Guidelines for Designing Social Networking Sites for older Adults: a Systematic Review with Thematic Synthesis.

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Social networking site (SNS) inaccessibility remains a barrier for many older adults. Increasingly, research has sought to address these shortcomings with recommendations for design. However, commercial uptake of these findings remains limited, in part, due to the scattering of recommendations across publications, heterogeneity in the SNS systems and features examined, and a lack of sensitivity within the existing guidelines to the heterogeneity of the target demographic. To counter these challenges, we conducted a systematic review following a thematic synthesis approach of 25 empirical studies on SNS design recommendations for older adults. From these, we synthesized a cohesive set of ten distinct design recommendations. These include ensuring an easy-to-use interface, improving social connection features, ensuring personal privacy, and introducing customized features and personalized content. In synthesizing the results, particular care was taken to capture the ways in which population diversity moderates recommendations. The results of this review can serve as a resource for designers and practitioners working on inclusive SNS for older adults. They also highlight the need for additional research into understanding user diversity in relation to SNS accessibility.

CCS Concepts: • **Human-centered computing** → **Accessibility design and evaluation methods**; *Accessibility technologies*; *Accessibility systems and tools.*

Additional Key Words and Phrases: Social Networking Site, SNS, Design and Usability, Older adult

1 INTRODUCTION

Social networking sites (SNS) such as Facebook, provide opportunities for maintaining meaningful social relationships that can contribute to an increased sense of well-being [10]. Recognizing these benefits, adults aged 65 and above have become the fastest growing group of SNS users [37]. These sites, however, have not been designed with the needs of older adults in mind and, as a result, they present numerous barriers to adoption and use [24, 38]. In response, researchers have devoted substantial effort to developing design recommendations for increasing their accessibility for older adults. These studies offer guidance for improving social media interfaces to be more inclusive of older adults' characteristics, preferences, and communication needs, including how different platforms, such as touch screens [34], tablets and TVs [11], can help to improve accessibility and how enhanced security and privacy features [9] can help to facilitate adoption. However, despite the breadth and depth of these efforts, the guidelines and design recommendations proposed to date have not yet translated into improved offerings in the marketplace. Instead, recent research has demonstrated that social media platforms have only become more inaccessible over time [31].

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One factor challenging the uptake of existing guidelines is their dispersion across dissimilar studies. To facilitate their use, guide application across different contexts, and encourage increased adoption, we conducted a systematic literature review of empirical research from peer-reviewed publications offering recommendations on SNS design geared towards older adults. Following a thematic synthesis approach [44], we synthesized literature sources to produce a cohesive set of design guidelines that capture nuances from the diversity inherent in this demographic. These guidelines can serve as a resource for designers and practitioners working on inclusive SNS for older adults and will facilitate future research into designing social technologies that meet older adults' preferences.

In particular, this work addresses three characteristics of the research body, which we believe have hindered easy synthesis of the existing guidance.

(1) Although recommendations for improvements are plentiful, they are currently scattered across several studies making them difficult for developers to adopt and follow. For example, our systematic review covered five different research databases and identified a total of 25 studies exploring recommendations for improving SNS for older adults. Pulling together the results across these diverse studies is a substantial undertaking, which would be impractical in most commercial settings. With our synthesis, we offer a more streamlined set of recommendations that pulls together best practices across studies.
(2) Synthesizing across studies is further complicated by the heterogeneity of the older adult demographic. Most of the studies we reviewed considered relatively small and fairly homogeneous user samples, but across studies coverage is more comprehensive. This at times can seem to lead to conflicting guidelines, where different studies seem to draw different conclusions due to the different populations considered. In our synthesis, we paid careful attention to sample demographics to try to account for these differences and provide a more nuanced understanding of how guidelines must be adapted for different sub-demographics. We additionally hope that by highlighting which sub-demographics have not been adequately studied, our work will help to motivate additional research to provide better coverage of the diversity of needs.
(3) Evaluations of SNS guidelines to date have largely been conducted through prototype systems. These systems are often disconnected from users' existing social networks and the evaluations are often geared to evaluating particular features or characteristics that may not easily map to existing systems. Because the recommendations from these projects tend to be very specific to the systems developed, the guidelines, at the individual study level, can be hard to generalize. In our review, by examining a variety of studies and seeing similar guidelines emerge from different experiments, we offer a broader context for interpretation that can more confidently offer guidance beyond a specific study context.

The remainder of this paper is broken down as follows. Section 2 introduces the objectives of the systematic review and the methodology of searching for and selecting candidate papers. Sections 3 presents the analysis and highlights the major observations conducted from the findings. Section 4 lists implications and potential study limitations and Section 5 concludes the paper and suggests potential future work.

2 METHODS

This review synthesizes empirical research findings on design recommendations for social networking sites for older adults. The specific objectives were:

- To identify primary research on the design of SNS for older adults.
- To develop design recommendations for practitioners and designers of SNS for older adults.

To achieve these objectives, we employed a systematic literature review to address questions and methods available in the context of guidelines development for SNS for older adults. Approaching this problem using systematic methodologies increases the transparency, credibility, trustworthiness, and confidence of the review findings [5].

In order to systematically synthesize the themes of guidelines for designing SNS for older adults, the thematic synthesis approach was followed. Thematic synthesis has the ability to develop either descriptive or analytic themes to inform the development of a guideline, especially when the guideline is focused on issues relating to the acceptability of a complex intervention [18].

2.1 Search Process

We conducted our search in five electronic databases on July 13, 2021 and then updated it on March 20, 2023. The databases are Web of Science (WoS) core collections, Scopus, Compendex, Inspec and IEEE Xplore. The WoS was chosen because of its multidisciplinary coverage with 11 indexes. Scopus was chosen as it contains linked data and linked scholarly content for Health, Life, Physical, and Social Science. Compendex and Inspec databases provide published literature on aspects of Engineering, which makes them suitable for getting articles on design. IEEE Xplore provides full-text access to literature on Engineering and Technology, and thus has the potential to capture published articles on social media designs. To ensure that this literature review covered all relevant papers published within the targeted time frame, we conducted a hand-search of Google Scholar to capture contents published in open access platforms and key conference proceedings such as CHI and ASSETS, which are not consistently indexed by traditional databases. We additionally considered including the ACM digital library. However, initial exploration confirmed that our combined use of Web of Science, Scopus, and Google Scholar had already captured all relevant papers from these venues. We found that examination of the title and abstract was generally sufficient for determining whether the paper was on topic. In cases where the title and abstract were not sufficient, the full paper was examined. Two authors met regularly to discuss the papers that were selected and a third author was consulted to resolve any doubts.

Leveraging our experience in conducting research in this domain, we generated a list of keywords (Table 1) to drive the database search. The fifth author has over 15 years of research experience in this field and the first two authors have more than two years of experience. We performed keyword searching in subject or topic fields of selected databases. Key concepts such as Design, Social networking Site and Older Adults and their synonyms were entered in the search fields of selected databases, with the use the Boolean technique (“OR” and “AND”) to combine and limit the results for relevance.

2.2 Selection Process

Prior to the searching for relevant articles, the authors defined and agreed on the inclusion criteria for this study. The following inclusion criteria were used for including articles relevant to this study:

- The paper was written in the English language.
- The paper was published between 2010 and 2021 (or between 2021 and 2023 for the update) .
- The paper’s main objective is related to SNS design for Older Adults.
- The paper presents original empirical work. This means that articles based on the study of one or more older adults were included, while literature reviews summarizing otherwise published empirical works and/or offering position/expert statements were excluded.
- The paper was published in scholarly peer-reviewed publications (e.g., journals and conference proceedings).

Table 1. Search Strategy

Concepts	Search terms
Social Networking Sites	"Social Networking Site" OR SNS OR "Social Media" OR "Social Media Platform" OR "Social Network" OR "Social Online Network" OR "Social Application" OR Facebook OR Instagram
Design	Design OR Usability OR Recommendation OR "User Interface" OR "Human Computer Interaction" OR HCI
Older Adults	"Older adult" OR "Older user" OR "Older people" OR Senior OR Elderly OR Ageing OR Aging OR "Later life"

Articles that did not meet the inclusion criteria were excluded from this study.

2.3 Search Outcomes

The initial search was conducted in each of the five databases using the search terms outlined in Table 1. As a preliminary review of the search outcomes, titles suggested a large number of irrelevant results. As a result, subject and keyword filters were used to limit the results as described for each database below. All final records were then exported to EndNote for further analysis.

In the Web of Science core collections database, our search initially returned a total of 3,546 records (2764 in July 2021, plus and additional 782 in March 2023). Filtering with subject categories such as HCI, Computer science, Engineering, Library science, and Communication reduced the final set to 272 results. Our search in the Scopus database returned 1,629 results (1461, 168)[1]. Results were then limited by subject and keyword relevance using Computer science, Social Sciences, Engineering, HCI, Social networks, Social Media, Older Adult while subjects like Nursing, Medicine, Mathematics were excluded, resulting in 277 records (273, 4). In Compendex, our search returned 2,858 records (2395, 463), which were then limited using controlled vocabulary (e.g., human computer interaction, user interfaces, Design, Product design), resulting in 85 records. Inspec initially returned 940 results (940, 0), which were reduced to 90 records after we applied subject filters of HCI, Ageing, Age issues, User interfaces, and user-centered design. The IEEE Xplore databases returned 115 results (115, 0), but after applying subject filters (e.g., Human Computer Interaction, social networking, user interfaces, mobile computing, age issues), these results were limited to 88 records.

