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Technology Use Across Age Cohorts in Older Adults: Review and Future Directions

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Abstract:

With the rapid expansion of the older adult population globally, understanding the diverse technology usage patterns within this group has become increasingly crucial. Existing research on older adults' use of technology is fragmented and lacks age-specific analysis. While many studies adopt a broad approach to technology use across all older adults, they often overlook age as a key analysis factor, focusing excessively on individual technologies. Other studies focus narrowly on specific older age cohorts, without extending their findings to other older groups. This results in a disjointed understanding of technology usage across different older age sub-groups, hindering broader conclusions. This study is among the first to address this gap through a systematic review of 81 studies from 64 journals, using age as the primary analytical lens. It examines variations in technological use among the young-old (ages 60-74), the old-old (75+), and other nuanced age cohorts. By integrating these insights into a cohesive conceptual model, this research provides a comprehensive view of technology usage trends among older adults. This approach not only advances theoretical knowledge but also offers practical strategies for developing targeted technological solutions that can significantly enhance the quality of life and independence for older adults.

Keywords: SLR, TCM, Technology Usage, Older Adults, Age Cohorts, Quality of Life.

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1 Introduction

The last several years have seen a huge increase in the aging population in all countries. According to the United Nations (United Nations, Department of Economic and Social Affairs, Population Division, 2013), 12% of the global population is expected to be over 65 in 2030. By 2050, this number is expected to rise to 16% and this growing portion of older adults is expected to significantly impact both societies and healthcare systems. As people age, they typically encounter an increase in cognitive, physical, and sensory limitations, prompting different age-related difficulties (Mäkipää et al., 2022; Schieber, 2003).

In response to these emerging challenges, several technologies have been developed globally to assist older adults with their daily activities and health management. These solutions range from basic personal computers (Ellis et al., 2021) to Digital therapeutics (Sestino & D'Angelo, 2024) as well as cutting-edge wearable technologies (Gopinath et al., 2022). Numerous studies have explored how older adults use technology and the issues that arise from its use. These technological advancements help address social and psychological challenges and promote independent living. The issues span multiple areas, including healthcare assistive technologies (Yusif et al., 2016), social networking (Yang & Lin, 2019), online purchasing (Kuoppamäki et al., 2017), internet-based occupations (Ellis et al., 2021), entertainment (Yein & Pal, 2021), as well as concerns related to the digital divide and digital burnout (Au & Ho, 2019; Da Silva et al., 2024).

Usage of technology among older adults varies due to several factors, including age, cognitive abilities, prior exposure to technology, and more (J. Chung et al., 2016; Mostaghel, 2016). A range of studies have investigated both the initial acceptance and ongoing usage over time. This has helped identify key influencers, which include perceived need, availability-of-alternatives, societal factors, technology anxiety, and individual traits like self-efficacy (Peek et al., 2019; Yap et al., 2022). Main obstacles preventing older adults from using technology are cost, privacy concerns, and usability issues, while key facilitators are ease-of-use and strong support systems. Older adults usually adopt digital technologies more slowly compared to younger generations (S. J. Czaja et al., 2006; Samhan et al., 2018), but they are more likely to embrace technologies when provided with training, hand-holding, and user-friendly features like voice control (Pradhan et al., 2020).

Older adult populations are typically categorized into distinct age cohorts, such as the young-old (60–74), old-old (75+), and oldest-old (85+), each facing unique health, social, and technological challenges (Hargittai et al., 2019). While these categories are not sacrosanct and are explored further in this study, they provide useful insights into differences in technology usage across age groups. Each cohort tends to exhibit distinct behaviors when using technology, and these behaviors can vary significantly from those of other age cohorts. Analyzing these variations is important for developing targeted solutions that meet the specific needs of each age cohort.

Age is a key factor influencing older adults' engagement with technology, alongside a range of other variables (Hargittai et al., 2019; Schlomann, 2020a; Schmidt et al., 2023). However, age is often examined in conjunction with other factors, which makes it difficult to isolate its specific role in shaping technology use (S. Czaja & Xie, 2020). Most of the existing research tends to treat older adults as a single, homogeneous group; thereby overlooking important variations in technology usage across different age-based subgroups (H. W. Choi et al., 2020). Such generalization limits the development of targeted solutions that effectively address the distinct needs, preferences, and capabilities of different age cohorts. Conversely, some studies focus narrowly on specific cohorts without linking their findings to broader trends within the older adult population. For example, research has examined mobile app use for social interaction among the oldest old (Neves et al., 2018) and the effects of aerobic training on the young old (Lucertini et al., 2019). While these studies provide valuable insights into the technology-related behavioral patterns of specific age groups, they lack cross-cohort comparisons, making it challenging to draw broader conclusions about how age differently influences technology engagement.

In reviewing the literature on older adults and technology, we identified two main research streams. The first includes studies that examine specific technological interventions across the general older adult population, such as virtual reality (Bevilacqua et al., 2019), wearable technologies (J. Y.-W. Liu et al., 2020), cognitive training exercises (F.-T. Chen et al., 2020), and digital mental health activities (Rivera-Torres et al., 2021). These studies, though not cohort-focused, offer useful age-specific insights. The second focuses on technology use within specific age cohorts, such as nonagenarians (K. J. Miller et al., 2020), the oldest old (Marston et al., 2016), or older adults recovering from stroke (Maranesi et al., 2020).

What remains lacking in the existing literature is a synthesis that integrates these two research streams to examine cohort-specific patterns of technology use among older adults. The primary purpose of this review is to close this gap by integrating insights from both general and cohort-specific studies to examine variations in technology use across aging cohorts. For the purpose of this review, only studies offering significant, cohort-specific insights were included. Studies examining broader older adult populations were considered only if their findings could be meaningfully segmented by age cohorts.

The study highlights two key nuances. First, there are differences in technology affinity - certain cohorts tend to prefer technologies that align more closely with their functional needs. Second, even when the same technologies are used, usage patterns differ notably in terms of prioritized features, expected benefits, or modes of access. By uncovering these cohort-level differences, this study provides insights into developing technologies that better meet the diverse needs of older adults. Understanding why specific age groups adopt or avoid certain technologies can help solution designers and policymakers tailor services more effectively, increase adoption, and improve outcomes for older adults. As older adults' needs and behaviors evolve—amid increasing social isolation and shifting family structures, traditional support systems prove insufficient (Ng & Indran, 2023; Rudnik et al., 2020). By adopting an age-focused analytical lens, this review highlights greater opportunities for technology to support active aging (Vilhelmson et al., 2022) and promote optimal lifestyles in later life (Dragone & Strulik, 2020).

This study is based on a structured review approach. The study begins with a keyword co-occurrence analysis to establish early technological usage trends, followed by content analysis of two article sets that refine these trends to better understand technology affinities across age cohorts. Finally, a theoretical analysis uncovers how different cohorts engage with technology in distinct ways, revealing unique usage patterns across age groups.

To achieve this goal, the study examines the following research questions:

RQ1: What are the predominant research themes, geographical contexts, theories, and methodologies used in studies of technological usage across different older adult age cohorts?

RQ2: Which technological solutions are most effective for various age cohorts within the older adult population?

RQ3: What are the specific gaps and emerging trends in literature that should guide future research on technology use among older adults?

To address these questions, we systematically synthesize and map the literature in this research stream using the PRISMA protocol, presenting key findings through the TCM framework (Themes, Contexts, and Methodologies), and propose a forward-looking conceptual model of technology use across different age cohorts within the older adult population. Importantly, no paper was included in this review unless it provided meaningful identification or discussion of a specific older age cohort. This criterion ensures the review remains focused on age-cohort-specific insights rather than generalized findings about older adults.

We organize the remaining sections of this article as follows. In the *Methodology* section, we outline the article collection process and describe the analytical tools employed. In the *Key Findings* section, we present a content analysis of the selected articles and address the research questions. In the *Contextual and Methodological Analysis* section, we analyze the studies across three dimensions: geography, theoretical frameworks, and research methodologies. In the *Discussion and Future Research Avenues* section, we explore the broader implications of our findings and identify directions for future research. Finally, in the *Conclusion*, we summarize the key insights drawn from this study.

2 Literature Review Methodology

This paper presents a systematic literature review (SLR) to achieve the identified research objectives, and it follows the process described in (Tranfield et al., 2003). SLR methodology is opted for as it allows a systematic and rigorous approach to perform synthesis of findings from a wide range of research studies (Okoli, 2015; Paul & Criado, 2020). This methodology allows a large variety of research approaches to be carried out for in-depth and diversified analysis, which is not possible through traditional literature review methods (Kitchenham & Charters, 2007; Te Herenga Waka et al., 2024). SLR in this study uses the TCM framework (Paul & Rosado-Serrano, 2019), and it is performed in accordance with the Preferred

Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocols (Tranfield et al., 2003; Schlimbach et al., 2024; Plachkinova & Vo, 2023) along with established guidelines published by (Rowley & Slack, 2004). This structured approach brings methodological rigor to the work, making it more reliable. The detailed steps are outlined below.

2.1 Data Collection

In accordance with the PRISMA protocols, the systematic literature review (SLR) process began by establishing eligibility criteria. For this review, four electronic databases were utilized: Scopus, Web of Science, ProQuest, and PubMed. The inclusion and exclusion criteria, detailed in Appendix A, specify that eligible sources for this study are peer-reviewed journal articles published in academic journals within the fields of business and management. Given that this study is likely a pioneering contribution to the field, we conducted an initial review of the literature from its emergence in 1992 through to 2024. However, we found that significant scholarly activity in this domain began to emerge around 2012. After examining the abstracts from earlier years, we chose to narrow our focus to publications from 2012 onward, as this period shows a substantial increase in relevant research. A combination of four keyword groups, detailed in Appendix B, was used to search for the chosen databases for literature relevant to the research focus. These keywords were chosen based on their frequent association with studies on the health, technology use, and social dynamics of older adults (J. Kim & Cha, 2021; Sims et al., 2016; X. Xu et al., 2016). The review included only studies that offered meaningful insights into specific older adult cohorts.

2.2 Data Screening

The search was conducted across the selected research databases, using the established inclusion and exclusion criteria. It initially yielded a total of 675 articles related to the use of technology by older adult aging cohorts. After removing duplicates, 275 articles remained for further analysis (reasons described in the Figure 1, the PRISMA flow diagram). The subsequent phase involved the screening of articles. To evaluate each paper, the authors applied a coding scale from 0 to 3 based on relevance to the research questions. Three independent coders, all of whom were authors, assessed each candidate article using its title, abstract, and keywords. Each coder individually reviewed the abstracts of 275 articles to ensure a thorough selection process. For abstracts that lacked sufficient detail, the full articles were also examined. Ultimately, 81 articles were included, each receiving a minimum quality score of 2 out of 3 based upon predefined quality assessment criteria (Sharma & Sharma, 2024). We anticipated the coders to produce consistent results with high reliability, because the study's subject is relatively transparent. To further ensure scoring consistency, an external reviewer conducted random checks of the coded articles. The Abstract screening led to the iterative exclusion of 194 articles that did not align closely with the study’s focus. Ultimately, 81 articles from 64 journals were selected as the final sample for this literature review. See Figure 1 below, which illustrates this in a PRISMA flow diagram.

