



Review

A literature survey on older adults' use of social network services and social applications

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ABSTRACT

With aging, adults which once worked and were active become isolated from the world because with retirement comes a whole range of problems which span from the physical to the social scope. One of the most concerning is social isolation, which can only be fought by satisfying social needs. In terms of technology, the challenges are in designing social technologies that encourage older people to actively engage with each other and with the people around them. This paper presents a survey reviewing research surrounding the emergent field of Social Network Services (SNSs), along with other meaningful social applications, and its use by the older segment of the population. A total of thirteen domains are identified related with how these services can be improved to consider older adults characteristics: from the most important related with the family role and privacy control, to issues related with the design of the user interface, the importance of multimodal interaction and adaptive solutions to compensate age-related declines, to several other focusing on the importance of groups, photos, cultural and health information. Main contributions to the field of SNS and older adults are given in a set of recommendations which result from discussions on each domain and which aim at the design of a more inclusive SNS solution.

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1. Introduction

Population all over the world is aging (Eurostat European Commission, 2011, 2012). In 2000, the world population aged 60 years or over numbered 600 millions, triple the number reported in 1950. In 2009, the number of older persons had surpassed 700 million. By 2050, 2 billion older persons are projected to be alive, implying that their number will once again triple over a span of 40 years (United Nations, 2010). Additionally, the population of older persons is itself aging. Among those aged 60 years or over, the fastest growing population is that of the oldest-old. Today, persons aged 80 years or over account for close to 1 in every 7 older persons. By 2050, this ratio is expected to increase to nearly 1 person aged 80 or over among every 5 older persons (United Nations, 2010). With this aging process, old age dependency ratios increase (Commission, ECFIN), along with several other problems ranging from physical aspects to social limitations (Age, 2010; McLaughlin, Rogers, & Fisk, 2009). One of the most concerning issues is social isolation, which has a greater impact typically at the age of retirement, leading to drastic health degrading situations (Joinson, 2008; Shari, 2008).

The main way to fight isolation is satisfying social needs through participation in social networks. Since the beginning of this century, social networks are described as serving a great number of functions in offline life, providing social and emotional support, information resources and ties to other people (Wellman, Haase, Witte, & Hampton, 2001). This is particularly relevant at old age. As people get old, their health and well-being gets more dependent of emotionally close relationships – family members and good friends – which provide bonding social relationships and enable specific reciprocity, emotional support and companionship (Gilbert & Karahalios, 2009).

Social Network Services (SNS) are on-line environments in which people create a self-descriptive profile and then make links to other people they know on the site, creating a network of personal connections (Boyd, 2007). Participants in SNS are usually identified by their real names and often include photographs; their network of connections is displayed as an integral piece of their self-presentation (Donath & Boyd, 2004). Boyd (2007) defined three main characteristics of an SNS as allowing users to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made with others within the system. In the words of Burke, SNS are designed to connect people with friends, family and other strong ties, as well as to efficiently keep in touch with a larger set of acquaintances and new ties, without having to share the same space (Burke, Kraut, & Marlow, 2011). A growing body of evidence suggests there are many social and cognitive benefits for older adults when they use technology to create content and actively participate in reciprocal information-sharing with family and friends (Baecker, Sellen, Crosskey, Boscart, & Barbosa Neves, 2014; Cornejo, Tentori, & Favela, 2013; Garattini, Wherton, & Prendergast, 2012; Giorgi, Talamo, & Mellini, 2011; Harley, Howland, Harris, & Redlich, 2014; Judge, Neustaedter, Harrison, &

Blose, 2011; Karahasanovic et al., 2009; Lindley, 2012; Lindley, Harper, & Sellen, 2009; Neves, Franz, Munteanu, Baecker, & Ngo, 2015).

While SNS have the potential to assist older adults in maintaining relationships, uptake by older adults is extremely low (Gibson et al., 2010; Lehtinen, Näsänen, & Sarvas, 2009; Norval, Arnott, & Hanson, 2014). The reasons for this are complex, and although issues of technology access and skill are important, there are many older adults with sufficient technology access skills and ability who do not use on-line social media. Even SNS developed specifically for them have not achieved popularity with their target user group (Chen, 2009; Waycott et al., 2013). Reasons which dictate this lack of use have to be understood so that a more inclusive design can consider every user and fulfill the deep social needs present in the older segment of the population. Much of the literature overlaps, with several emerging themes such as a lack of purpose, incompatibilities, preconceptions about SNS and privacy, being suggested as important reasons as to why older adults' participation on SNS is so low.

Modern research in intelligent interactive systems can offer valuable assistance to this segment of the population, by helping them to engage more fully with the world. However, many existing user interfaces enable older people to receive and view, but not to create and share, digital content (David, Benjamin, Baecker, Gromala, & Birnholtz, 2011; Gaver et al., 2011), or often work for the “average” user but do not cater for the needs of the growing population of elderly users (Czaja & Sharit, 1998; Gregor, Newell, & Zajicek, 2002; Kurniawan, 2008; Zuckerberg, 2010). This also contributes to a low uptake of SNS and social technologies by the older segment of the population. Therefore, the challenges are in designing interactions and social technology that encourage older people to actively engage with each other and the ones around them.

This article presents an extensive study and review of the related literature surrounding the emergent field of Social Networks Services, more particularly its use by older adults. It takes into account the literature, encompassing conference and journal papers, and research projects, to build the state of the art and laying the ground for a critical analysis of this technology.

The main contributions of this work can be summarized as follows:

- Extensive study, compilation, review, and critical analysis of the available literature surrounding the field of SNS and older adults;
- Study of the most promising SNS and social applications' designed in recent years, highlighting their main characteristics;
- Identification of the most relevant domains regarding SNS and social applications concerning older adults;
- Analysis and comparison of these services and applications, and the way they address each domain;
- Compilation of the most relevant guidelines concerning the development of inclusive SNS.

The remainder of the article is organized as follows: the next

section presents the methodology used for filtering the relevant related work. This is followed by the presentation of the results of the conducted literature review organized in three subsections or categories: the first concerns social experiments performed by older adults with applications; the second focuses on the use of typical SNS by older adults; and the third presents SNS developed to target specifically the older segment of the population. Afterwards, a discussion and analysis section is presented where a set of relevant dimensions concerning the design of SNS are introduced. Additionally, a list of guidelines for inclusive design of SNS focused on each of the domains identified is presented. The paper concludes with a summary of the findings and a discussion of the survey limitations and on the future directions of the research topic.

2. Material and methods

A number of mainstream journals and conferences in the area of human factors, ergonomics, and human computer interaction, as well as a number of specialist journals and conferences on aging, disability and technology, were selected for this survey. These quality conferences and journals were selected based on their impact factor (Thomson Reuters, 2013) and rankings by the Australian Research Council's ranking of journals and conferences (Australian Research Council, 2010). Conferences which, although not featuring on these rankings, are specially relevant to the field – like ASSETS – were also considered. Additionally, papers originating from other sources were selected based on the fact that they were strongly cited by papers in the main sources. Table 1 presents the sources from where papers were selected for analysis.

A total of 7384 papers from 11 distinct sources were analyzed in the literature search and review. Of these papers, 31 were selected for the survey which represents less than 0.5% of the entire pool of selection. Additionally 10 more papers were selected from additional sources as they were heavily cited in the selected pool of papers (Table 2). To give a full understanding of how these 41 relevant papers were selected we know explain in detail each of the five steps that composed the review process:

1. Venue selection: Taking into consideration their impact factor and rankings, a list of relevant conferences and journals were selected. Determinant factors were related with how the conferences and publications focus specifically on older adults, on aspects of Human–Computer Interaction, and on the social aspects of technology. Sources related with psychological and social aspects of old age which were not related with technology, tended not to be considered. Additionally, this literature review focused specially on the last seven years of research, so the majority of sources analyzed belonged to this time interval. The list of conferences and journals are presented in Table 1.

2. Keyword-based pre-selection of papers: For each conference and journal selected, a pool of papers for analysis was built from the ones featuring specific keywords in the title from four specific categories: terms related with (1) the older segment of the population like “elderly”, “older adults”, and “seniors”; terms related with (2) older adults characteristics like “vision impaired”, “cognitive decline”, “dementia”, etc.; terms related with (3) SNS and social applications like “social network”, “social network services”, “social services”, “social applications”, “SNS”, etc.; and terms related with (4) issues like isolation and social skills like “social isolation”, “loneliness”, “social decline”, “communication”, “keeping in touch”, etc.
3. Abstract-based pre-selection of papers: From the preselected papers, each abstract was analyzed to gain a general overview of each work. Taking into consideration the way the abstract focused on the general categories of the study (identified on point 2), papers were selected for the next step. The ones which the abstract gave a clear idea of not being in the scope of the study were filtered out.
4. *A priori* coding: All selected papers were read and coded following an *a priori* approach (Weber, 1990) and taking into consideration the categories and the keywords identified in point 2. This process allowed to filter out papers which approached the main subjects in a too superficial manner, and at the same time enabled the placement of each relevant paper into one of the three categories previously identified.
5. Emergent coding: Papers were annotated and classified using emergent coding (Miles & Huberman, 1994) from which, as a result of inductive reasoning, several domains resulted (each of these domains is individually explored later in this survey). As an example of this coding process we have the domain related with “family” (and how both SNS and social applications evolve around family members and family relationships) which was not considered as a keyword in the previous steps and was identified as the most relevant domain at this step. The most relevant papers, i.e. the ones which spanned over several domains, or the ones which introduced relevant domains, were selected as papers to include in the survey. A total of thirty one papers were selected using this process and the way they span over the selected sources can also be consulted on Table 1 by giving special attention to the “selected” column.
6. Additional papers: As a result of point 5, some papers cited by the selected papers were also identified as relevant and went through the same reading and coding steps. In total, an additional 10 papers were selected, and their sources are listed on Table 2.

In the next section a brief summary of each of the categories identified in this survey is provided. Moreover, a summary of each of the papers selected as the most relevant to include in this

Table 1
Journals and Conferences included in the survey.

Mainstream journal or conference	Years	Analyzed	Selected
ACM Conference on Human Factors in Computing Systems (CHI)	2005 – 2015	3178	13
ACM SIGACCESS International Conference on Computers and Accessibility (ASSETS)	2011 – 2014	108	1
ACM Transactions on Computer Human Interaction (TOCHI)	2012 – 2015	112	1
ACM Transactions on Accessible Computing (TACCESS)	2012 – 2015	27	0
British Computer Society Interaction Specialist Group Conference (BCS HCI)	2009 – 2015	348	3
Computers in Human Behavior	2009 – 2015	2119	4
Conference on Human–Computer Interaction (INTERACT)	2011 – 2015	620	3
Human Computer Interaction	2012 – 2015	57	0
International Journal of Human–Computer Studies	2009 – 2015	408	3
International Conference on Intelligent User Interfaces (IUI)	2011 – 2015	271	0
Universal Access in The Information Society	2012 – 2015	136	3
Total		7384	31

Table 2
Additional relevant Journals and Conferences included in the survey.