To ensure full coverage of articles published in conference proceedings such as CHI and ASSETS, [2] an additional search was conducted in Google Scholar using the same keywords of search concepts, with date limitation 2010–2023. Then, the first ten search results pages were hand-surfed through their titles for relevance, and 12 records were saved to EndNote. In total, 827 records (823, 4) were saved to EndNote. After duplicates removal, a total of 716 records (712, 4) were left for titles/abstracts screening of articles.

While our keywords were effective at capturing relevant papers, they also matched on similar but unrelated topics such as benefits and dangers of interacting with SNS; factors influencing the sharing of knowledge by seniors on SNS; comparison of younger adults and older adults on their

[1](X, Y) notation refers to (first search on July 2021, second search on March 2023)

[2]While many of these publications were captured by our earlier database searches, inclusion of such papers is not consistent or guaranteed. We considered additionally including the ACM DL in our sources but a preliminary assessment suggested this would not yield any additional results.

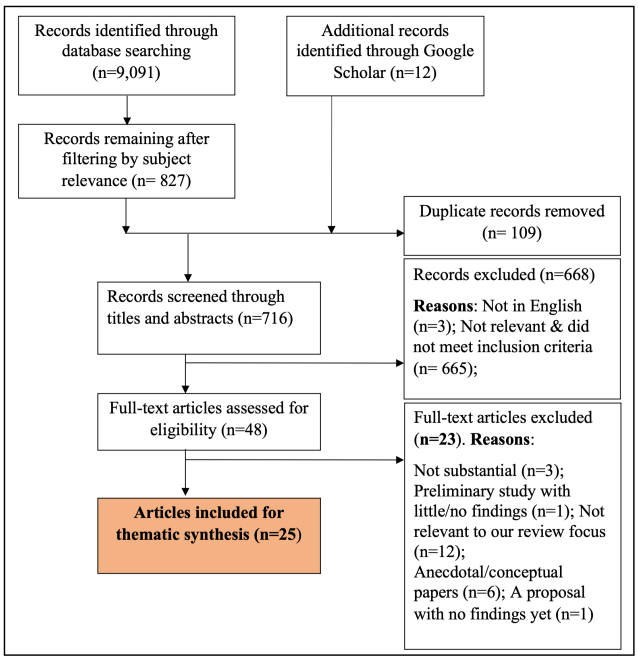

Fig. 1. Search process and outcome flowchart

Found in Compendex for 2010-2021: ((((("Social Networking Site" OR SNS OR "Social Media" OR "Social Media Platform" OR "Social Network" OR "Social Online Network" OR "Social Application" OR Facebook OR Instagram) WN KY) AND ((Design OR Usability OR Recommendation OR "User Interface" OR "Human Computer Interaction" OR HCI) WN KY)) AND (("Older adult" OR "Older user" OR "Older people" OR Senior OR Elderly OR Ageing OR Aging OR Older OR Elder OR Elderly OR "Later life") WN KY)) + ({social networking (online)} OR {human computer interaction}) WN CV + ({user interfaces} OR {product design} OR {design}) WN CV

Fig. 2. Sample search strings in Compendex

use of SNS; digital divide in the number of the older people using SNS compared to teenagers and young generation; assisting senior customers on online shopping platforms; perceptions of benefits using SNS; willingness to disclose personal health related information on SNS, to mention a few, resulting in a large number of papers being filtered during the titles/abstracts screening. While these papers are broadly related to the topic of SNS design, their focus was not aligned with the objectives of our review. Hence, they were excluded from the final inclusion for analysis. Other papers were excluded during title and abstract screening due to the language inclusion criteria. This step was conducted by the second author before screening the full-text content.

This resulted in a total of 48 (44, 4) eligible articles for full-text screening. During the full-text screening, the first and the second authors independently screened full-text of the 48 eligible articles. Authors met to discuss the outcomes of the screening and to reach consensus in cases where there was disagreement. When the two authors could not agree, the fifth author was consulted to reach consensus. A total of 23 articles were excluded during the full-text screening. Papers excluded at this stage described preliminary studies without findings, conceptual studies, and studies not relevant to the review focus.

This resulted in the final inclusion of 25 (24, 1) articles for the analysis presented in the rest of the paper. See Figure 1 for a summary of the search process, and Figure 2 for a sample of search strings from Compendex.

2.4 Data Extraction and Coding Approach

To identify the design recommendations of the included studies, the authors first extracted the text relevant to the study objectives. The first and the second authors extracted data from the included studies. Differences and variations in data extraction by the authors were discussed and an agreement was reached to ensure consistency and objective coding of the themes. When needed, the fifth author confirmed the code development and interpretation of themes from the included studies. Most of the relevant data was found in the results, findings, or discussion sections of the studies.

We then summarized the extracted text of findings and developed the corresponding codes for the themes based on the initial summary of findings from the included studies in an Excel spreadsheet. A summary of the included papers (See Table 2) is provided in a table with the following information: the paper's first author, the venue and year of publication, the country where the research was conducted, the sample size and age range of the participants, the research methods used, and the SNS application used in the study or the name of the prototype developed.

Table 2. Characteristics of the included studies

First Author	Venue & Year	Country	Sample	Methods	SNS App
Arfaa [2]	DUXU '14	USA	22 aged 65–89	Mixed-methods	Facebook
Arfaa [3]	ITAP '15	USA	22 aged 65+	Mixed-methods	Facebook-like
Çarçani [7]	Ix&DA '18	Sweden	7 aged 65+	Qualitative	Facebook
Chang [8]	ICOS '18	Malaysia	20 aged 55+	Mixed-methods	Facebook, WeChat, WhatsApp
Chou [9]	BIT '13	Taiwan	93 older adults	Mixed-methods	Facebook
Coelho [11]	Interact '15	Portugal	48 aged 60+	Mixed-methods	Facebook-like for TV and Tablet
de Souza Silva [13]	ICWI '19	Brazil	17 aged 60+	Mixed-methods	Facebook
Gibson [19]	BCS-HCI '10	Scotland	17 aged 63–83 & 15 aged 63–81	Mixed-methods	MyFriendsOnline, Facebook
Hafez [20]	AHFE '20	USA	5 aged 65+	Mixed-methods	SeniorBook (Facebook-like)
Harley [21]	HICSS '15	England	15 aged 65–87	Qualitative	Facebook
Hope [25]	CHI '14	USA	22 aged 71–92	Qualitative	Facebook, Twitter, LinkedIn, WordsWithFriends, JewishGen
Ibarra [26]	DIS '18	Costa Rica, Poland	28 aged 65–90	Qualitative	None reported
Jung [27]	NMS '18	USA	202 aged 60+	Quantitative	Facebook
Jung [28]	TI '17	USA	46 aged 65–95	Qualitative	Facebook
Norval [32]	CHI '14	Unknown	15 aged 60+	Qualitative	Facebook-like
Pandya [34]	ICMI '18	USA	14 aged 60–75 & 102 aged 60–89	Qualitative	Facebook & Facebook with TapTag
Restyandito [39]	HCII '20	Indonesia	30 aged 60-–83	Mixed-methods	WhatsApp-like

Susilo [43]	CUTE '18	Korea and Indonesia	86 older adults	Quantitative	Not specified
Song[41]	HCI '22	China	Not specified	Qualitative	WeChat
Sousa [42]	ICEC '11	Portugal	25 mean age 75	Mixed-methods	Story telling app for Facebook
Ting [45]	DSAI '15	France	4 aged 60+	Qualitative	Facebook
Ting-Yi [46]	IJCTE '18	Taiwan	17 aged 55+ & 17 under 55	Mixed-methods	Facebook
Tsai [47]	PlosOne '17	Taiwan	101 aged 50–89	Mixed-methods	TreeIt
Volkmann [48]	ITAP '20	Germany	7 aged 61–72 & 11 women 60–79	Mixed-methods	Historytelling (document/share life stories)
Xie [49]	EG '12	USA	10 aged 61–83	Qualitative	Facebook

2.5 Data synthesis

In this review, we followed a three-step process for thematic synthesis [44] that consisted of (1) coding the text, (2) developing descriptive themes, and (3) generating analytical themes. The first stage (coding the text) involved extracting the design recommendations from the findings of the included studies. The outcome of the coding text phase included in-line coding of design recommendations extracted from the included studies. The authors met regularly to discuss the codes and made adjustment throughout the phase to ensure consistency. The descriptive themes coding was performed by the first author in an iterative approach and then reviewed by one other author. The authors worked collaboratively and reviewed a final set of codes iteratively for descriptive themes and developed a codebook to document the themes. This codebook formed the sub-themes that were included in the Table 3 below. These informed the discussion of themes that are sub-set of the overarching themes. At the third phase, the authors generated analytical themes by going beyond the findings in the primary studies, generating additional concepts or understanding of the design recommendations for SNSs. This involved analyzing the themes, providing overarching themes and unified set of recommendations for designing SNSs for older adults.

