

Mobile technology and forgotten consumers: the young-elderly

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Abstract

The advancement in mobile technology and the increasing number of aging people have given rise to a need for better understanding on how mobile (smart) phones can be used to the advantage of the aging populations. The benefits of mobile technology and its merits to individuals have been phenomenal while young-elderly (aged 60–75), an important segment of the society, are lagging behind in using mobile technology and specifically using mobile health and wellness applications. Through a systematic literature review, this study examines our current understanding of the adoption of mobile health and wellness applications by young-elderly and highlights factors which may influence the adoption decision of this age group. The review shows that due to specific physical and functional challenges of this group, mere focus on traditional technology adoption and acceptance models provides necessary, but not sufficient insights into the dynamics of the mobile technology adoption. More specifically, the review results suggest that other relevant determinants such as sociological and psychological factors in addition to the aging-specific characteristics provide the means to better understand the dynamics of mobile technology adoption by the young-elderly. Based on the results obtained from the review of literature and other relevant studies, this study suggests a conceptual framework to be applied in the young-elderly studies.

Introduction

Over the last few decades, the mobile industry has undergone tremendous radical and disruptive changes. The mobile industry includes innovative mobile network technologies as well as advanced mobile phones, interfaces and applications. Mobile devices, such as smartphones and tablets, have been widely adopted and ubiquitously used in various contexts of people's everyday lives (Atkinson, 2013; Lee, 2014) millions of mobile services and applications have been designed and launched to facilitate business operations and make people's lives easier (Song *et al.*, 2014). The benefits of mobile technology have been nothing short of phenomenal. A recent study indicates that the penetration of smartphones in Europe is amongst the highest in the world. At the end of 2012, 49% of all Europeans owned smartphones and that the penetration rate has continued to grow substantially Groupe Speciale Mobile Association (GSMA, 2013). Various studies show that the main users of mobile technology, in particular smartphones, tablets and mobile services are young-middle age individuals, while the young-elderly, an important segment of the society, are lagging behind. As a result, their needs and preferences with regard to mobile technology have so far received much less attention from practitioners and academic researchers.

For this analysis of the published research, the focus is on what has been termed the 'young-elderly' defined as people between 60 and 75 years old (c.f. Haddon and Silverstone, 1996). This age group was born, grew up, lived and experienced their adult lives under significantly different social and economic conditions, while being surrounded more and more by innovative and disruptive information and mobile technologies. In other words, in their lifetime, they witnessed enormous technological and societal changes. Moreover, they clearly represent a large percentage of the population in modern Western societies, and are more and more concerned with their health and well-being. They are more likely to experience health problems –from high blood pressure and hearing loss to Alzheimer's and Parkinson's disease as well as other neurodegenerative disorders. However, the latest advances in mobile technology can be used to the practical advantage of aging adults. For example, if adopted in time, the regular use of mobile health and wellness applications can support lifestyle change. El-Gayar *et al.* (2013) argue that some of the existing mobile health applications have a positive impact on, for example, controlling diabetes and support self-management tasks such as blood glucose testing and insulin dosage as well as other support tasks such as notification, alert and tagging of input data.

Population aging is a major phenomenon in many countries around the world with significant implications for their health-care expenditures. Statistics Finland (2014), for example, reported that 14.4% of the total population of Finland was between 65–79 years old and it is predicted that the total number of Finns aged 65 or over will be 22.6% in 2020 and reaching 25.6% in 2030. This is in line with the growth rate in other EU countries. For instance, it is predicted that 25% of the Dutch population will be over 65 years old in 2038 (Statistics Netherlands, 2008), followed by the U.S. Census Bureau report which has estimated that over the next 20 years, the number of the U.S. adults aged 65 years and over is projected to rise from 40 million in 2010 to nearly 72 million in 2030 and more than 81 million in 2040 (Vincent and Velkoff, 2010). Given the rapid growth in both the aging of the population as well as in mobile technology in the recent years, one can argue that mobile health and wellness applications can be viewed as potential solutions to expand the range of health-care delivery options and to support the health-related problems of aging adults. For instance, the potential cause of cognitive processing deficits (Lopresti *et al.*, 2004; Charness and Boot, 2009) in addition to offering social benefits like community building, dealing with loneliness and increasing the level of physical activities (Hurling *et al.*, 2007), reducing health-care expenditures (Agree, 2014; Price *et al.*, 2014), allowing people to live independently longer (Intille, 2004; Mann, 2004) and providing remote treatment and intervention service even if they are physically challenged (Yuen *et al.*, 2012).