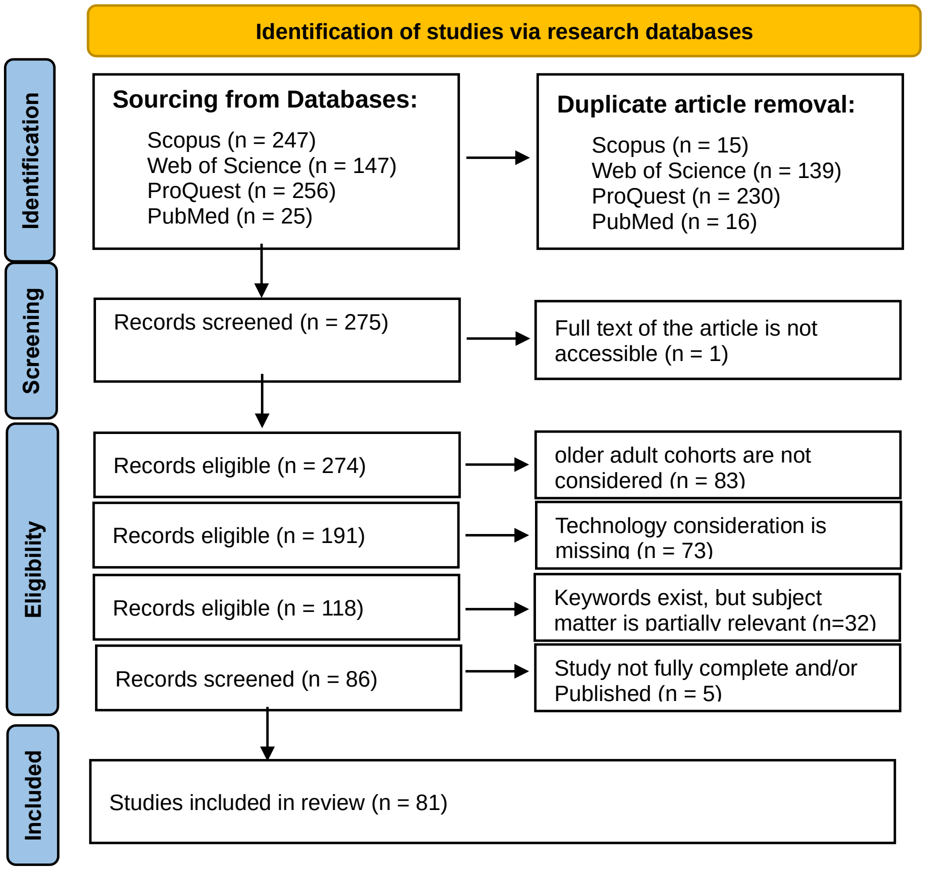

Figure 1. PRISMA Flow Diagram (Adapted from Paul and Criado (2020))

2.3 Data Extraction

See Appendix C for the distribution of the selected studies by age group. Our review identified a total of 81 studies. Of these, 45 focused on the use of technology among older adults as a whole, without explicitly considering the specific age sub-groups. However, these studies included incidental or embedded insights relevant to the age cohorts, which contributed meaningfully to our synthesis. The remaining 36 studies targeted the specific age groups within the older adult population- 16 amongst them examined the Young-old (60–74 years), 12 focused on the Old-old (75+ years), and 4 investigated the technology use among the oldest-old (85+ years). Additionally, 2 studies addressed technology use among the Octogenarians (80–89 years), and 1 study focused on the Nonagenarians (90+ years). The Middle-old cohort (70–80 years) also received only limited attention, with just 1 study dedicated to this group. All selected studies—regardless of whether they explicitly segmented participants by age cohort—were included only if they provided significant insights into specific age groups of older adults. This included either direct age-cohort specific analysis or sufficiently detailed participant characteristics that enabled inference of age-relevant patterns. Studies lacking such data were excluded from the review.

The metadata for the selected 81 articles was systematically compiled using MS Excel (Supplementary file, 2024) to facilitate comprehensive data analysis within the TCM framework. This metadata encompassed key details, including the aging cohort, type of technology, country of study, study design, and methodology. Specific information was carefully documented for each study category; - experimental, qualitative, and quantitative, such as participant volume, data analysis techniques, and the differences between cross-sectional and longitudinal approaches, along with the theoretical frameworks used. In addition, data regarding types of technology, their benefits, and the outcome variables were captured. This method of recording the metadata in a systematic manner helped in producing a visual representation of the findings, which is covered in the following sections.

2.4 Data Analysis

This study used the TCM framework for analyzing the data and later presenting the findings in three categories: Themes (T), Contexts (C), and Methodologies (M). The TCM framework is particularly powerful in reviewing cases where one needs to combine a wide range of studies and generate new concepts or themes (Kajol et al., 2022). Additionally, it helps in enhancing the analysis by incorporating several contextual and methodological dimensions into the analysis, which helps to increase the rigor of the insights obtained, and to identify research gaps and associated future research areas (Paul & Rosado-Serrano, 2019; Paul et al., 2023). The TCM framework was specifically selected for this work, which allowed for an understanding of the diverse nature of studies related to the topic of interest and highlighted important themes and their relationships.

Based on the search criteria, the review identified two main categories and six age-specific subcategories of studies, as detailed in Appendix C. Studies were only selected if they reported age-differentiated findings—such as behavioral, cognitive, or technological usage patterns—across distinct older age groups. Using this categorization, we applied a stepwise refinement approach. The first set of studies offered emergent insights into technology preferences and behaviors across age groups. These preliminary patterns were then validated, refined, or contrasted using the more cohort-focused studies in the second group. Through this progressive refinement approach, key themes emerged, highlighting both commonalities and differences in technology use across aging cohorts.

In addition to the discovery of themes, this study also incorporated contextual analysis of the selected papers with respect to their geographical distribution, theoretical frameworks, and methodologies used. The inclusion of these elements in the review increases the rigor of the study and makes it easier to identify current research gaps. This analysis approach is illustrated in Figure 2 below.

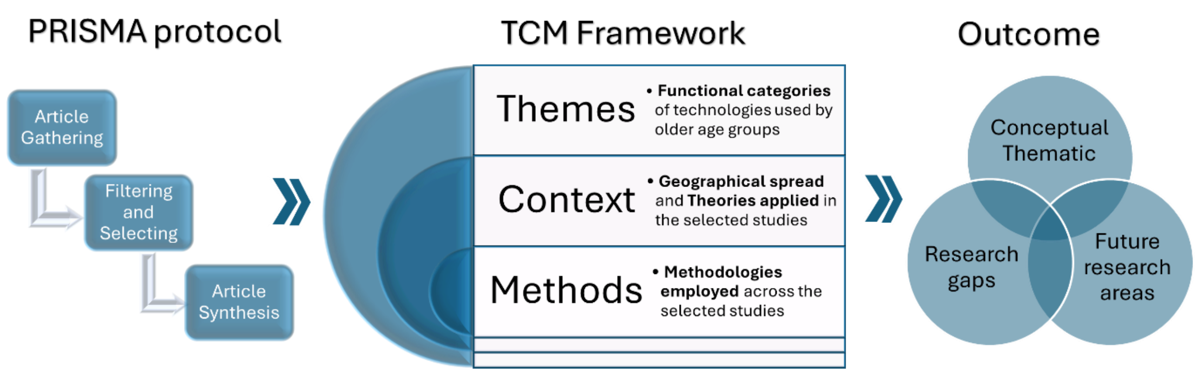

Figure 2. TCM Based Analysis Approach (Author's own creation)

3 Key Findings

This section aims to develop a conceptual thematic model that visually depicts the technological preferences of different older age cohorts using a deductive approach. It begins by defining each older age cohort in Section 3.1. Section 3.2 introduces a keyword co-occurrence network derived from the shortlisted studies, offering an initial visual representation of the associations between technologies and aging cohorts. This foundation is further enriched through content analysis of the two categories of studies: those examining technology use among older adults broadly (Section 3.4), and those specifically addressing age cohort–based usage patterns (Section 3.5). Finally, Section 3.6 validates and integrates these findings through literature-based justification, ensuring the model's conceptual coherence and empirical robustness.

3.1 Overview of Older Adult Cohort Definitions

Older adults are commonly grouped into age-based cohorts, such as the "young-old" (ages 60–74) and the "old-old" (75+) (Hu & Xu, 2024). However, these classifications vary depending on factors like geographic regions, the time period of the study, or the specific focus of the research. For example, some studies define the young-old cohort as starting at age 65, while few others break the older population into further subgroups such as "mid-old" (70–80), "oldest-old" (85+), "octogenarians" (80–89), and "nonagenarians" (90+) (Carrick-Ranson et al., 2022; Deshmukh et al., 2024; Kodali et al., 2018). These categorizations highlight the differences in health, functional abilities, and care needs that come with ageing; although, the latter subgroups are less commonly used. While the terminology for these cohorts may differ between studies, they remain crucial for understanding how age affects technology usage, health interventions, and social participation (Loe, 2015; Schmidt et al., 2023).

This study has performed a comprehensive literature review that examined the historical shifts in age group classifications and regional health profiles. From this analysis, it has proposed cohort definitions that align with current research and reflect the diverse behaviors of older adults. This approach supports researchers and policymakers in developing strategies that are tailored to the unique needs of older adults. The proposed cohort definitions are based on a synthesis of existing literature and established gerontological practices and have incorporated recent trends alongside valuable past research. Key factors influencing these categorizations, as well as global approaches and regional variations, have also been considered. Priority was given to recent large-scale studies—both global or regional—to ensure that any adjustments to age thresholds are supported by internationally recognized research (Doucet et al., 2023; Rivera-Torres et al., 2021).

This study defines the following cohorts: The "young-old" (60–74) cohort, typically active and independent, is often still engaged in the workforce or social activities. The "old-old" (75+) cohort may begin to face health challenges and require more assistance with daily activities. Sometimes referred to as the "older-old", this group serves as a broad category that includes all subgroups within the 75+ age range. The "oldest-old" (85+) cohort is characterized by frailty, multiple health conditions, and a higher likelihood of needing long-term care, representing the oldest segment of the old-old category. Additionally, smaller subgroups such as the "mid-old" (70–80), "octogenarians" (80–89), and "nonagenarians" (90+) are also explored to address specific health and lifestyle needs (Doucet et al., 2023; Jaul & Barron, 2017). However, due to the limited number of studies on these smaller cohorts, which offer fewer insights for this research, the primary focus is on the young-old, old-old, and the oldest-old groups. These are the most widely recognized and studied age categories in contemporary gerontological research. Smaller cohorts are still considered when their insights contribute meaningful context or suggest future research directions.

3.2 Keyword Co-Occurrence Network

The co-occurrence network diagram, shown in Figure 3 below, is generated by performing network analysis of all keywords extracted from the selected research articles. It visually depicts the relationships between technologies and aging cohorts based on keyword frequency and co-occurrence patterns. This serves as a foundational step in exploring cohort-technology associations and provides a preliminary analytical baseline. The insights derived from this visual analysis are further examined and validated through the content analysis in subsequent sections, allowing for refinement in the development of the final conceptual thematic model.

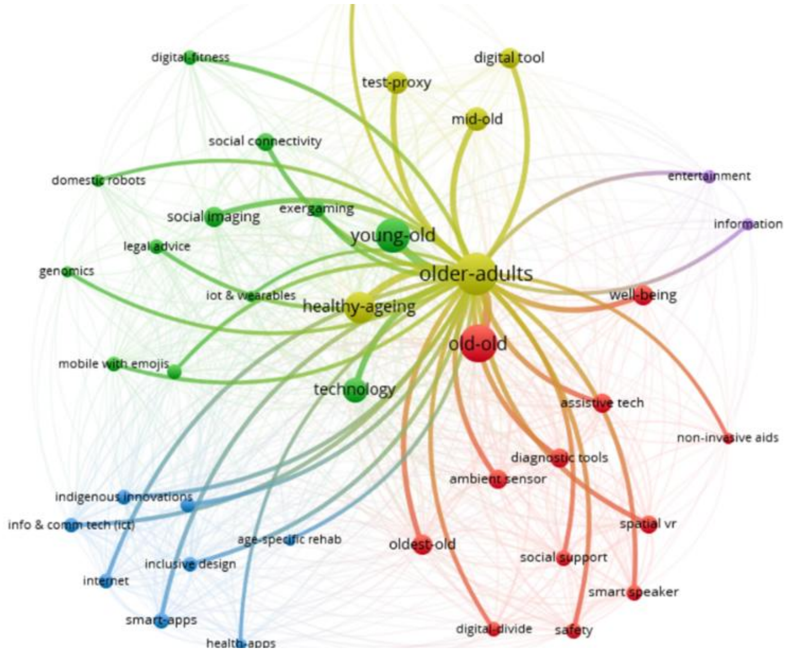

Figure 3. Keyword Co-occurrence Network (Vosviewer Output)

3.3 Thematic Framework and Empirical Basis

The research landscape on technology use among older adults is varied and context-driven. To make sense of this diversity, we propose a thematic framework comprising three primary themes, grounded in earlier research and insights from the reviewed studies. The themes—Health and Wellbeing, Community and Connectivity, and Lifestyle and Convenience- reflect common patterns in how different older age groups use technology, what they use it for, and what they hope to gain from it.

Several prior research studies have classified technologies used by older adults through varied lenses. Some have done so based on *device-function pairings*, such as smartphones for communication or health tracking (S. Lee et al., 2024; Mizrahi et al., 2025). Others have focused on *user segmentation*, for example, by levels of digital experience (Finkelstein et al., 2023); or by *specific use cases* such as health self-management applications (Garcia Reyes et al., 2023). *Design-oriented frameworks* have grouped technologies into categories like mobile apps, robots, sensors, and wearables (Mannheim et al., 2023), while *attitudinal models* have addressed the psychological engagement and motivational factors associated with technological use (L. Lee & Maher, 2021). *Structured taxonomies* such as the *SMART categorization* (Rybenská et al., 2024) and *IADL-based frameworks* (Arioz et al., 2024) provide functional classifications rooted in daily living and care needs. Other models, including the *Technology Experience Profile* (H. Liu & Joines, 2020) and *Quality of Life Technologies* (Kanade, 2012)**,** emphasize the affective and experiential aspects of technology use.