Additionally relevant journal or conference	Years	Analyzed	Selected
Australian Computer–Human Interaction Conference (OzCHI)	2012	1	1
Behavior & Information Technology	1993	1	1
Educational Gerontology	2012	1	1
IEEE Internet Computing	2005	1	1
Journal of Community Informatics	2012	1	1
New Media & Society	2003	1	1
Nordic Conference on Human–Computer Interaction (NordCHI)	2010	1	1
Personal Ubiquitous Computing	2007	1	1
Transactions on Information Technology and Biomedicine	2010	1	1
XRDS Crossroads ACM	2007	1	1
	Total	10	10

bibliographic review is also detailed. Each summary aims at the discussion of the relevant characteristics of each work which make the basis for the later identification of the relevant domains.

3. Results

This section presents an analysis of the several distinct contexts of social technology used in the past years and highlights the main conclusions regarding its characteristics and the “whys” and “hows” it can be used and designed to be better suited to the older segment of the population. The first subsection provides a look at older adults’ most distinctive social experiments (based on the use of applications with social purposes) and builds up some knowledge regarding the more important characteristics for the elderly. The second subsection focuses on studies related with the use of standard SNS like Facebook and the main causes of why older adults do not use these services as much as younger generations. The third and last subsection, focuses on research that investigated the main reasons why SNS targeted specifically at this population do not fulfill their goals. Articles in each section are presented in a chronological order to give a full overview of how the research field has evolved. The division of the literary review into these three sections is justified by the way researchers in each section had distinct goals. While researchers in the first section were more concerned with small and specific social problems related with older adults communication, researchers in the second section were concerned with the understanding of what is missing from typical SNS to be used by this population, and researchers in the last section focused only on the older population without even considering the younger generations as part of a SNS (or as the imperative force behind its use by the older population).

3.1. Social applications and older adults

This section presents the most relevant work regarding social applications developed in the most recent years. Although not full SNS, these applications focus on characteristics typically present in this type of services. Their review is crucial to capacitate the development of SNS fully understandable and accessible to the older segment of the population. Additionally, the use of several of these applications constituted a first experiment with social technology and that itself can contribute insights into how these technologies should be designed having older adults in mind.

The first relevant social application targeting older adults was Brunette, Eisenstadt, Pukinskis, and Ryan (2005) Meeteetse application which focused on place attachment to connect older adults on the same community. They wanted to strengthen shared identity into a community center (through a location-aware digital camera and a large public display) and create a tangible way of communication at older adults’ home (through a touch-screen

scheduling device and a digital picture frame). Photos were automatically upload and associated with events and seniors could share slide shows on the public display at the community center, and vote “thumbs up” or “thumbs down” on photos using a remote control to determine how long they are kept in rotation. Problems with taking or deleting photos and navigation issues created the necessity for animated transitions, visual cues and color coding to give users a visceral sense of change between pages. Additionally, the mechanisms for sharing experiences were too basic. Allowing community members to share stories in a more expansive fashion (Izadi, Brignull, Rodden, Rogers, & Underwood, 2003) and the possibility of making use of a messaging portal would make Meeteetse more interactive, inclusive and close to a SNS.

Evolving towards a family approach, Romero et al. (2007) ASTRA application focused on providing context for conversation within a household by using photos. It served as a foundation for a breath of subsequent research into situated displays, as the work of delivering specific objects and the appropriation of messaging devices can be seen as ways of sustaining family members relationships.

After this work, several other projects followed the same goal of establishing better ways of communication between older adults and family members: Lindley et al. (2009) and Vetere, Davis, Gibbs, and Howard (2009) work focused on sharing of photos between older adults and relatives, while Raffle et al. (2010) and Vutborg, Kjeldskov, Pedell, and Vetere (2010) prototypes focused on storytelling between grandparents and grandsons living apart.

Lindley et al. (2009) developed two social applications: ShoddyPop, an asynchronous email server which allowed for the recipient to take his time before replying or reciprocating the attention; and PersonCards an application which applied Brunettes’ early work (Brunette et al., 2005), and allowed for lightweight information to be sent to a situated display in an older adult’s home. In these, they made use of diverse channels for sending messages. Recipients could also reply with handwritten messages for a more personal and easy to produce form of contact. With both applications they promoted use cases for a number of design implications: (1) contact should allow for a level of intimacy that is personalized – e.g., the use of “personal touches”, like the tone of someone’s voice or obtained through the recognition of a loved one’s handwriting – thus supporting a level of expression that is lost with text messages and even in email; (2) technology should allow for more focused, intense communication, as older adults are prepared to devote time to activities – e.g., talking on the phone or writing letters – that demand thoughtfulness and skill, therefore, while time is dedicated to contact, this contact should be non-intrusive; and (3) design should support reciprocity, because while older adults appreciate the potential for new technologies to offer insights into the lives of their loved ones, they want to be able to give something back in return.

Vetere et al. (2009) developed the Collage, a technology probe to

allow the sharing of everyday experiences, story-telling, family history and the creation of new experiences. They designed the system to provide asynchronous exchanges of photographs and text-messages between smartphones and medium sized touch-screens located in prominent areas. Users could stop, drag and resize items and actions would reflect on both screens (WYSIWYG alike). Although only exploratory, its use showed electronic photographs and text became both the subject and object of inter-generation playful encounters. It had an ambiguous character with its use being both sanctioned and celebrated. It involved the capability of maintaining an important relationship and at the same time the feeling of familiar obligation. Lastly, although authors evidenced that older adults' possible physical impairments should be one of the main points of focus, these were not the in fact considered in their work.

Raffle et al. (2010) took inspiration from Romero's (Romero et al., 2007) and Lindley's (Lindley et al., 2009) previous work, and created a custom-made device to be used by grandparents and grandchildren for shared reading of physical storybooks. It included an audio channel and page sensing technology to determine if the child was on the same physical page. Evaluation showed that it not only made children more engaged in long-distance communication than when they used other technology, like Skype, but also that the quality of the intergenerational interactions improved as well. Their work also reinforced the value of intergenerational play first evidenced by Vetere et al. (2009).

Similar to Raffle et al. (Raffle et al., 2010), Vutborg et al. (2010) implemented and evaluated a technology to provide adequate communication between grandparents and grandchildren. It allowed the sharing of virtual objects, through a shared display. It consisted of two LCD monitors and two computers, one set for each household. It followed the WYSIWIS concept and was equipped with an audio channel through which users could talk to each other, as on a normal phone. Their work highlighted four important themes for the design of a system with social goals and focusing on older adults: conversational context (to have something to talk about), facilitation (to be given the opportunity to talk), supporting grandparent caring for grandchild, and diversified interaction forms (to maintain attention of different users with different characteristics). The latter theme was regarded as the most important and employed by subsequent systems focused on this segment of the population.

Still related with solutions regarding interaction with family, both Giorgi et al. (2011) Life Frame framework and Gaver et al. (2011) device employed the use of digital mementos and photos as a tool for increasing social interaction, while Judge et al. (2011) prototype focused on the inclusion of a "personal touch" on the communication between older adults and relatives.

Giorgi et al. (2011) Life Frame was composed of multiple interactive digital frames distributed in different places around the house. Each one worked like a tangible object with augmented services added to physical mementos for memory preservation and enhancement. They concluded these technologies can support specific needs connected with aging: the need for safety and the need for company. However, the process of appropriation was slow and relied closely on mediation by family members or close friends, and on the capability of suggesting functions they are familiar with. Still, the added value of generating opportunities for real encounters and relationships was seen as fundamental for satisfying the elderly people's need for company.

The Photostroller (Gaver et al., 2011) was a device designed for use by residents of a care-home for older people which showed a continuous slide-show of photographs retrieved from the Flickr image website using a set of six predefined categories modified by a tunable degree of 'semantic drift'. It was composed by a large

screen, a removable control unit and wheeled legs to allow it to be used both in large groups (dinner room) or more intimate sessions (bedrooms). Photostroller was well received because it allowed elderlies' memories and conversations to drift along with the imagery serving as a tool for sociability and reminiscence (and mentally engaging). Older adults saw it as a simplified version of a television with a clear and recognizable purpose and enjoyed the interaction it offered. It was novel because it only made use of photos to make older adults engage and socialize and confirmed the role of alternative modalities of interaction (like TV) for social engagement.

Judge et al. (2011) showed how a multifamily media space called Family Portals increased feelings of connectedness and awareness. They based their system on an always-on approach that provided continuous video connection between the households and supported asynchronous mobile (around the home) interaction by touch-writing on a Tablet PC. The dedicated area for writing resulted in increased information sharing between family members, and the combination with video improved domestic awareness. Additionally, the device also increased communication outside the family circle and activity participation in each-other's homes. Their results also showed differences in terms of awareness and communication needs between distinct family members and the necessity for adaptation features to tackle these.

Following these works, Lindley (2012) also focused on asynchronous communication between older adults and relatives, while, taking a distinct approach, Garattini et al. (2012) work presents the development of a device which makes use of a telephone and several input modalities to support social interaction among older adults.

Confirming their previous indications (Lindley et al., 2009) that older adults express a preference for heavyweight interaction, Lindley (2012) presented findings from a field trial in which three generations of a family were linked through a situated messaging device called Wayve, which, while designed to support lightweight messaging, also afforded rich and expressive contact. The main features to be acknowledged as important by the participants included the possibility of one-click message sending to a set of favorite contacts, the asynchronous nature of the system which made it possible for them to work-around the schedules of their relatives, or the ability to scribble messages. Wayve was perceived as very easy to use. However, older adults tended to use mobile phones only for talking instead of text messaging or sending picture messages. Older adults also valued the fact that Wayve was a closed network, only available to their family as it gave them a sense of privacy. Lastly, they tended to highlight the possibility of using alternative modalities, which could better met their communication habits, like speech interaction or other sorts of multimodal approaches.

