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Creating Age-Friendly Environments in a Smart Society in China: A Policy Review

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ABSTRACT

Technology is increasingly being integrated into Age-Friendly Environments (AFEs). This study explores how technology is manifested in AFE policies in China. We conducted a content analysis of 176 policies spanning seven years to identify the relationship between technology and AFEs and the characteristics of policy development. The findings indicate that technology plays a role in advancing a smart age-friendly society, particularly in terms of enhancing community support and health services and promoting social inclusion. The findings also reveal a list of policy actions and changes in collaborative leadership and strategic priorities throughout policy development. This study emphasizes the need for ongoing policy attention to technology as an integrated component of AFE policies.

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KEYWORDS

Digital transformation; healthy aging; multisectoral action; policy development

Introduction

The World Health Organization (WHO) has emphasized that social, physical, and economic environments are critical determinants of healthy aging, shaping our opportunities to age in good health and well-being (World Health Organization, 2021). This underscores the importance of creating Age-Friendly Environments (AFEs) that can support and enable individuals of all ages to thrive and contribute to society. Developing an AFE is also one of the four action areas during the United Nations (UN) Decade of Healthy Aging, serving as a strategy to promote healthy aging defined as “the process of developing and maintaining the functional ability that enables well-being in older age” (World Health Organization, 2021). Various countries have been developing age-friendly policies and programs, implementing age-friendly practices, and establishing networks at national and subnational levels to improve the lives of older adults, their families, and communities.

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As seen in various countries, technology has increasingly become a vital component of AFEs. Technology has permeated various areas of contemporary society such as health and social care, civil services, housing and transportation, it can directly or indirectly affect the health, well-being, and quality of life of older adults, as shown in prior research (Honeyman et al., 2020; Sen et al., 2022). During the COVID-19 pandemic, the digital transformation has accelerated during times of lockdown, revealing a digital divide among older age groups and affecting the health and well-being of social groups in vulnerable situations (United Nations Economic and Social Commission for Asia and the Pacific, 2022), which sheds lights on the effects of significant societal trends on the environments experienced by people of different ages. From a future-oriented perspective, technology is increasingly reshaping built environments, a digital transformation that holds implications for all generations and marginalized communities (Marston et al., 2023). This trend also indicates the need to further consider technology in creating and optimizing environments that can benefit everyone and support healthy aging. Despite this, opportunities and challenges of digitalization remain inadequately addressed in age-friendly policy and research (Fulmer et al., 2020; Marston et al., 2023; Reuter et al., 2020). As argued by Marston and van Hoof (2019), technology should be further integrated into AFEs in the broadest sense, covering both the design and assessment of age-friendliness. Further exploration of the intersection between technology and AFE can contribute to our understanding of how these environments interact with technology and inform future policies aimed at creating AFEs in an increasingly smart society.

The current study is situated within the global and regional contexts of AFEs, where various cities and communities have endeavored to create health-enabling environments for individuals throughout their lifespan, build local capacity, develop innovative solutions, and share knowledge and good practices related to AFEs. The WHO launched its Global Age-Friendly Cities project in 2006, releasing a guide in 2007 that covers eight AFE domains in social, physical, and service aspects of age-friendly urban environments (World Health Organization, 2007). However, technology is not explicitly manifested in this guide, as pointed out by Reuter et al. (2020). Since the inception of its AFE project, the WHO supports the global network of age-friendly cities and communities (GNAFCC) and maintains a global database of age-friendly practices, including various digital interventions to empower older adults. In 2023, the WHO published a new guide for national authorities and stakeholders, focusing on forming and sustaining national programs for Age-Friendly Cities and Communities (AFCC) (World Health Organization, 2023). This guide is based on literature reviews, network mapping, and stakeholder consultations, and it includes case studies showcasing co-health benefits resulting from partnerships with the technology sector. Zooming into the AFE context in the Western Pacific (WP) region, different countries have

diverse priorities on aging shaped by demographic, political, socio-economic, and digital realities. Nonetheless, 112 cities and communities across six WP countries (as of 2022), encompassing over 56 million people, are involved in the GNAFCC. AFEs continue to be a prominent topic on policy agendas in various countries, such as China, Japan, and Korea.

With a focus on our study setting, China's population aging is unparalleled in scale and speed, and it developed AFE policies and programs in response to demographic changes. In 2015, the "Law of the Protection of the Rights and Interests of Older People" was promulgated, establishing the legal status of creating AFEs and setting forth the objective of providing safe, convenient, and comfortable surroundings for older adults. This law has served as a guiding document for the development of policies relevant to AFE and other aging-related issues. Informed by this law, China introduced the "Guiding Opinions on Promoting the Construction of Age-Friendly Living Environments" in 2016, marking the initiation of AFE development. This policy lacks a clear indication of being influenced by the WHO framework (World Health Organization, 2007) and does not adhere to the WHO categorization of AFE domains. Additionally, it introduces three new environmental dimensions, namely medical facilities, health technology, and products for older adults. It prioritizes the development of care service systems and social security mechanisms for older adults, with a focus on enhancing management and support for these services; this approach differs from the policy focus observed in Europe and other East Asian countries (Yuan, 2021). The development of these Guiding Opinions involved 25 ministries and national authorities. It was released and distributed by the National Development and Reform Commission (NDRC) to governments of various provinces, autonomous regions, and municipalities directly under the central government for implementation.