Based on the frameworks and patterns found through keyword co-occurrence (Section 3.2) and content analysis (Sections 3.4 and 3.5), we grouped the identified technologies into three main themes: “Health and Wellbeing”, “Community and Connectivity”, and “Lifestyle and Convenience”. These themes reflect the key life domains that are commonly explored in aging-related technology research and highlight how older adults use technology to improve their quality of life. For instance, “Health and Wellbeing” incorporates models of health self-management and the SMART categorization; “Community and Connectivity” draws on the device-function pairing and design-oriented framework; and “Lifestyle and Convenience” includes technologies that support daily living, such as IADL functions and quality-of-life enhancements. This structure enables more precise cross-cohort comparisons and supports the development of more targeted insights, as outlined in our research questions**.**

3.4 Technological Themes Among Aging Cohorts

This review reveals multiple technology solutions that impact different aspects of older adults' lives. To enhance analytical clarity, these technologies are organized into three overarching themes based on their functional roles and the capabilities they enable: *Health and Wellbeing*, *Community and Connectivity*, and *Lifestyle and Convenience*. The themes are illustrated in a conceptual model (see Fig. 4), highlighting areas of overlap in technology usage across different aging cohorts.

3.4.1 Health and Well-being

This category includes technologies designed to help older individuals' physical and mental health. Assistive-technology, Diagnostic-tools, e-Health, Cognitive-aid, Exergaming and Genomics are the notable examples. These technological solutions enhance the general well-being of the older adults by improving their health outcomes.

3.4.1.1 Assistive Technology

Assistive technologies (AT) include devices and aids designed to support the daily activities of older adults to enhance the quality of life. Its usage differs across age groups, depending on their health status and support needs. The oldest-old are the primary users of assistive technology due to their functional limitations (Schlomann, 2020a). Several successful examples include long-term care facilities utilizing smart wheelchairs and emergency call systems, as well as older adult housing in Europe incorporating grab bars and intelligent ramps to improve safety (Schmidt et al., 2023). While the oldest-old derive greater benefits from assistive technology due to their higher safety concerns, the young-old use it more selectively, viewing it as a supplementary tool (Robinson et al., 2013). However, broader usage of assistive technology among older adults is hindered by a lack of awareness regarding affordable options (Schlomann, 2020a). Lack of social support is another barrier, but family and community encouragement play a crucial role in overcoming it (Schlomann, 2020a). Notification-heavy assistive solutions can lead to technostress, particularly among the oldest-old; underscoring the need for user-friendly personalized designs (Caroux et al., 2020). Overall, the oldest-old group is the primary user of the assistive technology, and its broader usage requires creating awareness, providing social support, and building tailored solutions (Caroux et al., 2020).

3.4.1.2 Diagnostic Tools

The diagnostic tools offer quick and accurate health assessments through easy-to-access applications and play an essential role in older adults' lives. While this technology is increasingly utilized across all older adult age groups, addressing a wide range of health challenges (Newman et al., 2020; Özkaya, 2021); its usage is more pronounced in the old-old adults, who carry a greater risk of cognitive and functional decline (Champaiboon et al., 2023; M. Z. Chen et al., 2022; Papaliagkas et al., 2017). Diagnostic tools are key in identifying age- and sex-specific health declines, helping shape healthcare strategies across all older adult age groups (Bischoff-Ferrari et al., 2023; Y.-H. Liu et al., 2019). However, the old-old cohort derives greater benefit from a diverse range of easy-to-use tools enabling early detection of motor and cognitive declines (Vianello et al., 2017). This early detection facilitates timely planning, helping to sustain daily functioning and enhance overall quality of life (Walters et al., 2017). Overall, diagnostic technologies enable older adults to take a more proactive approach to their health, with the greatest benefits observed in the old-old cohort (E. Chung et al., 2023).

3.4.1.3 e-Health

e-Health refers to the internet-based applications for managing health and shows a significant variability in its usage across age cohorts. Factors such as age, education, socioeconomic status, and access to technology contribute to these differences, with the young-old—particularly those with higher education and better socioeconomic status—exhibiting higher usage (Ali et al., 2021). The young-old effectively use e-Health as a decision-support tool to manage multimorbidity, while its usage tends to be lower among older cohorts (Del Cura-González et al., 2022). Although a significant portion of older primary care patients regularly access the internet, only a small subset uses it to seek health information online, with the lowest usage observed among the oldest cohorts (Crabb et al., 2012). e-Health holds high potential to improve healthcare management across all age groups, particularly in emergencies, by providing diagnostic quality and advice comparable to that of general practitioners (Gilbert et al., 2020). However, barriers remain, particularly for the oldest-old, who face challenges related to cognitive decline, digital literacy, and access (Gilbert et al., 2020). Addressing these obstacles through tailored designs and improved digital literacy is essential for expanding e-Health's reach and effectiveness among older adults.

3.4.1.4 Cognitive Aid

Cognitive aid technology brings notable benefits for cognitive and mental health among older adults, while its benefits and usage patterns differ by age groups. The young-old use it for social conferencing and new information access; which enhances their cognitive health (F.-T. Chen et al., 2020). In contrast, the old-old use it less frequently and for specific purposes, such as seeking health information and engaging in cognitive games, which benefit their mental well-being (K. Wang & Kubanga, 2021; J. Xu et al., 2024). Regular use of electronic gadgets, more common among the young-old, contributes to slowing cognitive decline, especially when paired with physical activity (F.-T. Chen et al., 2020; J. Kim & Cha, 2021). For the old-old, this technology supports cognitive health mainly through social, leisure, and spiritual activities (Rivera-Torres et al., 2021). Technology-based entertainment has been shown to reduce depression and improve cognitive health in older adults, with the most significant benefits observed in the young-old (J. Kim & Cha, 2021). While less frequently used by the oldest-old, cognitive aid plays a key role in promoting cognitive health through leisure activities, religious practices, and physical exercise (K. Wang & Kubanga, 2021). In summary, tailored cognitive technological designs effectively support cognitive and mental health across all older age groups, emphasizing their potential for individuals of all ages.

3.4.1.5 Virtual Reality and Exergaming

Virtual Reality (VR) offers cognitive and motor benefits to all older adults, though its effectiveness varies across the age groups. Studies have found that all older age groups tolerate the non-immersive VR systems well, and report physical and cognitive benefits from its use (Bevilacqua et al., 2019). For the young-old, exergames improve their physical health and social engagement while playing with younger partners. In contrast, the older-old derive greater benefits from peer interactions, gaining enhanced social connections among gamers (X. Xu et al., 2016). This intergenerational engagement bridges the digital divide, demonstrating how VR can foster social bonds across age cohorts. In terms of physical benefits, VR-based exergame interventions show physical strength improvements in all age groups, though the young-old experience the largest gains (H. Lee et al., 2019). The older-old benefit from simplified visual feedback in VR, which aids spatial orientation and improves physical workout effectiveness, compared to immersive, full-body VR (Pastel et al., 2022). In VR use, young-old adults show the most pronounced improvements in motor and cognitive abilities, while the oldest-old require more time to familiarize themselves with the technology to fully benefit (Bevilacqua et al., 2019). Overall, VR provides healthy aging benefits across all older age cohorts, with larger benefits and higher consumption found among the young-old group.

3.4.1.6 Genomics

Genomics technologies hold significant promise for aging adults; though, their usage varies across age cohorts. Studies on DNA repair have identified key genetic factors influencing lifespan across all older populations (Y. J. Kim et al., 2018). The young-old demonstrate higher acceptance of genomics, likely due to greater familiarity, with literature supporting their openness to personal genomics (Mählmann et al., 2017; T. Nguyen et al., 2021). The older-old cohort hesitates in using the genomic technologies, primarily due to concerns about data privacy and the perceived reliability of results (Mählmann et al., 2016). Despite these challenges, this technology holds significant potential in detecting the ‘frailty biomarkers’ that enable early diagnosis and improve the quality of life of older adults (Pan et al., 2020). While accessibility and trustworthiness of the technology remain the key barriers, addressing these concerns is essential to ensure that the benefits reach all older age groups.

3.4.2 Community and Connectivity

Technologies in this domain facilitate communication and social interaction among older adults. Key examples are Mobile-technology, Social-media-and-Imaging and the Community-and-Service, which collectively support and enrich social engagement and well-being.

3.4.2.1 Mobile Technology

Mobile technology includes diverse handheld devices with embedded applications, which are widely used across older age cohorts to enhance social engagement and safety (Enwald et al., 2016). The usage patterns vary widely between the young-old and the old-old. The young-old use mobile devices creatively, by leveraging multimedia features to fulfil informational and leisure needs. They demonstrate greater proficiency with mobile technology, using it more frequently and for a wider range of functions (Loe, 2015).

In contrast, news and health apps, which provide informational and preventive content, are particularly popular among the old-old cohort and play a significant role in supporting their well-being (Gilbert et al., 2020). The oldest-old use mobile technology in a more basic manner, and their primary focus is on social connections and health purposes (Jang & Je, 2022). They face barriers such as limited digital literacy, health-related challenges, and usability issues, which are often mitigated through social support (Jang & Je, 2022). In summary, mobile technology serves a broad range of purposes for older adults. While all older adult age groups benefit from this technology, the old-old primarily use it for social and health-related purposes, whereas the young-old engage with it more creatively and innovatively.

3.4.2.2 Social Media and Imaging

Social media technologies, which facilitate social connections and self-expression, are used differently across older adult age cohorts. A large number of older adults prefer social media to maintain social connections, valuing its simplicity despite privacy concerns and a preference for brief interactions (Van House, 2015). The young-old cohort, with greater digital familiarity, and use social media more creatively, incorporating features such as emojis and multimedia to enhance social interactions (Loe, 2015). In contrast, the old-old also use social media regularly, but the use is more towards reducing loneliness and accessing health information, which improves their life satisfaction (Dworschak et al., 2024). However, the oldest-old engage with social media in a more limited way, favoring face-to-face interactions due to lower familiarity with technology (Van House, 2015). The use of social media for self-imaging — by shaping and promoting a self-image through content sharing — also varies across age groups. Older adults, particularly the mid-old, actively use TikTok to build and showcase a self-image through well-curated posts (Ng & Indran, 2023). This trend of using social media for self-expression mirrors the behaviors seen in other demographic groups, such as adolescents (Charmaraman et al., 2024). These findings highlight the varying usage patterns across older cohorts and reflect differences in technological comfort and the social engagement needs of each age group.

3.4.2.3 Community and Service

Virtual communities help older adults by reducing loneliness and providing important health information (Dworschak et al., 2024). For the oldest-old adults, particularly those who are physically frail and mentally vulnerable, this technology helps maintain important family connections and support networks, greatly improving their well-being (Fang et al., 2018). For the old-old adults living in residential care, communities help further to form interest groups, enjoy entertainment, and engage in hobbies, all leading to improved quality of life (Seifert et al., 2017). In contrast, young-old adults utilize a wider variety of digital community tools to perform a broader range of activities (Dworschak et al., 2024). Community service and social volunteering activities have a significant impact on the well-being of older adults, particularly the old-old (Neves et al., 2018). Studies find that the old-old cohort shows an interest in social and political issues and prefers to volunteer in these areas, leading to improvements in their physical, psychological, and cognitive health (Rudnik et al., 2020). In spite of chronic health issues, old-old adults are found to engage in volunteering through customized community platforms, thereby maintaining social connections and fulfilling a sense of purpose (Fang et al., 2018; Jaul & Barron, 2017). Overall, technology-supported community engagement and volunteering play a crucial role in enhancing the lives of older adults, especially the old-old, by strengthening social connections and contributing to community well-being.

3.4.3 Lifestyle and Convenience

This group of technologies includes Ambient-sensors, Domestic-robots, Self-driven-vehicle, Smart-speakers, and Legal-assistance technology. These technologies improve the quality of life of older adults by making daily life easier and more convenient.

3.4.3.1 Ambient Sensors

Ambient sensor technologies unobtrusively monitor physical activity and vital signs in older adults, offering significant benefits for proactive health management (Ganesan et al., 2019). Wearable activity trackers automatically detect health issues and enable timely interventions to avoid frequent medical visits (Saner et al., 2020). The perceived value of ambient technologies varies significantly across age cohorts. The oldest-old adults, who frequently face cognitive or sensory issues, find ambient haptic signals more beneficial than traditional maps and voice instructions (Cœugnet et al., 2018). When combined with behavioral change techniques (BCTs), such as goal setting and performance feedback, the ambient sensors significantly enhance the preventive health of the oldest cohorts (J. Y.-W. Liu et al., 2020). While the young-old typically engage more easily with BCTs, the older cohorts benefit from integrating the ambient sensors with simpler tools such as traditional pedometers, enhancing usability (J. Y.-W. Liu et al., 2020). Overall, while ambient sensor technology is beneficial to all older adults, it is essential for the oldest-old group due to its passive nature and ability to provide safety and security without requiring active user engagement.