Garattini et al. (2012), through the Building Bridges project, developed a device consisting of a 12-inch touch screen computer and a phone handset with cradle and speakers. This device allowed older adults to listen to regular broadcasts and supported both audio and written exchanges between each other and their contacts. This provided further understanding into how this segment of the population engages through technology: (1) contact with strangers requires a certain amount of effort and, although it is possible with time, very few are interested; (2) informative and education content acts as an effective channel for encouraging social interaction; (3) usage can be influenced by gender and levels of loneliness but not by prior technological experience; (4) there are concerns about privacy and personal identity related with being seen on a web-cam and the necessity of having control over who can see what; and (5) the necessity for a system like this to work in conjunction with meeting face-to-face. Thus, Garattini et al.

confirmed indications related with the importance of the offline role and introduced new factors such as the need for privacy control, the importance of cultural and health subjects and the sensitivity of having to deal with strangers as key ones when using social applications.

Later, while Grosinger, Vetere, and Fitzpatrick (2012) developed an application targeting the promotion of social motivation by using issues related with physical activity, Kim et al. (2013) turned their attention to the empowering of social relationships between older adults and their relatives by including gifts as a motivation for social touch.

Grosinger et al. (2012) developed a tablet-based prototype called Agile Life that provided “Physical Activity Information Chunks” (PAICs) and promoted awareness of friends’ activities and opportunities to join in. Their findings supported the preference for the nurturing of close relationships over the forging of new ones and suggested that the content of information chunks needs to be tailored to each individual older adult, or group of older users.

TimelyPresent (Kim et al., 2013) main goal was to connect three-generation families across different time zones. It supported the ability to create video-based gifts to stimulate local-time-based conversations and collective reflection. Families found the prototype valuable for their communication with the presence of very few buttons being the main reason for its high usability. They further supported the importance of having family-related content and family-related features could help boost the adoption of socially-based services by older adults. They revisited the discussion related with avoiding the creating of new social obligations and provided indications that video-clips may have advantages over photos as they allow for non-verbal social cues such as laughter, smiles or funny gestures to be communicated more effectively.

More recently, Baecker et al. (2014) confirmed a lot of the previous findings regarding factors such as the importance of asynchronous communication, photos and the presence of some sort of personal form of communication for keeping contact with existing family ties. Additionally, they identified other relevant factors with identical relevance. Following, Neves et al. (2015) used the same device as Baecker et al. and further showed the importance of favoring additional forms of interaction, distinct uses and paying attention to the diversity of older adults.

Baecker et al. (2014) developed the “InTouch” prototype focusing on several recommendations originated from a user-centered design approach: they avoided traditional computer aesthetics and conventions; supported expressions of person-hood by providing alternative interaction (touch and gesture) and non-typing forms of communication like videos, photos and audio; used pictures of family and light forms of social exchanges like waves and smiles; focused on features for maintaining existing contacts and family communication; supported both asynchronous and synchronous communication; and were non-language specific by using icons. In their tests they found the necessity to enhance privacy features with the ability for receiving only messages from a set of contacts and identified three types of profiles for social active older users. Finally results showed gains on enabling new varieties of display media such as TV, family albums and smart-watches and exploring multimodal input.

Neves et al. (2015) deployed the same communication appliance as Baecker et al. (2014) and, making use of the same properties, they suggested factors that facilitate the adoption of social technologies such as social support by family members and the importance of factoring security and considering cultural issues (such as the meaning of gestures) into the interaction design. They also found that, different types of media, types of use (active vs passive), and adaptive mechanisms to compensate motor

limitations, should be used as necessary. Finally, they provided further recommendations for the design of more inclusive social service, like avoiding the use of ambiguous symbols and using explicit affordances, such as icons to indicate how to perform specific gestures to achieve specific tasks.

3.2. SNS use by older adults

This section focuses on the most relevant studies performed in the last years regarding the use of standard SNS (like Facebook) by the older segment of the population. Special emphasis is given to the works that contribute to characterize the main causes for the lack of use of SNS, and the main motivations for its adoption.

In 2005, Santana, Rodríguez, González, Castro, and Andrade (2005) performed the first study in which SNS were appointed as being fundamental for social relationships in the old age. They revealed that phone calls were the main method to connect with relatives and friends, but these are used more to update information or on important dates, rather than as a proper SNS. They also showed a preference of older adults for family contacts over friends.

After them, Sayago, Santos, Gonzalez, Arenas, and López (2007) study focused on the role of images when older adults share information for social purposes, and Joinson (2008), Karahasanovic et al. (2009) and Lehtinen et al. (2009) followed with investigations on the views and motives of SNS use, and on the involvement of older adults on generating content for these platforms.

Sayago et al. (2007) looked at the subject of online sharing by the elderly. They generated novel recommendations for that time: (1) elderly learned more from past experiences than from tests or other learning activities, and more efficiently together than from studying alone; (2) text-based instructions proved to be less useful than video-based ones; and (3) avoiding computer jargon enabled them to understand new technologies better.

Joinson (2008) was the first to investigate the use of a real SNS (Facebook), and identified several unique uses and gratifications: social connection, shared identities, content, social investigation, social network surfing, and status updating. Additionally, results suggested the main goal of “keeping in touch” comprised two main functions: surveillance, as the function where Facebook is used to see what family and friends are “up to”; and the use of Facebook to research offline contacts. As older adults are strongly associated with the first function, this study was the first to support the direct value SNS can have for this population.

Karahasanovic et al. (2009) showed that although older adults are resistant to participate in online communities, given the right circumstances, they would be very interested in social services: (1) a TV with additional functionalities could offer a solution because of its simplicity to turn on and operate; (2) co-creation of content would make it easier for them; (3) personalization would be highly appreciated not only in adapting their own page but also out of curiosity about what others do with their pages; and (4) they should be able to choose which people can see which of their content and at all times feel in control regarding privacy settings.

Lehtinen et al. (2009) were aligned with Karahasanovic et al. (2009) findings concerning privacy control as they showed older adults perceived the Internet as a socially unsafe place. They stated that the functions for controlling the recipients of the content published should be clear and simple and further suggested that privacy settings should be by default set for keeping everything private and then give options for its public disclosure. Their other findings suggested the main issues to address were users’ computer skills and transferring or constructing a common experience.

All these studies served as the basis for other, more relevant and recent, studies like the one performed by Gibson et al. (2010),

which published findings regarding the main causes and reactions about the use of this technology by the older segment of the population. On their studies, older adults compared SNS to a “round robin” letter they might put in a Christmas card. Additionally, and building from Karahasanovic et al. (2009); Lehtinen et al. (2009) findings, older adults felt vulnerable with the customary binary or tertiary privacy settings and counter-intuitive nature of default settings and found critical to distinguish between what they want to share with family, close friends and acquaintances. Furthermore, the importance of varying degrees of reciprocity were identified as motivational factors, and there was dissatisfaction with the way the SNS made use of the word “friends” as a catch-all term for anyone. Finally, older adults felt more secure with a group identity rather than highlighting themselves as an individual.

Later, Burke's (Burke et al., 2011) understanding of social capital and how different users can relate with different uses and Xie, Watkins, Golbeck, and Huang (2012) perceptions on how older adults can learn to use SNS also contributed to understand the use of SNS by older adults.

Burke et al. (2011) distinguished between two types of social behavior in SNS: direct communication consisting of personal, one-on-one exchanges (messages, wall posts and synchronous chat) which is associated with increases in bonding social capital Gilbert and Karahalios (2009); and passive consumption of social news and its association with bridging social capital Joinson (2008). In their conclusions they rejected previous findings and stated that Facebook may work best for increasing the value of weaker relationships among the older population, and that status updates and photos could increase feeling of connectedness among less socially skilled elderly. They suggested several guidelines: the UI should focus on creating incentives for users to produce stories that create opportunities for more inbound communication; adapting the display of content so users can be prompted to interact with contacts in need of communication; suggesting reconnecting with old friends or reordering lists of people to highlight acquaintances over regular contacts; and resurfacing prior content as a means of stimulating communications for inactive relationships.

Xie et al. (2012) identified privacy (e.g. knowing if there were ways of making information available only to some contacts) as being the key perceptual barrier to adoption. However, and contrary to prior studies which considered privacy issues, instead of focusing on influencing design, they developed educational strategies to overcome privacy concerns like introducing the concepts before introducing the functions, responding to privacy concerns and making social media personally relevant. The most relevant aspect of the study was the fact that participants changed from the initial unanimous, strongly negative to a final eventual willingness to actually participate in SNS. This means that, as older adults become more familiar with SNS, they will likely integrate it into their daily lives. Still efforts are needed on educating about the existing settings.

Taking all the previous studies into consideration, Hope, Schwaba, and Piper (2014), Norval et al. (2014) and Harley et al. (2014) performed broader studies on the main causes and reactions of using this technology.

Differentiating themselves from previous studies, Hope et al. (2014) focused on technological aware users who expressed interest in improving communication with their social network. They supported earlier findings on “heavyweight” communications (Burke et al., 2011; Lehtinen et al., 2009), but extended this by analyzing the importance of tangible communications, like paper-based and hand-written communications. They supported “letter writing” as a social practice that should be explored in a SNS context when targeting this population, as it supports varying degrees of formality depending on the content and tone used and

enables both immediate and later reflection on interactions. Other results showed that older adults are concerned about the time required for legitimate participation and the loss of deeper communication, content irrelevance, and privacy. A major curiosity here is the suggestion that “by not calling anyone” (in the family) they can in fact be communicating their wellbeing and independence. Additionally, seniors believe they can fill gaps in the communication with people of their age who do not use SNS or have an active role on mass communication of illness or identical situations to the whole family. Thus, they provided additional recommendations regarding the design of inclusive SNS: (1) foster strong tie relationships; (2) afford expression of thoughtfulness and concern by supporting social communications with tangible value; (3) support older adults' value regarding the ability to foster communication and help younger relatives; and (4) offer content from venerated sources only.

Norval et al. (2014) identified a series of recommendations from a focus group study with older adults: (1) the need to clarify and simplify privacy settings; (2) avoid technical terminology and use a simple layout; and (3) avoid friend suggestions. As a result they developed a system with two user interface versions, one for control which was strongly influenced by Facebook default UI, and a modified UI which adapted the control UI to follow these recommendations (and others from previous works). They changed feature location, color and size aspects and the default privacy settings and buttons related with it. Although no direct communication or photo upload features were present, participants preferred and thought it would be easier to use the Modified UI regularly rather than the default UI. Further recommendations were suggested such as modifying the navigation panel for privacy purposes and removing details related with assumption of prior knowledge. Their implementations of prior research in an usable prototype showed Facebook could be much more usable by the older population.

Harley et al. (2014) looked at the significance of family and local community and how these influence online engagement among older adults. Their findings spanned over the most common domains identified until date. They reported problems related with privacy and disclosure and the necessity for clear transition from public to private interactions. They also stated a clear preference for meeting face-to-face and for SNS to work as a tool for achieving this aim. They suggested the inclusion of several features: “sharing rooms” focused on sharing ideas and content not only dedicated to family members but also for anonymous sharing; focus on initiatives to connect with local communities offline; and the existence of formal roles within a SNS to make other people engage more in the purpose of each older user.