Various concepts and initiatives such as mEducation, mHealth, mIdentity, Smart Cites and Connected Europe have emerged to investigate the potential benefits that mobile technologies can deliver to EU and to meet the expected growth, sustainability and innovation objectives set out in the EU 2020 strategy (GSMA, 2013). Key actors in the mobile industry such as device manufacturers, telecom operators, application developers, and Over-the-Top (OTT)¹ service provider play a critical role to help address the objectives set in the EU 2020 strategy. The current outlook suggests that mobile technology in general, and mobile health and wellness applications in particular, provide solutions and opportunities that can make the daily lives of young-elderly more comfortable and can solve the problems they may encounter (Kurniawan, 2008; Rosser and Eccleston, 2011). This is agreed upon by researchers and practitioners in other areas, like professional psychology research. Luxton *et al.* (2011) argue that the advances in smartphone capabilities are increasingly viewed as solutions to expand the range of health-care delivery options. Moreover, Sahakian (2014) argues that the mobile phone is becoming one of the greatest tools in medical research, with existing mobile applications making it possible to monitor patients in real-time manner.

Despite clear evidence that the world is becoming increasingly digitalized and mobilized, the young-elderly are lagging behind in the usage of technology-based innovations in general and mobile technology, mobile health and wellness applications in particular (Rogers, 2003; Kobayashi *et al.*, 2011; Deng *et al.*, 2014). Thus, having detailed insight into the factors influencing their decisions to adopt and use mobile technology, health and

wellness applications, is of the utmost importance to the world economy, if the aim is to reduce the growth in health-care expenditure for people in this age group. There exists diversified studies in the literature that separately discuss topics such as mobile health, technology adoption, technology use for health-related interventions and adoption of mobile health services by the older adults. But, there is scant research that explicitly includes young-elderly (aged 60–75) and provides insights and knowledge on the factors influencing their decision to adopt and use of mobile health and wellness applications. In light of this, the core objective of this current analysis is to:

1. Carry out a systematic literature review to examine the current state-of-the-art on the adoption and use of mobile health and wellness services and applications by young-elderly.

For this particular age group, due to specific physical and functional challenges, widely examined determinants in the traditional technology adoption theories such as monetary, hedonic, and utilitarian are of little or no value, whereas self-efficacy, psychological, sociological, usability and aging-specific factors may play a crucial role in their perceptions of mobile technology (Kurniawan, 2008; Lorenz and Oppermann, 2009; Pedlow *et al.*, 2010; Seto *et al.*, 2010), therefore, the next objective is to:

2. Identify and summarise factors that impact the decision of young-elderly to adopt and use mobile health and wellness applications.

This will be achieved by synthesizing specific insights from: (i) the literature review; (ii) an extended technology adoption, usage and effect model introduced by Nikou (2012); and (iii) insights from sociological, psychological and public-health science research literature that discusses behaviours of and concerns for older adults with regard to mobile technology.

Factors effecting young-elderly mobile technology adoption

In the young-elderly context, the adoption and use of mobile technology can be examined from different theoretical standpoints. At a more generic level, this includes literature on individual technology acceptance and mobile service characteristics by making use of kernel theories, such as Technology Acceptance Model (TAM) (Davis 1989) and the Diffusion of Innovation (DOI) (Rogers 2003). At a more specific level, it includes literature on the social psychology of inclusion and exclusion (Abrams *et al.*, 2004), health behaviour and its underlying theories, for instance Protection Motivation Theory (PMT) developed by Rogers (1975, 1983). Yet, there are particular aging characteristics or aging-specific factors associated with behavioural intention that impact the decision of young-elderly to adopt mobile technology and in particular mobile health and wellness services. These factors are, for example, (i) technology anxiety (Xue *et al.*, 2012); (ii) perceived physical condition (Mathur, 1999; Xue *et al.*, 2012); and (iii) resistance to change from continuity of normal aging (c.f. Atchley, 1989; Chen and Shoemaker, 2014).

Adoption and acceptance models

In an attempt to understand the mobile technology acceptance better, Nikou (2012) shows that mobile services have to be evaluated in their own right and on their own merits, and not merely based on the concepts used in acceptance theories, as has

¹OTT service refers to any kind of services that user receive over the Internet that is not provided directly from the Internet Service Provider, such as Viber or WhatsApp as communication services.

been done in many studies (Gerpott and Thomas, 2014). Orlikowski and Iacono (2001) argue that most of the Information Systems studies have taken the core subject matter (*Information Technology artefacts*) for granted or have treated them as a black-box. Moreover, Nikou (2012) demonstrates how and why different dimensions –like (i) acceptance factors (e.g. willingness to pay); (ii) techno-economic factors (e.g. innovativeness); (iii) personal characteristic factors (e.g. perceived ease of use); and (iv) contextual factors (e.g. situational context, mobility) influence people's behavioural intentions toward adoption of mobile services. These factors have been shown to play a crucial role in the people's decision to use and realize the intended effects (e.g. the ability to organize life more efficiently) of mobile technology. Moreover, the recent theoretical contributions of other scholars provide new insights on people's intention to adopt mobile technology. For instance, Venkatesh *et al.* (2012) have recently extended the original Unified Technology Acceptance and Use of Technology (UTAUT) theory and included other determinants such as hedonic motivation, price value and habit in a consumer context and concluded that the added determinants have extensively improved the variance explained in consumers' behavioural intention and technology use.