3.4.3.2 Domestic Robots

Domestic robots assist older adults with daily tasks, aid rehabilitation, and boost their mobility. Studies show varied usage patterns across age cohorts. Robotic gait trainers are found to significantly improve walking capacity in older patients, particularly among the young-old, when they are used with personalized interventions (Maranesi et al., 2020). However, the oldest-old show limited acceptance of the technology, even with a tailored rehabilitation (Maranesi et al., 2020). Qualitative studies have highlighted distinct usage patterns of domestic robots - the young-old view them as tools for independence, while the old-old prefer human caregivers to supplement the robotic assistance (Poli, 2023). These findings emphasize the need for inclusive robot designs that meet the diverse physical, cognitive, and emotional needs of all older adults.

3.4.3.3 Self-driven Vehicle

Self-driving vehicles have the potential to enhance mobility and independence for older adults, but their design must incorporate age-specific approaches to meet the needs of different cohorts. The old-old adults exhibit slower response times than the young-old during simulated automated vehicle drives that require intermittent driver intervention (Li et al., 2021). Despite the age-related declines in reaction time and motor skills, all older age groups demonstrate willingness to use the technology. The young-old adults respond more favorably due to fewer physical limitations and greater comfort with new technologies (Isbel et al., 2022). In contrast, the old-old exhibit hesitation, reflecting skill concerns to interact effectively (Haghzare et al., 2021). Research highlights the need to tailor automated vehicle systems to accommodate the diverse needs of older adults (Trencher et al., 2024). Overall, the young-old cohort has demonstrated greater willingness to use self-driving vehicles, while the older-old cohort requires more tailored designs and targeted support.

3.4.3.4 Smart Speaker Ecosystem

Smart speakers, which are the voice-activated devices that perform tasks, play music, and control smart home functions, offer significant benefits for older adults, particularly by reducing loneliness and enhancing ease of use (Pradhan et al., 2019). Studies have highlighted the widespread use of smart speakers across the older age groups, with a notable reduction in social isolation, especially among the old-old and those living in long-term care facilities (Astell & Clayton, 2024). In contrast, the young-old use smart speakers more extensively for a broader range of functions such as home automation, information access, and entertainment (McCloud et al., 2022). However, older adults have also reported difficulties with formulating questions and managing the continuous, always-on nature of the technology (Pradhan et al., 2020). Despite these challenges, smart speakers are regarded as modern technologies useful to all older cohorts, due to their natural, voice-assisted interface (Pradhan et al., 2019). They also provide a sense of companionship, which results in reducing isolation in the oldest-old adults (O'Brien et al., 2020). This technology is identified as a prominent emerging trend due to its diverse potential in addressing the social and emotional needs of all older adult age groups (Astell & Clayton, 2024).

3.4.3.5 Legal Assistance

Legal assistance using technology is becoming increasingly important as older adults encounter more legal challenges. However, the usage of technology-based legal services varies significantly across age cohorts. Older cohorts use technology for legal assistance much less frequently than younger generations, with the young-old more likely to seek legal help online compared to their older counterparts (Denvir et al., 2014). This trend reflects the young-old cohort's greater familiarity and comfort with technology, making them more willing to explore online legal services. In contrast, the old-old cohort, which is more skeptical of this technology, uses the internet to search for offline legal contracts, rather than engaging with digital legal tools (Jenkins, 2008). While online legal systems and AI-based e-justice services are rapidly developing (Stockdale & Mitchell, 2019), the old-old group remains disengaged, due to their preference for face-to-face interactions and deeper cultural resistance to technology (Denvir et al., 2014). Thus, the development of legal technologies should account for these age-specific challenges to ensure broader acceptance and use across all older age cohorts.

3.5 Theme Validation Through Age-Cohort Studies

This section performs analysis of the second category of studies, which focus on technology's impact on individual age cohorts, to validate and further refine the previously identified themes. These age-cohorts include: the Young-old (60-74), the Mid-old (70-80), and the old-old (75+), along with its age-based subsets such as the Oldest-old (85+), the Octogenarians (80+) and the Nonagenarians (90+). The findings below are categorized by age-groups of the studies, as listed in Appendix C.

The young-old cohort (ages 60-74) exhibits early signs of aging, but maintains higher activity levels and greater independence than the old-old cohort (Jang & Je, 2022). Though this cohort shares common concerns like social isolation and loneliness with other older adults, it benefits more from improvements in digital literacy and social engagement, which boost their mental well-being (F.-T. Chen et al., 2020). Technology plays a crucial role in their lifestyles, through the frequent use of e-health services, mobile devices, social media, and digital community platforms, all of which enhance information access and support cognitive well-being (Jang & Je, 2022). Young-old adults participate in technological pilots such as the modern wearable aids (Verrusio et al., 2017), advanced rehabilitation programs (Lucertini et al., 2019), preventive diagnostic trials (Schütz et al., 2019), and the well-being initiatives (Gouveia et al., 2018). Beyond the initial participation, the young-old actively consume emerging technologies, including Genomics, robotic gait trainers, and online legal services (Bevilacqua et al., 2019; Denvir et al., 2014; Maranesi et al., 2020). This cohort also shows willingness to engage in adventurous technology experiences, such as the self-driving vehicles (Li et al., 2021) and the exergames (H. Lee et al., 2019), to gain cognitive benefits. Their active participation in social platforms like the TikTok and self-expression with innovative emojis reflect their desire to redefine societal perceptions of aging (Ng & Indran, 2023). Overall, the young-old cohort's receptiveness to technology underscores their openness to improving the quality of life. This analysis is consistent with the technological trends observed in the previous section.

The middle-old cohort (ages 70-80) is viewed as a transitional group and serves as an experimental population to predict the oldest cohorts' response to new technologies. This cohort demonstrates a blend of behaviors and interests from both the younger and older age groups. This is evident in various studies; for example, examining leisure and recreational activities for mental health benefits (Rivera-Torres et al., 2021), dance-based programs to improve balance and psychosocial well- being (Federici et al., 2013), and virtual biking with augmented gaze, designed to enhance visual exploration (de'Sperati et al., 2023). Few studies have also highlighted unique behavioral patterns in the middle-old cohort; such as active content creation about positive self-portrayal on social media (Ng & Indran, 2023). Overall, the middle-old cohort plays a key role in the introduction and testing of new technologies for older adults. Understanding this transitional role helps to tailor technology to better serve the needs of both the younger and older cohorts. This analysis aligns with the technological trends observed in the previous sections.

Studies involving the old-old cohort, include older adults aged 75+, along with subgroups such as the Oldest-old (85+), the Octogenarians (80-89), and the Nonagenarians (90+), and highlight the growing digital divide along with its impact on their technology use (Lu et al., 2022). Health challenges, cognitive decline, depression, and loneliness are the defining characteristics of the old-old cohort, which lead to their reduced use of technology (Vargas et al., 2017). This cohort uses technology to stay connected socially, increase comfort, support independence, and favors solutions tailored to their specific needs (Loe, 2015; Rudnik et al., 2020). The group shows a strong tendency toward diagnostic and proactive health practices (Champaiboon et al., 2023) and finds smart speakers particularly effective in addressing companionship needs among the most socially isolated (McCloud et al., 2022). Additionally, they embrace technology that promotes civic engagement and volunteering services, which enhances their self-image and well-being (Rudnik et al., 2020). The oldest-old subgroup within this cohort demonstrates the lowest technology usage; however, it embraces technologies enhancing safety, mobility, and independence, such as the assistive devices, environmental sensors, and non-intrusive health technologies (Y.-H. Liu et al., 2019; Manias et al., 2019). When faced with more complex technologies, they often rely on family members for support (Rudnik et al., 2020). While they recognize the importance of technology for healthy aging, significant barriers, such as the fear of falling, and lack of trust persist, particularly among the Octogenarians and the Nonagenarians (Carrick-Ranson et al., 2022; K. J. Miller et al., 2020). They favor a 'comfortable aging' approach, prioritizing non-invasive technologies, balance, and control over excessive medical treatments and life extension (Erikson, 2013). Overall, the old-old cohort prioritizes preventive diagnostic tools and community services that boost independence and healthy ageing. The oldest-old cohort exhibits a preference for assistive and ambient non-invasive technologies for comfort and end-of-life care (Kodali et al., 2018; Loe, 2015; Vargas et al., 2017). These patterns are consistent with the technological trends identified in the previous sections.

3.6 Conceptual Thematic Model

This section presents a conceptual thematic diagram (see Figure 4 below) that provides an overview of the trends of technology usage across different age cohorts. The formulation of this is based on the themes and technological trends that surfaced from the analysis in the prior sections.

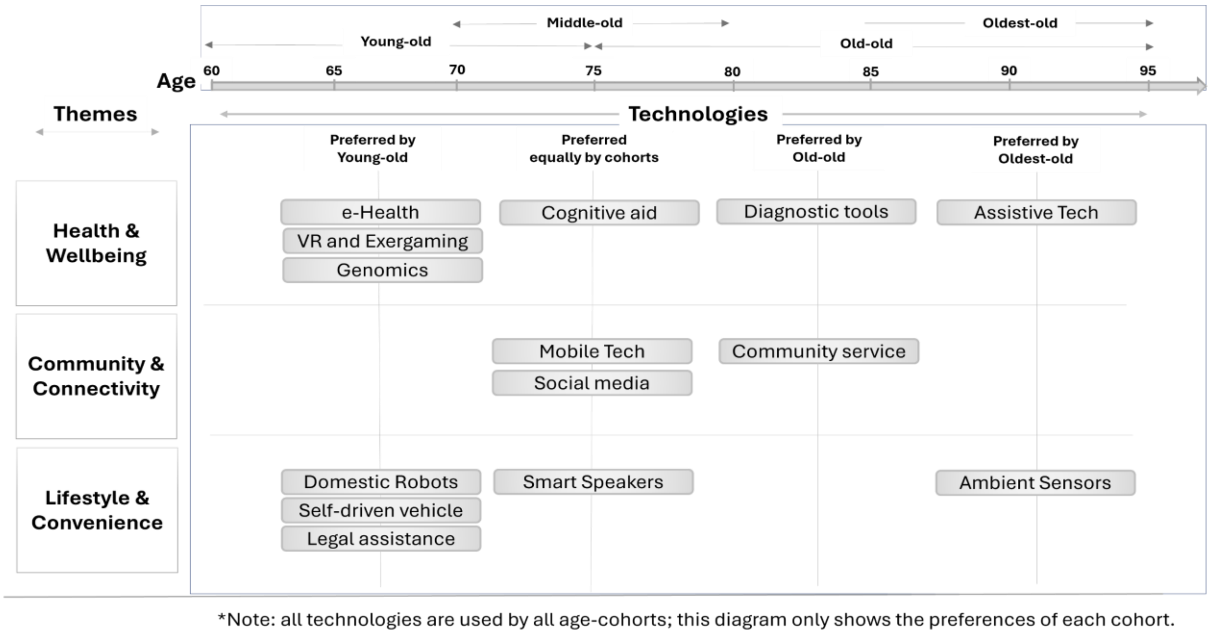

Figure 4. Conceptual Thematic Model (Authors' own creation)

As illustrated above, while all technologies are used across age cohorts, the vertical axes serve as reference points indicating the dominant preference of each cohort. The canvas features four vertical axes, each corresponding to the midpoint of a specific cohort's age range. For instance, the axis labelled "*Preferred by Young-old*" is placed at age 67, representing the midpoint of the Young-old age range (60-75). The axis for "*Preferred equally by all cohorts*" is set at age 75, marking the intersection of the Young-old and Old-old cohorts, thus symbolizing broad applicability across older adults. The "*Preferred by Old-old*" axis is positioned at age 83, the midpoint of the Old-old age range (75-90+), while "*Preferred by Oldest-old*" is set at age 92, approximating the midpoint of the 85-100 age span (assuming age span of 100 only for representation). Technologies are plotted along these axes based on their predominant use across older age cohorts. Those favored by the young-old are positioned along the axis at age 67, those preferred by the old-old near age 83, and those used most by the oldest-old near age 92. Technologies widely adopted across all older cohorts are placed along the central axis at age 75.

The three technological themes are listed on the left side of the diagram. Based on the content analysis detailed in Sections 3.4 and 3.5, technologies have been grouped under these themes to better reflect their intended purpose and benefits.