2.6 Quality Assessment of Included Studies

Following best practice, we assessed the methodological quality of each article in our corpus using an established study quality assessment tool [22]. Since the studies included in this review employed qualitative, quantitative, and mixed methods, we found this critical appraisal tool—which provides measures for assessing a variety of study methods—appropriate for assessing the methodological quality of the included articles. Two authors independently assessed the quality of each article separately, then discussed their assessment and any disagreements until they were resolved. A third author reviewed any disagreement that could not be resolved. Most of the articles (n=21, 84%) received a "good" quality rating, while only four (16%) received a "fair" rating. This implies that studies included in this review are methodologically sound. No studies were excluded from the review based on their quality rating consistent with [44].

One criterion on which the papers consistently failed poorly was on the handling of ethics and bias. Only four studies (16%) provided sufficient information on ethics approval and participant consent, while most did not mention these topics at all. This is perhaps not surprising given that the HCI community has only recently started to encourage explicit reporting of such details and appropriate reporting of ethical considerations is an ongoing discussion within the broader HCI community [16]. See Appendix 6 for details of quality assessment of each article.

3 RESULTS

In this section, we report the findings of this systematic review by summarizing the study characteristics, and synthesizing the SNS design recommendations from the included studies as follows.

3.1 Study Characteristics

Of the 25 articles included for thematic synthesis, most reported on studies conducted in the United States of America (n=8, 33.3%), followed by Taiwan (n=3, 12.5%), Portugal (n=2, 8.3%) and Indonesia (n=2, 8.3%). The remaining studies were carried out in Scotland, England, Korea, France, Malaysia, Sweden, Brazil, China, and Germany. One study did not reveal the country where the study was conducted. Most of the included studies used a mixed-methods design (n=13, 52%) employing the combination of interviews, user studies and questionnaire, while ten (40%) used a qualitative design and two studies (8%) used a quantitative design to survey older adults. Facebook was the most studied social networking site or application, possibly due to the fact that Facebook is the most popular social network application in general [15], and among older adults [30, 36]. SNS research prototypes examined (e.g., TapTag, SeniorBook, TreeIt, Historytelling, and MyFriendsOnline) were predominantly based on Facebook. Other commercial systems studied included JewishGen, LinkedIn, Twitter, WeChat, and Words With Friends. Table 2 highlights key characteristics of each study included in this systematic review.

3.2 Synthesis of SNS Design Recommendations from Included Studies

We identified ten broad themes of design recommendations to improve SNS usage and experience by older adults. These are: Text Formatting, Non-Text Content, Navigation and Layout, Help and Support, Engagement/Social Connections, Privacy Protection and Assurance, Alternate Interaction Modalities, Understandable Language, Cognitive Accessibility Features, and Personalized Guidelines. Table 3 summarizes the first and second order themes, linking them to their source studies. Next, inspired by these ten themes extracted from the 25 included empirical studies following a thematic synthesis approach, we developed each theme into a guideline that summarizes and synthesizes the guidance within that theme. These guidelines are: 1) Ensure text-based content is formatted to be accessible, 2) Use non-text content to support text comprehension while ensuring its presentation is accessible, 3) Support navigation with simple page layouts, consistent designs, and clear, easy-to-identify navigation elements, 4) Include help interfaces targeted to the concerns of older adults and ensure error messages are easy to understand and clearly outline appropriate corrective actions, 5) Provide support for progressively growing and maintaining social connections, 6) Prioritize privacy protection features, making privacy the default and ensuring privacy settings are visibly activated, 7) Support alternate interaction modalities such as voice, tap, etc., 8) Ensure terminology used in the interface is understandable to older adults, 9) Build cognitive accessibility features to address older adults' specific needs, 10) Support older adults' different backgrounds, cultures, needs, communication preferences, etc. when designing SNS. Each guideline is then described in more detail in sections below.

Table 3. Thematic Synthesis

Second order	First order	References

Table 3 Thematic Synthesis (*Continued*)

Text Formatting	Adjust and provide appropriate font and text size - large and clear.	[2, 3, 7–9, 20, 32, 39, 41–43]
	Adjust the contrast between background color and text.	[2, 3, 42]
	Avoid sudden change of brightness, coloured text, and coloured background.	[8]
	Choose comfortable colour matching.	[41]
	Appropriately highlight content using a dark font color and light contrasting background color.	[2, 3, 7, 42]
Non-Text Content	Make images as clickable areas.	[42]
	Ensure image information can be easily comprehended.	[9]
	Replace text with images, videos, and sounds.	[7, 42, 48]
Navigation and Layout	Add intuitive text button.	[3]
	Separate the “sign-up” and “login” links.	[3]
	Make buttons as clickable areas.	[42]
	Provide intuitive icons with labels.	[11, 42]
	Enable easy location of functional buttons.	[9, 41]
	Use camera icon to direct users to photo library.	[20]
	Add home button to take users to personal profile page.	[20]
	Ensure consistency in the placement of instruction button in SNS pages.	[20]
	Include a “stop button” which would be directly accessible on the modules to turn off Text to Speech (TTS) when vocal outputs are not desired.	[45]
	Enable meaningful classification of contents.	[41, 43]
	Ensure quick and stable system.	[41]
	Provide large targets and generous spacing between items.	[8, 9]
	Improve labeling and layout consistency.	[2, 20, 41, 42]
	Provide consistent pattern to browse different types of web pages.	[9]
Help and Support	Provide online help.	[9, 49]
	Ensure error messages are easy to understand.	[13]
	Add trial period before registration feature.	[48]
	Add instructions, user guide and headings to facilitate learning.	[3, 13, 20, 34, 49]
	Make search functions easier to use.	[9, 28]
	Provide a walk-through feature that walks users through all possible functionalities.	[34]

Table 3 Thematic Synthesis (*Continued*)

Engagement/Social Connections	Provide themes options for older adults to enable them join conversations and groups of the interest.	[7]
	Include features that allow sharing of printed photos that older users have in their albums.	[11]
	Include features for auto-suggest friends to promote the generation of more connections with common links.	[47]
	Enable social display to remind users to engage in SNS	[47]
	Include the hot-topic function to provide information regarding the most active discussions.	[47]
	Establish online roles (such as sharer, humourist, and game player, etc.) to ease integration to SNS.	[21]
	Include mood display/emotional feedback function to allow for care and emotional support for friends.	[47]
	Include common album features that make users enhance intimacy with friends.	[47]
	Friend requests prompt should provide enough context (e.g., common history, current life).	[26]
	Adapt the interface and interaction model to stimulate and support social interactions between older adults.	[13]
	Simplify group chat management such as adding, deleting, etc.	[41]
Privacy Protection and Assurance	Protect personal privacy and Internet security.	[9, 11, 13, 19]
	Limit information disclosure.	[19]
	Allow users to share information selectively.	[19, 21]
	Include anonymous sharing space.	[21]
	Limit online community members.	[21]
	Ensure partial anonymity for group identity.	[19, 21]
	Various sharing features should be provided as opt-in features rather than opt-out features.	[28]
	Disable auto-friends suggestions for users who do not want to be exposed to other unknown users.	[28]
	Remove allow access screen in the camera action.	[20]
	Make privacy information more visible, especially when users share their information.	[25, 28, 34]
	The SNS should state clearly how the data is used and what data is being shared with others.	[47]
	Remove advertisement and reminder bars.	[32, 41]
	Privacy protection should be the default setting rather than opt-in option.	[28]
Alternate Interaction Modalities	Include voice interaction features or application.	[11, 13]
	Add voice commands and speech-to-text functionalities.	[11]
	Provide single touch-based interaction.	[43]
	Enable SNS to be viewed on TV to interact with SNS using alternative modalities like speech, or back-of-device taping.	[11]
	Improve navigation through gestures, buttons by touch and tilting.	[11, 34]
	Design big screens with the possibility to offer a real-life sensation of interaction and to enhance face-to-face interaction and fight loneliness.	[7]
	Ensure hardware are more convenient to use.	[9]

Table 3 Thematic Synthesis (*Continued*)

Understandable Language	Use wordings that suit the older adults semantic field.	[8]
	Avoid unknown technical terms by using easier terms to explain them.	[48]
	Provide shorter explanation by using keywords.	[34, 48]
	Reduce the amount of content/information that shows up.	[2, 42, 43]
	Ensure text information can be easily comprehended.	[9]
Cognitive Accessibility Features	Constantly inform the user on their current action.	[8, 32]
	Explain actions and consequences.	[13]
	Minimize the sequence of actions required by providing simple features.	[2, 9, 42, 45]
	Provide simple, concise, and familiar interface to help users learn faster.	[39, 41, 48]
	Remove features that makes information automatically disappear from the screen.	[8, 42]
	Integrate paper-based or hand-written artifacts into an online experience.	[25]
	Improve visual presentation of message contingency in the comment function.	[27, 28]
	Include storage space for messaging system.	[45]
	Allow users to control their personal profile, with an option to customize the app content.	[27, 34]
	Simplify emoticon stickers management.	[41]
Personalized Guidelines	Support older adults' communication needs and preferences.	[25]
	Cultural aspects of older adults should be considered in the design.	[25, 26]
	Make social media personally relevant to older adults' needs.	[49]
	Educate older adults about SNS features which will encourage them to use SNS more often.	[28, 49]

3.2.1 Ensure text-based content is formatted to be accessible. This guideline covers text appearance within pages. Font choice, size, and color were all noted as crucial to older adults' successful use of SNS, as most older adults experience some degree of visual impairment [8], thereby making reading difficult [9]. Although this guidance is broadly consistent with established guidelines for web accessibility for older adults [1], its prevalence in the data set reveals poor adherence to these guidelines in current SNS designs. This does not appear to have diminished over time as issues relating to font choice and text size were discussed in 10 articles (41.7%) spanning up to 2020, with strong recommendations to adjust and provide appropriate fonts [2, 3, 7–9, 20, 32, 39, 42, 43]. Arfaa [2] reported that most older adults in their study (50%) found the contrast between text and background colors insufficient. This is consistent with other calls for better contrast [2, 3, 42], with recommendations to use dark font color on lightly colored contrasting backgrounds [2, 3, 7, 42]. Emphasizing the importance of font size, Boldt Sousa [42] found that the minimum usable font size should be 2.8mm so older adults can read comfortably on mobile devices – which agrees with what prior studies have found [12].