Similar to the implementation of other national policies in China, local governments tailor AFE policies to suit their specific conditions and develop detailed implementation plans accordingly. As found by Chu and Zhang (2022), the policy strength of AFE in China exhibits significant variation among provinces, which impacts social participation of older adults. The size of a city or province is an essential consideration in policy implementation, as policy customization at the local level needs to account for diverse needs, resources, and administrative capacities. Collaboration and coordination among various government departments, agencies, and stakeholders at the local level is essential to ensure effective policy execution. Monitoring of policy progress and impact assessment is conducted by local governments, with periodic reporting of progress and outcomes to the central government. Feedback from local implementation may also be considered for potential policy revisions at the national level.

Against this backdrop, the present study aims to explore how technology plays out in national aging policies in China. Specifically, it answers two research questions: (1) How have policies been developed over the past seven years since 2016 to create AFEs in a smart society? (2) In what ways does technology relate to AFEs in policies? To address these questions, we analyzed national aging policies adopted in China, utilizing the WHO's AFE framework (World Health Organization, 2007). The results of this study can contribute to the discussion on increasingly smart AFEs from a policy development perspective. Specifically, we provide insight into the status, development, and gaps in recent years at the intersection of aging and technology in China. Furthermore, this article highlights and discusses current AFE policy domains and measures in the context of digital transformation.

Age-friendly environment, technology, and digitalization

The WHO recognized the challenges of population aging and rapid urbanization and, in response, published a guide in 2007 on creating age-friendly cities. This guide presents an AFE framework comprising eight domains, namely outdoor spaces and buildings, transportation, housing, social participation, respect and social inclusion, civic participation and employment, communication, and community support and health services (World Health Organization, 2007). The aim of this framework is to foster health and well-being in older age and empower older adults to lead fulfilling lives that align with their values (World Health Organization, 2007). The guide also highlights the essential values of health, participation, security and aging-in-place, serving as the foundation for age-friendly urban planning and development initiatives worldwide. It is crucial to acknowledge the interconnectedness of an age-friendly ecosystem with social determinants of health, healthcare systems, and a prevention-focused public health approach (Fulmer et al., 2020; Xu et al., 2023). These elements for an age-friendly ecosystem are supported by qualitative data from older adults and policymakers and can be further implemented at the national level (e.g. Xu et al., 2023).

Recognizing the profound impact of technology in a smart society, researchers have extended the initial WHO framework to incorporate technology-related considerations. For instance, Marston and van Hoof (2019) proposed a smart age-friendly ecosystem framework in 2019, which adds an additional “technology and associated Information and Communication Technologies (ICTs)” sphere. This sphere encompasses various digital devices, software applications, and usability features across different environmental settings. Building on the expanded ecosystem framework, Marston et al. (2020) introduced the concept of age-friendly smart ecologies by incorporating additional spheres and segments. This extension recognizes the significance of stakeholder interactions and engagements within AFEs. It highlights

the dynamic relationships and collaborations among different actors, organizations, and individuals involved in creating and sustaining age-friendly ecosystems. While most of the conceptual work was developed and applied primarily across Western smart and age-friendly ecosystems, they can be inspirational in international contexts as they offer valuable insights and adaptable frameworks for fostering AFEs in the context of digital transformation worldwide.

With a growing interest in age-friendly smart ecosystems, there are ongoing efforts to conceptualize and explore different domains of the age-friendly ecosystem to enhance the health, participation, and security of older adults in the digital era. For instance, some studies have investigated the utilization of smart home technologies to establish age-friendly home environments, with the potential to promote health benefits and facilitate aging in place (Marston & van Hoof, 2019; Sengers & Peine, 2021; van Hoof et al., 2019). With a focus on transport, Loos et al. (2020) proposed the term “mobility digital ecosystem” from a justice-informed perspective, which consists of five elements – mobility practices, digital data, digital networks, material geographies, and digital devices and access to services – aiming to provide a framework for evaluating age-friendly smart transport. Furthermore, Reuter et al. (2023) proposed a partnership framework that spans macro-, meso-, and micro-levels. This framework emphasizes the need for collective efforts from various actors to optimize conditions and environments and foster diverse, meaningful, and fulfilling engagement with ICTs, ultimately enhancing the overall age-friendliness of environments. While some conceptual work has been conducted on various age-friendly domains, further research is needed to explore additional aspects that could contribute to a more integrated and collective framework and enhance the evaluation of age-friendliness within this smart ecosystem.