The "Health and Wellbeing" theme encompasses technologies aimed at supporting both physical and mental health. This includes Assistive Technologies for home modifications, which are particularly suited for the oldest-old cohort, and Diagnostic Tools for preventive health management, which are more commonly utilized by the old-old cohort. It also includes Cognitive-Aid technologies, widely used across all older adults, providing essential physical and cognitive support. Other technologies under this theme-such as e-Health platforms for online health and fitness, Exergaming for simulated physical engagement, and Genomics for genetic and biotechnical advancements—are more advanced and internet-based. These are primarily favored by the young-old cohort due to their novelty and the higher digital literacy they require. The "Community & Connectivity" theme focuses on technologies that support social engagement among older adults. This includes Mobile technologies and Social Media Platforms, which facilitate interaction and are widely used across all older age cohorts. Additionally, this theme encompasses Community Service enabling technologies that support the old-old cohort in forming social groups and engaging in volunteering activities. The final theme, “Lifestyle and Convenience,” focuses on technologies designed to simplify the daily lives of older adults. This includes Ambient Sensors for unobtrusive environmental monitoring, which are especially beneficial for the safety of the oldest-old cohort. Smart Speakers enabling voice-activated home automation are widely popular across all older age groups. This theme also includes Domestic Robots for household tasks, Self-Driving Vehicles, and Legal Assistance Technologies - particularly favored by the young-old cohort due to their novelty, autonomy, and strong alignment with the practical needs and everyday contexts.

The middle-old group serves a transitional role in introducing new technologies to the older-old cohort. The Octogenarian and Nonagenarian subsets represent narrower age ranges within the old-old cohort. These four subgroups are not explicitly depicted on the canvas due to limited distinct insights in the selected literature.

Comparing the findings from the network analysis (Section 3.2) with those from the content analysis (Sections 3.4 and 3.5) reveals several alignments in technology categorization. Notably, the network analysis grouped technologies more broadly across the Young-old and Old-old cohorts. Technologies such as Exergaming, Genomics, Domestic Robots, and Legal Advice aligned predominantly with the Young-old cohort, whereas Assistive Devices, Diagnostics, Community Support, and Ambient Sensors were associated with the Old-old cohort. These categorizations demonstrate consistency between both analyses. However, some discrepancies emerged in the technology alignments. For example, health apps were categorized in the network analysis as relevant to all older adults, whereas the content analysis indicated a stronger association with the Young-old cohort. This alignment is further supported by existing literature (Ahmad & Mozelius, 2022; X. Wang et al., 2019). Similarly, Social Connectivity technologies, Smart speakers, and Wearables (referred to as Ambient Sensors in content analysis) were grouped in the network analysis as primarily used by the Young-old cohort. However, recent literature (Balki et al., 2022; Choukou et al., 2021; McCloud et al., 2022) confirms that these technologies are also widely used by the Old-old cohort. Therefore, they have been appropriately positioned in the proposed conceptual thematic, consistent with the content analysis. Self-driven vehicles did not emerge in the network analysis due to insufficient keyword data in the reviewed studies.

This matching exercise validates the proposed thematic model and reconfirms the robustness of the technology categorization process. The model effectively highlights the distinct technological needs across aging cohorts and provides a framework to tailor technologies that better address the practical requirements of the aging population.

The following table provides a simplified summary of technological preferences across the different older age cohorts.

Table 1. Technological Preferences Amongst Older Age-Cohorts

Cohort	Sub-Cohort	Technological Preference of the Cohort	Key References
Young-old (60-74)	no sub-cohort	1. **e-Health** (internet-based apps, accessed via gadgets to monitor and manage health) 2. **VR and Exergaming** (simulated exercise training with spatial benefits and cross generational collaboration) 3. **Genomics** (technology to detect frailty biomarkers for early diagnosis and repair) 4. **Legal assistance** (access to legal knowledge online and automated legal advice systems) 5. **Domestic Robot** (Tech-substitute to human support for daily tasks and rehabilitation) 6. **Self-driven vehicles** (helps gain independence by enhancing mobility)	(Ali et al., 2021) (Pastel et al., 2022) (Mählmann et al., 2016) (Wong et al., 2012) (Denvir et al., 2014) (Maranesi et al., 2020) (Li et al., 2021)
Middle-old (70-80)	no sub-cohort	The cohort serves as an experimental transitional group to test modern technologies before they are introduced to the older-old. However, due to the lack of sufficient independent studies, no separate consideration is given to this cohort in the thematic diagram.	(Federici et al., 2013; Ng & Indran, 2023; Rivera-Torres et al., 2021)

Old-old (75+)	Old-old (pre-oldest)	1. **Diagnostic** (facilitate early detection of functional decline to help proactive prevention) 2. **Community & Service** (virtual groups to reduce loneliness, share advice & offer service to society)	(Bischoff-Ferrari et al., 2023) (Rudnik et al., 2020)
	Oldest-old (85+)	1. **Assistive Tech** (devices and smart features to increase safety, mobility and assist with daily tasks) 2. **Ambient Sensor** (unobtrusive devices to auto-detect and respond to environmental changes for safety and security)	(Cœugnet et al., 2018; Schmidt et al., 2023)
	Octogenarian (80-89)	Although part of the oldest-old, this group has very few independent studies. They tend to prefer non-invasive tech and exergaming to maintain independence, aligning overall with the finding for Oldest-old	(Carrick-Ranson et al., 2022; Kodali et al., 2018)
	Nonagenarian (90+)	Although part of the oldest-old, this group has very few independent studies. They tend to prefer tailored technologies focused on health benefits, aligning overall with the finding for the Oldest-old	(K. J. Miller et al., 2020)
Cross Cohort preference	Tech used commonly among all cohorts	1. **Mobile Tech** (modern handheld devices to enhance social engagement, health Mgmt., and safety) 2. **Social media & Imaging** (platforms to facilitate social connect, expression and image projection) 3. **Smart-speaker** (voice-activated Internet device to perform tasks, & control smart home features) 4. **Cognitive aid** (Tech based leisure, recreation, and activity to enhance cognitive function)	(Jang & Je, 2022) (Ng & Indran, 2023) (McCloud et al., 2022) (Rivera-Torres et al., 2021)

4 Contextual and Methodological Analysis

This section provides further analysis of the chosen studies from three distinct dimensions: geographical distribution, theories applied, and methodologies used in these studies. The goal is to increase the rigor of the insights gained and assist in the identification of research gaps and related future research areas.

4.1 Geographical Context

The geographical distribution of research on technology use among older adult cohorts reveals key regional trends in focus areas (see Figure 5). **Europe** leads with 42 studies, with emphasis on technology acceptance, cognitive health, and assistive technologies among ageing cohorts (Appendix D). Countries such as the UK, Switzerland, Germany, and Italy investigated how the ICT applications address loneliness, improve physical safety, and promote well-being across age cohorts (Del Cura-González et al., 2022; Seifert et al., 2017). The **Asia-Pacific** region, represented by 14 studies, has explored older age-specific differences in psychological well-being, digital inequalities, and social connectivity (Appendix D). For example, studies from China and Korea focused on mental health and functional assessments, while others examined how technology supports social engagement and intergenerational relationships among older age groups (Ali et al., 2021; Jang & Je, 2022). **North America** contributed 9 studies, highlighting technology use, health outcomes, and civic participation across different aging cohorts (Appendix D). US-based research, In particular, emphasized older adults' engagement in meaningful activities through technology, focusing on both young-old and old-old cohorts (Rudnik et al., 2020). The **Middle East** showed limited research, with only 2 studies examining the role of technology on health and cognitive functions among older adults. These studies primarily focused on the oldest-old cohort, investigating technology's potential to enhance cognitive health and overall well-being (Fallahnezhad et al., 2023; Özkaya, 2021). Other studies are individual, scattered investigations with less impact and are not specifically listed in Appendix D.

These regional variations mirror broader global trends. Developed countries tend to focus on advanced themes such as cognitive health and personalized interventions, having largely addressed issues related to digital access. In contrast, other regions are still grappling with foundational challenges, including basic technology adoption and social participation. The limited evidence base underscores the need for more targeted research on technology use across different aging cohorts in these regions.

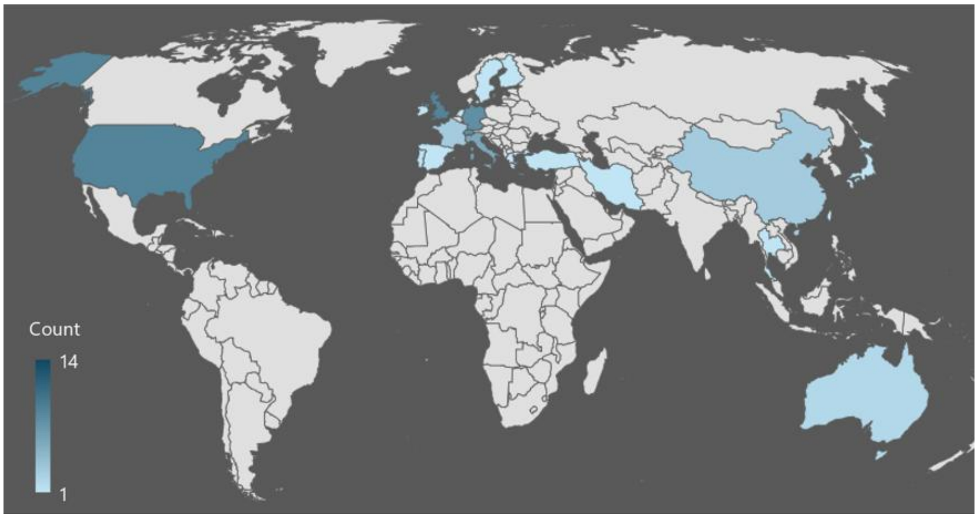

Figure 5. Geographical Distribution (Source: Metadata of Selected Studies)

4.2 Theoretical Context - Understanding the Cross-Cohort Usage Patterns

While the preceding sections outlined the technological preferences of different older adult cohorts, this section shifts focus to 'usage patterns'—the distinct ways in which these cohorts engage with similar technologies. These variations are best understood through theoretical frameworks applied in the reviewed studies. Within the corpus, ten studies utilized eight distinct theoretical frameworks. Some highlight cohort-specific technology preferences—like the oldest-old's focus on assistive tools (Heinz et al., 2013)— while others explain how and why similar technologies are used differently across age groups, reflecting differences in preferred features, perceived benefits, and ways of interaction.

The analysis of these frameworks plays a critical role in reinforcing a core contribution of the study, which is the identification of distinct usage patterns across older adult cohorts. While the content analysis revealed cohort-specific technology affinities, the theoretical analysis deepens our understanding of how and why similar technologies are used differently across age groups. As synthesized in Table 2, these frameworks collectively advance the field beyond surface-level observations by highlighting the psychological, social, and motivational factors that shape older adults' engagement with digital tools. For example, Life Course Theory (Heinz et al., 2013) and Socioemotional Selectivity Theory (Ng & Indran, 2023) reveal how shifting life priorities, from self-expression and exploration in the young-old to autonomy and emotional well-being in the old-old, drive differences in technology adoption goals. Symbolic Interactionism (Loe, 2015) and Person-Environment Fit Theory (Seifert & Cotten, 2020; Seifert et al., 2017) uncover how older adults align technology use with their self-concept, sense of dignity, and perceived abilities. While younger cohorts tend to embrace novel features, the oldest-old express ambivalence and prefer familiar tools. Diffusion of Innovation (Fernandez-Zubieta, 2021) and Social Identity Theory (X. Xu et al., 2016) explain how social influences on technology use vary by age, with the old-old depending more on peer-trust and familiarity, compared to the young-old. Finally, Digital Inequality Theory (Hargittai et al., 2019) clarifies how structural and skill-based barriers disproportionately affect the oldest-old.

Overall, Table 2 helps clarify how diverse theoretical lenses contribute to a more nuanced understanding of technology engagement among older aging cohorts. This synthesis offers valuable guidance for the design of cohort-sensitive technologies and policies, while strengthening the use of theoretical frameworks within the field to better capture the complex, cohort-specific behaviors by which older adults adapt to and derive benefits from digital tools.