More recently, while Michailidou, Parmaxi, and Zaphiris (2015) focused on the differences between the use of Facebook by older and younger adults, other authors continued to focus on the importance of privacy aspects, the key role of photos, direct communication and adaptation for keeping connected to family through SNS (Coelho, Rito, Luz, & Duarte, 2015; Hayes, van Stolk-Cooke, & Muench, 2015; Lang & Barton, 2015).

Michailidou et al. (2015) investigated the use of online social based services by older adults in culturally diverse countries (Greece and UK). They found cultural differences in terms of preference for online or offline support, perceptions on technology use and preference for using SNS only with family members or close friends. They found similarities in the way older adults rely on offline means of communication and physical presence in cases of deep support, and consider themselves less capable of using and learning how to use technology than their younger counterparts. They mainly defended the need to incorporate the “language of the user” which differs with the type of culture by adopting concepts

such as culturally adaptable interfaces (Reinecke & Bernstein, 2011). They also recommended that SNS should provide features to understand content in any language, make use of pictures to increase member visibility and support the ability to have a video conversation in an instance.

In the line of previous works which focused on the importance of privacy, and the role that photos play on interaction and adoption of SNS, Lang and Barton (2015) explored the methods individuals use to manage perceived invasions of privacy in the form of undesirable Facebook photos uploaded and tagged by other users. They showed older users are less likely to untag or request deletion than younger counterparts as they are less technically skilled and less likely to experience undesirable Facebook photos. Still, when they face this type of problem, older adults tend to comment on the photo, or contact the uploader via chat or private message instead of untagging.

Hayes et al. (2015) hypothesized that older adults use Facebook differently and less often than younger users, and that they are more resilient to the negative effects of Facebook use. Results showed younger adults use the tool more frequently and are more emotionally impacted by it than older adults. In more detail: (1) there was a negative relationship between age and the amount of time spent viewing own photos, with younger adults doing it more frequently; (2) there was an inverse relationship between time spent and frequency of checking Facebook per day and age; (3) older adults use features like chat and posting photos less than younger users mainly because they are more skeptical and less skilled about its usage; and (4) older adults update their personal information and status significantly less than younger adults. However, this study suffers from limitations, including the fact that, not only they did not fully consider differences between younger and older adults (only 19% of participants were older adults), but also performed no comparison between younger older adults and older adults (no participant was age more than 70 years of age).

Coelho et al. (2015) showed older adults were receptive to performing social tasks on TV and Tablet-based applications. Informed by a participatory design on the two prototypes, they provided a collection of recommendations regarding the design of interfaces for this population: (1) non-Facebook users tend to reject all alternatives for access because of privacy issues and bad feelings associated with the word “Facebook”; (2) tasks related with viewing photos and videos of family and close friends, creating events with these groups, video-conferencing and sending messages are the most relevant when talking about the possibility of accessing SNS; (3) TV and Tablet based prototypes should support traditional interactions but provide alternative ones too (especially voice and gestures); (4) SNS should always provide contextual help through several outputs as well as adaptation and personalization mechanisms; (5) inclusion of new photo-based features (like sharing of printed photos through TV and digital photo frames through Tablet) and contextual-based features (like sharing TV content through TV) can enhance use and adoption of these services.

Lastly, Vroman, Arthanat, and Lysack (2015) confirmed already consensual findings with the majority of older adults in a study using ICT for connecting with family and other close social relationships or to access health and routine-related information and rejecting activities related with knowing new people. However, they distinguished themselves by both rejecting the notion that older adults would like to use direct communication in this context, and by revealing the influence of other unacknowledged factors. They showed both education and age can have a strong impact and also revealed that being alone makes older adults less likely to self-initiate exploration of these services. Moreover, they showed the use of ICT for social purposes is also associated with the perceived

importance of the activities and with feeling healthy. Finally, they envisioned a three-tiered person-centered model to explain and promote ICT social use among older adults with the attitudes, needs and ICT capacity of an older adult at the center surrounded by personal relationships, utility factors, and the virtual community.

3.3. Social network services developed for older adults

In this final section, focus is given to the most relevant SNS developed specifically for older adults as a response for the lack of use of traditional SNS like Facebook.

Czaja, Guerrier, Nair, and Landauer (1993) developed the first meaningful attempt of prototyping a SNS to target older adults specifically. It consisted of a simple messaging system to support social connectedness for users with little computer experience. Participants could operate the system with a minimal amount of difficulty and indicated it facilitated social interaction and provided a chance to meet new people. Still, a decline in use was observed over time, as people were busy and the system had limited functionalities. Also not favoring its use was the fact that it focused exclusively on the female gender.

It lasted around one decade until another SNS for older adults was developed. Morris (2005) solar concept focused around giving health feedback to older adults and provided meaningful ideas on how to present content in SNS, while four years later Sillanpaa, Alli, and Overmark (2009) concept focusing on people with cognitive and language impairments was relevant as it supported alternative ways of interaction when considering user characteristics typically present in the older population.

In Morris (2005) symbolic representation, the older person was the sun at the center of the solar system, and was surrounded by stars representing their relatives. It made use of sensors and self-reported data, and conveyed minimal information to avoid stigmatizing the elder. It kept history of recent interactions by tracing a line between each person's initial and current level of contact and modifying the distance and thickness of the line. Elders could switch to a line graph (with aggregate contacts with everyone in the social network) or a bar graph (with the levels of contact with each contact on a given day). This display was considered to act as a catalyst for people to contact the ones they were losing touch with. It also incited elders to be less passive, by preparing food for visitors, initiating phone calls, or driving somewhere to see someone. In general, this SNS constituted a good example for monitoring social ties and alerted for the importance of family and photos when designing for older adults and to the relevance of offline interaction.

Sillanpaa et al. (2009) introduced solutions used in Kaveriipiiri dfi web service, a SNS targeting young people and older adults with intellectual and developmental disabilities, or any kind of communication, attention control or guidance problems. Kaveriipiiri's layout was focused on grouping items by proximity, and the appearance of UI elements and functionalities was unified throughout the service so that active areas and essential functions could be located more easily. They showed that registering and logging in were challenging in many ways and that users with reading and writing difficulties could not fully participate, as communication in SNS is mostly done in written form. Having this in mind, they added text-to-speech functionality for all messages, a text input tool with ready-made phrases to choose from and login by selecting a sequence of symbols. Concerning privacy they reorganized the content based on privacy level (“me and my friends”, “all users” and “private messages”) in order to make it more obvious what was the audience for the content posted. Their experiments showed that adaptations had a major impact on the service's accessibility. Additionally, their findings rejected the

notion that older adults do not want to know new people online. Lastly, they provided a discussion around the difficulties of situations where people are communicating but cannot see or hear each other and on how that places an extra burden on older adults interactions in social media.

Following these studies, we find one of the most relevant studies performed until date in [Chen \(2009\)](#), which focused on several SNS solutions targeting older adults and their main pros and cons. One of the first recommendations given was that elderly benefit most from a simplified and obvious UI, i.e., less is more. This fact is in line with [Sillanpaa et al. \(2009\)](#) findings regarding simplicity. However, Chen's expanded on this by contributing the notion that offering less possibilities of interaction would be better for older adults. Additionally, he defended the importance of supporting domestic languages in SNS targeting older adults, as well as further supporting the notion of family members being the central focus point. Moreover, and resulting from his analysis of several SNS, several good practices can be resumed: (1) resulting from [Bettie \(http://www.bettie.ie/\)](#), non-technological savvy older adults could place a relative pass (a card) at three distinct areas which supported distinct functionalities (sending a message, showing updates, showing details of that contact). The existence of this type of shortcuts for specific functionalities as well as the existence of cards for specific persons, evidences the importance of the notions of grouping and favorites; (2) from [Oldkids \(http://www.oldkids.cn\)](#) and [Eons \(http://www.eons.com\)](#), emerges the discussion that SNS based on both social approval between the old-age community, E-commerce and gaming approaches, rather than on the benefits of social communication with family and close friends are not appreciated by older adults; (3) finally, resulting from [AboutMyAge \(http://www.aboutmyage.com\)](#) and [Sagazone \(http://www.sagazone.co.uk\)](#), comes the reflection that not adapting content and UI to the older segment of the population also makes them opt out.

After Chen study, other three more recent SNS were proposed: [Burmeister \(2012\)](#) study on an online community of seniors called GreyPath; [Cornejo et al. \(2013\)](#) proposition for a novel ambient SNS which was based on a strong multimodal component to drive elderly closer to these kind of systems; and finally, [Waycott et al. \(2013\)](#) SNS prototype build for older adults sharing of photographs and messages.

[Burmeister \(2012\)](#) GreyPath portal supported from technologically novice users, to technologically literate people. Greypathians could enroll in courses, contribute to or receive information on a wide variety of topics, and there were rooms and forums, each moderated by a senior volunteer who had a name and a face on the site. Older adults saw it as an inclusive "neighborhood" community defined by a social exchange that goes beyond the act of information exchange and encourages personal contact. Additionally, Greypath showed that a SNS targeting older adults has to aim for offline interaction (just like [Morris \(2005\)](#) first indicated) and to somehow construct a community around each user. Be it a community of family members and close friends, or a community of people who live close to each other.

[Cornejo et al. \(2013\)](#) developed Tlatoque, a multi-touch screen PC resembling a photo frame, which communicated to Facebook to expose photographs in the user's home and provided means of reciprocating information back. It was implemented as an Ambient

Social Network System (aSNS),¹ in which the SNS component could automatically share on the user's behalf, having privacy and interests in consideration. It further enabled the use of ambient feedback services to share meaningful routine and hobbies related information (like in [Tentori, Cornejo, and Favela \(2010\)](#)). Along with touch based gestures, it supported a set of natural gestural interaction to achieve tasks like turning on or off the display, and browsing photographs. Tlatoque made use of four distinct feedback services: the first enabled older adults to share interests; the second enabled them to rate the content being displayed; the third enabled the sharing of their whereabouts; and the last was an exergame that enabled users to socialize through exercise accomplishments. Results of using Tlatoque, showed that displaying information through sentient objects and the inclusion of touch, body and gesture-based interaction eased older adults adoption of technology and manipulation of social information. Additionally, older adults used the content uploaded by relatives to enrich both in-person and online conversations and increased interaction with relatives also due to the content of family events.