Age-friendly policies serve as a crucial catalyst in advancing the development and progress of AFE initiatives by providing a clear vision, defining actionable directions, and establishing institutional structures and mechanisms to support short- to long-term actions and impact (World Health Organization, 2023). Notably, they form an integral part of the environmental and sustainability factors within the age-friendly smart ecologies proposed by Marston et al. (2020). Research serves as a pivotal tool for enhancing knowledge and translating it into evidence-based age-friendly policy and practice, thereby driving positive outcomes in communities (Okayasu & Xu, 2023). However, as highlighted by Greenfield and Buffel (2022), there are still substantial gaps in understanding how to achieve environmental and systems change to better cater to the needs of older adults and enable them to do what they value. This underscores the necessity for further research to advance our understanding of the processes and contexts (including the policy aspect) driving community change and impact.

With a specific focus on the convergence of AFE and technology, the smart cities agenda has garnered significant research and policy attention. According to Ivan et al. (2020), the age-friendly component has been relatively peripheral in smart city initiatives in developing countries within the European Union, including Romania, which highlights the potential for further connecting the agendas of smart cities and age-friendly cities and underscores the importance of recognizing that older adults may benefit from the outcomes of specific smart city programs. As noted by van Hoof et al. (2021), the arena of AFE is currently not sufficiently incorporated into smart city agendas and budget allocation in various cities and countries, so this limited integration may result in restricted age-friendly initiatives in public spending.

There is a call and request for providing opportunities to relevant stakeholders, particularly present and future older adults, to collaboratively establish and implement an ecosystem of AFE (World Health Organization, 2023). In the context of technological developments, there is a growing concern about the risk of digital exclusion among older adults. This phenomenon may hinder older adults from fully participating and contributing to a smart AFE. As a result, it has brought attention to other interconnected issues, such as digital inequalities and ageism, which may emerge during the development and implementation of AFE in the digital era. For instance, Buffel and Phillipson (2018) underscore the challenges arising from growing inequality in age-friendly policies and advocate for a manifesto that aims to address social inequality, facilitate the co-design of AFE, foster collaboration across multiple sectors and disciplines, and enhance the integration of research with policy to tackle these challenges. Additionally, ageism is a significant concern in policy design at the intersection of AFE and technology. As mentioned by van Hoof et al. (2021), certain design features within age-friendly initiatives may be influenced by age stereotypes, leading to potential embedded ageism in their creation. This issue is also relevant in the context of AFE and technology policies, where ageism can manifest in the design, deployment, use, and application of technology, ultimately affecting the health and well-being of older adults (World Health Organization, 2022). Thus, it is worthwhile to explore whether these issues are tackled within the existing policies in the field of AFE and technology.

Our study can hopefully make several unique contributions to the exploration of how technology shapes age-friendly policies. Our study focuses on the under-studied context of China mainland. Despite having only one city involved in the WHO-led GNAFCC, the country has recognized almost 3000 age-friendly communities, which can be attributed, in part, to national age-friendly policies implemented since 2020. Despite the conceptual work primarily developed in Western smart and age-friendly ecosystems, our findings could provide valuable insights and adaptable frameworks that can inspire international efforts in fostering AFEs amid digital transformation.

Furthermore, our study sheds light on the significance of policy examination as a means to showcase the possibilities of AFE initiatives. By analyzing the guidance and provisions in these policies, policymakers can identify potential areas for enhancement, ensuring that AFE initiatives become more inclusive, equitable, and responsive to the evolving needs of older adults in the digital era. The results of our study could contribute to the development of a collective policy agenda and a national AFE program in China that encompasses various age-friendly domains and areas in a smart society and offer valuable lessons for similar contexts globally.

Methods

Data collection

We utilized the policy database hosted by the State Council of China, which includes publicly available national policies. We retrieved and downloaded policies issued between January 1st, 2016, and December 31st, 2022. The sampled period covers the full timeline of the 13th Five-Year Plan (2016–2020) and the first two years of the 14th Five-Year Plan. We refer to the policy context, the 13th Five-Year Plan, as the background against which policy decisions are made. The 13th Five-Year Plan, a macro-level policy framework, outlines social, economic, and technological development targets from 2016 to 2020. Its objective is to position China as a global innovation leader across various technology sectors by prioritizing the development of key technologies, upgrading manufacturing capabilities, and expanding the use of the Internet in industries.