Table 2. Theoretical Frameworks Used

Theory	Young-Old	Old-Old	Oldest-Old
Person-Environment Fit Theory (Caplan & Van Harrison, 1993; Seifert & Cotten, 2020; Seifert et al., 2017)	With better functional abilities, explore newer technology features.	Prefer simple, traditional features requiring minimal adjustment.	Rely on legacy functions or analog tools aligned with routine use.
Life-Course Theory (Elder et al., 2003; Heinz et al., 2013)	—	Reflect generational differences in addressing life-stage needs through technology.	Prioritize features that enhance independence and preserve human connection.
Technology Acceptance Model (TAM) (Cœugnet et al., 2018; Venkatesh & Davis, 2000; Wong et al., 2012)	Value features of smart health tools beyond the basic reminders, while focusing on utility and interface responsiveness.	Use is motivated by perceived usefulness in routine management; found medication reminders especially relevant.	Find vibrotactile navigation aids; supporting spatial orientation—most beneficial as they align with critical late-life needs.
Diffusion of Innovation (DOI) (Fernandez-Zubieta, 2021; Rogers, 1976; Seifert et al., 2017)	Less influenced by peers' usage of technology.	Prioritize user-friendliness as the primary driver of selection.	Usage spread mainly via peer diffusion.
Socioemotional Selectivity Theory (SST) (Carstensen et al., 1999; Ng & Indran, 2023)	Engage with contemporary platforms like TikTok for emotional well-being and self-expression.	Middle-old (entering old-old stage) use modern platforms like TikTok to promote positive aging and challenge stereotypes.	—
Symbolic Interactionism (Loe, 2015; D. L. Miller, 1973)	—	Show ambivalence toward complex devices; prefer tools aligned with self-concept.	Adapted everyday technologies to support autonomy and aging with dignity.
Digital Inequality Theory (Hargittai, 2007; Hargittai et al., 2019)	Advantaged due to stronger digital skills, leading to greater benefits from online engagement.	Experience declining benefits linked to weaker digital skills and shifting social roles.	Encounter compounded exclusion with limited chances to develop or use web skills.
Social Identity Theory (Tajfel & Turner, 2004; X. Xu et al., 2016)	Benefited more from intergenerational exergames boosting their sociability.	Preferred peer-based interactions, shaped by age-related stereotypes	—

Additionally, Table 3 below summarizes how technology use varies across the aging cohorts, based on the insights drawn from the theoretical analysis of selected studies. It highlights key motivations, levels of willingness, barriers, and usage modalities for each age group, offering a clearer understanding of diverse ways in which older adults engage with technology.

Table 3. Tech Usage Pattern Among Older Age Cohorts: A Theoretical Perspective

Focus area	Young-Old (60-74)	Old-Old (75-84)	Oldest-Old (85+)
Motivators of Technology Use	The young-old are more open to using tech, especially when it helps them stay independent and manage health. They also use tech for socializing and improving quality of life. For	The old-old group is also motivated by health needs and social connection but uses tech more selectively. They prefer user-friendly, easy-to-operate technology offering features – of	The oldest-old prioritize emotional and social benefits, using tech for managing health and maintaining relationships. They prefer simpler, familiar technology and rely heavily on

	example, playing exergames with younger individuals helps reduce social anxiety and increase sociability (Heinz et al., 2013; X. Xu et al., 2016)	demonstrability and ease-of-use. The focus is to improve quality of life and reduce isolation. ((Neves et al., 2018; Wong et al., 2012)	assistive and ambient tech to manage fragile health. They show ambivalence in accepting necessary treatments over complex medical tools (Neves et al., 2018; Schlomann, 2020a; Sims et al., 2016)
Willingness of Technology Usage	The young-old are more willing to adopt modern technologies, particularly those aligned with health and independence. Influencing factors include education, income, and technical affinity. They embrace innovation which align with their lifestyle (Seifert et al., 2017; Wong et al., 2012)	The old-old are less open to new tech but show interest when it supports health needs. Their willingness is influenced by their physical and functional status, as well as education. Resistance grows for those in living places of LTC especially with functional impairment (Schlomann, 2020a; Seifert et al., 2017)	The oldest-old tend to resist technology that seems complex or unfamiliar. They prefer traditional solutions and are more likely to resist if they feel technology could result in dependency. Willingness to adopt declines rapidly with increasing age, and tech complexity (Heinz et al., 2013; Yoo et al., 2021)
Barriers of Technology Use	The young-old group faces barriers like privacy concerns, technology complexity, and lack of awareness. However, their resistance is lower compared to older groups, and they are motivated to overcome these barriers for health and independence benefits (Heinz et al., 2013)	The old-old face stronger barriers, such as health limitations (cognitive/physical impairments), lower technical affinity, and privacy concerns. They require support or customization to use technology effectively (Schmidt et al., 2023; Seifert & Cotten, 2020)	The oldest-old experience the strongest barriers, including physical health issues, lack of digital literacy, and fear of dependency on tech. Resistance is also fuelled by the desire to avoid confirming stereotypes about their incapacity. 'Value and tradition barriers' play a major role here (Hargittai et al., 2019; Sims et al., 2016)
Modality of Technology Use	The young-old embrace a wide range of technologies and modalities, from smartphones to wearables, integrating health management and social connection tools. They are comfortable with various technology forms, like video calling, exergames, and health apps (Heinz et al., 2013)	The old-old group favours simpler, user-friendly tech such as simplified smartphones, health apps, and voice-activated systems. They prefer easy-to-use interfaces and less complex devices (Heinz et al., 2013; Neves et al., 2018)	The oldest-old prefer traditional simpler platforms using text messages, audio calls, voice notes and basic assistive tools. They prefer simpler devices like mobile phones with radio/video and avoid complex social media or apps (Hargittai et al., 2019; Neves et al., 2018)
Implications for the Future Research	Explore how young-old adults can participate in platform-enabled digital work (e.g., gig work) for purposeful post-retirement activity. Studies might examine how the personalized digital health tools can align with user's tech-affinity and self-management behavior (Ghosh et al., 2023; Swanson, 2024).	Research should focus on the inclusive, simplified designs that support autonomy without increasing cognitive load. Investigation into responsible tech use in chronic care contexts, particularly systems that can dynamically adapt to functional decline (Ho et al., 2019; McCarthy et al., 2020; Sjöström et al., 2024)	The oldest-old require assistive, emotionally supportive tech solutions that minimize operational complexity. Future studies should investigate how ambient and conventional technologies can be co-designed to reduce isolation, enhance chronic care support, and uphold users' dignity (Becker et al., 2022; Milovich et al., 2024)

4.3 Methodological Context

Based on our analysis, approximately 80% of the empirical studies (54 out of 81) employed the quantitative methods, including experimental interventions, while excluding review articles and report-based publications. In contrast, only 6 studies adopted qualitative approaches, and just 4 utilized mixed-method designs. Furthermore, fewer than half of the selected studies (19) employed a longitudinal design, with the remaining 43 relying on cross-sectional data. Table 4 presents a breakdown of these methodological choices across thematic domains relevant to the lives of older adult cohorts. While this summary is primarily descriptive, it underscores a significant methodological imbalance in the current literature. Given the unique dynamics of technology use among older age cohorts - particularly the gradual nature of their behavioral adaptation - there is a clear need for more longitudinal and qualitative research to capture behavioral shifts and resistance over time (Rudnik et al., 2020). Encouragingly, recent studies from countries with advanced aging policies- such as Japan, Switzerland, the Netherlands, Italy, and Portugal - demonstrate a growing preference for longitudinal and context-sensitive methodologies (von Humboldt & Leal, 2015; Iijima et al., 2021; Manias et al., 2019; Poli, 2023; Van Der Cammen et al., 2016). These developments offer promising models for future research in regions with diverse socio-economic and cultural contexts.

Table 4. Methodologies Used in Literature

Methodology	Technology Areas among ageing cohorts	References
Quantitative (29)	a) Technology utilization and influencing factors b) Barriers to use across age cohorts c) Health outcomes and chronic condition mgmt. d) Social engagement and loneliness e) Civic participation in advanced age f) Multimorbidity and medication management	(Schlomann, 2020a) (Neves et al., 2018) (Sims et al., 2016) (Fang et al., 2018) (Rudnik et al., 2020) (Del Cura-González et al., 2022)
Experimental Interventions (25)	a) Health mgmt. and psychological well-being b) Technology acceptance and usability c) Reducing isolation d) readiness for modern Tech across cohorts	(Ali et al., 2021) (Fang et al., 2018) (X. Xu et al., 2016) (Fang et al., 2018) (Li et al., 2021) (Van House, 2015)
Review articles (14)	a) Application of modern technologies b) Support for healthy aging c) Managing multimorbidity d) Focus on specific older adult cohorts	(Bürger et al., 2023; Cœugnet et al., 2017) (Federici et al., 2013; Sandberg et al., 2021) (Del Cura-González et al., 2022) (Lund & Wang, 2020)
Qualitative (6)	a) Cognitive function and mental well-being b) Social engagement and usage behavior c) Technology acceptance across age groups d) Comparative insights across aging cohorts	(J. Kim & Cha, 2021; Newman et al., 2020) (Ng & Indran, 2023) (Von Humboldt et al., 2022) (Seifert et al., 2017; Wong et al., 2012) (E. Chung et al., 2023)
Mixed-methods (4)	a) Contextual studies on care settings b) Digital exclusion and behavioral insights c) Preventive tools for geriatric issues	(Schlomann, 2020a), (Bischoff-Ferrari et al., 2023) (Lu et al., 2022) (Enwald et al., 2016)
Report (3)	a) Regional patterns in innovation use b) Health management in specific age groups	(Vargas et al., 2017) (Fallahnezhad et al., 2023; Lucertini et al., 2019)

5 Discussion and Future Research Avenues

The field of technology for older adults has evolved significantly, expanding its focus from Europe and the United States to a more global landscape. This shift reflects a growing recognition of technology's potential to enhance the quality of life for older adults across diverse cultural, social, and geographic contexts. Despite this progress, critical research gaps remain, especially concerning differences in technology acceptance and usage patterns among various older adult age cohorts.

A common limitation in the current research is the tendency to treat older adults as a homogeneous group, overlooking the age-specific variations in technology use. Although some studies focus on individual cohorts, they often do not compare or extend their findings across other age-cohorts. Moreover, systematic analysis of these cohort-level differences is scarce, limiting the broader applicability and generalizability of the findings. This study addresses these gaps by applying the TCM framework and PRISMA methodology to systematically review 81 high-quality articles published over the past 12 years, focusing on technology use across different older adult cohorts. By analyzing this body of research, the study reveals nuanced patterns of technological engagement among older adults, making a significant contribution to both theory and practice.

A key contribution of this study is the identification of two critical factors that influence how older adults across different age cohorts engage with technology. The first is the **technology affinity**, where certain cohorts demonstrate a stronger preference for technologies that closely align with their specific needs. The second pertains to **differences in usage patterns**; - although multiple cohorts may use the same technologies, they interact with them differently, prioritizing different features, expecting varied benefits, and favoring different modes of interaction. By highlighting these cohort-specific distinctions, the study provides valuable insights for technology developers, service providers, and policymakers seeking to design more targeted and effective interventions. Understanding why certain age groups adopt or avoid specific technologies enables the creation of tailored, age-appropriate strategies that enhance acceptance and promote greater social inclusion. For the field of Information Systems, this research marks a significant step toward deepening our understanding of age-related influences on technology acceptance, ultimately guiding future technology development, policy-making, and the design of user-centered solutions for older adults.

This study not only addresses critical gaps in understanding technology use among older adults but also lays the groundwork for several important future research avenues. It offers forward-looking ideas based on the identified patterns of technological affinity and behavioral differences across older age cohorts. These include exploring healthy aging through age-transition ecosystems and companionship technologies tailored to specific age groups, as well as promoting societal collaboration through cross-generational platforms and multi-generational housing models.

In addition, the study calls for greater attention to the geographical context, emphasizing the need to compare technology use across urban and rural settings while considering cultural and societal factors that influence technology acceptance among the different older age cohorts. Theoretically, it highlights the value of incorporating underexplored frameworks such as *Uses and Gratifications* and *Attachment Theory* to better understand companionship behaviors among older adults. It also proposes *Frugal Innovation* Theory as a valuable lens for addressing the socio-economic and physical constraints faced by digitally excluded seniors. Methodologically, the study identifies the need for more qualitative and longitudinal research approaches, which are well-suited to capturing the lived experiences and evolving needs of older populations.

5.1 Implications of Findings

The findings of this study hold important implications for business strategy, policymaking, and broader societal engagement, especially in the context of rapidly aging populations.

From a business management perspective, organizations should prioritize inclusive design and customized technological solutions that reflect the diverse needs of older adult cohorts (Milovich et al., 2024). For the old-old demographic, emphasis should be placed on simplified, user-friendly interfaces, while the younger-old may be more receptive to innovative modern features. Tailored marketing strategies that align with the values, motivations, and capabilities of each age group can improve technology usage. In addition, businesses are encouraged to develop cohort-specific training and onboarding programs to facilitate smoother adaptation to digital tools.