[Waycott et al. \(2013\)](#) investigated the nature and role of digital content that has been created by older adults, for the purpose of forging new relationships. They used a prototype application called Enmesh to create and share photographs and messages. It made use of the iPad in-built-camera and the virtual keyboard for exchanging photographs and messages which would float down the screen in a semi-random fashion displaying recent items more frequently. Each object could be manipulated on the screen in real-time by one user at a time, building a sense of social presence with the goal of creating a community. Findings showed that participants did not shy away from sharing some of their bad and good aspects of their daily life, often using humor to describe their experiences. Thus, this enabled them to build rapport and find common interests. Additionally, while sharing information, participants were not overly concerned with privacy as all of them knew each other through face-to-face meetings before. Moreover, the combination of images and text enabled participants to describe and share personal objects and spaces that communicated details of their histories and everyday lives. Therefore, [Waycott et al. \(2013\)](#) findings evidenced the importance of constructing a community around the older adult, just like [Burmeister \(2012\)](#) had proposed before. However, they further showed how older adults who are nor previously acquainted, can interact with each other in a social-technology manner, without too much privacy concerns, if the interface is transparent in terms of each user's actions.

4. Discussion

From all the work presented in the last section it was possible to identify and distinguish a total of thirteen different domains. In [Table 3](#) those domains are enumerated and it is also shown how they span across all the related work. In this section, we discuss each domain, starting with a small summary of how related work embraced the domain through time, and deriving conclusions and recommendations which aim to increase the usability and accessibility of SNS, specially when considering older adults.

4.1. Family

Across all the work performed in recent years concerning SNS and older adults, there is a clear indication of what makes them adopt these tools: the possibility of keeping in contact with family members which by some reason, or a combination of factors, physically or emotionally, got away. Correspondingly, more than half of the literature reviewed in this survey puts family as the foundation for the use of social services and tools among elderly.

¹ An aSNS is an ubiquitous system with a set of SNS services moved outside the desktop into the environment where we live and interact embedded into common objects (e.g. portraits, lamps, and notebooks) or tangible artifacts available in the user environment providing intuitive means for browsing, managing, or generating social media content.

Table 3
Related work and domains.

	Study	Family	Interface	Privacy	Photos and media	Multimodal	Direct communication	Knowing New people	Personalization and adaptation	Grouping	Tangible Value	Offline	Gender	Reciprocity
Social applications	Brunette2005				✓	✓								
	Romero2007	✓			✓		✓							
	Lindley2009	✓				✓				✓				✓
	Vetere2009	✓	✓		✓	✓	✓							
	Raffle2010	✓				✓								
	Vutborg2010	✓				✓								
	Giorgi2011	✓	✓							✓		✓		
	Gaver2011	✓	✓		✓									
	Judge2011	✓				✓	✓	✓	✓					
	Lindley2012	✓	✓	✓		✓	✓			✓	✓			
	Garattini2012			✓				✓				✓	✓	
	Grosinger2012	✓						✓	✓					
	Kim2013	✓	✓		✓									
	Baecker2014	✓	✓	✓	✓	✓	✓	✓	✓		✓			
Neves2015	✓	✓	✓	✓	✓	✓		✓		✓				
SNS Use	Santana2005	✓					✓							
	Sayago2007		✓											
	Joinson2008	✓		✓							✓			
	Karahasanovic2009	✓		✓		✓			✓	✓				
	Lehtinen2009			✓										✓
	Gibson2010	✓	✓	✓				✓		✓			✓	✓
	Burke2011				✓		✓	✓	✓					✓
	Xie2012	✓		✓					✓					✓
	Hope2014	✓	✓	✓			✓	✓			✓			
	Norval2014		✓	✓				✓						
	Harley2014	✓						✓		✓		✓		
	Michailidou2015	✓			✓		✓		✓			✓		
	Vroman2015	✓						✓						
	Lang2015			✓	✓		✓						✓	
Hayes2015		✓		✓										
Elderly SNS	Coelho2015	✓		✓	✓	✓	✓		✓	✓	✓	✓		
	Czaja1993							✓					✓	
	Morris2005	✓	✓		✓							✓		
	Chen2009	✓	✓		✓					✓				
	Sillanpaa2010		✓	✓		✓	✓	✓	✓					
	Burmeister2012									✓				
	Cornejo20013	✓	✓	✓		✓					✓			
	Waycott2013		✓	✓	✓	✓				✓				

Since the first meaningful social studies and applications started to target older adults social issues, that family has been appointed and used as the main motivator (Santana et al., 2005). This can be seen in the metaphor of the interactive solar system which focused on keeping touch by using representations of family members' contacts (Morris, 2005), and other systems which also used them as the "bread and butter" for its goals (Judge et al., 2011; Kim et al., 2013; Lindley, 2012; Raffle et al., 2010; Vetere et al., 2009). In fact, exchanging messages and pictures between younger and older generations (Romero et al., 2007; Vutborg et al., 2010), was also appointed by the elderly as vital in the process of learning new technology (Giorgi et al., 2011; Karahasanovic et al., 2009; Vroman et al., 2015). Finally, family was also appointed as the main focus of SNS targeting specifically old age (Chen, 2009) and situational display applications (Lindley et al., 2009), and appointed as a main cause for using existing SNS like Facebook (Baecker et al., 2014; Coelho et al., 2015; Cornejo et al., 2013; Gibson et al., 2010; Grosinger et al., 2012; Hope et al., 2014; Michailidou et al., 2015; Neves et al., 2015; Vroman et al., 2015; Xie et al., 2012).

From all these works it becomes evident the necessity for SNS to give a clear and central role to family or to contacts with whom the user maintains or wants to maintain a strong relationship. Taking into special consideration indications from older adults, and having the inclusive goal in mind, SNS should be designed to **better support the maintenance of family relationships**. This means that SNS should not only support a better specification of family roles but also consider the implementation of mechanisms capable of notifying users regarding situations related with their family contacts, like alerting to periods of inactive interaction or favor interaction contexts with these users as a way of mitigating these situations. Still, the implementation of this kind of mechanisms is not easy, mainly because technology suffers from an ambiguous character being both sanctioned and celebrated when involving familiar obligations. By exposing users to these features, systems can be both favoring and forcing interactions, with previous findings showing that, sometimes, by not communicating with family, older adult could be in fact communicating that "everything is alright" (Hope et al., 2014).

Several researchers implemented alternative ways for grandparents to communicate with grandsons or with other elements of the family living apart, suggesting that SNS should **support traditional forms of expressing family engagement**. An example of this, is the support for grandparents (or other family role) caring or the necessity of providing solutions for that type of caring to be reflected in SNS functions (Hope et al., 2014). Other supports for this recommendation could be related with: media implementations capable of being translated to "animated gifts" or implementations of "gestures" which reflect family communication (Michailidou et al., 2015; Neves et al., 2015); functionalities which can produce an effect close to storytelling (Lindley, 2012; Lindley et al., 2009); and direct messaging or chat features (Coelho et al., 2015; Vroman et al., 2015). On non-traditional technological contexts it is also important to make use of features related with that context and the way older adults are used to use it with their relatives. One example is the ability of sharing what they are seeing on the TV, if the TV is to be used for SNS purposes (Coelho et al., 2015).

Other solution several times suggested as a way of giving a more central role to family would be to **provide a family group with its own settings** to give users (specially elderly) the sense of a close network, available only to family, where safety and company can be found. In this group, older adults could also perform their active role of mass communication of one member situation (like illness) to the whole family, contributing to their self identity and self-worth. As SNS, like Facebook, already create a family group by default, this recommendation would only require the setting of

different privacy mechanisms inside the group and, possibly, the implementation of small functions, once again related to family. In fact, the **support or implementation of family-related functionalities** was also identified by older adults who already make use of SNS and social applications as something that would develop a sense of connectedness between family members, not only online but also offline (Chen, 2009; Hope et al., 2014).

4.2. User interface

Real life social networks are a product of the interaction between individuals and have no real interface, except the one provided by each person. SNS have a typical interface which, regardless of minimal changes, is provided to every user in the same way. Although this principle could favor interaction with SNS when compared with real life social networks, users of all ages have complaints about SNS interfaces being too complex, having too many options, and not being appropriate for "non typical" users who suffer from physical or mental impairments, or to users without a technological background. By taking another look at Table 3, it is evident that the SNS interface issues are the second most debated domain in the last ten years of research, or since SNS were actually launched globally. Current SNS interfaces are not only one of the main causes for many to not adopt SNS, but also one of the main complaints from the ones who adopted.

A lot of research on SNS has focused on suggesting alternative interfaces (Chen, 2009; Giorgi et al., 2011; Morris, 2005), or simplifying interface elements (Baecker et al., 2014; Gibson et al., 2010; Hayes et al., 2015; Hope et al., 2014; Neves et al., 2015; Norval et al., 2014; Sayago et al., 2007; Sillanpaa et al., 2009), specially when considering older adults as a target. Additionally, several other social applications focused on different ways of getting closer to older adults by providing dedicated interfaces focused on message exchange between older adults in the role of grandparents and the rest of the family (Cornejo et al., 2013; Kim et al., 2013; Lindley, 2012; Vetere et al., 2009), or on a community context (Gaver et al., 2011; Waycott et al., 2013).

In their conclusions, researchers are unanimous in terms of what a SNS like Facebook offers: its features are placed in a non-intuitive manner in the user interface; specific functionalities are hard to find; terms used in buttons and links are not familiar to those who have not been using these kind of services before; and it is not usable by impaired users, older adults, or users which shift away from the typical 20–40 year segment. Because of all these issues, several suggestions are proposed in several studies' conclusions.

First, the **user interface should be the simplest possible**. The elderly would not be the only ones to benefit from a more simplified and obvious UI where it is safe for anyone interact. Several ways of achieving this recommendation have been proposed: grouping items and functionalities by proximity would help users who have no past experience in finding every function and at the same time give users only the essential information needed for each context; give clear evidence to active areas so that users can locate them more easily; move secondary functionalities – or the ones less used by users – to secondary interaction areas so that users can more easily locate primary functions; and change the color and increase the size of the header and content, or give the option to increase and decrease size, so that users with visual impairments can also interact with the tool. All these solutions would be feasible and do not implicate radical changes in the standard UI of a SNS like Facebook. However, identifying the relevance of each functionality and what to collapse or highlight, can be tricky, as different users use different functions. A solution would be to start off with less primary features, and automatically "promote"

secondary features if they are used frequently.

