identifying the problem area and its human elements.

The human requirements for digital well-being originate from two primary concepts: the digital divide and requirements for inclusive design [10,11,12,13]. The *digital divide* is caused by the failure of technology development to sufficiently consider democratic accessibility and the adoption of products and services. For example, the digital divide for senior citizens can be caused by an inability to use the services due to a lack of knowledge, education and training, and even a reluctance to acquire and try new technologies [14]. Digital services should thus be designed to meet seniors' needs at the service concept design stage.

Many seniors may be unable to access (or are uninformed about) the services offered through technology, as commonly used types of interactions may be beyond their competence. Difficulties in accessing new technologies and services due to a decline in vision and hearing can exclude many from benefiting from their advantages in several aspects of life. Others may be unable to understand the logic involved in operating new technological solutions. Some seniors are reluctant to invest the necessary time and effort to learn to use new solutions, especially if they have had bad experiences using other products or services. Such experiences can cause anxiety in the midst of ever-increasing digitalization in seniors' everyday lives.

The concept of *inclusive design* [13] recognizes age and disability as part of the normal life course, and offers a rationale for design that is more closely aligned with contemporary social expectations. According to this approach, design should move away from specialist solutions and assistive devices towards increasing accessibility and inclusivity in mainstream design.

The remainder of the paper analyses the properties of digital well-being and the need to create human requirements for concept design. It then considers a more concrete analysis of the role of technology in fulfilling the human requirements associated with digital well-being.

A. Human requirements for digital well-being

Kaijanen and Stenberg (2018) [8] suggest four recommendations to enhance inclusion in today's digital society. First, old people need to be included in service development. The focus should be on easy-to-use devices, the reliability of digital services, and technology usage that does not depend on user ability. Second, professional low-cost advice should be offered when choosing, buying, or using technological and digital services. Third, digital services should be free of charge (public) or at least low cost. Fourth, service accessibility needs to be promoted and the possibility of face-to-face communication kept as an option. Finland's Ministry of Finance has likewise stated that public digital services must be functional, easy to use and safe [15].

Leikas [14] proposes four main ethical requirements for services for older people—self-efficacy, privacy, trust, and autonomy. *Self-efficacy* refers to an individual's ability to achieve a desired outcome; it influences their choice of activities as well as their maintenance [16]. Self-efficacy is particularly important when a task requires specific knowledge and skills, because it is necessary for people to have—and to believe to have—knowledge of how to achieve a desired outcome [17]. The feeling of self-efficacy in using technology is influenced by the complexity and versatility of the technology and the support offered by social networks (family members, service providers, technical support of the workplace, etc.).

In order to efficiently serve older citizens, applications and systems increasingly collect private information about them. Older people must be able to *trust* that this private data in different systems and services is protected, and that no one can misuse this information (such as a personal code or account information). User control is an essential factor when designing trust [18]. The user should be able to trust that the system or device functions as it should and remains in full operational order. When consciously adopting a technology, a person should also be able to trust that they can decide whether to operate the system/device or not and, for example, to turn it off whenever they wish [14].

Assuring the user's *privacy* requires considering the following issues [14]:

- Only very essential information about the user should be gathered.
- The user should be able to easily verify this information.
- The user should be aware of the span of the personal information stored, and this span should be abided by.
- The information gathered for a specific purpose cannot be used for another purpose without the user's permission.

- All information gathered during the usage of a service should be considered private (except where a serious crime is suspected).
- The user should be informed about the content of the data gathered during the usage of a service, and for what purpose and how this data is exploited.
- The user should be able to easily cancel their permission to gather and use personal information.

Autonomy is the perceived ability to control, cope with and make personal decisions about how one lives on a day-to-day basis, according to one's own rules and preferences [19]. It is a basic element of human rights that should be seriously taken into account when designing technology for older people [14].

B. From human requirements to concept design

Digital well-being should also be examined from the point of view of innovation: Is it possible to create a solution that would prevent the further loss of well-being of senior citizens as users of technology? In other words, would it be possible to create technology to eliminate the negative impacts of digitalization? If technical developments cause—directly or indirectly—a digital divide, underuse of technology or "technostress" [20], it is fair to ask whether modern technology can be used to counteract these affects in order to achieve digital well-being. This paper uses the LBD approach to explore novel ways to reach a state of well-being supported by technology.

Technology can enhance the well-being of older people in many ways [21]. It should also be able to contribute to human–technology interaction in a way that enables digital well-being when needed, regardless of the time and place. Hence, the digital well-being of older people should be studied as a combination of technology impacts and approaches to human–technology interaction, taking three factors into account:

- actions, i.e. the desired states of digital well-being,
- user interface paradigms, and
- background technologies.