To identify policies related to smart AFEs in the database, we employed a search strategy using a set of terms related to aging and older adults (Chinese characters). These terms include 老年(later life), 老龄(old age), 老人 (older adults), 养老 (eldercare), 适老(elder-friendly), 高龄(very old age). In terms of the social perception of what is considered “old” in China, it can vary among individuals and be influenced by cultural factors. Generally, individuals aged 60 years and over may be perceived as “old,” which aligns with the common belief that 60+ is considered old in developing countries. Additionally, in certain instances, individuals who have reached the legal retirement age may be perceived as “old.” The legal retirement age is 60 for male workers and 50 or 55 for female workers, depending on their profession and occupation. We then read over the policy documents line verbatim to further identify the policies that contain the terms related to technology. The technology-related terms include 科技 (science and technology), 技术(technology), 互联网/网络(Internet), 信息技术(information technology), 计算系统(computing system), 智慧(smart), 智能(intelligent), 数字(digital), 平台(platform). As a result of the initial

search, 198 policy documents were identified and downloaded as PDF files. We then conducted a second review and excluded 22 policies that did not fall within the intersection of aging and technology. This resulted in a final data corpus of 176 policy documents, which can be found in Supplemental Materials (including a list of policies and descriptive statistics of the policies).

Analyses

In this study, we conducted a content analysis to address the research questions. To begin, we familiarized ourselves with the policy documents by thoroughly reading and re-reading them verbatim. Our analysis primarily focused on exploring the relationships between AFE domains and technology concepts. A directed approach to content analysis, as described by Hsieh and Shannon (2005), was employed in this study. The WHO's AFE framework encompasses eight domains: outdoor spaces and buildings, transport, housing, social participation, respect and social inclusion, civic participation and employment, communication and information, and community support and health services (World Health Organization, 2007). These domains served as coding categories during the analytic process, where we identified relevant policy excerpts and generated initial codes for meanings at the sentence level of analysis. Our codes represented statements or relationships between concepts. To ensure rigor in the analysis, the authors critically reviewed and discussed the initial codes, and jointly confirmed the final codes. Any discrepancies were thoroughly discussed between the authors until a consensus was reached. The final codes were then mapped out in alignment with the WHO AFE framework. To facilitate this process, we utilized Nvivo, a qualitative data analysis software.

Furthermore, we coded the policies based on several additional characteristics, such as the number of policies, policy type, issuing body, and the year of policy issuance. Additionally, to gain insights into the distribution of relevant policy experts across AFE domains during the seven-year period, we visualized how the focus on specific age-friendly domains varied over time. We also calculated the percentages of policy excerpts for each domain in the WHO age-friendly framework by year. This calculation enabled us to track the trend of policy focus on different AFE domains over the seven-year period under investigation. Through these analyses, we aimed to provide an improved understanding of how technology is addressed within AFE policies in China and its potential policy implications for creating AFEs.

To enhance the validity of our content analysis, we engaged in thorough discussions to establish clear concept categories for technology, ensuring inclusivity by encompassing synonyms and implicit terms in the Chinese language, and extending technology beyond ICTs. During the coding process,

we were mindful of potential preconceptions that might influence our interpretation of the relationship between technology and age-friendly policies. While acknowledging that technology can sometimes be considered as a separate environment, our primary focus was on exploring the intersection between technology and other environmental dimensions (such as social, physical, and service aspects). This approach was chosen because technology's influence has been increasingly affecting our access and experiences within various environments in rapidly digitalizing societies. During the mapping of the codes into the WHO age-friendly framework, we referred to the WHO's policy checklist (World Health Organization Regional Office for Europe, 2016). This reference helped us align our analysis with international policy frameworks, further enhancing the accurate presentation of our findings. For a detailed presentation of the codes, please refer to the Supplemental Materials provided in this study.

Results

Temporal dimension of policy development

Our analysis of 176 policies related to smart AFEs over seven years (2016–2022) revealed a clear temporal trend, as depicted in [Figure 1](#). Specifically, the number of new policies enacted per year increased rapidly from 13 to 50, which suggests a sustained and concerted policy effort in the intersection of aging and technology.

This study focused on the policy development of age-friendly and technology policies over time, involving 26 national government agencies during the sample period. This extensive involvement reflects a strong emphasis on multisectoral collaboration and co-development at the policy level. The policy-issuing bodies encompass three types of agencies: inter-ministerial

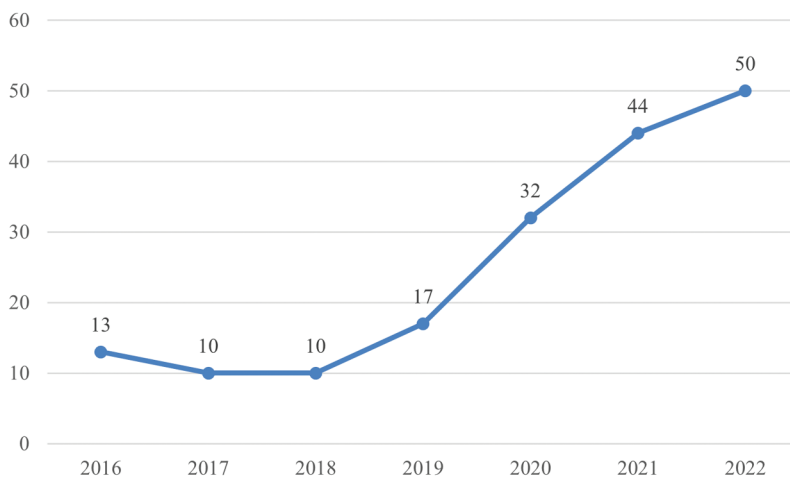


Figure 1. Number of new policies issued between 2016 and 2022.