Psychological factors

To move forward, young-elderly intention to adopt and use of mobile technology also needs to be examined from a psychological standpoint, for instance, health behaviour theories, Health Belief Model (HBM) (Becker, 1974), or PMT (Rogers, 1975). Health behaviour, as reviewed by Nutbeam (1998), is defined as 'any activity undertaken by an individual, regardless of actual or perceived health status, for the purpose of promoting, protecting or maintaining health, whether or not such behaviour is objectively effective' (p.355). PMT is a widely used theory in psychological and sociological studies and is an effort to bridge the gap between research on fear appeals and attitude change. The main purpose of PMT is to provide a conceptual framework that can be used to specify the components of a fear appeal and determine the common variables that produce a change in attitude.

Moreover, HBM, a psychological model, has been developed to predict health behaviours and a persons' tendency to not engage in activities to prevent or detect health problems. The HBM introduces four major determinants (1) perceived benefits; (2) perceived barriers; (3) perceived susceptibility; and (4) perceived severity. These determinants address the attitude and beliefs of individuals while an individual (i) feels that a negative condition can be avoided; (ii) has a positive expectation that taking a recommended action will avoid the negative health condition; and (iii) believes that can successfully take a recommended health action. In the young-elderly context, this can be seen as: by making simple lifestyle changes to daily life in time, for instance, using mobile health and wellness applications on a regular basis, some of the health issues of young-elderly can be controlled or prevented.

Sociological factors

From a sociological point of view, Hagestad and Uhlenberg (2005) put forward the term of age-based segregation and char-

acterized it as an entity of modern society. Tinker (2014) argues that a striking feature of modern society in recent years has been the growing proportion of older adults living alone and the link between growing older and living alone is significantly high. To build on what Haddon (2000) refers to as the loneliness factor, mobile technology forms a paradox for social inclusion. On the one hand, it has promised to bring more social inclusion while, on the other hand, when someone decides to not adopt mobile technology, this self-isolation can lead to social exclusion (Ling, 2008).

Aging specific factors

From this standpoint, looking at changes that occur as someone ages, there are several age-related characteristics which may directly or indirectly effect the young-elderly's decision to adopt mobile technology. For instance, perceived physical condition plays a major role in the young-elderly context. Biophysical and psychological changes (cognitive and physical capabilities) impact the way one responds or interacts with her or his soundings. Moreover, it has been argued that older people are habitually resistant to changes and typically maintain the same habit, behaviour and lifestyle they previously had (Atchley, 1989; Deng *et al.*, 2014). Consequently, the young-elderly might not be comfortable with the use of newer technologies and be reluctant to engage with them. This age-specific factor or psychographic variable has been labelled as 'technology anxiety' in the literature (Laguna and Babcock, 1997; Lim & Lee, 2010). Lim and Lee (2010) argue that technology anxiety is one of the most important psychographic variables and determinants of technology adoption.

In an attempt to understand mobile phone adoption in the Finnish context, Puro (2002) found that the mobile phone is best seen as an extension of the urbanization process that reflected deeper attitude and value changes in Finnish society and that the difference between young and old people in terms of ownership of mobile devices is much smaller than expected. The adoption rate by people over 60 years old who live alone is very low but this is the only group that apparently manages without mobile phones. However, Oksman (2006) found that Finnish people over 60 years old, with their distinctive personal histories and daily routines, give different meanings to mobile technology than do younger Finns who grew up in a more recent technological environment. Nevertheless, Oksman believes that mobile technology is an essential part of future self-service systems for the older adults. In another attempt to help independent Finnish older adults, Harjo *et al.* (2005) conducted empirical research in one of the Functional Homes (*Toimiva Koti in Finnish*) in Helsinki, Finland. A Functional Home is a showroom and information centre for people with different backgrounds visiting the centre to find devices, services and solutions for older and disabled people. The results indicate that delivering messages and controlling equipment with mobile phones were considered the most important functionalities when it comes to helping the young-elderly.

Some of the studies mentioned were conducted several years ago and recent studies indicate significant changes in terms of the adoption and use of smartphones (Lee, 2014). Thus, it can be argued that it may be time to take another look and carry

out a systematic literature review of empirical evidence on studies that combine older adults and mobile technology, and assess if they contribute to a revised understanding of the operation of the sociological, psychological, technoeconomic, aging-specific and personal characteristics factors outlined above.