Accordingly, the following design requirements should be considered:

- Digital services should be accessible to all users, regardless of their abilities. Older people with poor manual dexterity and declining vision and cognitive capacity can find accessing services with small control devices very difficult.
- All user groups should be considered when implementing new services.
- Fading technology behind the user interface should be invisible to the user.
- The personal interface level should be customized to suit each user's profile.

After understanding the human requirements for the digital well-being of older people, designers must make assumptions and decisions about which technologies are most compatible with the human requirements and can be used to help people reach the state of digital well-being. While there are various ways to design digital well-being, some of which are culture dependent, there are common technological elements. These common elements are studied below as examples of services and applications with emerging technologies that can help achieve digital well-being.

IV. THE PROBLEM OF DIGITAL IDENTIFICATION

In Finland, a minimum of Web Content Accessibility Guidelines (WCAG) level of AA is typically required for the availability of public web services. WCAG recommendations are focused on making Internet content accessible to a wider range of people with disabilities, but they do not take into account the special needs of older people [22]. The public sector has hundreds of information systems, and there is no common service interface. Independent service digitization solutions lead to the fragmentation of services and numerous stand-alone technical solutions [23].

In Finland, user authentication is a critical issue in accessibility, which is strictly controlled by law. Many digital services require strong authentication, which can be an overwhelming task for older people that prevents them from using such services.

Finland's Population Register Center maintains the free *Suomi.fi* identification service. Each citizen's electronic identity is linked to their personal data in the Finnish Population Register System [25]. In 2018, there were 81.7 million identification cases in the public administration system. The center conducted a study in 2019 [24] to identify an operational model that would make electronic identification for public administration services available to the entire population without discriminating against anyone regardless of their age or physical restrictions. It proposed developing a national identity wallet that can be accompanied, in addition to verification, by various licences such as driving licence information.

Other countries have developed their own systems for managing electronic identities such as Myinfo in Singapore [26], Smart-ID in Estonia [27] and BankID in Sweden [28]. However, such systems require users to have the necessary equipment and ability to utilize authentication in digital services.

A new social and health care information system called Apotti [29] has recently been launched in Helsinki region. Apotti's patient and client portal, Maisa, allows patients and clients to digitally manage services, appointments and information, and to communicate with health care and social care professionals. Signing up for the Maisa portal requires strong authentication via a smart device such as a smartphone. Seniors can authorize someone else to act on their behalf in Maisa [30].

Another public service that is relevant to the elderly is Kanta, which provides digital services from social and health services agencies, such as prescription renewals and viewing their own patient information. Strong authentication is required to log into this service, and an individual can authorize another person to act on her behalf [31].

V. TECHNICAL SOLUTIONS

Digital services require a smartphone, tablet or computer, which represents a challenge for older people who have experienced a decline in physical or cognitive functioning. A possible solution for expanding senior citizens' access to