While these findings reinforce well-established guidelines [1], their pervasiveness suggests more needs to be done to aid in their application to SNS design. SNS designers should use relative font sizes in their interfaces to permit easy scaling. When possible, they should also include easy-to-access configuration tools that enable easy adjustment of the font, font-size, and contrast.

3.2.2 Use non-text content to support text comprehension while ensuring its presentation is accessible. While the last theme focused on the presentation of text-based content, this guideline covers other kinds of content including images, videos, audio, and charts. Within this theme, prior studies have recommended greater use of these formats to enhance the comprehension of textual content. Sousa et al. [42] pointed to lower literacy rates among older populations and suggested using images to facilitate comprehension. This recommendation was echoed in the results of a participatory design workshop with older adults [48] that likewise suggested that longer texts should be replaced or complimented with photos and videos to aid understanding. Participants in [2] reported finding it easier to click on links when they were formatted as clearly labeled images or buttons, as opposed to underlined hyperlinks. A preference for non-text representation was also reported for content generation. Older adults in [7] expressed a preference for photo and video-based SNS applications, noting that writing content was too complicated and created a barrier to use.

Although non-text content like images and video have been offered as a way of improving accessibility for older adults, studies have also noted the need to ensure these elements themselves were accessible. This includes ensuring that images are large enough [42], that they are understandable to older adults [9], and that icons are intuitive and reinforced with labels [2]. Designers are thus encouraged to ensure that older adults are included in usability testing of new content to ensure these items are accessible to this demographic.

A particular challenge to ensuring non-textual content is accessible to older adults is the degree to which such content is user-generated on SNS. Designers should include features to better prompt, remind, and reward users for ensuring their content is accessible with features similar to those used for nudging people to include alt-text. [3] Designers should also ensure that their content choices do not reinforce negative stereotypes of aging, by for example selecting positive images depicting older adults from the Disrupt Aging Collection assembled by Getty Images and the American Association of Retired People (AARP).[4]

3.2.3 Support navigation with simple page layouts, consistent designs, and clear, easy-to-identify navigation elements. Issues with navigation were widely discussed in the included studies, with recommendations calling for better use of links, button, icons, or other interface components to help older adults find desired content more easily. This includes ensuring navigation links are easily identifiable by using buttons instead of hyperlinked text [2], adding home buttons [20], labeling icons and buttons [3, 11, 42], using graphical representations to reinforce purpose (e.g., using arrow shaped buttons for forward and back navigation instead of solely text) [3], ensuring that functional buttons are consistently designed and visually distinct from other content [9], and visually separating buttons that could be easily confused (e.g., sign-up and login) [2].

Content representation has also raised concerns among older adults in some of the included studies. Chou et al.[9] found that when text included buttons these were often regarded as part of the text and not perceived as interactive. This implies that some older adults may have difficulty knowing when and what to press, or which buttons are functional on Social Media. As older adults may not be as savvy as their younger counterparts, it is important for SNS designers to enable meaningful classification of contents to make it easier for them to use [43].

While the previous guidelines were related to movement between pages, the following set of guidelines refer to the arrangement of visual elements on a page. Previous studies highlighted the need for care in determining the number and the size of page elements and their placement in relation to white space and page margins. Recommendations include ensuring clear labeling with consistent clear layouts across pages [2, 20, 42], as well as consistency in the patterns to browse

[3]https://www.theverge.com/2022/7/13/23178465/twitter-alt-text-alert-reminders-test-accessibility
[4]https://www.gettyimages.ca/collections/disruptaging

different types of web pages [9], and the provision of large targets with generous spacing between items [8, 9].

In general, designers are encouraged to strive for consistency with planning layouts to ensure navigation elements are placed where older adults expect to find them. They should additionally pay careful attention to terminology and graphics used for navigation elements to ensure these are easy to understand.

While the suggested guidelines are in line with the general GUI guidelines (e.g. Shneiderman's Eight Golden Rules [40]), implementing these recommendations needs careful consideration for older adults' special needs. For instance, social media designers follow Shneiderman's Golden Rule of "strive for consistency" in SNS by implementing a double-tap gesture used consistently throughout the platform to like or react to posts, view images, or open links. While this feature might help regular users, it might cause a challenge for older adults who are less familiar with touch-based interactions. To address this challenge for older adults, designers can offer alternative interaction options and provide clear cues for navigation.

3.2.4 Include help interfaces targeted to the concerns of older adults and ensure error messages are easy to understand and clearly outline appropriate corrective actions. As older adults have been slower to adopt SNS, many will have less experience and turn to help and support features built in the SNS for guidance. Studies pointed to the need for online help to aid users better navigate the interface [9, 49], for search features to enable users find what they are looking for efficiently [9, 28], and for trial periods to support practice prior to adoption [48]. Support can also be achieved by improving error handling to ensure error messages are easy to understand and help users take the proper corrective actions [13]. Futhremore, Pandya et al. [34] recommended the provision of an interaction walkthrough feature that walks a user through all possible functionalities to better support older adults' adoptions of SNS.

Some SNS platforms provide general accessibility tools to help create a good experience for its diverse set of users. For example, Meta Inc. has a dedicated Accessibility page,[5] and a help centre accessibility section.[6] Twitter runs an official account devoted to help with accessibility matters.[7] However, most of the introduced interventions focus on providing help and support for people with disabilities, such as vision loss and deafness. In SNS, there is a lack of such tools that target older adults specifically to provide help and support regarding topics to address their specific needs. Pandya and El-Glaly's TapTag [34] provides a model for how help instructions can be incorporated within the interface to support learning. In their system, help instructions are overlaid on the Facebook interface to provide an interactive walk-through.

Another challenge to consider when designing help and support tools for older adults is their preference for receiving help from close friends and family rather than from written instructions, even when such instructions are clear and easy to follow [29]. Designers should consider ways of facilitating the provision of help within their interface, by for example, by making it easy for an older adult to ask questions within the interface about its features (e.g., "can you tell me what this button does") or by enabling others to demonstrate their use of the system while preserving privacy (e.g., "here's a video showing how I enabled this feature"). Designers might also consider how they could enable limited account sharing capabilities so that an older adult can delegate to a trusted other certain account configuration or review tasks (e.g., to review privacy settings and ensure they are set consistently with the user's goals).

[5]https://www.facebook.com/accessibility
[6]https://www.facebook.com/help/accessibility
[7]https://twitter.com/TwitterA11y

3.2.5 Provide support for progressively growing and maintaining social connections. Older adults require more nuanced support for developing and growing their social networks. While prior studies indicate that older adults join SNS to connect with friends and family, they can be reluctant to use existing features to grow their networks and engage with others. For example, Ibarra et al. [26] found that older adults would avoid accepting friend requests on Facebook over concern that such features may expose their personal information. As a solution, they suggested the addition of features to support incremental and mediated connection to provide an opportunity to gain additional contextual information before giving full friend access.

The importance of additional contextual information is echoed in the work by Tsai et al. [47]. Their TreeIt system explored the use of social promotion functions "to increase social connection, maintain the intensity of social connection and strengthen social experience". While this work found success with an auto-suggest friend feature, these suggestions provided additional information on how the suggestion was derived, which may have helped increase trust in the recommendation.

Other social promotion functions in TreeIt encouraged engagement by visualizing the intensity of connections and filtering out weak ties, by displaying friends' moods to prompt users to reach out, by showcasing hot-topics based on the most active discussions within the user's network, recommending chat topics based on a pair of user's shared interests, facilitating the development of common albums to enable users to identify common interests with their friends, and highlighting recent groups within the user's network. Other research has also suggested the inclusion of features that help users join conversations and groups based on common interests [7]. SNS designers should consider how features to aid engagement can be incorporated into the system while also ensuring older users can comfortably grow and maintain their networks without unduly releasing personal information.

3.2.6 Prioritize privacy protection features, making privacy the default and ensuring privacy settings are visibly activated. To make their systems more appealing to older adults, SNS designers should prioritize privacy protection when determining how to collect, secure, use, and disclose personal information. Findings from past studies show that privacy issues are of the most significant barriers that deter older adults from using SNS [9, 11, 13, 19–21, 25, 28, 34]. One of the respondents from Coelho et al.[11] captured this sentiment with "I think that Facebook is not safe. How do I know if talking to a person on Facebook, that person is the only one that sees what I write" (p. 118). Chou et al. identified protection of personal privacy as one of the most important user requirements in their analysis [9]. In a survey of older adult Facebook users, nearly 60% of the 121 respondents reported that they felt Facebook's features to protect privacy could be improved. Focus group participants in [19] were largely unaware of the privacy controls in social networking applications.