Methodology

Literature search and database selection

Primarily, any literature research includes various steps after formulation of the research objectives. The first step is searching the literature and gathering information which involves choice about sources. As formulated above, the core objective of the literature review here is to gain insights about the current adoption of mobile health and wellness applications by the young-elderly cohort. Thus, in a systematic manner, relevant studies will be identified through the exhaustive search of academic online databases publishers, and sources such as: Association for Computing machinery Digital library, Emerald, Institute of Electrical and Electronic Engineers Xplore, Inderscience, Web of Science, Google Scholar, Scopus, Science Direct, Association for Information Systems Electronic library and Wiley Online Library.

Search terms

In the next step and to narrow down the database search and to find more relevant studies, specific search terms and inclusion criteria for data collection are specified. These terms include the search keywords such as young-elderly, senior citizen, older adults, mobile health, wellness applications, smartphone, mobile technology and technology adoption. Moreover, the database search was informed by the following criteria for selecting appropriate studies for inclusion in the review:

- Articles which were published between January 2000 and October 2014.
- Articles must utilize a mobile phone as an intervention, involve or directly aim at older people over the age of 60 years.
- Articles must address the question of how mobile services and applications can be utilized to help improve and assist young-elderly daily lives routines.
- Articles must include at least one combination of the search keywords (i.e. target group + mobile technology or mobile services and applications).
- Articles must be peer-reviewed publications.

It should be pointed out that using several search keywords and inclusion criteria, while increasing the complexity of the search process, nevertheless improves the quality of the search output.

Evaluating the relevance

In the third step, gathered data were screened for their correspondence to the objective of the literature review. Thus, during the first phase of screening the data, abstracts were reviewed if the articles met the specified inclusion criteria. If this was confirmed then the full texts were downloaded for thorough and detailed review. Articles were excluded from fur-

ther analysis if their inclusion could not be resolved by discussion with colleagues in the field. Furthermore, articles which were unclear to author for inclusion or exclusion were resolved via discussion with a senior and knowledgeable researcher in the field.

Analysing and integrating the outcomes of studies

In this step, the aim was to combine and condense the search results. The database search on various research outlets yielded 169 journal articles and conference papers in total. After removing the duplicate articles and reviewing the titles and abstracts, 34 articles were selected for the full review. After reviewing the selected articles thoroughly, 25 more articles were eliminated from the final set due to the lack of theoretical and methodological rigour, empirical relevance or their inadequate fit with the search criteria. For example, they did not specifically point to mobile health or wellness applications and age group specified in this study. The final set contains 9 peer-reviewed articles (see Table 1) discussing various issues related to mobile phones use for health related interventions with regards to older adults. Interestingly, the literature search result did not provide any study which explicitly and directly address the interventions of mobile technology particularly mobile health and wellness applications and the aged group (60–75 years old) specified in this study. In the following section, the literature search results are explained and adoption factors relevant to mobile health and wellness applications emerged from the literature review will be highlighted.

Literature review results

With regard to the use of mobile devices for health-related interventions, selected studies took diverse approaches, each with specific strengths and weaknesses. For example, Joe and Demiris (2013) carried out a literature review where the research aim was to find studies which concern mobile phone use for health-related interventions targeting older adults aged 60 years and over. Although, the research results revealed insights about the current state of mobile phone use for health-related issues addressing the older people, the findings mainly revolved around the categorizations of prior studies and their clinical domains without providing any insights into what factors may influence the aging adults' decision to adopt and use mobile health services. Furthermore, Diño and Guzman (2014) conducted empirical study to investigate the behavioural intention for Tele-health use among 82 senior citizens (60–66 years old) in Philippines making use of traditional TAMs such as TAM (Davis, 1989), and UTAUT (Venkatesh *et al.*, 2003). The results show that effort expectancy is the major determinant that influences the behavioural intention of senior citizens to adopt or reject a Tele-health system. This factor can be considered as one of the core personal characteristics with regard to the adoption of mobile technology. However, the determinants and factors used in the traditional adoption theories (i.e. TAM and UTAUT) cannot merely be used to predict the older adults' behavioural intention towards the adoption of mobile health services. Other determinants such as sociological and psychological factors should be used in the conceptual model in order