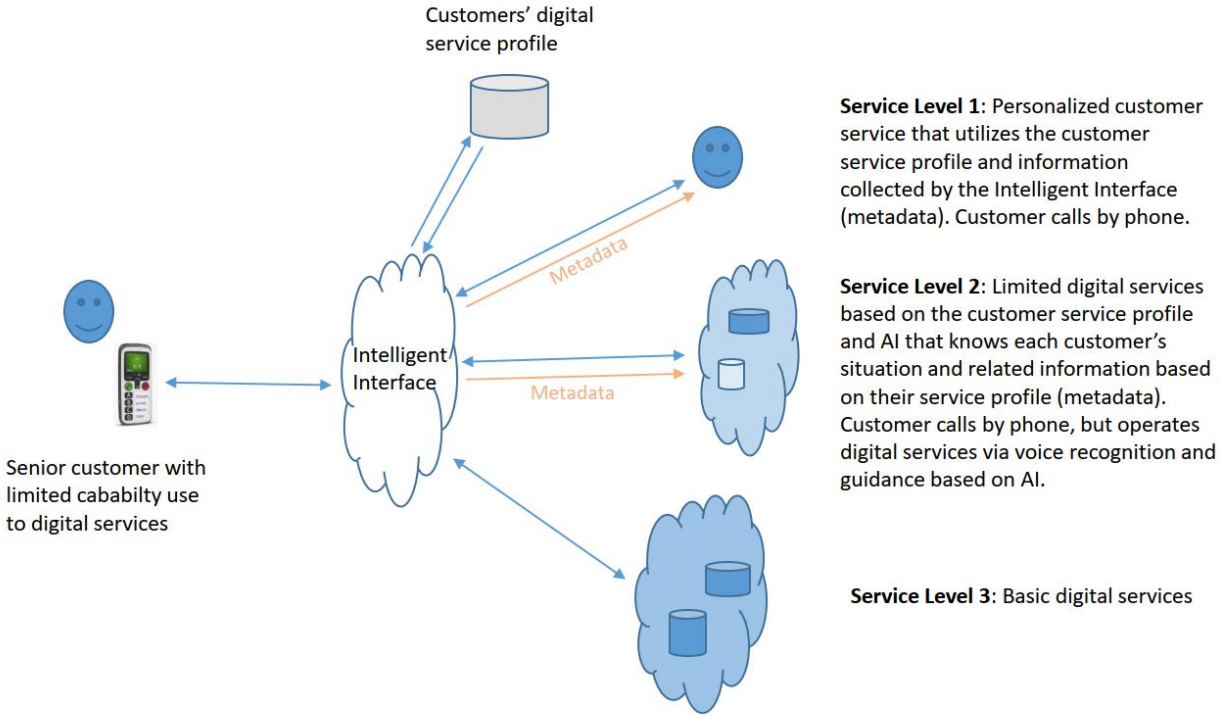

Fig. 1. Intelligent interface with customer-specific digital services

The proposed intelligent interface would identify the customer's cognitive and physical abilities to interact with digital services. The interface would then choose the appropriate form of service based on customer needs and select the needed services that best suit the customer. This selection would be performed without the customer having to actively make any choices. A digital service can have different levels of service:

- Service Level 1: The customer calls by phone to receive personalized services based on their profile and information collected by the intelligent interface.
- Service Level 2: The customer calls by phone and receives service via voice recognition and AI.
- Service Level 3: The customer receives digital service adjusted to the customer service profile level.

In the intelligent interface, the customer can be identified, for example, based on their identity wallet. Each user is provided with an identification code and associated service profile that allows them to adjust the level of digital services to fit their needs. Individual service profiles should be defined based on the LBD approach described above. For digital service providers, an intelligent interface and personalized service profile provide an opportunity to address the specific needs of older people in service design. The service profile can be located in the cloud or be stand-alone metadata on the customer's smart device, allowing the intelligent interface to provide the necessary level of digital services based on attributes related to the user's needs (residence, services used in the past, age, cognitive level, date and time, etc.). The interface can deliver customer-related metadata that can be utilized in customer service design or digital services built with AI components. Each customer's digital service profile information is updated at each service event, allowing service providers to adjust services in real time.

VI. DISCUSSION

Ensuring older people's digital well-being requires placing their everyday lives at the centre of the design process and taking it as a starting point for technology design. This makes knowledge of human sciences important in the design process. Designers need to understand the forms of life in which older people live and act, and the three basic elements of forms of life—biological, psychological and cultural.

This article presents a possible technical solution for a service architecture that enables unrestricted access to digital services for older people. This architecture allows elderly people to automatically access the service, hides the authentication process and, if necessary, redirects them to a personalized telephone service or simplified digital service view. Data protection will play a key role in designing solutions that can bypass the existing strong technical authentication systems and enable the use of digital services by the elderly.

It is important to consider how to ensure that an intelligent interface prevents user errors in the use of the services—i.e. to make sure the user understands what he or she is doing and the resulting effects. The proposed service interface also enables the further development of digital services by taking into account different levels of user needs: the view of the digital service provided is tailored to each user. A personalized telephone service benefits from an intelligent

user interface that can automatically transmit disease information related to a service event and streamline the service process.

The development of new digital services must take into account the needs of specific groups such as senior citizens during the early design stage. This poses a major challenge for developing digital services, but enables the elderly to live as independently as possible, and thus brings savings to society. The article outlines the design requirements that should be considered when developing digital services for senior citizens: 1) Digital services should be accessible to all users, regardless of their cognitive abilities. 2) All user groups should be considered when implementing new services. 3) Fading technology behind the user interface should be invisible to the user. 4) A personal interface level should be customized to suit each user profile. These requirements also serve the needs of other special groups.

We are currently at the forefront of AI development. This article presents an architectural model for an intelligent digital interface to bring existing digital services to the end user, but this model is only a stand-alone entity and does not consider the whole. Future services will feature multiple levels of AI components that optimize the relationship between users' needs and the service provided. Identifying user needs, even those that the user does not know exist, is used to trigger service development across layers of a dynamic service pool.

The main goal of design is to improve the quality of life. This is possible only if the concept is understood on all required levels. The designed applications must make sense in everyday situations and support the form of life of the users. As these everyday contexts are linked to psycho-social rather than technological questions, it is essential to outline the ways in which communication operates in the design processes of modern IT systems.