Second, the **user interface should act as a catalyst** by motivating interaction and keeping users from losing touch with their contacts. To achieve this, there are several related recommendations which could be considered when designing a more inclusive SNS: the ability to support the various family roles, enacted by both older adults and their family members, would help in fostering communication and help both younger and older users, as well as the supportive/educative roles; the possibility of more recent items to be shown more frequently could help users at both ends of the interaction to keep motivated and interact more; provide support for more self-expression and creativity when composing content like implementing approaches related with letter writing for older adults (this is further discussed in this section, when focusing on tangible value), or making possible sending gifts and visualizing those media artifacts, which would enable older participants to describe and share details of their histories and everyday lives in a closer way to what they are used to.

As a third recommendation, the **use of easy-to-understand language instead of computer jargon** is crucial to, not only enable older adults to better understand and interact with this type of technology, but also to attract new users. This translates into two distinct recommendations: (1) removing details related with assumptions of prior knowledge (meaning of icons, features which appear on mouse hover and enter-to-submit boxes). Although this seems easy to implement, there is still a major problem with this approach. Changing language terms to which frequent users are used to, introduces a radical change which may not be well received by these users; and (2) make use of icons which can suggest the distinct SNS functionalities. However, these icons should avoid both ambiguous and explicit affordances. As an alternative, augmenting the terms already used with descriptions or other types of feedback could also help new users without changing the interaction paradigm too much.

Lastly, there must be also concerns on **providing easy-to-understand privacy options** and on **providing multimodal interaction** to accommodate users' social, physical and intellectual differences. Still, as these by themselves constitute separate SNS domains, elaborate discussions and specific design recommendations can be found in their respective subsections.

4.3. Privacy

All the papers focusing on SNS use by this segment of the population, refer privacy as the main barrier for its adoption. While this issue is relevant for a lot of users, as older adults have a more restrictive goal when using SNS, privacy assumes extreme relevance. In the same way they are mostly interested in keeping contact with relatives and close friends, they also need to feel secure when favoring SNS over more traditional ways of communication. Currently, SNS, as they are, are not safe for older adults to adopt, as privacy definitions and configurations are too complex for them to use or get used to.

The fact that users need to have some knowledge to understand where the information they share actually ends up, makes older adults opt out of these services (Gibson et al., 2010; Sillanpaa et al., 2009). Therefore, there is a common view that older adults should be able to feel in control of privacy settings and choose which people can see which content (Coelho et al., 2015; Cornejo et al., 2013; Hope et al., 2014; Karahasanovic et al., 2009; Neves et al., 2015; Xie et al., 2012) and that privacy settings should be kept clear and simple for them to use (Lehtinen et al., 2009; Norval et al., 2014). This is particularly relevant concerning family and close friends. Keeping a “closed network”, available only to their relatives, is known to be a reason for adopting social applications

(Baecker et al., 2014; Lindley, 2012), as well as gradually granting access to more information as they get familiar with each contact (Garattini et al., 2012; Waycott et al., 2013).

Researchers not only agreed in terms of the problematic issues but also agreed in the way these should be solved. As already described, privacy settings have to be clear and simple, therefore the **SNS interface should focus on facilitating the discovery and access to privacy settings**. In Facebook, for example, modifying the panel in the top right to include text in addition to the white arrow of the drop down box would better identify the menu. Additionally, and also on Facebook, changing the way privacy settings can be accessed when sharing status – by making it more evident, or changing its size – would be another solution. An alternative way of achieving the same results regarding privacy settings would be to not change the way users can access privacy settings, but rather rethink the disclosure and promotion of content and information. In this sense, SNS should **change default settings to be more private and give options to gradually reach more contacts (or groups)**. Changing default settings to post only to family or to favorites, or even to be only visible to contacts with which the user interacts the most, would be a way to make sure that the only way information is available to others would be by explicitly declaring that to the service. Interestingly, Facebook's policy changed recently to make new content available by default only to the user's Facebook Friends. Additionally, the possibility of re-organizing content based on the level of privacy or the confidence in its origin, could also help to make the user feel safer, as the majority of posts and information he or she would visualize would be from their most worthy SNS contacts.

Although research also suggests that changing SNS's interfaces could introduce significant changes in the way a SNS is used, and be disruptive for users who are already used to it, this should not prevent changes. Not only because they represent a crucial step for older adults to adopt SNS, but also because the majority of the “typical” users are also not fully aware of privacy definitions, and currently do not make a conscious use of SNS. For the ones who are already fully aware of all privacy definitions, and have in fact changed these definitions since they began using the service, there should be a careful transition to the new implementations, making sure that their privacy settings are not changed in the transition.

Moreover, and considering the importance that alternative ways of interaction can assume in the future regarding interaction with SNS there will be also the need of to **tailor privacy settings to fit each mode of communication or interaction**. This is not only relevant when considering ways of making use of privacy settings with distinct modalities of interaction, but also when considering ways to automatically share older adults context, like the ones used by (Cornejo et al., 2013). Distinct ways of interacting should not be intrusive to the privacy settings defined by a user. However, for distinct interactions must be considered distinct privacy settings (for example, when considering mechanisms which share information regarding the presence of an older adult at home, this information should only be available to family, even if the user has changed default privacy settings to public).

4.4. Photos and media relevance

The relevance of certain types of media is a subject discussed in great part of the literature concerning SNS. More specifically, the role of photos in drawing older adults closer to social applications and services has been studied by several researchers as a relevant one.

Starting ten years ago, there has been strong evidence that older adults prefer all image modalities to text (Morris, 2005) and that bringing pictures to older adults' homes through the use of digital

frames can build attachment to a place like a community center (Brunette et al., 2005) as well as provide context for conversations with family members living apart (Romero et al., 2007; Vetere et al., 2009). Additionally, the use of photos as the focus of SNS profiles and sharing activities (Baecker et al., 2014; Burke et al., 2011; Chen, 2009; Coelho et al., 2015; Waycott et al., 2013) has been shown to have a crucial effect on the ones with lower social communication skills, increasing their feelings of connectedness. Moreover, and although some studies reported that older adults tend to have and upload less photos than their younger counterparts (Hayes et al., 2015; Lang & Barton, 2015) the implementation of interaction around the direct manipulation and visualization of photos (Baecker et al., 2014; Gaver et al., 2011; Michailidou et al., 2015; Neves et al., 2015; Vetere et al., 2009; Waycott et al., 2013) has also been shown to be important in building attachment to the system and their contacts.

Based on these studies, several recommendations can be drawn when designing more inclusive social systems: **Automatically uploading photos associated with events and family** or making it easier for older adults to share this type of information in the form of photos is critical for motivating better interaction between them, their relatives and people close to them (e.g. neighbors); **providing interaction around photos** by supporting the use of touch and gestures directly on photos as a way of performing several SNS related tasks is also a possible solution for increasing older adults use of this type of systems, as they feel more involved with the system and its members. Other solutions are the ones reported on the tangible value subsection regarding the replication of real photos through the SNS and the implementation of passive social consumption modes based on photos. Moreover, the possibility of **supporting combined media items which make use of photos and audio** could also favor older adults interaction by compensating visual impairments and enriching the interaction.

However, the use of photos is not the only one to have been highlighted in SNS related studies. Recently, there were also indications that video clips can be better than photos for expressing non-verbal social cues such as laughter, smiles or personal gestures (Kim et al., 2013). Not contradicting any findings related to the use of photos, it points to the possibility of videos also having a role in making SNS more inclusive. Still, the generation of this type of media and the way it can be shared over the Internet has to be made more accessible for older adults. One idea could be to **provide short-clip sharing through the direct use of the device's camera** as a sharing functionality of SNS.

4.5. Multimodality

One of the major limitations of current SNS like Facebook, and also one of the main causes for its lack of use by users with age-impairments, is the absence of alternative ways of interaction, different from the traditional keyboard and mouse, remote control in TV contexts, and touch in smartphone contexts. In almost half (14 out of 31) of the literature considered in this survey, researchers refer alternative modalities, adaptation mechanisms focused on complementary ways of interaction, and the support for several modalities at the same time, as indispensable for compensating the old-age associated impairments.

In the vast majority of the cases, suggestions and findings regarding multimodal interaction in the context of SNS, have been a result of older adults' suggestions when faced with accessibility problems (Lindley, 2012), or when asked about the main reasons for not adopting this type of services (Judge et al., 2011; Karahasanovic et al., 2009; Lindley et al., 2009). As a response to these suggestions, solutions have been proposed by the community with the goal of facilitating the use of social services, with different modalities

being proposed by almost every researcher: location-aware cameras, large public displays and remote controls (Brunette et al., 2005); television with additional functionalities (Karahasanovic et al., 2009); digital frames, handwritten input and smartphones (Lindley et al., 2009); smartphones and touch-screens (Vetere et al., 2009); ready-made phrases for text input and symbolic input for logins (Sillanpaa et al., 2009); laptops, audio and page sensing technology (Raffle et al., 2010; Vutborg et al., 2010); speech input augmentation (Lindley, 2012); touch and gestures (Cornejo et al., 2013); combination of text and images or text and videos (Judge et al., 2011; Waycott et al., 2013); waving, tapping and gesture based interaction (Baecker et al., 2014; Neves et al., 2015); and remote control and touch complemented with voice and gestures for TV and Tablet interaction (Coelho et al., 2015).

Generally, these works show that, support for self-expression and creativity to describe and share personal details of their histories and everyday lives, is fundamental to raise the adoption of SNS by the older population. Multimodality can not only compensate for age-related declines but also provide this bridge. Additionally, findings indicate that for alternative modalities to be used, a special concern should exist regarding their intuitive use. If users have to learn how to use a modality they will not adopt the service. Therefore, SNS should **make alternative modalities of interaction non-instructional** so that users (older or younger ones) may simply "pick up and use" any way of interaction. At the same time **interactions should be automatically associated with functionalities** to avoid the feeling of using a replacement modality. Both of these recommendations heavily depend on different contexts of interactions, and on the characteristics of each individual (or combined) modality, and therefore, their implementation may depend greatly on user testing or in the implementation of some profiling mechanism. However, findings also showed that older adults only make use of alternative modalities for tasks they cannot accomplish using the traditional ones, and for that reason: **traditional ways of interaction should be kept as the main interaction mode** and **gestures should be provided as an alternative for spatial and navigation tasks** while **speech should be provided as an alternative for text input tasks**. In fact, the necessity to **adapt availability of modalities to each user** is also indirectly suggested by some of the selected literature. Still, and contradicting this recommendation, many may say that, if modalities are designed and integrated in an intuitive way, users will use them if they feel the need or not even notice them otherwise.