To improve the usage of SNS by this population, designers and providers need to both ensure that personal privacy and security are protected and that these protections are clearly communicated. One way of ensuring privacy protection of SNS as suggested by older adults in the included studies is to make privacy information more visible especially when users share their information [21, 25, 28, 32]. Specifically, existing guidelines have advocated for more transparency when using these applications. For example, SNS should state clearly how the data is used and what data is being shared with others [48]. More importantly, sharing features of SNS should be provided as opt-in features rather than as opt-out features [28] and options to allow access to the camera need to be designed with care [20].

Furthermore, findings show that older adults are more vigilant about protecting their personal information from being shared with entities with whom they don't wish to share, which could include strangers and commercial corporations. Similarly, older adults are wary of having all their information exposed to all group participants, especially those with whom they are not very

familiar [19, 21]. This might be due to the fact that privacy and online identity theft have been a hot topic in the media coverage lately. Hence, "maintaining appropriate levels of privacy and allowing the sharing of information to various degrees of friendship is recommended" [21]. In addition, a lack of awareness and understanding of existing privacy features further complicates privacy concerns. For example, Gibson et al. [19] found that the older adults in their study were unfamiliar with the privacy settings that exist on most SNS. Thus, SNS platforms need to adopt incremental approaches to revealing personal information that provide more transparency regarding how data is shared and with whom.

Considering these reoccurring requirements, SNSs should provide clear contact categorization and put it at a central role during the interaction. Moreover, SNSs should limit online community members and prioritize family and/or close friends grouping and provide interactions around these groups to facilitate relationship maintenance [21]. Further, SNS users should be allowed to share information selectively [19, 21] and anonymously [21]. To further mitigate privacy breaches and exposure, older adults have recommended that privacy protection should be the default setting rather than opt-in option [28].

An additional source of uncertainty about Internet security for older adults comes from the misconception that online games and advertisements require money transfer or that data may be hacked [9, 28]. In particular, apps and games feature advertisements that pop up intermittently on SNS that can be hard to distinguish from other content, and which may be particularly unsuitable for older adult users [9]. In Jung' study [28], one of the respondents lamented that "Facebook is an unsafe place because she thinks there is a risk of exposure to strangers such as third-party advertisers and their friends' friends" (p. 1076). To address this concern, researchers suggest that older adults can benefit from reminders (such as prompting: 'Are you sure you want to post this content?' or 'Only your friend will see this post') to better control their privacy.

3.2.7 Support alternate interaction modalities such as voice, tap, etc. To broaden the reach of their systems, SNS designers should provide support for alternative methods of interaction (such as voice, tap, etc.). In this review, we found that older adults are increasingly positive towards voice command and other interaction features and desire that these be integrated in social media beyond what is currently available [11, 13, 34, 43, 45]. For instance, Coelho et al.[11] found that some older adults reported that having an application talking to them could make them feel less alone. They further noted the advantages of including voice interaction on SNS on tasks. Their study found that older adults can employ voice interaction for tasks such as browsing photos and videos (75 %), adjusting the tablet volume (78 %), playing the media content (74 %), and performing speech-to-text tasks (68 %) and notes (71 %).

To further improve older adults' interaction with SNS, Susilo et al.[43] recommended using single touch-based interaction. A few studies focused on the use of tablets and recommended alternate navigation approaches such as using gestures and tilting for menu navigation and scrolling tasks [11], and the use of two-step tap interactions to separate exploration and activation of interface elements[8]. Another suggestion was to enable SNS to be viewed on TV to interact with SNS using alternative modalities like speech, or back-of-device taping [11].

Hence, interaction experiences of older adults on SNS can be improved by adding voice commands and speech-to-text functionalities [11], as well as including a "stop button" which would be directly accessible on the modules so older adults can turn off text to speech (TTS) when vocal outputs are not desired [45].

[8]In this system, a first tap was used to provide feedback on the interface element with a second tap needed to confirm activation.

Finally, to improve the accessibility of SNS for older adults, some of the included studies considered helpful insights with the assumption that some users might want to access SNS over TVs or other large displays. These guidelines promote improving interaction features during design to support such hardware. For example, Çarçani et al. [7] proposed designing big screens with the possibility to offer a real-life sensation of interaction and to enhance face-to-face interaction and fight loneliness.

3.2.8 Ensure terminology used in the interface is understandable to older adults. This guideline defines the list of recommendations when creating and managing content in SNS to be customized for older adults such as using specific wording to ensure the terminology used in the interface is understandable to the targeted population. Looking at the studies included in this thematic synthesis, SNS designers should use wordings that fit into older adults' semantic field [8]. In a prior study aimed at designing a smartphone application designed to promote exercise and prevent falls amongst older adults [8], participants were not familiar with wording related to games when associated with dancing and moving; i.e., they did not see themselves as playing the game and dancing. The wording was then rearranged which helped participants better understand the game and the application as a whole. To improve the SNS interface, authors suggested choosing wording that corresponds to older adults' vocabulary.

Social media has its own set of unwritten rules and communication styles that might differ from traditional forms of communication. Terminologies such as hashtag, DM, tagging, selfie, follow, influencer could be confusing due to common generational differences. Providing guidance, explaining terms, and offering support can go a long way in helping older adults navigate the digital realm more comfortably.

Another suggestion to improve the terminology on SNS to better support older adults is reducing the amount of information by providing shorter explanations by using keywords [34, 48].For example, if someone is not interested in political news, they may be able to filter the news feed by ignoring posts with keywords: President, White House, Deputy, Government, etc.

3.2.9 Build cognitive accessibility features to address older adults' specific needs. This guideline is relevant to the new features to be added or the existing ones to be adjusted into current SNS to better address older adults' specific cognitive accessibility needs. Specifically, while not every older adult has issues with memory and concentration, there are cognitive declines that happen with age for many people. The included studies suggested different adjustments to overcome memory issues. Examples include explaining actions and consequences [13], and removing features that make information automatically disappear from the screen [8, 42]. As many older adults may be relatively less familiar with some required actions of SNS, there is a need to regularly and consistently inform them of their current actions [8, 32].

Furthermore, some studies have recommended the minimization of the sequence of actions required on SNS by providing simple features [2, 42, 46]. For example, Ting-Yi et al.[46] redesigned the Facebook interface by removing minor functionalities and limiting interface functionalities to only include interactive functions such as online chatting and communication. Their experiment showed that the redesigned interface was preferred over the original Facebook interface by older adult users [46]. Further, Arfaa et al.[2] found that older adults encountered scrolling issues when more than one feature, such as "Find Friends" was available on the top and left side navigation. They reported that many "did not prefer or want to scroll to reveal more information and many became resigned when experiencing dexterity issues with the mouse" (p. 59). To overcome this barrier, Arfaa et al.[2] suggested using concise terminology, consistent formatting, as well as reducing scrolling to improve the experience for older adults. Hence, studies have recommended that SNS designers should provide a simple and familiar interface to help users learn faster [39, 48].

Moreover, a number of studies suggested that SNS designers should improve the presentation of message contingency i.e. the continuity of message exchange and interaction in the comment function [27, 28]. For example, Jung and Sundar [27] found that visual presentation of message contingency is effective in motivating older adults to use Facebook for obtaining greater interaction gratification. Since many older adults value paper-based or hand-written artifacts, there should be an opportunity to integrate those into their online experiences [25]. Hope, Schwaba and Piper [25] agree that paper-based artifacts can play a particularly important role in the correspondence practices of older adults in their study. Hence, SNS designers should provide older adults with similar experiences, as well as ensuring a more holistic view of what social media is for seniors by supporting older adults' communication needs and preferences.

Customization is one of the key design considerations in some of the included studies [25–27, 34, 49]. Older adults are a user population with quite diverse preferences, and it is certain that one design is difficult to fit the needs of all. According to Jung and Sundar [27], "customization allows users to become a content creator or source of the information in the digital media environment, which leads users to be more agentic" (p. 4140). One of the ways of ensuring customization of SNS is by allowing users to control their personal profile, with an option to customize app content [27, 34]. To further buttress this, Jung et al. [27] found that profile customization and posting personal stories on Facebook are key activities for obtaining agency-based gratification (i.e., enhancement and community-building). This implies that gratification in using SNS by older adults will increase when they are able to customize SNS features to suit their specific needs.

3.2.10 Support older adults' different backgrounds, cultures, needs, communication preferences, etc., when designing SNS. This guideline summarizes the general specifications SNS designers need to keep in mind to ease usage of SNS by older adults. In the included studies, researchers highlighted different aspects to address this point. Specifically, designers, and providers of SNS are encouraged to make concerted efforts to support older adults' communication needs and preferences [25]. This is particularly important as older adults have lamented that the "forms of expression afforded by material social communications are lost with online social media" (12 p. 3911). Their needs and preferences can be supported by enabling depth of thought, careful and reflective composition, and personalization. It is also important that designers understand age-related needs pertaining to cultural practices and preferences of older adults [25, 26]. For example, Ibarra et al. [26] found that there are cultural differences among older adults in their study as some do not want to involve other people when trying to reconnect. Additionally, unknown technical terms should be avoided by using more familiar terms to explain them [48], thereby ensuring SNS are personally relevant to older adults' needs. Furthermore, the various design decisions need to keep in mind differences in the educational and cultural background for the end users.