coordination bodies (e.g., Communist Party of China – CPC Central Committee, Office of the State Council, Office of the National Committee on Aging), ministries (e.g., ministries of industry and information technology, civil affairs, health, transport, housing and urban-rural development, commerce, education, science and technology, culture and tourism, human resources and social security, finance, public security), and consolidated regulators (e.g., administrations for healthcare security, traditional Chinese Medicine, market regulation, radio and television, statistics, cultural heritage, cyberspace).

Over the seven-year period, the State Council and the Ministry of Industry and Information Technology emerged as the top two policy-issuing bodies, owing to their prominent roles in developing age-friendly smart environments. In terms of temporal dynamics, the State Council and CPC Central Committee were the primary policymakers in 2016, with other ministries and administration bodies gradually engaging in policy development thereafter. By 2022, the most active actors in this area of policy development included the ministries of industry and information technology, civil affairs, health, national development, and reform, as well as transport and housing. These findings provide valuable insights into the evolving landscape of age-friendly and technology policies at the national level in China.

With regards to the temporal trends of policy development, our study also found that China's policy development in this area can be roughly divided into two stages, namely 2016–2019 and 2020–2022. Starting in 2020, the number of policies in this area increased significantly; the main policy type shifted from comprehensive planning policies to specific policy guidance. Additionally, the leading policy-making body shifted from the State Council and its office toward a more balanced group of ministerial agencies. The policies issued at stage 1 (2016–2020) focus on strategic planning for an age-friendly society in the context of digital transformation. Most policies during this phase were issued or promoted by the General Office of the State Council. Overall, this phase of policy development focuses on the top-level design of an age-friendly society and encourages cross-sectoral collaboration on optimizing the services environment (mainly community support and health services). The policies issued during stage 2 (Year 2020 ~ 2022) address specific and emergent issues at the intersection of aging and technology in times of COVID-19. There is a sharp increase in the number of policies during this phase, with a growing interest in social aspects of aging (e.g., social inclusion, communication, and social participation). This involves over 20 ministries and administrations as policymakers. Three of the policies provided guidance and mandates on addressing the negative impacts of accelerated digital transformation on older adults' lives in the times of COVID-19. During this phase, the policies tend to promote a multisectoral approach to collaboration and action on various new issues and start improving the social environments of older adults.

Policy domains of smart AFEs

Our content analysis, which involved categorizing the policy excerpts related to age-friendly and technology into the eight domains of the WHO age-friendly framework, yielded significant findings. Specifically, we observed that technology is evident across all of the age-friendly domains, indicating its wide-ranging impact on various aspects of AFE. Among the different domains, “community support and health services” and “respect and social inclusion” emerged as the domains with the highest concentration of policy experts. This suggests that these two domains are particularly prominent in the integration of technology into age-friendly policies and initiatives.

The analysis revealed that the policy domain of “community support and health services” is the dominant focus of smart AFEs (97 excerpts, 40% of the sample). These excerpts mainly relate to digital health services and products aimed at providing personalized care for the older population. A key policy action in this domain is to promote high-value, quality, and diverse intelligent medical services and telemedicine technology to address the various health needs of an aging population. This action is also essential for upgrading industries and ensuring economic sustainability. Some policies highlight the need to support the development of high-end technologies such as artificial intelligence, big data, the Internet of Things, and virtual reality, as they can help address the shortage of health services and the workforce. Artificial intelligence, in particular, is seen as a crucial infrastructure technology that can facilitate the development of human-machine interactive robots, smart diagnosis and treatment assistants, wearable and biologically compatible health monitoring systems, new medicines, and smart epidemic surveillance and control. The policies within the “community support and health services” domain also cover personalized health promotion and management, smart long-term care, and other aspects.

Our analysis reveals that the “respect and social inclusion” domain in our sample of policies ($n = 71$, 30%) is focused on addressing the challenges faced by older adults in accessing and utilizing technology in different aspects of their lives, including barriers during the COVID-19 pandemic. The policies emphasize several key actions, such as addressing the digital divide for older adults and enhancing the protection of the rights of older adults in the digital era. Notably, the policies highlight China’s adoption of a multi-stakeholder approach, person-centered approach, customized approach, and educational campaign approach to enhance social inclusion and respect for older adults.

