

Navigating the digital age: The gray digital divide and digital inclusion in China

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Abstract

Rapid digitalization and an aging population are leading to an increasingly prominent age-based digital divide among the world's elderly population. This study focuses on China, one of the most rapidly aging and digitalizing countries in the world. Employing a mixed-method approach, this research examines how elderly individuals experience the digital transformation and the associated digital divide. The findings suggest that the elderly interviewees encounter multiple barriers to learning and using digital technologies, which highlights the significant role of social support and networks in facilitating their adaptation to the digital society and lifestyle. Attitudes toward digital engagement and digitalization vary greatly among the elderly, ranging from being optimistic to feeling left behind and having multiple concerns. Our findings further reveal that the Chinese government has implemented numerous digital apps tailored to the demands of the elderly and provided training opportunities to bridge the gray digital divide. This emphasizes the responsiveness and adaptiveness of Chinese authorities in addressing pressing societal issues. However, we identify a gap in digital outreach, as most elderly interviewees have limited awareness of government digital inclusion policies and programs. This article contributes to digital divide research and offers practical implications for countries grappling with the gray digital divide.

Keywords

digital inclusion, digital inequalities, digital technologies, elderly people, gray digital divide

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Introduction

Over the past decade, many countries have undergone a significant digital transformation and experienced population aging. Owing to the unprecedented acceleration of digitalization and a rapidly growing aging population, the gray digital divide (i.e. the age-based digital divide among the elderly) has become a global issue, garnering increasing public and scholarly attention. It is considered a representative manifestation of digital exclusion, inequality, and unfairness among older adults in a digitalized society (Kidron and Yang, 2021). The digital divide and exclusion among the elderly has become a particularly prominent social issue in China (Yang and Du, 2021), which has one of the largest aging populations in the world and has entered a moderately aging society (Liu et al., 2021). As of 2021, the population aged 60 years and above exceeded 267 million, constituting 19% of the total population in China (Gov.cn, 2021).

As a digital frontrunner, China has witnessed the widespread implementation of advanced technologies such as digital payment systems, facial recognition, and QR codes in various real-life scenarios. The COVID-19 pandemic further accelerated the adoption of emerging technologies like Health Code, which authorities claimed would curb the spread of the virus. As pandemic-related technologies became mandatory in many places, elderly individuals were also largely expected to adopt these digital tools, leading to unexpected challenges (Song et al., 2021; Wang et al., 2021). This makes China a particularly representative case to examine elderly individuals' digital practices in a rapidly digitalizing context.

This study employs a mixed-method approach to investigate the barriers elderly individuals encountered in their digital practices and their attitudes toward learning and using digital technologies amid China's rapid digitalization. We draw on Van Dijk's (2006) digital divide theoretical model as a primary analytical framework to examine how the different types of technological access and usage divide influence the elderly individuals' digital engagement and their experiences of digital divide. We also examine the Chinese government's responses to the digital divide and exclusion among the elderly.

Our findings highlight the multifaceted barriers faced by the elderly interviewees in learning and using technologies, encompassing physical limitations, lack of digital skills, motivation, and social support. Attitudes toward digital learning and digitalization vary greatly among our interviewees, with some expressing optimism and actively engaging in digital learning and participation, while others perceive themselves as lagging behind and have various concerns (e.g. privacy and safety) regarding their digital engagement. Our study underscores the pivotal role of social support and networks in facilitating the elderly's adaptation to the digital society and lifestyle. While interviewees who had access to supportive families and/or local communities could engage in digital technologies more effectively and confidently, those lacking such networks and support encountered more obstacles and experienced heightened anxiety and concerns in their practices. Our findings also indicate that both central and local Chinese governments have implemented various measures to address the gray digital divide, including digital adaptation reforms and the provision of training opportunities. This highlights the adaptiveness of Chinese authorities in tackling pressing social issues. However, our research reveals a

gap in digital outreach, as the majority of elderly interviewees had limited awareness of these digital inclusion policies and programs.

Our study makes several significant contributions to the growing literature on the digital divide and digital inclusion. Firstly, it adds to existing research on the gray digital divide (Friemel, 2016; McDonough, 2020) by identifying and examining the multiple barriers that hinder the elderly's digital learning and participation. Secondly, while most studies have concentrated on the gray digital divide and digital inclusion in developed Western societies, our research focuses specifically on China. In so doing, we shed light on the digital transformation and the digital divide within an authoritarian context and reveal how the Chinese government has developed adaptive measures to address the digital divide issue and promote digital inclusion, thereby offering new perspectives that challenge conventional perceptions of authoritarian states. Moreover, our research contributes to the growing literature on digital governance in China (Kostka, 2023), highlighting the limitations of the government's responsive measure like the gap in digital outreach. Finally, this study provides insights into the Chinese government's digital inclusion practices, offering practical implications for countries grappling with the similar digital divide issues.