Aside from suggesting personalized guidelines for SNS, Jung et al. [28] and Xie et al. [49] emphasized that educating older adults about SNS features is key to encouraging them to adopt the usage of SNS applications.

Reflecting on these points, some existing tools have been developed in the past as an attempt to build customized technologies for older adults. For example, a customized email service for seniors[9] was developed to address older adults' specific needs. Furthermore, prior research from more than twenty years ago, have suggested various email systems targeted for older adults [4, 14, 23]. Such solutions did not manage to reach great success and impact due to various reasons. One potential explanation is that older adults don't see themselves as needing specialized systems [23]. Further, older adults prefer to frequently seek help and support from family and friends to use SNS. This type of support will be lost if they adopt technologies that are senior friendly and are not familiar by

[9]https://www.intouchlink.com/seniors/simple-email-for-seniors/

others. A potential solution to address these challenges might be to simplify the existing interfaces for SNS. For example, one could design a dedicated button that moves back and forth between a clean version of the interface and an original version. The dedicated button can then be used voluntarily by older adults when feeling overwhelmed by the many SNS features.

4 DISCUSSION

In this section we discuss the insights and gaps as opportunities for future research, and list potential limitations to the presented systematic review. We further highlight potential weaknesses of the currently suggested design guidelines to support designers and researchers to make more informed decisions about which findings are most applicable and meaningful.

4.1 The Interpretation of Older Adults' Definition

Older adults are not a homogeneous group: individual differences exist which influence needs and preferences for SNS [17]. However, looking at the included studies in this systematic review, only age was used to define when a person is considered an "older adult". Other characteristics were not considered. Furthermore, the age used to define the threshold between young and old was not consistent among the studies. (Note: In this systematic review, we did not impose a particular definition of older adult but included all studies reporting on 'older adults'). Hence, an individual might be considered an older adult if aged 55 and older [8, 46], or 60 and older [11, 13, 27, 32, 34, 39, 48], or 63 and older [19], or 65 and older [2, 3, 7, 20, 21, 26, 28], or 71 to 92 [25]. As a result of the reporting differences across studies, the explored research findings correspond to different age groups. A potential implication of a missing universal definition would result in biasing research findings based on the age group of focus. When interpreting the research findings, it is always important to remember that, focusing on a specific age group, findings might not always be generalizable to another age group. It is also important to acknowledge that the definition of 'older adult' is not straightforward because there are no definitive boundaries between young and old.

4.2 The Need for Heterogeneous Solutions for Older Adults

While summarizing different design recommendations of SNS for older adults, we found that the included studies sometimes disagreed on implementing specific features for the benefit of older adults. For example, while Tsai et al [47] suggested including features for auto-suggest friends to promote connections, Jung et al [28] suggested disabling this feature for users who do not want to be exposed to unknown users. These variations in recommendations highlight the heterogeneity of the older adults' population. When designing solutions geared towards older adults, researchers generally rely on the fact that older adults do have commonality in terms of biological, psychological, and social dimensions, regardless of the individual differences. In other words, designing these solutions rely on those similarities in order to optimize the design process. However, we must also be aware of the immense individual differences and characteristics (e.g., pre-retirement usage of technology in the workplace, socio-economic status, physical and cognitive well-being) that exist among older adults, to properly determine whom the design solution can and cannot accommodate.

For instance, older adults who have previously worked in technology-driven environments may possess a higher level of digital literacy and comfort with using online platforms. As a result, they might be more familiar with standard user interfaces and may require less guidance in navigating SNS (walk-through features, trial period, online help, etc. (Section 3.2.4)). Furthermore, Socio-economic status plays a significant role in determining the accessibility of technology among older adults. While some older adults have the privilege of access to high-speed internet and the latest devices that enables them to benefit from rich interaction modalities (Section 3.2.7), others

face digital disparities due to limited resources and will not be able to benefit from such design recommendations. To address this, SNS designers are encouraged to adopt progressive enhancement strategy that guarantees a core user experience accessible to all users regardless of their device or internet speed [35]. Older adults with high-speed internet and the latest devices would benefit from the additional enhanced features, while those with limited resources would still have access to the essential functionality.

4.3 The Need for More Specificity in Research Studies

Some recommendations from the studies included in this review are not specific or explicit which makes it hard for designers to adopt such recommendations. For example, Hope et al. [25] suggested integrating paper-based or hand-written artifacts into an online experiences and supporting older adults' communication needs and preferences within the "Cognitive Accessibility Features" theme. While those recommendations were clearly justified, no specific recommendation was suggested by the authors on how these guidelines can be implemented in real-life with SNS applications. As a result, it might be hard for stakeholders including researchers and industry practitioners to successfully translate those guidelines when embedding accessibility within product development. This is particularly challenging due to the sheer number of products and speed at which they are launched.

One potential solution to the lack of specificity in the presented recommendations might potentially be mapping these studies' design guidelines with studying older adults' behaviours and attitudes towards SNS. Specifically, research focusing on understanding how older adults engage in SNS via creating and sharing online content informs the design of SNS to better engage and support the targeted population [6]. However, this research direction is out of the scope of the presented systematic review. In this paper, the inclusion criteria only covers research detailing specific design recommendations to improve SNS for older adults. A potential future research venue will be to expand the current review by including studies about understanding older adults' usage of SNS applications and map the findings with the proposed design recommendations.

One additional research direction worth exploring is involving designers in the process of building SNS design recommendations for older adults. As a future step, we plan to collaborate with designers and provide them with the suggested recommendations to create SNS user interfaces tailored for older adults. After the interfaces are developed, older adults could be asked to interact with these designs and provide feedback on the accessibility and usability of the interfaces.

4.4 Looking Beyond The Facebook Application

In this review, 19 out of 24 studies were about improving the Facebook application specifically for older adults. While this large amount of research aligns with what current older adults are extensively adopting, this may restrict the design recommendations studied in the literature to be applicable to only one specific SNS application. Furthermore, this limits the generalization of the findings, as not all recommendations can be applied to different platforms. This paper highlights the limited research targeted towards a variety of SNS applications to reach more accessible and inclusive SNS recommendations geared towards older adults using different platforms. Research shows that only 7% of Twitter users and 13% of Instagram users are aged 65 years and older [37]. While older adults are not among the majority of users in these SNS platforms, promoting the inclusion of older adults' voices in SNS could have beneficial consequences, such as encouraging non-ageist attitudes, destabilizing stereotypes, and discouraging prevalent ageist and negative vision of older people. Addressing accessibility issues in these platforms might even encourage older adults to adopt the usage of various SNS.

4.5 Limitations

This review has contributed to the knowledge of understanding SNS design requirements and expectations from the older adults' perspective. The design recommendations we synthesized in the study can inform the design of new SNS for older adults, and can help build more inclusive and accessible SNS. However, some limitations have been noted. First, three studies that were not conducted in English language were excluded from this study. This may introduce some potential bias as those studies may provide design recommendations that are more relevant to the culture they were conduced in. Therefore, studies that account for other languages aside from the English language are needed to provide cross-cultural and global recommendations for designing SNS for older adults. Also, grey literature such as reports, thesis, and technical reports were not included in this review as they are usually not per-reviewed. While grey reports have been found useful in new and rapidly evolving research areas [33], we excluded non-peer-reviewed publications to ensure that findings are relevant and reliable in meeting our research objectives.

5 CONCLUSION

We have presented a literature review of current academic research efforts about design recommendations for SNS from the perspectives of older adults. We reviewed and analyzed literature that contributes to improving the accessibility of existing SNS. Our analysis revealed several efforts to build design requirements to make SNS more inclusive and easier to use by older adults. These efforts include improving navigation; ensuring easy-to-use interfaces and layout; providing content and features that are of interest to older adults; ensuring personal privacy; including voice command and interaction features. Similarly, to improve the experiences of older adults with SNS, we uncovered several methods that designers and providers should follow such as focusing on content visualization, and empowering users to customize their profiles and SNS features to meet their specific and diverse needs. At the same time, the literature has focused more on some SNS applications over others, highlighting the need to divert efforts to understudied SNS applications.

Despite the laudable research progress in examining SNS accessibility for older adults, gaps and opportunities for future work still exist as highlighted in this paper. Specifically, the quality assessment of the included studies revealed that ethical issues were not sufficiently discussed in most of the articles. Therefore, efforts must be made by researchers to more transparently discuss the ethical considerations of the research. Furthermore, many researchers have studied design guidelines of SNS targeted for older adults, but much less work has been done to determine how such guidelines can be actually used by practitioners and designers of SNS for the benefit of older adults. We hope this work provides a comprehensive and consistent description of the current research that will serve as guidance for future studies as well as an entry point to new researchers in the field.

REFERENCES

[1] Andrew Arch and Shadi Abou-Zahra. 2010. Developing websites for older people: how web content accessibility guidelines (WCAG) 2.0 applies. *Web Accessibility Initiative* (2010).