Table 1 The final list of articles included in the review

References	Subjects	Technology	Research aim	Research results
Joe and Demiris (2013)	NA (literature review)	Mobile phones	Literature review on the current state of mobile health	Current use of mobile phones for older adults use are spread across a variety of clinical domains
Diño and Guzman (2014)	82 senior citizens (60–66 years old)	Tele-health system	Study to investigate the behavioural intention for Tele-health	Effort expectancy is the major determinants that influence the behavioural intention of senior citizens to adopt or reject a Tele-health system
Deng, Mo and Liu (2014)	424 respondents over 40 year old	Mobile technology	The adoption of mobile health services among Chinese	Determinants such as resistance to change, perceived value, attitude and perceived behaviour control are the major constructs influencing the decision of the respondents to adopt a mobile health service
Deng (2013)	435 students (83% below 30 years old)	Mobile technology	The adoption of mobile health services	Determinants such as perceived usefulness and benefits, perceived barriers and external cues positively impact respondents' attitude toward the adoption of mobile health services
Mendes <i>et al.</i> (2014)	Five older adults aged over 60 years	Mobile technology using smartphone	Evaluating a solution capable of monitoring vital parameters (e.g. tracking ones' heart rate)	There was a wide acceptance of the concept by the older people, system was received as to be practical and discreet allowing the older people to live a normal life
Varshney (2014)	NA(literature review)	Mobile technology	Research on mobile health and understanding the relevant emerging themes of research	Mobile health can result in four major advances: it can (i) expands healthcare coverage; (ii) improves decision making; (iii) manages chronic conditions; and (iv) provides suitable healthcare in emergencies
Lorenz and oppermann (2009)	17 participants (aged 62–94 years)	Mobile senSAVE application	Monitoring vital personal parameter, specifically adapted to the need	User interfaces for older adults should be designed for different capabilities and needs
Qian <i>et al.</i> (2011)	20 older adults aged 60–83 years and 16 aged over 60	Mobile phones	Examining the potential of tactile feedback to help older adults modify their walking behaviours	Older adults can more effectively resolve feedback and maintain a predefined pace when tactile cues are presented in combination with auditory feedback
Abdul Razak, Sulo and Wan Adnan (2012)	8 older adults aged 52–68 years	Mobile technology, mobile calendar	Utilizing two reminder systems	The usability of the systems, participants were all agreed that such systems should be simple, familiar, flexible and recognizable to them

to understand better the adoption intentions in the young-elderly context (Gao and Koronios, 2010; Conde *et al.*, 2014).

In an attempt to investigate the adoption of mobile health services among Chinese aged over 40, Deng *et al.* (2014) explored a conceptual model based on the value attitude model (Jayawardhena, 2004; Tan, 2011), the theory of Planned Behaviour (Ajzen, 1991), and four aging characteristics constructs. The research results revealed that resistance to change, perceived value, attitude and perceived behaviour control are the major constructs influencing the decision of the respondents in the study to adopt a mobile health service. Albeit, the research results provide interesting and useful information, it could be argued that due to their special physical conditions, the young-elderly preferences and their behavioural intention towards adoption of mobile technology are considerably different from other age groups. Thus, this age cohort cannot be mixed with any other age group in the same study, especially if the aim is to understand and investigate their behavioural intention

towards the adoption of mobile technology and in particular mobile health and wellness applications. Furthermore, Deng (2013) had conducted a similar study using the same approach to investigate the adoption of mobile health services among 435 Chinese respondents with 83% of them being under 30 years old. The findings show that perceived usefulness and benefits, perceived barriers and external cues (e.g. information about the benefit of using mobile health services from doctors' advice) positively impact respondents' attitude toward the adoption of mobile health services. Despite the extensive knowledge provided by this research, one can argue that to merely focus on behavioural intentions of public users of mobile health services does not explicitly provide adequate insights which reflect the preferences of the young-elderly. Nonetheless, adoption factors found in the Deng *et al.* (2014) and Deng (2013) studies can be associated to sociological and psychological variables which may influence older adult's decisions about adoption of mobile health and wellness applications.

Mendes *et al.* (2014) created a prototype mobile solution capable of monitoring vital parameters (tracking ones' heart rate) and generating alerts to the care-givers and to the medical emergency teams in the presence of abnormal values. The prototype was tested on five participants aged over 60 years. In the project, a smartphone was used as an instrument to send the vital parameters to the care-givers. The authors concluded that there was a wide acceptance of the concept by the older adults and the system was perceived as practical and discreet allowing the older people to live a normal life without noticing that they are using it. In an effort to examine to what extent mobile technology can be used to the advantage of aging adults, Varshney (2014) recently has carried out an extensive research on mobile health and the relevant emerging themes of research around it. At the more theoretical level, Varshney argues that mobile health is an emerging area of research and can result in four major advances: it can (1) expand healthcare coverage; (2) improve decision making; (3) manage chronic conditions; and (4) provide suitable healthcare in emergencies.

Other studies have attempted to gain insights about how mobile health services can be utilized to help support older people, for instance, Lorenz and Oppermann (2009) developed a user interface for monitoring vital personal parameters for people aged 50 years and over. Moreover, Qian *et al.* (2011) used mobile phones and a pedometer to study how an older person can monitor and modify his or her walking habits, the research results showed that tactile signals could be perceived while in motion and could support an older person in walking at a range of paces. Still, there have been other attempts to understand how an older person perceives the reminder system as part of assistive technology. For example, Razak *et al.* (2012) in an effort to help older people to use mobile technology utilized two reminder systems among eight people aged 52–68 years. The results show that the reminder systems can be used to the advantage of those who experience some memory decline, for instance to take medicine or remembering doctors' appointments. After evaluating the usability of the systems, participants all agreed that such systems should be simple, familiar, flexible and recognizable to them. In line with these findings, it can be argued that the design of such mobile applications play a significant role in decision making of the aging adults to adopt and use such system. Application developers, while designing mobile health and wellness applications should in particular pay attention to the needs and preferences of this cohort. The findings from Razak *et al.* (2012) study can be associated to the techno-economic factors influencing an individual's decision to adopt mobile health and wellness services.