Digital exclusion and inclusion among the elderly

Digital divide and the gray digital divide

The term *digital divide* originally referred to the disparity in access to information communication technologies (ICTs) among different groups of people (Van Dijk, 2006). This access divide is considered the first level of the digital divide. Over time, the concept has evolved to include the second level, which refers to the unequal distribution of skills, knowledge, literacy, support, and training opportunities for using digital technologies (Friemel and Signer, 2010; Hargittai, 2001). In this article, we refer to both levels of the digital divide to explore how they manifest in Chinese society.

Derived from the broader concept of the digital divide, the *gray digital divide* highlights the age-related divide among different age groups (Morris and Brading, 2007). Specifically, it signifies the gap between older and younger adults in accessing and using digital technologies, implying that older adults typically possess lower digital literacy and encounter more challenges in adopting digital technologies and acquiring digital skills. Consequently, older adults tend to lag behind younger adults in technology usage (Friemel, 2016; Millward, 2003). In this article, we use the term *gray digital divide* to describe the gap in access, usage, knowledge, and skills among elderly people in adopting and using digital technologies.

While existing studies on the digital divide mostly concentrate on developed Western countries like the United Kingdom, Canada, and Switzerland (Friemel, 2016; Neves et al., 2018), a growing body of research has shed light on the gray digital divide in China. Yang and Du (2021) highlight the gender-based digital exclusion experienced by elderly people in China, revealing that rural elderly women face higher levels of digital exclusion than their rural male and urban female counterparts due to their lower rate of smartphone usage. The lack of financial resources, education, and economic security is

the main reason why the rural older women face difficulties in accessing and using smartphones and the Internet.

Yuan and Jia (2021) identify two major challenges faced by elderly Chinese individuals when engaging with digital technologies: unfamiliarity with smartphone operation and complicated app design. These difficulties cause anxiety and an increasing fear of technology. Their findings align with those of Wang et al. (2021), who emphasize that visibility, complicated interface design, and frustration arising from the inability to master new functions are the main obstacles encountered by older adults when using smartphones.

Existing research highlights that the COVID-19 pandemic and the extensive use of digital technologies have both exacerbated the pre-existing digital divide among the elderly (Shao and Kostka, 2023). For instance, Song et al. (2021) uncover that the widespread adoption of digital technologies during the pandemic resulted in both physical and virtual exclusion of older adults. Elderly people face various challenges in accessing public transportation, making medical care reservations, conducting digital transactions, and maintaining contact with family and friends, due to their limited digital literacy, Internet access, and technological capabilities. This research offers valuable insights into understanding the impact of widespread technology usage on the gray digital divide during the pandemic. Research conducted beyond China also indicates that the pandemic has had a significant impact on the gray digital divide worldwide (e.g. in South Korea and Ireland) and created numerous challenges for the elderly (Han and Nam, 2021; Jaarsveld, 2022). The gray digital divide has thus emerged as a pressing social issue and an important research topic.

Digital divide and exclusion: The elderly's non-use of digital technology

This study utilizes Van Dijk's (2006) theoretical model of the digital divide as the analytical framework. According to Van Dijk (2006), the digital divide comprises four types of access: (1) Motivational access refers to the lack of motivation, often caused by fear, stress, mistrust, and technophobia, which leads to reluctance and non-adoption of digital technologies. (2) Material access pertains to the lack of physical and other types of access (e.g. financial resources) required for accessing and using technology, which can also result in exclusion from technological participation. (3) Skills access encompasses operational, information, and strategic skills, including digital literacy and the capabilities required to achieve particular goals with technology. Insufficient skills can lead to difficulties in digital participation. (4) Usage access covers factors like usage time, application diversity, broadband or narrowband use, and level of active or creative use, which affects the individuals' technological participation. These four types of technological access significantly influence how individuals adopt and participate in digital technologies, thereby contributing to the digital divide across different groups. Drawing on this analytical framework, we examine the types of technological access and usage divide experienced by elderly individuals in China and how their digital practices are affected as a result.