From a policy standpoint, governments play a pivotal role in fostering environments that support inclusive technological innovation. This can include fiscal incentives such as tax rebates or grants to encourage the development of age-friendly technologies tailored to diverse aging cohorts. Additionally, policies that ensure strong privacy protections and provide personalized support mechanisms-particularly for the old-old, can build greater trust and facilitate more active engagement (Ehrari et al., 2020). Investments in public education and community-based programs are also essential for promoting digital literacy and encouraging participation in technology co-creation. Such initiatives are especially important for empowering the oldest cohorts, who are most at risk of digital exclusion.

At the societal level, the development of personalized, context-aware technologies can significantly enhance the quality of life for older adults. Greater digital engagement can support health self-management, increase day-to-day convenience, and strengthen social connectedness (Ncube et al., 2023). Technologies that enable interaction among peers and with younger generations play a vital role in reducing social isolation and fostering a sense of community belonging.

Overall, the findings highlight the need to translate research insights into practical, inclusive solutions that advance digital equity and foster social integration among older populations.

5.2 Research Gaps and Future Research Avenues

Despite growing scholarly attention on technology use among older adults, several critical gaps remain—particularly in advancing cohort-specific understanding. These include gaps within previously identified technology-based themes, as well as limitations in current research methodologies, theoretical frameworks, and demographic inclusivity, underscoring the need for a more focused research agenda.

5.2.1.1 Future Research Avenues Based on Technological Affinity and Behavioral Patterns

We summarize these into three key categories—Healthy Ageing, Societal Collaboration, and Innovation Potential—emerging from our synthesis of thematic patterns and theoretical framings discussed earlier. These categories capture the core dimensions through which older adults engage with technology: maintaining personal well-being, strengthening social connections, and navigating change through adaptive use. Within each category, the goals and modes of technology engagement vary distinctly across different age cohort. Focusing on these categories provides a clearer overview of how older age-groups use technology and helps identify promising opportunities for future research. Table 5 below provides more details of these future research categories.

Table 5. Future Research Categories

Category	Key areas, current insight and future research needs	Res-Questions and References
Healthy-ageing	The concept of healthy aging varies across older age cohorts as priorities and technological preferences evolve with age (Milovich, Jr. & Burleson, 2020). For the young-old, it centers on maintaining physical health, cognitive ability, and an active independent lifestyle (Mount et al., 2016). In contrast; old-old focus more on existential concerns, such as finding a sense of purpose (Sims et al., 2016), while the oldest-old prioritize simplicity and ease-of-use, favoring unobtrusive technologies (Schmidt et al., 2023). While older-adults are generally open to using technology; these cohort-specific distinctions underscore the need for tailored interventions (Srivastava & Panigrahi, 2019). This marks a shift from traditional "successful aging" model to a personalized concept of "comfortable aging"; emphasizing autonomy in health and end-of-life decisions (Loe, 2015). Future research on healthy aging must adopt approaches catering to the unique needs and preferences of each age cohort. **(Age Transitionary Ecosystem: applicable to all age-cohorts)** Emerging research can focus on creating a 'multi-technology domestic environment' to address the evolving needs of older adults as they transition between ages (Arioz et al., 2024). This environment integrates technologies useful to each cohort, from smart home devices and health apps for the young-old, to ambient sensors for the older-old, and legacy tools like radios for the oldest-old (Mendoza-Holgado et al., 2024). The design incorporates 'personal-environment fit' (PEF) and 'life course' (LCT) theories to guide technology selection based on age, traits, and life-stages (Schmidt et al., 2023). PEF's 'needs-supplies fit' and 'demands-abilities fit', along with LCT's environmental and social factors, can help identify technologies that promote autonomy and acceptance. Aim is to support daily living, maintain independence, and delay nursing home relocation. Further research should explore how healthcare and urban planning innovations can enhance this ecosystem, promoting age-friendly cities and active aging (Iijima et al., 2021; Milovich et al., 2024). **(Companionship with technology: applicable to the Oldest-old)** An emerging area of research is technology's role in providing companionship. Smart speakers, popular across age groups for their hands-free interface and smart-home features, have been shown to reduce loneliness in the oldest-old by providing a sense of presence and control (McCloud et al., 2022). Future research should explore their companionship potential, as emotional well-being may be more significantly impacted by companionship than social support (Rook, 1987). Attachment theory, traditionally applied to human and animal bonds (Meehan et al., 2017), could further explore the impact of smart speakers on emotional well-being.	How can "person-environment fit" and "life course" theories guide the design of adaptive smart technology environments for aging adults? (Ciuffreda et al., 2023; Tanniru et al., 2021) How can an integrated care ecosystem – combining smart healthcare and urban planning - support active aging in age-friendly cities? (Arioz et al., 2024; McNeil et al., 2022; Mendoza-Holgado et al., 2024; Sakurai & Kokuryo, 2018, 2018; Schmidt et al., 2023) How do smart speakers influence the emotional well-being of older adults, particularly the oldest-old, through their "companionship effect"? (McCloud et al., 2022; Meehan et al., 2017; Rook, 1987)
Societal collaboration	Collaborative technologies play a role in reducing loneliness, and enhancing life satisfaction by enabling knowledge exchange (Dworschak et al., 2024). Usage patterns vary by age cohort: the young-old use emojis	How do cross-generational collaboration platforms, like

	and multimedia creatively (Loe, 2015), the mid-old focus on social imaging (Ng & Indran, 2023), and the old-old use social media to counter isolation (Dworschak et al., 2024). These tools also foster intergenerational collaboration- for instance, Exergames reduce social anxiety in young-old adults when interacting with younger individuals, whereas the old-old prefer peer interactions (X. Xu et al., 2016). Contrary to common beliefs, older-old adults including the oldest-old actively use technology to volunteer to contribute socially, leading to better quality of life (Guiney & Machado, 2018; Neves et al., 2018). These insights underscore technology's role in promoting community engagement and social connection among older adults. **(Cross-generational collaboration platforms: for the Older-old)** Providing opportunities for older adults to connect with younger generations and peers is crucial. Emerging platforms like 'GetSetUp' enable older adults to share knowledge and life lessons with younger individuals, fostering intergenerational learning (Centralina Blog, 2023). Symbolic Interactionism's concepts of 'role-taking' and 'meaning-making' offer insights into how these cross-generational interactions impact social dynamics, self-perception, and well-being. Future research should examine how these platforms reduce social anxiety and enhance sociability, particularly among the older-old (X. Xu et al., 2016). **(multi-generational community housing: applicable to all age cohorts)** The "age-friendly community-housing" initiative, such as the one supported by the Canadian government, promotes multi-generational co-living environments. Future research should explore the benefits and challenges of this model for different older-cohorts, with a focus on social connection and active aging (K. H. Choi & Ramaj, 2023). **(Post-Retirement Caregiving: more applicable to the Young-old)** Future studies should apply 'Symbolic Interactionism' to examine how caregiving roles differ between younger-old and older-old caregivers, focusing on how technology can address their cognitive, emotional, and physical needs in post-retirement social work (Yan et al., 2023). Additionally, 'Person-Environment Fit' theory can identify suitable part-time social service roles for the young-old. Study examining the role of digital health tools and online support networks in enhancing caregiving and encouraging volunteering across older cohorts (Atoyebi et al., 2022).	"GetSetUp", affect the well-being of older adult cohorts, and what impact do they have on younger generations? (Centralina Blog, 2023) What are the benefits and challenges of "multi-generational community housing" in fostering social connection and active aging across different older adult age cohorts? (K. H. Choi & Ramaj, 2023) How can "Symbolic-Interactionism" and "person-environment fit" theories guide older cohorts' engagement in volunteering and part-time social roles post-retirement? (Atoyebi et al., 2022; Swanson, 2024; Yan et al., 2023)
Innovation Potential	Young-old adults are more open to innovations such as genomics (Y. J. Kim et al., 2018), legal-tech (Denvir et al., 2014), and domestic robots (Poli, 2023). However, all older cohorts benefit from technology innovatively tailored to their abilities, such as haptic signals for city navigation (Cœugnet et al., 2017), ambient sensors paired with behavior-change techniques (J. Y.-W. Liu et al., 2020), and non-immersive VR systems with enhanced spatial orientation for better visibility (Pastel et al., 2022). Affordable, innovative solutions with tailored functions drive quicker adoption and improve quality of life across all cohorts, especially the oldest (Schütz et al., 2019; Wong et al., 2012). These findings highlight the broad impact of innovation and point to key areas for future research. **(Building Tailored Solutions: applicable to all older age cohorts)** Developing effective solutions for older adults requires integrating the life course perspective, inclusive design, and positioning theory. The life course perspective highlights how technology needs evolve with age	How can combining Life-Course and Positioning Theory with co-creation approaches support development of unified technology solutions tailored to diverse older adult age cohorts? (Willatt et al., 2024) How can "frugal innovation" leverage ordinary devices to develop cost-effective, sustainable

	(Heinz et al., 2013). Inclusive design involves older adults in co-creation, ensuring technologies address diverse needs (de'Sperati et al., 2023; Neves et al., 2018). Positioning theory examines how older adults shape their perceptions through technology interaction (Elliott & Carpentieri, 2020). Combining these frameworks aligns technology with changing needs across all cohorts, supporting a holistic, multi-perspective approach (Montuwy et al., 2019).	technologies that support independent living across older adult age cohorts? (Cevallos et al., 2023; K. Lee et al., 2023)
	(Frugal innovation: more applicable to the Oldest-old) Frugal innovation offers cost-effective solutions for supporting independent living. Recent studies highlight simple, customizable, inexpensive tools for daily activities helping the oldest-old to maintain independence (Cevallos et al., 2023), and open-source smart-home systems for autonomous remote care coordination (K. Lee et al., 2023). These approaches build on Loe's (Loe, 2015) foundational work showing how nonagenarians repurpose everyday technologies to maintain well-being. Future research should expand frugal innovation in gerontology beyond assistive and medical devices, aligning with the traditional values of the oldest-old and addressing the specific needs of developing countries and rural settings. **(Overcoming Innovation Resistance: applicable more to the Old-old)** Value/image barriers, technology anxiety, and technostress are significant obstacles for older adults, especially in the oldest age groups (H.-N. Kim et al., 2023). While solutions like training, social dialogue, inclusive workplaces, and 'aging in public' policies have been proposed (Seberini et al., 2022), learning interventions alone have shown limited effectiveness (Zhang et al., 2024). Improving technology features and leveraging social influence can further reduce resistance (Bae et al., 2021). Future studies should explore integrated approaches—such as 'Scenario Personarrative' co-creation (Sheahan et al., 2022), Actor-Network Theory (family/caregiver roles), Socioemotional Selectivity Theory (addressing emotional needs) and supportive public policies - to wholistically address the technological, social, and emotional needs of the old-old (Ciuffreda et al., 2023; McNeil et al., 2022; Tanniru et al., 2021).	How can Co-creation, Actor-Network Theory, aging in public policies and Socioemotional Selectivity Theory combine to create a social influence network that reduces innovation resistance among older adults, especially the old-old? (Mead & Neves, 2018)

5.2.1.2 Future Research Avenues Based on Geographical Context

Geographical context highlighted significant gaps in the research across diverse populations, particularly in comparing technology use between urban and rural areas globally, as well as among different age cohorts within these regions. While studies such as Schlomann (Schlomann, 2020b) and (Schlomann, 2020a) address some of these differences, more research is needed to explore how different geographies influence the technological use across age cohorts and healthcare access, especially in rural settings. Cultural context is crucial in shaping technology acceptance. Fang et al. (2018) suggest that cultural views on aging and technology vary by location, influencing the technological use. Further studies should investigate how these views differ across regions and affect the experiences of older adults within distinct age cohorts. (Jaul & Barron, 2017) set a valuable precedent by examining differences in the long-term health impacts of technology across diverse regions. This research direction should be further advanced through the multinational studies employing cross-cohort comparisons. (B. V. Nguyen et al., 2015; Seifert & Cotten, 2020) emphasized how urbanization, healthcare provision, and infrastructure variations contribute to the differing health outcomes and technology usage among older adults. Further research is needed to understand how these factors influence the health outcomes among aging cohorts across regions. Hu and Xu (2024) identified socioeconomic disparities in technology access in China, highlighting the need for similar studies in other culturally diverse countries. Additionally, Rudnik et al. (2020) explored how the local policies influence older adults' technological use for civic engagement. More research is required to examine the role of community resources and policies in shaping technological usage across different geographies and age groups.