Looking at design issues from a more conceptual standpoint, Isaacs *et al.* (2013) argue that, for developers to be successful, it is crucial to adopt a user-centric approach, after which it becomes possible to examine perceived ease of use and design a proper training for the potential target group to ensure that an application will meet actual user needs rather than merely the specifications defined by the development team. As a complement to the existing mobile health-care applications, a new application could increase its value by adding features, for instance, reminding people when to take their medication if they suffer from loss of memory or poor recall.

Application developers need to keep in mind, however, that too much functionality may overwhelm the young-elderly and may have a negative effect on their experience. Razak *et al.* (2012) constructed an older person mental model (i.e. assessing one's thoughts and expectations) on reminder system and argue that applications should be kept simple, familiar and flexible. This is confirmed by Zhou *et al.* (2013) who show that older adults use mobile applications that offer only one or two (simple) functionalities. Compared to younger users, who use multiple functionalities more extensively, older adults use only a few functions. Within the context of the young-elderly, this can be seen as a way to cope with potential health problems or reduction of complexity. Thus, while designing mobile health and wellness applications for older adults, particular attention has to be paid on the familiarity, different levels of commitment, and competences of the target group.

Moreover, it has been estimated that currently there are 40,000 mobile health related and wellness applications across multiple platforms such as iOS, Android and Windows (West, 2012). Furthermore, the current outlook suggests that there is a need for more advanced mobile health and wellness applications which support behavioural, technical, social and financial interventions for medication adherence, well-being, life-style and management of chronic conditions of the young-elderly. However, the suitability and the effectiveness of these types of applications should carefully be evaluated to find out if they can be used to the practical advantage of the young-elderly. This can be done based on using for instance, design science approaches and relevant theoretical models specified explicitly for the young-elderly to obtain better understanding of their requirements.

From these reviewed studies, one can easily distinguish that the selected studies took diverse approaches, each with specific strengths and weaknesses. The above discussed studies neither have covered explicitly (i) young-elderly (60–75 year old) cohort; (ii) mobile health and wellness applications; and (iii) adoption of such applications in one research project nor have provided a theoretical foundation which can be used to investigate young-elderly adoption of mobile health and wellness application. In line with this and to summarise relevant adoption factors of mobile health and wellness applications in the context of the aging adults, Table 2 is provided. The use of theories and methodologies in the studies are illustrated in bold.

The behavioural intention of people regarding the adoption and use of mobile technology is influenced by various factors, some of which have been specified above. However, because the young-elderly are a specific category with specific experiences and characteristics (e.g. physical and functional challenges) a more specified theoretical framework is required. Thus, in the forthcoming section the aim is to integrate the knowledge and insights gained from (i) literature review; (ii) an extended TAM proposed by Nikou (2012); and (iii) other relevant studies to bridge the theoretical gap found in the literature and to develop a specific technology adoption and use model for the young-elderly.

Discussion

It can be argued that older people are the most difficult market segment when it comes to the adoption and use of mobile technology.

Table 2 Identified factors emerged from literature review

Reference	Title	Examined/evaluated factors
Joe and Demiris (2013)	Older adults and mobile phones for health: A review	Literature review: Generic technology adoption factor (feasibility, acceptability and effectiveness)
Diño and Guzman (2014)	Using Partial Least Squares (PLS) in Predicting Behavioural Intention for Tele-health Use among Filipino Elderly	UTAUT (behavioural intention, effort expectancy, social influence, gender, and performance expectancy)
Deng <i>et al.</i> (2014)	Comparison of the middle-aged and older users' adoption of mobile health services in China	Theory of Planned Behaviour (perceived value, attitude, perceived behaviour control and subjective norm) and Aging-characteristics (perceived physical condition, resistance to change, technology anxiety and self-actualization need)
Deng (2013)	Understanding public users' adoption of mobile health service	Technology acceptance model (perceived usefulness and ease-of-use) and Health belief model (perceived service availability, benefits, barriers and external cues)
Mendes <i>et al.</i> (2014)	Secure low-cost solution for elder's eCardio surveillance	Technological issues (service platform, simplicity of the systems, data security)
Varshney (2014)	Mobile health: Four emerging themes of research	Literature review: Cognitive processes and adherence, cognitive load theory and health promotion model
Lorenz and Oppermann (2009)	Mobile health monitoring for the elderly: Designing for diversity	Usability (ease-of-use, ease of operation and user interface)
Qian <i>et al.</i> (2011)	Maintaining and modifying pace through tactile and multimodal feedback	Generic technology adoption factor (willingness to use and perceived effectiveness) and System usability (confidence in using the system and enjoyment using interface)
Razak <i>et al.</i> (2012)	Elderly User Mental Model of Reminder System	Mental model (simplicity, familiarity, flexibility and recognisability)