In the domain of “transport and mobility” ($n = 15$, 6%), policies outline key areas for action, such as building an intelligent transportation system by providing local programs to support older adults with mobility constraints in accessing public transportation and shared-ride services, as well as expanding the availability of diverse and convenient digital travel

services and information via platforms such as WeChat, Weibo, mobile apps, and convenience hotlines. However, some policies also highlight the digital barriers that can hinder older adults' mobility, particularly during the COVID-19 pandemic. For example, the implementation of a national digital health code system has created challenges for older adults who lack access to, or the necessary skills to use, the required technology. To ensure equitable access to services and support, the policies aimed to improve "health code" management for older adults' travel convenience in times of COVID-19, by allowing alternative options to the health code, such as valid ID or paper certificates, for older adults who may not have access to or be proficient in using technology. As portrayed in such policies, older adults are technologically incompetent and digitally marginalized, and this can result in overlooking the needs and preferences of digitally competent and active individuals who are aging healthily.

In terms of the "communication and information" domain ($n = 14$, 6%), the policies aim to leverage the potential of telecommunications, including mobile communications and the internet of things, to create digital age-friendly information for older adults and support digital communication. Some suggested policy actions involve utilizing new media to enhance health-related knowledge and establishing integrated communication and information systems that span various areas, including health care, public health, Chinese medicine, noncommunicable disease management, and care services for older adults. To achieve this goal, policymakers aim to enhance the provision of accessible and affordable telecommunication services for older adults living in different environments, such as rural and poverty areas. These services are crucial for enabling access to aging-related information and services, such as pensions, medical records, and lifelong education.

The policies falling under the domain of "outdoor spaces and buildings" ($n = 14$, 6%) aim to enhance the safety, convenience, and comfort of older adults in physical environments using digital solutions, such as elevators, security equipment, and emergency call systems. Notably, the national age-friendly community program launched by the government prioritizes the transformation of old residential facilities, buildings, and communities into age-friendly spaces. The program involves mobilizing grants to support older adults in vulnerable situations, promoting the provision and development of accessible digital self-services and equipment, establishing online information platforms for aging services, and enhancing digital literacy through education and training.

In the domain of "social participation" ($n = 12$, 5%), the policies aimed to enhance digital support for cultural and sports participation and develop digital educational resources for older learners. Especially, a primary focus was on providing more life-wide learning opportunities that are rich in ICT and digital services to support older adults' meaningful participation in society.

The policies related to the “housing” domain ($n = 9$, 4%) aim to enable aging in place for older adults through the support of technology. An innovative model of eldercare, known as “home care beds,” is being piloted and promoted at the subnational level, which aims to support families in transforming housing environments to be more age friendly. The policies also called for mobilizing government subsidies and donations to improve the housing conditions of older adults who are living with disadvantages.

In the domain of “civic participation and employment” ($n = 4$, 2%), the available policies call for providing vocational skills training and guidance services for older adults who wish to continue working, with a particular focus on digital innovation and entrepreneurship. The policies also encourage the creation of a digital information database for older adults with identified expertise and offer opportunities for them to participate in volunteer activities such as grassroots democratic supervision, cultural customs, family education, and health promotion. While the digitalization of volunteering, late working life, and local decision-making is gaining traction in China and can be determinants of healthy aging, the policies in this domain are currently limited in their scope. Further attention is needed to fully support and integrate the potential of technology for promoting active and healthy aging in this domain.

Moreover, our results showed that community support and health services were dominant in the 13th Five-Year Plan, while respect and social inclusion, civic participation, and employment received less attention during this period (Figure 2). However, a significant change was observed at the beginning of the 14th Five-Year Plan, as policies began to address issues across various domains, particularly in improving the respect and social inclusion of older adults. This substantial increase may be attributed to the impact of strict COVID-19 public health and social measures.

Discussion

The present study explored how technology plays out in age-friendly policies in China mainland, with the support of a content analysis of 176 policies spanning seven years. In light of previous work on Age-Friendly Environments (AFEs) and technology, our study provides insights into the policy development that can drive and sustain community change and impact, an essential aspect of the sustainability and environmental factors within age-friendly smart ecologies proposed by Marston et al. (2020).

By mapping the policies into the WHO AFE framework, our study highlights how technology is embedded across all AFE domains, demonstrating its pervasive impact on society. For instance, some of the policies aim to increase the supply of intelligent medical services, telemedicine, and the utilization of big data for health services. Additionally, they focus on developing IoT-enabled care infrastructure and personalized health promotion. Bridging the digital divide, the policies provide