[2] Jessica Arfaa and Yuanqiong (Kathy) Wang. 2014. A Usability Study on Elder Adults Utilizing Social Networking Sites. *Proceedings of the Third International Conference on Design, User Experience, and Usability. User Experience Design for Diverse Interaction Platforms and Environments, DUXU'14*, 50—-61. https://doi.org/10.1007/978-3-319-07626-3_5

[3] Jessica Arfaa and Yuanqiong (Kathy) Wang. 2015. Usability Evaluation of a Social Networking Site Prototype for the Elderly. *Proceedings of the First International Conference on Human Aspects of IT for the Aged Population. Design for Aging*, 297—-306. https://doi.org/10.1007/978-3-319-20892-3_29

[4] John L Arnott, Zayneb Khairulla, Anna Dickinson, Audrey Syme, Norman Alm, Roos Eisma, and Peter Gregor. 2004. E-mail interfaces for older people. In *2004 IEEE International Conference on Systems, Man and Cybernetics (IEEE Cat. No. 04CH37583)*, Vol. 1. IEEE, 111–117.

[5] Meghan A Bohren, Erin C Hunter, Heather M Munthe-Kaas, João Paulo Souza, Joshua P Vogel, and A Metin Gülmezoglu. 2014. Facilitators and barriers to facility-based delivery in low-and middle-income countries: a qualitative evidence synthesis. *Reproductive health* 11, 1 (2014), 1–17.

[6] Robin Brewer and Anne Marie Piper. 2016. " Tell It Like It Really Is" A Case of Online Content Creation and Sharing Among Older Adult Bloggers. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. 5529–5542.

[7] Klaudia Çarçani and Christina Mörtberg. 2018. Enhancing engagement and participation of seniors in society with the use of social media – The case of a reflective participatory design method story. *IxD&A* 36 (2018), 58–74. https://doi.org/10.55612/s-5002-036-004

[8] Jing Jing Chang, Nor Salsalbilal Hildayah binti Zahari, and Yu Hong Chew. 2018. The design of social media mobile application interface for the elderly. *Proceedings of the 2018 IEEE Conference on Open Systems*, 104–108. https://doi.org/10.1109/ICOS.2018.8632701

[9] Wen Huei Chou, Yu-Ting Lai, and Kuang-Hsia Liu. 2013. User requirements of social media for the elderly: A case study in Taiwan. *Behaviour and Information Technology* 32, 9 (2013), 920–937. https://doi.org/10.1080/0144929X.2012.681068

[10] José Coelho and Carlos Duarte. 2016. A literature survey on older adults' use of social network services and social applications. *Computers in Human Behavior* 58 (2016), 187–205.

[11] José Coelho, Fábio Rito, Nuno Luz, and Carlos Duarte. 2015. Prototyping TV and Tablet Facebook Interfaces for Older Adults. *Proceedings of the 15th IFIP TC.13 International Conference on Human-Computer Interaction*, 110—-128. https://doi.org/10.1007/978-3-319-22701-6_9

[12] Iain Darroch, Joy Goodman, Stephen Brewster, and Phil Gray. 2005. The effect of age and font size on reading text on handheld computers. In *Human-Computer Interaction-INTERACT 2005: IFIP TC13 International Conference, Rome, Italy, September 12-16, 2005. Proceedings 10*. Springer, 253–266.

[13] Thiago Alexandre de Souza Silva, Natália Moreira de Paula, Glívia Angélica Rodrigues Barbosa, Ismael Santana Silva, and Flávio Roberto dos Santos Coutinho. 2019. Characterization of sociability on online social networks in brazilian elderly' perspective: a case study on Facebook. *Proceedings of the 18th International Conference on WWW/Internet*, 11–18. https://www.iadisportal.org/digital-library/characterization-of-sociability-on-online-social-networks-in-brazilian-elderly-perspective-a-case-study-on-facebook

[14] Anna Dickinson, Alan F Newell, Michael J Smith, and Robin L Hill. 2005. Introducing the Internet to the over-60s: Developing an email system for older novice computer users. *Interacting with computers* 17, 6 (2005), 621–642.

[15] eBizMBA Inc. 2021. *Top 15 Best Social Networking Sites & APPs*. eBizMBA Inc. http://www.ebizmba.com/articles/social-networking-websites

[16] Casey Fiesler, Christopher Frauenberger, Michael Muller, Jessica Vitak, and Michael Zimmer. 2022. Research Ethics in HCI: A SIGCHI Community Discussion. *CHI Conference on Human Factors in Computing Systems Extended Abstracts*, 1–3.

[17] Dan Fisk, Neil Charness, Sara J Czaja, Wendy A Rogers, and Joseph Sharit. 2004. *Designing for older adults*. CRC press, London, UK.

[18] Kate Flemming, Andrew Booth, Ruth Garside, Özge Tunçalp, and Jane Noyes. 2019. Qualitative evidence synthesis for complex interventions and guideline development: clarification of the purpose, designs and relevant methods. *BMJ Global Health* 4, Suppl 1 (2019), e000882.

[19] Lorna Gibson, Wendy Moncur, Paula Forbes, John Arnott, Christopher Martin, and Amritpal S. Bhachu. 2010. Designing Social Networking Sites for Older Adults. *Proceedings of the 24th BCS Interaction Specialist Group Conference*, 186—-194.

[20] Abdulrahman Hafez and Yuanqiong (Kathy) Wang. 2019. A Training Social Media Mobile App Prototype for the Elderly: A Pilot Study. *Proceedings of the 10th International Conference on Applied Human Factors and Ergonomics*, 188—-197. https://doi.org/10.1007/978-3-030-19135-1_19

[21] Dave Harley, Kate Howland, Eric Harris, and Cara Redlich. 2015. "Nearer to Being Characters in a Book": How Older People Make Sense of Online Communities and Social Networking Sites. *Proceedings of the 2015 48th Hawaii International Conference on System Sciences*, 2023–2032. https://doi.org/10.1109/HICSS.2015.242

[22] Sheila Hawker, Sheila Payne, Christine Kerr, Michael Hardey, and Jackie Powell. 2002. Appraising the evidence: reviewing disparate data systematically. *Qualitative health research* 12, 9 (2002), 1284–1299.

[23] Dan Hawthorn. 2002. How universal is good design for older users?. In *Proceedings of the 2003 conference on Universal usability*. 38–45.

[24] Graeme Hawthorne. 2006. Measuring social isolation in older adults: development and initial validation of the friendship scale. *Social indicators research* 77, 3 (2006), 521–548.

[25] Alexis Hope, Ted Schwaba, and Anne Marie Piper. 2014. Understanding Digital and Material Social Communications for Older Adults. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 3903—-3912. https://doi.org/10.1145/2556288.2557133

[26] Francisco Ibarra, Grzegorz Kowalik, Marcos Baez, Radoslaw Nielek, Norma Lau, Luca Cernuzzi, and Fabio Casati. 2018. Design Challenges for Reconnecting in Later Life: A Qualitative Study. *Proceedings of the 2018 ACM Conference Companion Publication on Designing Interactive Systems*, 141—-146. https://doi.org/10.1145/3197391.3205426

[27] Eun Hwa Jung and S. Shyam Sundar. 2018. Status update: Gratifications derived from Facebook affordances by older adults. *New Media & Society* 20, 11 (2018), 4135–4154. https://doi.org/10.1177/1461444818768090

[28] Eun Hwa Jung, Justin Walden, Ariel Celeste Johnson, and S. Shyam Sundar. 2017. Social Networking in the Aging Context. *Telemat. Inf.* 34, 7 (2017), 1071—-1080. https://doi.org/10.1016/j.tele.2017.04.015

[29] Amela Karahasanović, Petter Bae Brandtzæg, Jan Heim, Marika Lüders, Lotte Vermeir, Jo Pierson, Bram Lievens, Jeroen Vanattenhoven, and Greet Jans. 2009. Co-creation and user-generated content–elderly people's user requirements. *Computers in Human Behavior* 25, 3 (2009), 655–678.

[30] M Madden. 2010. Older adults and social media. Pew Internet & American Life Project. https://www.pewresearch.org/internet/2010/08/27/older-adults-and-social-media-3/.

[31] Meredith Ringel Morris, Annuska Zolyomi, Catherine Yao, Sina Bahram, Jeffrey P Bigham, and Shaun K Kane. 2016. "With most of it being pictures now, I rarely use it" Understanding Twitter's Evolving Accessibility to Blind Users. *Proceedings of the 2016 CHI conference on human factors in computing systems*, 5506–5516.

[32] Chris Norval, John L. Arnott, and Vicki L. Hanson. 2014. What's on Your Mind? Investigating Recommendations for Inclusive Social Networking and Older Adults. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 3923—-3932. https://doi.org/10.1145/2556288.2556992

[33] Arsenio Paez. 2017. Gray literature: An important resource in systematic reviews. *Journal of Evidence-Based Medicine* 10, 3 (2017), 233–240.

[34] Shraddha Pandya and Yasmine N. El-Glaly. 2018. TapTag: Assistive Gestural Interactions in Social Media on Touchscreens for Older Adults. *Proceedings of the 20th ACM International Conference on Multimodal Interaction*, 244—-252. https://doi.org/10.1145/3242969.3243003

[35] Todd Parker, Scott Jehl, Maggie Costello Wachs, and Patty Toland. 2010. *Designing with Progressive Enhancement: Building the web that works for everyone.* Pearson Education.