In a sense, this segment can be seen as the laggards identified in the DOI theory (Rogers, 2003). They may require specific incentives and educational efforts to motivate them to use the Internet and/or mobile technology (Paul and Stegbauer, 2005). Haddon (2000) argued that they are an age group that lives under different socioeconomic circumstances, have different interests and horizons, and are widely dispersed. Also, they tend to be conservative when it comes to innovative mobile technology (the reasons which can be associated to the aging-specific characteristics). In addition, a handful of studies show that the young-elderly have different levels of commitment, familiarity and competences in relation to the adoption of mobile technology (Pérez *et al.*, 2012). Pérez *et al.* (2012) suggest that given proper training and in some cases, specific adaptations to lower the threshold, senior citizens can benefit from the various advantages that mobile technology offers (e.g. tracking their health condition and well-being using assistive applications). Ling and Haddon (2002) 'argue that several motivational factors, such as display, accessibility, coordination, safety and security are associated with the adoption of mobile technology in the young-elderly context' (pp. 246–247) making it important to have an in-depth understanding of their needs and requirements and their perception of mobile technology.

Recently, there has been much discussion about the claim that the young-elderly can improve their quality of life by adopting and using Information and Communication Technologies (ICT) health-related services (Heart and Kalderon, 2013)

and in particular mobile health and wellness applications (Rosser and Eccleston, 2011; Kaplan and Stone, 2013). While a number of different kernel theories have been developed to investigate this claim, their relative applicability in this context is difficult to ascertain. Because, as yet, no unified conceptual model has been developed which contains all the relevant aspects. There are numbers of diverse theoretical evaluation criteria that are essential to investigate the adoption and use of mobile technology in the young-elderly context. These comprise three types: (i) general acceptance criteria, including factors like technoeconomic (e.g. service characteristics and service functionality), personal characteristics (e.g. perceived usefulness) and context of use (e.g. situational context); (ii) psychological criteria, rooted in health behaviour and HBM, such as perceived benefit and perceived barriers; and (iii) sociological criteria, rooted in social inclusion and exclusion theory through various dimensions, which emphasizes the relationship between perceived social anxiety and social exclusion, loneliness and depression. Still, there are some aging-specific characteristics (e.g. technology anxiety) which play an important role to understand the mobile health adoption.

Analysis in this systematic review of literature, and related studies, have provided the groundwork for identifying instrumental adoption factors that influence older adults' intention to adopt and use mobile health and wellness applications. To summarise these factors in the form of a model, a hypothetical

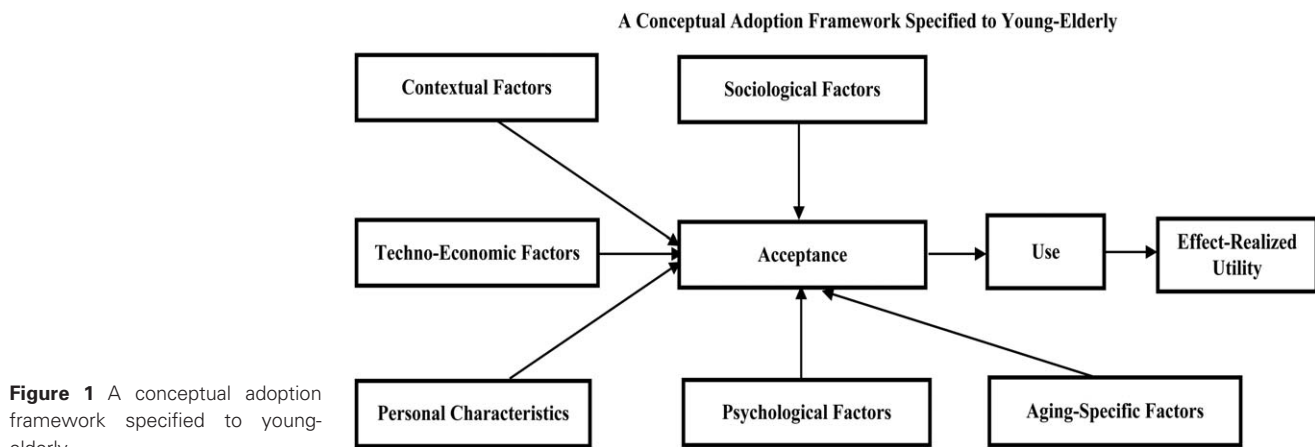


Figure 1 A conceptual adoption framework specified to young-elderly.

conceptual framework is provided in Fig. 1. The conceptual framework entails several constructs to examine whether the combination of generic technology adoption factors (contextual, technoeconomic and personal characteristics) with more specified factors (sociological, psychological and aging-specific) have a measurable influence on the decisions of the young-elderly to accept, use and realize the intended effects of mobile health and wellness applications. The expectation is that the behavioural intention of the young-elderly is affected by several important factors that can be grouped into three general categories:

1 Contextual, technoeconomic and personal characteristics;

- context of use;
- willingness to pay;
- perceive usefulness;
- ...