REFERENCES

[1] *Newell, A. & Simon, H. A. (1972). Human Problem Solving. Engelwood Cliffs, NJ: Prentice-Hall.*

[2] *Saariluoma, P., Canñas, J. & Leikas, J. (2016). Designing for Life. London: MacMillan.*

[3] *Turing, A. (1950). Computing machinery and intelligence. Mind, 59, 433-460.*

[4] *Harrington. T. & Harrington, E.L. (2000) (Eds.). Gerontechnology Hhy and How. Maastricht: Shaker.*

[5] *Sobczak D. (2014) Population Ageing in Europe, European Commission, doi:10.2777/60452.*

[6] *Niehaves B., Plattfaut R. (2014). Internet adoption by the elderly: employing IS technology acceptance theories for understanding the age-related digital divide, European Journal of Information Systems, 23:6, 708-726, DOI: 10.1057/ejis.2013.19.*

[7] *Statistics Finland (2017). Use of information and communication technology by individuals. http://www.stat.fi/til/sutivi/2017/13/sutivi_2017_13_2017-11-22_kat_001_fi.html.* (accessed 21.11.2019)

[8] *Kaijanen, S., & Stenberg, L. (2018). How to empower old people to join the digitalisation of services? Gerontechnology 2018;17(Suppl):58s;https://doi.org/10.4017/gt.2018.17.s.058.00*

[9] *Parikka, S. (2018). FinSote research report 2018, http://www.julkari.fi/bitstream/handle/10024/138210/URN_ISBN_978-952-343-355-7.pdf?sequence=1&isAllowed=y* (accessed 21.11.2019)

[10] *Attewell, P. (2001). Comment: The first and second digital divides. Sociology of Education, 74, 252–59.*

[11] *Hilbert, M. (2011). The end justifies the definition: The manifold outlooks on the digital divide and their practical usefulness for policy-making. Telecommunications Policy, 35, 715–36.*

[12] *Norris, P. (2003). Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide. Oxford: Taylor & Francis.*

[13] *Clarkson, J., Coleman, R., Keates, S., & Lebbon, C. (2003). Inclusive Design: Design for the Whole Population. Cambridge: Springer.*

[14] *Leikas, J. (2009). Life-based Design – A Holistic Approach to Designing Human-Technology Interaction. Helsinki: Edita Prima Oy.*

[15] *Ministry of Finance (2019). https://vm.fi/en/digital-services* (accessed 21.11.2019)

[16] *Bandura, A. (1977). Selfefficacy: Toward a unifying theory of behavioral change. Psychological Rewiew, 84, 2, pp. 191–215.*

[17] *Rogers, W. A., & Fisk, A. D. (2000). Human factors, applied cognition, and aging. In F. I. M. Craik & T. A. Salthouse (Eds), The Handbook of Aging and Cognition (pp. 559–91). Mahwah, NJ: Lawrence Erlbaum Associates Publishers*

[18] *Walker, J. (2001). Control and the Psychology of Health: Theory, Measurement and Applications. Buckingham: Open University Press.*

[19] World Health Organization (2002). *Active Aging: A Policy Framework.* http://whqlibdoc.who.int/hq/2002/WHO_NMH_NPH_02.8.pdf (accessed 21.11.2019)

[20] *Arnetz, B. B., & Wiholm, C. (1997). Technological stress: Psychophysiological symptoms in modern offices. Journal of Psychosomatic Research, 43, 35–42.*

[21] *Keränen, NS., Kangas, M., Immonen, M., Similä, H., Enwald, H., Korpelainen, R., & Jämsä, T. (2017). Use of information and communication technologies among older people with and without frailty: A population-based survey. J Med Internet Res 2017; 19(2):e29. DOI: 10.2196/jmir.5507.*

[22] *WCAG – Web Content Accessibility Guidelines, 2019, http://www.w3.org/TR/WCAG21* (accessed 21.11.2019)

[23] *Vilpponen H., Grudström M. Abrahamsson P. (2018). Combining social service and healthcare as the first country in the world: Exploring the impacts on information systems. Journal of Advances in Information Technology (JAIT), Vol. 9, No. 4*

[24] *Mitrunen J., Salovaara T., & Viskari J. (2019). Electronic identification Report on current status and needs for development, http://urn.fi/URN:ISBN:978-952-367-000-6*

[25] *Population Register Centre (2020). https://vrk.fi/en/population-information* (accessed 13.1.2020)

[26] *Singapore MyInfo service (2020).https://www.singpass.gov.sg/myinfo/intro* (accessed 13.1.2020)

[27] *Estonia SmartID (2020). https://e-estonia.com/solutions/e-identity/smart-id/* (accessed 13.1.2020)

[28] *Sweden BankID (2020). https://www.bankid.com/en/* (accessed 13.1.2020)

[29] *Apotti system (2020). https://www.apotti.fi/en/* (accessed 13.1.2020)

[30] *Maisa portal (2020). https://www.apotti.fi/en/maisa-3/* (accessed 13.1.2020)

[31] *Kanta services (2020). https://www.kanta.fi/en/citizens* (accessed 13.1.2020)