4.6. Direct communication

Although SNS can be used for many different goals, for older adults, the main reason for using social technologies is to keep in touch with relatives. The main way of keeping in touch is by establishing some sort of direct communication. On the studies performed with this segment of the population, it was common for older adults to talk about features related with receiving direct feedback from their contacts. Consequently, many social technologies focused on the implementation of communication channels between them and their family, which could work as an alternative to standard communication devices like the telephone or traditional, and now, less used practices, like writing letters. From these works it is possible to infer guidelines which can make a difference in services like SNS.

A study performed around 2005 first showed a strong preference towards alternative ways of communicating with relatives rather than making phone calls (Santana et al., 2005). Following, other works showed the importance of chat and direct messaging related functionalities, or a preference for interactions that better approximate a "real conversation", specially when focusing on

family contact (Romero et al., 2007; Vetere et al., 2009). Studies also showed that older adults are usually the ones who initiate great part of the “conversations” (Lindley, 2012). This can be directly related to findings showing that, these type of functionalities where people communicate but cannot see or hear each other, are known to place an extra burden on interaction, as they usually involve some kind of response obligation (Hope et al., 2014; Sillanpaa et al., 2009; Vetere et al., 2009). Because of these obligations, the use of asynchronous messaging as a way for older adults to work around the busy schedule or availability of their relatives (or just keeping contact with new friends) (Judge et al., 2011; Vetere et al., 2009), the use of hybrid services which provide both asynchronous and synchronous communication (Baecker et al., 2014; Coelho et al., 2015; Neves et al., 2015), as well as the creation of incentives for users to produce stories that create opportunities for more inbound communication (Burke et al., 2011), were adopted in several applications and studies. The importance of direct communication for dealing with privacy issues, like unwanted tags on a photo, was also revealed (Lang & Barton, 2015).

As a result of the first studies regarding the use of SNS, and the consequent solutions developed for older adults to keep in contact with relatives, it became evident the need for SNS to favor direct forms of communication. As the most immediate solution **chat should have a central role in SNS** either by making it a central functionality (instead of just one more), or by motivating its use. In this sense, other possibility is to **create incentives for more direct communication in SNS**. This could be accomplished by issuing different notifications related with chat, establishing simple connections between chat and other functionalities (like commenting a post), introducing simple features related with family or close friends contact, or by making more radical changes to the SNS interface so that share and comment features could follow a more direct way of communication. Still, as more radical changes to SNS would be disruptive to the way they are generally used, solutions should focus on small augmentations of the interface (these augmentations could even be considered only for some users). Additionally, and as the main conclusion of the works discussed, **“direct forms of communication should be capable of capturing both the permanence of asynchronous exchanges and the interactivity of synchronous play”**(Vetere et al., 2009). Furthermore, functionalities related with direct communication should be kept interesting and conserve the properties of real offline exchanges at the same time as they do not create a sense of social obligation. Moreover, both Michailidou et al. (2015) and Coelho et al. (2015) also evidence the necessity of **supporting or increasing the visibility of video-chat features** as these are used by the older segment of the population for obtaining a more direct and rich online contact with their family or close friends.

As a result of older adults general concerns when interacting with social applications, it is also important to **avoid the creation of new social obligations**, specially when communicating with close relatives. This concern extends to both sides: older adults do not want to be a burden for their contacts, and at the same time, younger users do not want to look badly or unconcerned, specially when focusing on older family members. There is a time and place for communication, and users purposefully structure their lives and home environments to support this goal, so technology should also support this. Again, a solution could be to take an asynchronous approach to communication or restrict direct messaging features to the availability of each contact (and therefore provide mechanisms for configuring, or making others aware, of these periods of availability).

4.7. Knowing new people

Along with re-connecting with old contacts, the original goal of SNS was the possibility of making new friends and meet new people. This goal was first accepted by users who first adopted this kind of social services on the Web, but later dropped by the majority of people (Boyd, 2007). Nowadays, there is a lot of research showing a relation between the way SNS are used to establish new friendships and the age of the user, with younger users being the ones associated with being more capable of meeting new people online (Burke et al., 2011). Research also showed that for older adults, the use of SNS for this purpose is not only unattractive but also scary and appointed by the majority as a cause for not making use of tools like Facebook.

Early research showed that SNS needed to be perceived as useful for them to be adopted in the long term, and meeting new people, most of the times, was not enough (Czaja et al., 1993). In the same way, research which followed showed that: it is necessary to make a distinction between close relatives and people the user does not necessarily know (Gibson et al., 2010); for older adults, to call and talk with someone they do not know, requires courage (Garattini et al., 2012); connecting with family and close friends instead of establishing new friendships, builds up social capital in the way older adults need (Burke et al., 2011; Grosinger et al., 2012; Hope et al., 2014); SNS should not disrupt social ties with existing family or friends by making new ones (Baecker et al., 2014); avoiding friend suggestions and unsolicited email is a necessary step for older users to adopt Facebook (Norval et al., 2014); and that there is in fact a tendency to reject social activities online which are related to knowing new people (Vroman et al., 2015). On the other hand, research also suggests that with time people get to know each other and have less frequent but longer and more meaningful conversations, like the ones they have with family and close friends, and that in fact these new relationships can be more reciprocal than the others (Garattini et al., 2012; Judge et al., 2011; Sillanpaa et al., 2009). Still, even these studies conclude that providing opportunistic, light-hearted social interaction among strangers is hard, closely related with taking risks (Harley et al., 2014) and again usually not enough to encourage the use of a SNS.

All these indications suggest that features related with meeting new people should be avoided or made optional for the majority of older SNS users. Taking into consideration that this would require a radical change in the paradigm of SNS like Facebook, other solutions could achieve the same result. One way would be to **highlight acquaintances over “new friends”**. This could be achieved by reordering the lists of contacts and prioritizing the first group of contacts over the latter (this was also suggested as a privacy-related recommendation). Other way of achieving the same result could be by giving less importance to functionalities related with “friends of friends”. In this sense, to **provide appropriate terms when referring to individuals the user does not know** instead of using familiar terms, which somehow try to impose a friendship degree, is fundamental. Additionally, it is also important to **provide options for avoiding friend suggestions and unsolicited emails** as these are not only hated by older adults but also by almost every other type of user.

4.8. Personalization and adaptation

Older adults suffer from age-related impairments which, by affecting each one's sensory, motor and cognitive functions in a distinct way, create a great heterogeneity of characteristics in this segment of the population. In past works concerning the use of social features, these differences between older individuals were also evidenced, and several considerations concerning the use of

personalization and mechanisms to adapt to each situation have been presented.

Since at least 2009, researchers have been verifying in user trials that personalization and adaptation are highly appreciated by older adults, specially when considering SNS profile presentation (Karahasanovic et al., 2009) and features (Burke et al., 2011; Coelho et al., 2015; Lindley, 2012; Sillanpaa et al., 2009; Xie et al., 2012). Although in terms of profiles and pages, it is more a matter of taste, when talking about functionalities and the way each user can, not only have access to it, but also make use of it, it is a matter of necessity. Additionally, other studies focused on the differences between distinct family members with differing awareness and communication needs (Judge et al., 2011), and in the differing older adults' needs regarding chunks of information (Grosinger et al., 2012), and how these differences also have to be considered when designing a service usable by the elderly. More recently, other researchers have focused on distinct dimensions which evidence the necessity for personalization and adaptation features: the identification of different older adults' styles of social users (Baecker et al., 2014; Hayes et al., 2015); the necessity to address physical factors and how they should be compensated regarding the weight of the device and dexterity levels (Neves et al., 2015); and the influence of culture regarding the choice for online and offline support by family members (Michailidou et al., 2015).

When considering the adaptation of SNS interaction, **supporting an SNS interface with adaptation mechanisms** like adapting interaction with text-to-speech, text-input, speech commands and other augmentative alternatives could have a positive role on helping users with age-related impairments to make use of the SNS functionalities. Additionally, to further **adapt the display of content, so users can be prompted to interact with individuals who may benefit from direct communication** is also a possible solution to decrease elderly loneliness and boost their SNS use. This can be tricky, as users prompted with these mechanisms, are changing their ways of using these services, which can ultimately cause a decrease of SNS use in their side. A less "intrusive" way of achieving the same goal can be the **resurfacing or prioritization of information as a means of stimulating communication**. For example, making status updates, photos or comments related with an older adult more visible in their relatives and close friends news feed would create more opportunities for interaction without changing the way they use the service. Additionally, SNS should also make space for **adapting the interface to distinct older adults' user profiles**. Factors, such as physical, sensory and cognitive impairments, as well as cultural characteristics and social characteristics, should be tailored into a set of profiles. Although preliminary steps have been taken, investigation on these profiling steps and consequent dynamic adaptation is still needed.

4.9. Grouping

Even for the younger generations, SNS like Facebook are generally too complex in terms of the vast number of features they offer, and in the way they can be accessed or reconfigured to fit each one's tastes and needs. Older adults, and the way they cannot make use of the majority of the features, are the best example to understand how SNS features are not designed in an inclusive or accessible way. In the past five years, solutions contemplating the grouping of functionalities and contacts were appointed by several older users in several distinct studies and projects, as one of the simpler ways of making SNS more usable.

In the last seven years, a set of technology and studies suggested grouping functionalities into family (Chen, 2009; Gibson et al., 2010), favorites (family and close friends) (Gibson et al., 2010; Harley et al., 2014; Lindley, 2012), and community (Burmeister,

2012) oriented features. Grouping was suggested considering how content can be displayed and shared with others for content production to be a rewarding and engaging activity (Coelho et al., 2015; Harley et al., 2014; Karahasanovic et al., 2009; Waycott et al., 2013). Many different solutions were tested. Older-adult specific applications, for example, focused on co-creation of content (Karahasanovic et al., 2009), restricting the contact list to the essential (Chen, 2009; Lindley, 2012) and adapting the interface to highlight only meaningful contacts (Waycott et al., 2013).

Taking all the related research into consideration, and focusing on the solutions investigated by more than one researcher, several recommendations can be extracted focusing on the simplification of SNS features: **making group-specific functionalities or group-specific options** is the necessary step to not only focusing on meaningful contacts, but also to simplify the majority of functionalities or solve issues related to its use (like the already discussed privacy-related issues). One example of a feature like this, would be the possibility of creating "rooms" within a specific group (or with specific contacts) so users could share ideas and contents in a more group-oriented way. Other example, which could lead to an increase in the number of online and offline interactions, would be to give the option for creating sub-groups like it was evidenced on Coelho et al. (2015); other solution could be to **simplify a feature's access focusing on frequency of use**. This could be accomplished by either, simplifying functionalities and changing default sharing settings, or by giving priority and evidence to each user's most used functionalities and most frequent contacts. In both solutions, the main challenge is to not radically change the interface so that users do not feel they are using a completely different service than their younger counterparts. Additionally, to **give the option of naming each group** can also be a simple way for older adults to get around some issues related with phrasing and naming, while making them feel to be in control of the service, and not the opposite.