[36] Pew Research Center. 2016. *Social Media Update 2016.* Technical Report. Pew Research Center, Washington, D.C. https://www.pewresearch.org/internet/2016/11/11/social-media-update-2016/

[37] Pew Research Center. 2021. *Social Media Fact Sheet.* Technical Report. Pew Research Center, Washington, D.C. https://www.pewinternet.org/fact-sheet/social-media/2019

[38] Katharina Reinecke and Abraham Bernstein. 2013. Knowing what a user likes: A design science approach to interfaces that automatically adapt to culture. *MIS Quarterly* 37, 2 (2013), 427–453. http://www.jstor.org/stable/43825917

[39] Restyandito, Febryandi, Kristian Adi Nugraha, and Danny Sebastian. 2020. Mobile Social Media Interface Design for Elderly in Indonesia. *Proceedings of the International Conference on Human-Computer Interaction*, 79–85. https://doi.org/10.1007/978-3-030-60703-6_10

[40] Ben Shneiderman. 2005. *Designing for Fun: Can we design user interfaces to be more fun?(2004).* Technical Report.

[41] Xiaokang Song. 2022. User Experience Design of Elderly-Oriented Social Apps Based on Kano Model—The Case of WeChat. In *HCI International 2022–Late Breaking Papers: HCI for Health, Well-being, Universal Access and Healthy Aging: 24th International Conference on Human-Computer Interaction, HCII 2022, Virtual Event, June 26–July 1, 2022, Proceedings*. Springer, 546–558.

[42] Tiago Boldt Sousa, Pedro Tenreiro, Paula Alexandra Silva, Francisco Nunes, and Eduarda Mendes Rodrigues. 2011. Cross-Platform Social Web Application for Older Adults with HTML 5. *Proceedings of the 10th International Conference on Entertainment Computing*, 375—-378. https://doi.org/10.1007/978-3-642-24500-8_45

[43] Fanny Febriani Susilo, Jung-Ho Lee, Ji-Hyung Park, and Jung-Min Park. 2018. Cross-Cultural Touch-Based SNS Interface Design for the Elderly. *Proceedings of the 12th KIPS International Conference on Ubiquitous Information Technologies and Applications*, 1153–61. https://doi.org/10.1007/978-981-10-7605-3_184

[44] James Thomas and Angela Harden. 2008. Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology* 8, 1 (2008), 1–10.

[45] Karine Lan Hing Ting and Myriam Lewkowicz. 2015. From Prototype Testing To Field Trials: The Implication of Senior Users in the Evaluation of a Social Application. *Proceedings of the 6th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-Exclusion*, 273–282. https://doi.org/10.1016/j.procs.2015.09.271

[46] Wu Ting-Yi and Chen Rain. 2018. Study on Social Software Interface Subtracting Design Used by the Ageing Population-Taking Facebook as an Example. *International Journal of Computer Theory and Engineering* 10, 6 (2018), 212–15. https://doi.org/10.7763/IJCTE.2018.V10.1228

[47] Tsai-Hsuan Tsai, Hsien-Tsung Chang, Yan-Jiun Chen, and Yung-Sheng Chang. 2017. Determinants of user acceptance of a specific social platform for older adults: An empirical examination of user interface characteristics and behavioral intention. *Plos One* 12, 8 (2017), 1–23. https://doi.org/10.1371/journal.pone.0180102

[48] Torben Volkmann, Isabella Miller, and Nicole Jochems. 2020. Addressing Fear and Lack of Knowledge of Older Adults Regarding Social Network Sites. *Proceedings of the 6th International Conference on Human Aspects of IT for the Aged Population*, 114—-130. https://doi.org/10.1007/978-3-030-50232-4_9

[49] Bo Xie, Ivan Watkins, Jen Golbeck, and Man Huang. 2012. Understanding and Changing Older Adults' Perceptions and Learning of Social Media. *Educational Gerontology* 38, 4 (2012), 282–296. https://doi.org/10.1080/03601277.2010.544580

6 APPENDICES

QUALITY ASSESSMENT

Table 4. Critical appraisal of methodological quality of included studies

First Author, Year	Q1 - Q9	Total	Rating*	Comment
Arfaa [3], 2015	4 4 4 4 4 3 4 3 4	**33**	Good	Handling of ethics and bias issues not explicitly stated (beyond consent form signing).
Arfaa [2], 2014	4 4 4 2 4 2 4 3 4	**31**	Good	Insufficient details on sampling and sample size determination. Only brief mention of ensuring confidentiality.
Boldt Sousa [42], 2011	3 3 3 2 2 1 3 2 3	**22**	Fair	Abstract missing key information. Insufficient detail and justification for sample size / selection process.
Çarçani [7], 2018	4 4 4 4 4 1 4 3 4	**32**	Good	Missing details on handling of ethical and bias issues.
Chang [8], 2018	4 4 3 3 3 1 4 3 4	**25**	Fair	Method appropriate but description lacking detail. No detail on handling of ethical and bias issues.
Chou [9], 2013	4 4 4 2 4 1 4 3 4	**30**	Good	Insufficient details on sample size. No detail on handling of ethical and bias issues.
Coelho [11], 2015	4 4 4 3 4 1 4 3 4	**31**	Good	Some missing detail on sample size. No detail on handling of ethical and bias issues.
de Souza Silva [13], 2019	4 4 4 3 4 3 4 3 4	**33**	Good	Missing details on handling of ethical and bias issues (beyond consent form signing)
Gibson [19], 2010	3 4 4 3 3 1 4 3 4	**25**	Fair	Appropriate data analysis, description could be improved, missing details on handling of ethical and bias issues.
Hafez [20], 2020	4 4 4 3 4 3 4 3 4	**33**	Good	Missing details on handling of ethical and bias issues (beyond consent form signing).
Harley [21], 2015	4 4 4 4 3 1 4 4 4	**32**	Good	Missing details on handling of ethical and bias issues
Hope [25], 2014	4 4 4 4 4 1 4 4 4	**33**	Good	Missing details on handling of ethical and bias issues.
Ibarra [26], 2018	3 4 4 3 4 1 4 3 4	**30**	Good	Appropriate adopted methods, description could be improved, missing details on handling of ethical and bias issues.
Jung [27], 2018	4 4 4 4 4 4 4 4 4	**36**	Good	All questions were answered sufficiently in this study.
Jung [28], 2017	4 4 4 4 4 1 4 4 4	**33**	Good	Missing details on handling of ethical and bias issues.

Norval [32], 2014	4 4 4 4 4 4 4 4 4	**36**	Good	All questions were answered sufficiently in this study.
Pandya [34], 2018	4 4 4 3 4 3 4 4 4	**34**	Good	Missing details on handling of ethical and bias issues (beyond consent form signing).
Restyandito [39], 2020	4 4 4 3 4 1 4 3 3	**30**	Good	Appropriate adopted methods, description could be improved, missing details on handling of ethical and bias issues.
Song [41], 2022	4 4 2 4 3 1 1 3 4	**26**	Fair	Missing questionnaire details, description lacking details, missing details on handling of ethical and bias issues (beyond consent form signing).
Susilo [43], 2018	4 4 4 3 4 1 4 3 3	**30**	Good	Appropriate adopted methods, description could be improved, missing details on handling of ethical and bias issues (beyond consent form signing).
Ting [45], 2015	4 4 4 4 4 4 4 4 4	**36**	Good	All questions were answered sufficiently in this study.
Ting-Yi [46], 2018	4 4 4 3 4 1 4 3 4	**31**	Good	Appropriate adopted methods, description could be improved, missing details on handling of ethical and bias issues.
Tsai [47], 2017	4 4 4 4 4 4 4 4 4	**36**	Good	All questions were answered sufficiently in this study.
Volkmann [48], 2020	4 4 4 4 4 1 4 4 4	**33**	Good	Missing details on handling of ethical and bias issues.
Xie [49], 2012	4 4 4 3 4 2 4 4 4	**33**	Good	Missing details on the process of obtaining participants consent. Obtaining consent was mentioned in passing.

* Good (4 = scores from 29-36), Fair (3 =scores from 22-28), Poor (2 = scores from 17-21), Very Poor (1 = scores from 9-16). More details about the conditions for the four categories of ratings can be found in Hawker et al.[22].

The nine appraisal domains and questions for assessing methodological quality were adopted from [22] and are listed as follows:

- Q1. Abstract and title: Did they provide a clear description of the study?
- Q2. Introduction and aims: Was there a good background and clear statement of the aims of the research?
- Q3. Method and data; Is the method appropriate and clearly explained?
- Q4. Sampling: Was the sampling strategy appropriate to address the aims?
- Q5. Data analysis: Was the description of the data analysis sufficiently rigorous?
- Q6. Ethics and bias: Have ethical issues been addressed, and what has necessary ethical approval gained? Has the relationship between researchers and participants been adequately considered?
- Q7. Findings/results: Is there a clear statement of the findings?
- Q8. Transferability/generalizability: Are the findings of this study transferable (generalizable) to a wider population?

- Q9. Implications and usefulness: How important are these findings to policy and practice?

These questions were used to conduct the critical appraisal of methodological quality in the included studies summarized in the following table.