2 Psychological and sociological factors;

- social inclusion and exclusion;
- perceived susceptibility and perceive severity;
- perceive benefits, barriers;
- ...

3 Aging-specific characteristics;

- technology anxiety;
- perceive physical condition;
- resistant to change;
- ...

Contextual factors play crucial role and impact users' decision to accept, adopt and use a mobile service. In the young-elderly context, for example, this can be referred to a situation when an older person lives alone or find him/her increasingly homebound, thus situation dependency increases the user acceptance. Personal characteristics are the results of a user's (young-elderly) personal history and experience with mobile technology. By the same token, the success of adoption and use of a mobile health application and the resulting appeal of such applications to young-elderly depend on the technological and economical feasibility and support provided by mobile technology. Thus, it can be argued that the ease-of use, interface design, and cost (willingness to pay) of such services influence the attitude and behavioural intentions. It is impressive to see the number of previous studies on acceptance and

adoption of mobile services motivated by the traditional acceptance and diffusion theories using various generic factors. Nevertheless, it would be unrealistic to measure the young-elderly behavioural intentions toward the acceptance, use and realize the intended effects of mobile health and wellness applications without considering other relevant and specific adoption (sociological, psychological and aging-specific) factors. Accordingly, these specific factors might be expected to influence and have a positive impact on the young-elderly behavioural intentions. Young-elderly have limited exposure to newer (mobile) technologies, as they have spent most of their lives under significantly different environmental conditions, before the innovative and disruptive mobile technologies became available to them. It is important to evaluate their perceptions towards mobile technology and to measure for example, the impact of technology-anxiety, resistance to change, perceived benefit and barrier. In other words, as in their lifetime, they witnessed enormous technological and societal changes it can be argued that these specific factors play a paramount role in determining the success of the adoption of mobile health and wellness services (see Fig. 1). However, the applicability of the conceptual framework is yet to be determined in future empirical research.

Conclusions and limitation

The research on mobile (smart) phone use for supporting the life-style and health of aging adults is in its early stage. The growing populations of older people can potentially benefit from the rapid growth in mobile technology and investigate how mobile health and wellness services can be used to the practical advantage of aging-adults. Most of the previous studies covered in this review of mobile phone use for providing health and wellness services to older adults are typically pilot or experimental studies and lack to provide a specified adoption conceptual framework for young-elderly. Despite the fact that prior studies focusing on mobile technology and older people provide impressive results, they are not explicitly aimed at the young-elderly and their perceptions about adoption, and use of mobile health and wellness applications. With the aim of overcoming the existing behavioural and attitudinal hurdles, in addition to providing scientific and practical results, this review provides an insight into

the adoption and use of emerging mobile health and wellness applications by the young-elderly. Furthermore, the hypothetical conceptual framework suggested in this review provides a theoretical foundation to bridge the gap between various adoption-related, aging-specific characteristics, psychological and sociological studies. Following this systematic review, the proposed conceptual framework needs empirical testing and validation.

At a more practical level, this review provides insights to application developers and designers aiming at the young-elderly. Mobile health and wellness applications are only of value to the young-elderly if they are designed according to their needs and preferences. It should be noted that too many functionalities and features in a mobile health or wellness application may overwhelm them and have a negative effect on their perception.

Despite the fact that during the literature search the aim was to collect the most relevant studies and the inclusion and exclusion criteria were chosen carefully, as a limitation, this review may suffer from not including other scientific publications which might be found in other databases. The second limitation is the validation of the conceptual framework. The framework needs to be empirically tested in order to measure its applicability. The last point to address is that of legal issues associated with mobile health and wellness applications which have not been addressed in this review. The legal issues associated with mobile health and wellness applications must be evaluated against policies related to medical ethics, privacy, security and malpractice liability to prevent the misuse of health application data (Yang and Silverman, 2014). The current outlook shows that the research on mobile technology and in particular mobile phone interventions for supporting the young-elderly health's and well-being via assistive mobile applications is far from its maturity. Thus, more scientific studies are needed and as a future work, the next phase for research must be to organize and undertake a large-scale survey among a representative sample of Finnish young-elderly through the electronic sampling frame provided by the Finnish Population Register Centre.

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