5.2.1.3 Future Research Avenues Based on Theoretical Frameworks

As outlined in Table 2, while the established theories have been commonly used to study technology usage among older adult age cohorts, the emerging demographic nuances across aging cohorts remain under-theorized. Several lesser-applied frameworks offer new opportunities to investigate how the distinct older age cohorts differ in their engagement with technology. Social Cognitive Theory provides valuable insights into how cognitive processes of self-evaluation, goal-setting, and observational learning influence technology use among older adults (Oliverio, 2023). It is particularly suited to explain how the cognitive changes associated with aging (J. Kim & Cha, 2021) affect self-efficacy and technology adaptation differently across age cohorts, particularly when these processes are reinforced by the social support and inclusive design. Similarly, Adaptive Structuration Theory (AST) helps uncover how older individuals adapt to technology within the evolving social and environmental structures (Schmitz et al., 2016). Variations in adaptation among the age subgroups (Li et al., 2021) suggest the need to explore how the shrinking social networks and differing environmental affordances shape cohort-specific digital practices. AST surfaces micro-level adaptation dynamics that the broader frameworks like Actor-Network Theory (ANT) and Diffusion of Innovations (DOI) may overlook. Evidence also points to the promise of the frugal, low-cost innovations that cater effectively to the specific needs of the oldest-old (Bischoff-Ferrari et al., 2023; Kodali et al., 2018). However, this area lacks a cohesive theoretical foundation. Frugal Innovation Theory (Sarkar & Mateus, 2022) provides a relevant lens to understand how the resource-constrained, high-impact technologies can meet the unique socio-economic and physical limitations encountered by the older cohorts in the underserved settings. Recent studies have also noted how the smart speakers are increasingly adopted by older adults- particularly those having mobility or cognitive challenges; as the tools for companionship and daily assistance (Astell & Clayton, 2024) . The positive psychosocial outcomes reported (J. Chung et al., 2024; Pradhan et al., 2019, 2020) invite an exploration through the ‘Uses and Gratifications’ Theory and the ‘Attachment’ Theory, which can help explain the emotional connections and evolving trust in digital agents, particularly among the oldest-old who face social isolation. Srivastava and Panigrahi (2019) used a multi-theoretic lens to examine how ICT use promotes social participation by reducing loneliness and isolation among older adults. Introducing an age cohort perspective could reveal the differential effects across age-groups, while also uncovering the cohort-specific resistance factors, which is an area where the ‘Innovation Resistance’ Theory (Ellen et al., 1991) can offer valuable guidance for delivering targeted interventions.

Incorporating these theoretical perspectives can enable a deeper understanding of how the distinct aging cohorts perceive, adopt, or resist digital technologies. Doing so will support the development of more nuanced, age-sensitive strategies for technological design and policy.

5.2.1.4 Future Research Avenues Based on Methodologies Applied

Out of the 81 studies reviewed, the majority (54 or 67%) relied solely on the quantitative and experimental interventions (see Table-4). While quantitative methods provide the actionable insights, the unique characteristics of the older age cohorts highlight the need for qualitative research to gain a more nuanced understanding of their experiences, as emphasized by Poli (2023). Only 10 studies (12%) employed qualitative or mixed methods, underscoring the relative scarcity of research that captures the perceptions and lived experiences of older adults. Moreover, fewer than a quarter of the studies (19/81) utilized the longitudinal designs. Given that technology usage among older adults is a gradual, long-term process, more longitudinal studies are required. Such research would provide deeper insights into the ongoing evolution of technology use, including the role of social support and the long-term benefits for aging cohorts (Heinz et al., 2013; Newman et al., 2020). A stronger emphasis on both the longitudinal and qualitative approaches is essential to fully understand how technology evolves across different aging cohorts.

5.2.1.5 Future Research Avenues in the Less Focused Cohorts

This review identifies a significant research gap concerning the under-represented aging cohorts, particularly the oldest-old, nonagenarians, octogenarians, and middle-old adults (see Appendix C). Research on the oldest-old (85+ years) is notably scarce. While Robinson et al. (2013) and Sims et al. (2016) comprehensively explored the impact of the ICT and assistive technology on the well-being of this cohort, the subsequent research remains limited. Similarly, studies on octogenarians and nonagenarians (90+ years) are rare, with a limited number addressing their unique needs and behaviors compared to the other older cohorts (Robinson et al., 2013; Vargas et al., 2017). Research on the middle-old (70-80 years) is also limited, with scarce studies exploring their use of technology for chronic condition management

(Seifert & Cotten, 2020). More focused research on each of these aging cohorts is crucial for bridging these gaps, supporting the older adults at various stages of aging, and enabling various tailored technological interventions (Sims et al., 2016).

6 Conclusion

Technology has the potential to greatly enhance the quality of life for older adults. As the global population of older adults expands rapidly, understanding technology usage within this demographic is increasingly critical. However, much of the existing research treats this population as homogeneous, overlooking the nuanced differences among various aging cohorts or failing to apply findings consistently across different age groups.

This study addresses these gaps by providing critical insights into technology engagement among older adult age cohorts. Utilizing a systematic literature review, it analyzed 81 relevant articles from 64 journals published in globally recognized electronic databases. All included studies provided age cohort specific insights, ensuring that age-related differences within the diverse literature were meaningfully captured. The application of the TCM (Themes, Contexts, and Methodologies) framework enabled the identification of key themes, geographical contexts, and methodological approaches in the literature on technology use among older adults.

Our findings reveal several impactful themes influencing technology usage among older adult cohorts and highlight significant research gaps. Notably, most research is concentrated in regions such as Europe and the US, with less focus on the Asia-Pacific and Middle East regions, indicating a need for more research in developing nations. We also recommend integrating newer theoretical frameworks, such as Frugal Innovation and Attachment Theory, alongside more qualitative and longitudinal studies to better explore the dynamics of technology usage.

One of the key contributions of this study is the identification of the two key nuances in technology usage among older adult cohorts. First, it highlights the varying affinities of age cohorts toward specific technologies, with certain cohorts showing a stronger preference to technologies that address their particular needs. Second, the study uncovers distinct usage patterns across cohorts - while older adults may use the same technologies, they tend to engage with them differently- prioritizing different features, seeking varied benefits, and using diverse modes of access.

The study results in the development of a thematic model, which illustrates distinct technology preferences and usage patterns among older age cohorts, highlighting key groupings of technology use within these populations. This model serves as a foundational guide for future studies and encourages exploration of specific, previously uncovered areas in technology usage. By building this model, future research can better tailor technological solutions to meet the distinct needs and preferences of different older aging cohorts.

Declaration of AI

During the preparation of this work, the authors used ChatGPT only in the drafting process to improve the readability and language of the manuscript. After using this tool/service, all the authors reviewed the manuscript for accuracy and confirmed full responsibility for the content of the submitted article.

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Appendix A: Inclusion and Exclusion Criteria

Inclusion	**Description**
Incl-1	Research, Review articles, peer-reviewed, English language
Incl-2	Article published in open access or subscription-based journal
Incl-3	Technology used for/by the older adults is the central theme
Incl-4	Articles published during and after 2012
Exclusion	**Description**
Excl-1	Older adult cohorts are not considered
Excl-2	Technology consideration is missing
Excl-3	Subject matter of the article not very relevant
Excl-4	Study not fully complete and/or not yet Published

Appendix B: Search Keywords

Criteria	Search Keywords
Older adults belonging to any of the ageing cohort [A]	["old-old" OR "older-old" OR "Oldest-old" OR "young-old" OR "younger-old" OR "middle-old" OR “mid-old” OR "old ageing cohort" OR "old age Cohort"]
Study employs technology to support ageing adults [B]	[“Information and communication Technology" OR "ICT" OR "Digital" OR "Technology" OR "Tool" OR "APP"]
Study relates to adoption, acceptance or rejection of technology [C]	[“Adoption” OR “behavior intention” OR “intention” OR "Rejection" OR "Acceptance"]
Study helps improve the life of older adults [D]	[“Quality of life” OR "well-being" OR "self-efficacy" OR "Cognitive health" OR "Digital inclusion”]

Appendix C: Distribution of selected studies by age-group

Older-adults (age 60+) (45 studies)	(Ali et al., 2021), (Fang et al., 2018), (Hu & Xu, 2024), (Zhang et al., 2024), (Schmidt et al., 2023), (Enwald et al., 2016), (Bischoff-Ferrari et al., 2023), (Lu et al., 2022), (Maranesi et al., 2020), (F.-T. Chen et al., 2020), (Hargittai et al., 2019), (Y. J. Kim et al., 2018), (Doucet et al., 2023), (Bevilacqua et al., 2019), (Rivera-Torres et al., 2021), (J. Y.-W. Liu et al., 2020), (Papaliagkas et al., 2017), (Newman et al., 2020), (Poli, 2023), (Suzuki, 2018), (E. Chung et al., 2023), (H. Lee et al., 2019), (J. Kim & Cha, 2021), (Van Der Cammen et al., 2016), (Gouveia et al., 2018), (Ng & Indran, 2023), (X. Xu et al., 2016), (Dworschak et al., 2024), (Saner et al., 2020), (Seifert et al., 2017), (Schütz et al., 2019), (Wong et al., 2012), (Champaiboon et al., 2023), (Özkaya, 2021) (Castro et al., 2018), (Denvir et al., 2014), (Hazan et al., 2022), (Walters et al., 2017), (Li et al., 2021), (K. Wang & Kubanga, 2021), (Van House, 2015), (Crabb et al., 2012), (S. J. Czaja, 2016), (Heinz et al., 2013)
Young-old (age 60-74) (16 studies)	(Fallahnezhad et al., 2023), (Lucertini et al., 2019), (Verrusio et al., 2017), (Jang & Je, 2022), (Del Cura-González et al., 2022), (Belloni et al., 2021), (Federici et al., 2013), (Cœugnet et al., 2017), (Montuwy et al., 2019), (Cœugnet et al., 2018), (Gilbert et al., 2020), (Pastel et al., 2022), (Heilbronner & Münte, 2013), (Bürger et al., 2023), (Vianello et al., 2017), (Sandberg et al., 2021)
Old-old (Age 75+) (12 studies)	(de'Sperati et al., 2023), (Caroux et al., 2020), (Schlomann, 2020b), (Capanema et al., 2022), (Vargas et al., 2017), (Seifert & Cotten, 2020) (Manias et al., 2019), (Rodondi et al., 2012), (Astell & Clayton, 2024), (Loe, 2015), (Rudnik et al., 2020), (Y.-H. Liu et al., 2019)
Oldest-old (Age 85+) (4 studies)	(Schlomann, 2020a), (Marston et al., 2016), (Neves et al., 2018), (Robinson et al., 2013)
Octogenarians (age 80-89) (2studies)	(Carrick-Ranson et al., 2022), (Kodali et al., 2018)
Nonagenarian (age 90+) (1 study)	(Carrick-Ranson et al., 2022)
Middle-old (Age 70-80) (1 study)	(Deshmukh et al., 2024)

Note: Studies were included only if they contributed to the understanding specific older age cohorts—either by design or through findings that allowed cohort-specific insights to be drawn.

Appendix D: Context of geography in literature

Region	Technology Areas among ageing cohorts	References
Europe (42)	a) Technology Adoption and Use: ICT adoption challenges for aging cohorts b) Social Connectedness and Loneliness: Addressing loneliness and well-being. c) Assistive Technologies for Health and Safety: Enhancing health outcomes. d) Cognitive and Physical Health Interventions: Addressing health challenges. **e)** User-Centred Design and Co-Creation: Co-design for aging cohorts	(Seifert et al., 2017; Seifert & Cotten, 2020). (Dworschak et al., 2024; Schlomann, 2020b). (Cœugnet et al., 2017; Saner et al., 2020). (Del Cura-González et al., 2022; Gouveia et al., 2018). (Poli, 2023; Van Der Cammen et al., 2016).
Asia Pacific (14)	a) Psychological Well-Being and Digital Inequalities: Literacy, access, and well-being b) Technology for Mental Health and Social Connectivity: Enhancing mental health. **c)** Social Engagement and Intergenerational Relationships: Role of technology	(Jang & Je, 2022; K. Wang & Kubanga, 2021). (Denvir et al., 2014; Neves et al., 2018). (Ali et al., 2021).
North Americas (9)	a) Technology Use and Engagement: Factors influencing technology use. b) Health and Well-Being: Linking technology with health outcomes. c) Civic Engagement and Social Participation: Technology in civic participation d) Challenges and Barriers: Training, accessibility, and digital literacy	(K. Wang & Kubanga, 2021). (Y.-H. Liu et al., 2019). (Rudnik et al., 2020). (S. J. Czaja, 2016).
Middle East (2)	a) Health and Cognitive Function: Technology's role in health and cognitive functions	(Fallahnezhad et al., 2023; Özkaya, 2021).

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