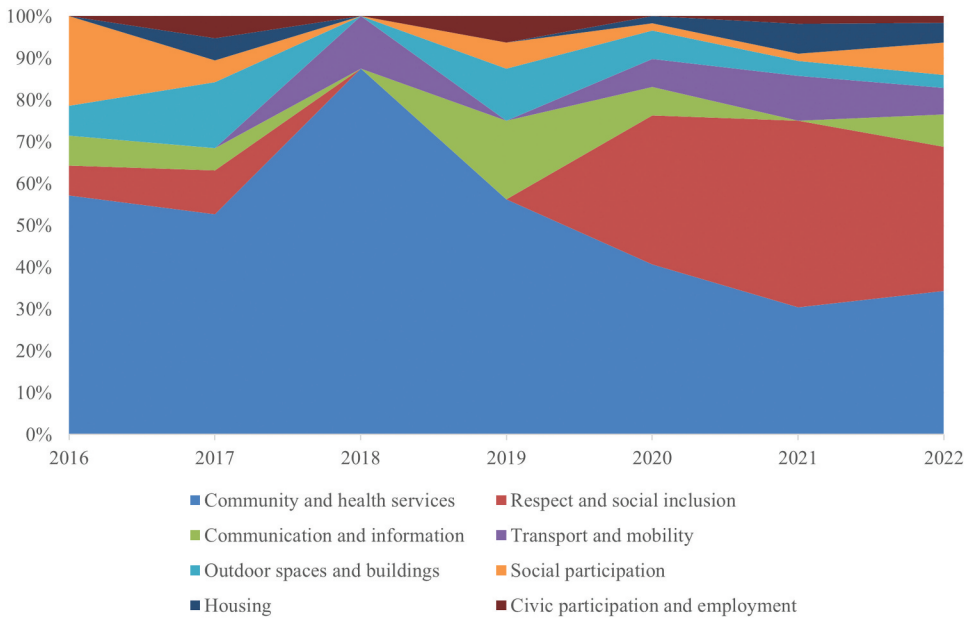


Figure 2. Distribution of policy excerpts across AFE domains between 2016 and 2022.

education and safeguard the rights of older adults, improve transportation through digital solutions, and support cultural and sports participation. These technology-driven policies reflect policy efforts to develop age-friendly smart ecologies. The policy focus primarily revolves around addressing critical issues, such as aging services, digital exclusion during the COVID-19 pandemic, and community design affecting the health and mobility of older adults. However, there is a need to expand policy attention to other domains, such as civic engagement, social activities, and paid employment, which are also important to older adults. Previous studies, such as those by Chen and Hartt (2021), Komp-Leukkunen et al. (2022) and Reuter et al. (2020, 2023) have also highlighted the need for attention in these areas. These findings reveal the significance of policy examination in showcasing the potential of AFE initiatives, allowing researchers and policymakers to identify areas for enhancement to ensure equity and responsiveness to the evolving needs of older adults in the digital era.

Our findings indicate that technology's role within age-friendly policies has mainly focused on its potential as a solution. However, it's important to approach this topic more critically and recognize the possible risks and downsides that technology might present to older adults. This is especially important in the context of disruptive technologies like artificial intelligence, which have become essential parts of smart aging services. Zhu et al. (2022) pointed out that policymakers should include measures to protect older adults from potential harm, including concerns about privacy breaches, biased algorithms, ethical responsibility, and excessive reliance on technology. The ethical and governance aspects of

AI have gained attention since the State Council introduced the Development Plan for the New-Generation Artificial Intelligence in 2017, indicating a phase where China is shaping its stance on AI governance (Qiao-Franco & Zhu, 2022). However, as our analysis reveals, the recognition of older adults as a particularly vulnerable group to the unethical use of algorithms has not been adequately addressed so far. This underscores the necessity for a comprehensive examination of the ethical consequences of integrating technology into age-friendly policies.

Our study sheds light on the characteristics of policy development in China's smart AFE over a span of seven years, with a particular focus on two key aspects: multisectoral collaboration and attention to equity. Multisectoral cooperation is the linking of various sectors for action, beginning with the technology sector and expanding to other sectors. Multisectoral and multistakeholder collaboration is a recommended approach for addressing complex social determinants of health across the life course (World Health Organization, 2021; Ye et al., 2021); however, few available studies provide insights into how different sectors jointly deal with challenges and opportunities of technology in aging societies. Our study has addressed one aspect of this gap by showcasing multisectoral collaboration in China's policies. However, our study is limited in providing in-depth insights into the effectiveness of such collaboration and action at different levels. The other characteristic is advancing equity and support for underserved communities by "equitable access to basic public services." As demonstrated in China's policies around transforming community environments for older adults of different backgrounds, some of the policies aimed to address the needs of older adults and their families in vulnerable situations or living with disadvantages, such as the older rural females (Yang & Du, 2021).