4.10. Tangible value

Most research performed in the last decade concerning social applications in the scope of older adults focuses on family before anything else. However, in most of cases, family is not around, and the virtual interaction is more meaningful when supported by photos, or some kind of media and personal artifacts related with family members. This is similar to what older adults have around their houses: framed pictures and objects that remind them, everyday, of the ones they want to keep contact with or, at least, the ones who make them feel accompanied. The tangible value, or the presence of this kind of artifacts in digital format can also have a similar role, at the same time as they help older adults in keeping contact with the ones they want the most. In the last seven years there were some works which evidenced this tangible value, and made suggestions about ways of merging this with SNS.

In the last years, there was a lot of research on digital frames capable of presenting or exchanging family photos between older adults and their relatives (Giorgi et al., 2011). This is the most direct and basic way of providing tangible communication, and also one of the main ways of making older adults adopt this type of social technologies. Additionally, there were other suggestions on supporting scribbling, handwritten messages and notes on pictures, as other types of exchanged media which constituted a more personal form of contact going deeper into the tangible value (Lindley, 2012; Lindley et al., 2009). Furthermore, a recent study showed the importance of paper-based communication, even in a virtual environment (Hope et al., 2014), mainly because it affords varying degrees of formality and gives users a chance of immediate reflection. Lastly, a couple of studies (Baecker et al., 2014; Neves et al., 2015) reinforced this need for supporting expressions of

person-hood through tangible interfaces based on real world objects and practices, and Coelho et al. (2015) also leaned on these findings to deliver the ability of uploading real photos into Facebook by using the TV or implementing a passive way of consuming SNS information by turning a Tablet into a digital frame.

Based on these studies, several solutions for the integration of tangible communications in SNS can be suggested: **support the transmission of handwritten messages as a type of media** is the most obvious one, however for this to be possible requires having some kind of hardware associated with the service; **providing a “letter writing” mode or look-and-feel for sharing functionalities** would be a better solution, as it could be optional and would make it possible for older adults (and users with the same interests) to identify with the process of sharing as a way of exchanging digital letters (like email); and finally, **supporting features that enable the virtual representation of real artifacts** such as pictures and objects, would work as a good incentive for the creation of new interactions between SNS users, turning the oldest segment of the population into the main vehicles of these interactions.

4.11. Offline role

Although SNS are all about social relationships on a virtual environment, and the use of these social contexts can have an important role in decreasing isolation and loneliness, there is still a dimension related with how the opportunities provided by these virtual environments can act as catalysts for offline interactions. This relation between online and offline relationships is referred by a substantial part of the chosen literature.

Morris (2005) solar system, which situated the older adult user as the sun in the center of a system constituted by their relatives, showed direct relation with an increase of offline activities initiated by the older users. In fact, this first indication was later confirmed as a relevant incentive for the use of SNS by older adults: SNS should work best in conjunction with meeting face to face (Garattini et al., 2012); generate opportunities for real encounters (Giorgi et al., 2011), like the creation of events (Coelho et al., 2015), for satisfying the elderly people's need for company; provide a clear transition from public to private interactions and provide opportunities to connect with local communities (Harley et al., 2014); and because older adults rely on offline communication for more urgent situations (Michailidou et al., 2015). Additionally, topics of conversation and affinity themes found in online interactions are also used by older adults as a way to enrich in-person conversations (Cornejo et al., 2013).

All these reports show that the line between online interactions and offline interactions should be very thin, and that SNS should employ features to boost offline interactions, at least when considering older adults as target users. One possible way of achieving this would be to **give attention to functionalities related to events**, for example by locating them in a more central role in terms of the general SNS interface. Other alternative for inciting offline interaction would be to **incorporate phone numbers into SNS contacts** as a way to make it possible to follow up an online interaction with a phone call. Still, this is a delicate suggestion, as it should be dependent of each contact's availability and privacy preferences. Finally, the possibility of **generating or promoting local events close to the SNS user** could also boost offline interactions with members of the same community or people who live close by.

4.12. Gender

Although there are clear human factors which influence the use of SNS, little is known regarding other factors directly related with

each one's characteristics. Specially regarding older users, and resulting from the extensive research performed in the last years, some intrinsic factors have also been appointed as having an influence. The gender of the elderly user is one of those factors.

Since one of the first studies regarding SNS was performed only with women between the ages 55 and 95 (Czaja et al., 1993) there was the notion that gender would have a direct influence in the use of these tools. Still, in the literature reviewed for this survey, only other three researchers compared the use of SNS by users of different genders (Garattini et al., 2012; Gibson et al., 2010; Lang & Barton, 2015). Although their results show that women are more frequent users of social tools than men, none of them has advanced any justifications for why this happens. Additionally, and from a technology point of view, as both old women and old men suffer from the same kind of impairments, there seems not to be any explanation related with their physical or perceptual characteristics. Therefore, no particular recommendation can be given rather than **different genre should not be targeted differently** when designing SNS. Only a more extensive analysis of each gender interpretation of online social functionalities can provide more detail on how much equally they should be targeted.

4.13. Reciprocity

The main goal of social tools like Facebook, specially when focusing on older adults, should be on establishing and keeping contact with loved ones. However, the way in which communication is supported by the tool can be determinant for this goal. Older and younger adults are very different from each other (and older adults between each other) not only in the level of technology awareness but also in terms of interests. Being capable of attracting each individual to contents which enable reciprocity of communication will determine if both ends of communication are able and interested in maintaining the type of constant contact which results in social advantages. Still, until recently, not many researchers have evidenced this domain of reciprocity.

The first relevant study referring the notion of reciprocity and its importance in the scope of SNS, concluded that a service like Facebook was already capable of affording expressions of reciprocity, mostly by focusing on similar interests (Lehtinen et al., 2009). In their opinion, the job was more on constructing a common experience for both older and younger users than anything else. These notions were also confirmed by a study focusing on older adults' opinions, which showed reciprocity is a factor in the adoption of SNS (Gibson et al., 2010), and later picked up and “enhanced” by subsequent studies where content could be sent to digital frames at an older adult's house by adapting channels of communication which reflect multi-use by younger generations (this way reciprocity could be supported by fitting interaction modalities to both older and younger adults capabilities and habits) (Lindley et al., 2009). In another example, resurfacing prior content, like status updates or photos with comments, was used as a means for stimulating communications for relationships that have been inactive for some time (and once again favor interactions in which reciprocity was missing) (Burke et al., 2011).

Considering that just a few studies have drawn conclusions on this specific domain, not many recommendations can be extracted. However, taking Lindley and Burke suggestions could be a first step to unveil more about reciprocity. Therefore **designing features which enable reciprocity and multi-use** will be determinant for the adoption of SNS by the older segment of the population, be it by **evidencing and resurfacing content capable of stimulating communications** or by **adopting different ways of interaction for each type of user** so that everyone can use social tools without having to adapt to supported modalities of interaction, and that

way supporting the easiness of reciprocating any interaction.

5. Conclusion

From an extensive analysis of the state of the art on social network services and social applications and their use by the older segment of the population, conclusions and recommendations were drawn which need to be considered when designing more inclusive services. After going through a process of selecting the most relevant research papers published in the last ten years, this paper distinguishes thirteen domains from which several recommendations are extracted. General conclusions highlight the crucial role that both family and privacy have in the adoption of SNS by the elderly, and recommend considering functionalities specifically dedicated to improve the interaction between older adults and relatives. Rethinking privacy settings is also important, by changing default settings and simplifying the access to privacy options when sharing information. Related with these two domains, the need for changing the typical SNS user interfaces was also discussed, in order to make them simpler and work as a catalyst for the adoption of these services. Additionally, the necessity of making grouping, reciprocity, and direct communication essential features for the increase in SNS usability was also verified. The inclusion of features related with tangible value and immersion when producing content to spur feelings related with the past and with old communication procedures is another factor with the potential to increase adoption. Additionally, the discussion also focused on the secondary and dangerous role of functionalities related with making new friends, on the necessity for features capable to spur offline interactions, as well as for the implementation of alternative ways of interaction and mechanisms of adaptation and personalization capable of compensating age-related declines. Finally, the role of gender and how men and women should probably be targeted differently by SNS, as well as the value of photos, and cultural and health information, on increasing the interest, attention and adoption of these kind of services by older adults were also discussed.

5.1. Limitations and future directions

Regardless all the recommendations that were extracted from the research performed in recent years under the scope of SNS and social applications for the older segment of the population, there are still gaps in this field. Few papers present adaptive solutions which focus on older adults' changing characteristics related with sensory channels, motor capabilities and cognitive skills. While the technology expertise of this population might evolve in the coming years, these are characteristics that will still decline with the aging process. Even the researchers who dedicated their time to the development of applications and services exclusively having older adults in mind, were more concerned with the social aspects of old age (which can change drastically with distinct generations) than with these aspects. Additionally, few research has focused on the use of alternatives to the traditional computer when talking about providing older adults with access to existing SNS. Although devices like Tablets – because they are simpler to interact, look more robust and provide direct manipulation of the interface (Kallio, Korpip, Linjama, & Kela, 2010; Stossel & Blessing, 2010) – and Television – because older adults use it everyday and are present at almost every home (Karahasanovic et al., 2009) – could provide ideal vehicles for the adoption of these kind of services, they have not yet been studied as real alternatives.

Not many research works focusing on how several socio-demographic factors influence the adoption of SNS and social technology by older adults has been considered in this survey.

These factors might include racial factors, educational factors, or how social skills are influenced by prior professional activities, economical situation and geographic factors. All are expected to also play a role on the adoption of services like SNS. However, as these roles are less related with technology and more related with psychology and health factors they were not generally considered (being only considered when in addition with technology). This is, probably, the main limitation of this review. Research on these factors together with the use of new technology should be encouraged in the future, so that a better understanding of them can be also related with technology aspects and drawn in the form of human-factors.

Also to be considered is the possibility of the development of social technologies to be directly related with the development of home-ambient technology or smart-home technologies. With the concern over the monitorization of health conditions gaining relevance in recent years, it would be only a natural step to include social mechanisms and communication capabilities as part of this research scope.

Finally, with the great variety of older adults present in today's society, the necessity of distinguishing between younger old adults and older old adults might be another natural step in the future of Gerontechnology and therefore in the future of more inclusive SNS. While for the first group technology will probably be able to neutralize the differences from younger generations, solutions for the second group will have to be more complex and less usable by the rest of the population, not only because age-related impairments are more intense but also because they are less open to try new solutions and technology in general.

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