Focusing on stakeholder engagement within the policy development of smart AFEs, the active involvement of older adults is not evident. While various government agencies are considered in the formulation of these policies, the voice and representation of the older adult demographic remain underrepresented. This raises important questions about the inclusivity and effectiveness of such policies in addressing the needs and preferences of older adults from different backgrounds they are designed to benefit. Some possible means to address this issue could be establishing dedicated forums, conducting surveys or focus groups, and fostering collaborations with more organizations representing older adults' interests. Moreover, as the personal aspirations of future older adult generations play a crucial role in shaping the vision of age-friendly smart ecologies (Marston et al., 2023), policymakers should take proactive measures to anticipate the future needs of older adults in a digital society and address challenges related to aging and digitalization. By doing so, they can create an age-friendly society that empowers older adults, promotes their agency, and facilitates their active and meaningful participation in the digital era. For example, policymakers should provide more support to older adults to maintain their independence and well-being in home and

community environments, co-produce smart city policies and practices (Li & Woolrych, 2021), and ensure their secure financial inclusion in the digital era (Zeng & Li, 2022).

Despite the positive strides in policy development, there are some critical remarks to consider. Our findings suggest that the policies predominantly depicted older adults as a homogeneous group that is technologically incompetent, digitally inactive, and unable to learn new technology. This portrayal often served as a premise for China's policy development and influenced strategic directions for creating smart AFEs, which currently focus on support and care. The prevalence of such discourse is not unique to China and has been identified in other societies as well (Fleming et al., 2018; Mannheim et al., 2022). However, recent studies have highlighted older adults' agency and autonomy in utilizing and learning technology, indicating the need to optimize the policy environment by shifting from inclusion toward empowerment (Kania-Lundholm & Manchester, 2022). This recognition of older adults as agents of change in the era of digital transformation can encourage them to generate positive changes in their living environments. Therefore, China's age-friendly policies should shift the focus toward empowering older adults to exercise their agency and maintain their functional ability. Such a shift will enable the government to effectively create an age-friendly society, communities, and families where older adults can participate and contribute while promoting digital inclusion among older adults. Future policies may further address the full spectrum of aging populations, including those who are digitally proficient, to promote active and healthy aging for all.

The existence of policies on record does not ensure their effective implementation in practice. Although these policies may be formally established and documented, their actual execution and enforcement at the local level can exhibit significant variations. Some policies may not result in substantial actions to address the intended issues, despite being indicative of national political will, commitment, and policy priorities. In this context, several factors come into play, influencing the connection between policy formulation and implementation. These factors, such as resource allocation across communities, the regular monitoring and evaluation of policy implementation, and the capacity of local institutions responsible for executing the policies, warrant further consideration and examination to sustain positive policy outcomes.

Our study has detailed the development of policies aimed at establishing AFEs in the context of a technologically advanced society, specifically within the Chinese context. These insights hold the potential to be valuable for the broader international community. However, these policies have been formulated within the framework of specific socio-political and cultural conditions. For example, the prevailing culture of filial piety, while diminishing, has instilled a traditional perspective that places a high ethical value on the care for older adults by younger generations. Consequently, when devising AFEs

that integrate smart technologies, the active involvement of the younger demographic becomes pivotal in supporting older adults in adjusting to these advancements. Given the limited scope of our study, the interplay between smart AFEs and cultural influences remains a potential avenue for future research. Such endeavors could yield deeper insights into how technology policies intersect with cultural norms and shape the development of AFEs.

Limitations

Our study is subject to potential biases and limitations inherent in the data collection and analysis process, such as our subjectivity and the potential for misinterpretation of data. While we aimed to achieve a high level of credibility through iterative data analyses and discussions among ourselves, our findings may not fully represent the perspectives of all policies in the area of smart AFEs. While we used content analysis to analyze policy development trends and content related to technology and AFEs, alternative analytical approaches, such as discourse analysis, may yield different interpretations. Finally, while our study contributes valuable insights into the development of aging and technology policies, further research is needed to evaluate the effectiveness and impact of these policies on older adults and society. These gaps provide an opportunity for future research.

Conclusion

Our study provided an analysis of policies to explore the way that technology plays out in China's national aging policies. Over seven years, our analysis demonstrates policy advancements in age-friendly smart ecologies across various domains such as community support, health services, and social inclusion. Our study identified two stages of policy development, each with different strategic priorities, including strategic planning, creating age-friendly communities, and addressing emerging issues around aging and technology. Our findings suggest that inter-ministerial cooperation and advancing equity are key trends in policy development. Moreover, the study sheds light on the established collaborative leadership, the convening powers, and a comprehensive list of policy actions aimed at advancing the age-friendly agenda in the context of the digital era. This research contributes to enhancing our understanding of creating an enabling and supportive policy environment for age-friendly smart ecologies. The findings hold relevance and interest for policymakers in other countries with similar initiatives, providing potential strategies for fostering age-friendly smart ecologies.

Key points

- There is a lack of research on aging policies in smart society, nationally and internationally.

- China's smart age-friendly policies need improvement in employment, housing, and social participation.
- Policymakers worldwide must leverage technology strategically for creating AFEs.
- Integration of technology in aging policies is becoming prominent in the context of global aging and healthy aging.

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Data sharing statement

A list of sampled policies with accessible links, a summary of subthemes and codes, and the descriptive statistics of data are available in Supplemental Materials.

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