Prior research has identified various determinants contributing to limited or non-use of digital technologies among the elderly, resulting in a digital divide within this population. These factors include a perceived lack of necessity for digital participation (McDonough, 2020), perceived complexity of technology and the effort required for

digital learning (Friemel, 2016), lack of interest (Morris and Brading, 2007), privacy and safety concerns (Wu et al., 2015), perceived limited usefulness or value of technology (Han and Nam, 2021), fear of new technology (Morris and Brading, 2007), mistrust of technology (Friemel, 2016), and lack of social support (Han and Nam, 2021).

Existing literature suggests that elderly individuals hold diverse perceptions regarding participation in technology. Some older adults show an embracing attitude, viewing technology as a valuable tool that empowers them, improves the quality of their lives and well-being, and prevents them from digital exclusion (Abbey and Hyde, 2009; Hill et al., 2015). However, some elderly adults express concerns about the use of technology and its risks, including privacy infringement, cybercrime, reduced human contact, and over-reliance on digital technologies (Wu et al., 2015). Research also indicates that perceptions such as ‘digital technologies are designed for the young generation and not for them’ and being ‘too old to learn and use new technology’ hinder elderly individuals’ willingness to adopt technologies (McDonough, 2020; Millward, 2003).

Previous research indicates that the exclusion of elderly individuals from digital technologies has negative impacts on various aspects of their lives, including decreased autonomy and control over financial resources and independence, heightened feelings of social isolation, increased sense of inferiority and powerlessness, and negative effects on their life satisfaction (Liu et al., 2021; Wu et al., 2015). This thus highlights the importance of bridging the digital divide and promoting digital inclusion among older individuals.

Digital inclusion: Narrowing the gray digital divide

The concept of *digital inclusion* encompasses the development of measures and implementation of activities to mitigate the digital divide and exclusion. It seeks to eliminate barriers for individuals and communities (especially the disadvantaged, vulnerable, and marginalized) to access and use ICTs. In so doing, individuals can fully engage in public activities, contribute to economic development, and obtain social benefits (National Digital Inclusion Alliance, 2016). This concept provides a conceptual lens through which we can examine the Chinese government’s various initiatives to narrow the digital divide and promote digital participation among the elderly population.

Existing studies offer diverse recommendations for addressing the gray digital divide and promoting digital inclusion among the elderly. As the second level of the digital divide (i.e. usage divide) has become more prominent than the first level (i.e. access divide), Han and Nam (2021) propose that prioritizing appropriate digital training is crucial rather than solely focusing on improving digital accessibility. Community-based training programs to improve digital literacy among local elderly residents are recognized as effective measures (Jaarsveld, 2020; Yang and Du, 2021). Jaarsveld (2020) argues that local governments and communities should implement specific digital inclusion programs to increase motivation among the elderly population and help them better understand the potential benefits of technology usage, thereby addressing motivational access.

Other measures that are proposed to facilitate digital participation among the elderly include the Intergenerational Mentor-Up program, which involves college students tutoring older adults. This program is recognized as an effective intervention in helping older

participants reduce social isolation and technophobia while boosting their confidence in learning and using technology (Lee and Kim, 2019). Support from family and friends is also highlighted as vital approach to address the gray digital divide. Several studies underscore the pivotal role of family support in stimulating the elderly's interest in using digital technologies and enhancing their participation in digital society (Flynn, 2022; Liu et al., 2021).

Methods

A mixed-method approach was employed for data collection and analysis. We conducted a platform analysis of mobile applications tailored to the elderly, including the all-in-one app WeChat, payment app Alipay, social entertainment app Douyin, the banking app of the Industrial and Commercial Bank of China (ICBC), travel and transportation app Baidu Map, shopping apps Taobao and Pinduoduo, and the mobile government app Zheliban.¹ We examined the interface design and key technological features and functions of these elderly-oriented apps and identified the major differences between the elderly versions and the general versions of these apps. The platform analysis yielded valuable insights into how platform developers strive to cater to the demands of elderly users, making it more convenient and easier for them to engage with these apps.

Between October 2022 and May 2023, we conducted 46 semi-structured individual interviews and 4 focus group interviews ($n=14$), involving a total of 60 interviewees, to examine the real-life usage and participation of digital technologies among elderly individuals in China. We first disseminated the recruitment post among our personal networks using social media platforms like WeChat Friend Circles and chat groups. We then employed a snowball sampling approach to expand the recruitment pool, asking our interviewees to help us distribute the information more widely. Our elderly interviewees ($n=55$) were aged between 60 and 85 years. The detailed sociodemographic information about them is provided in Table A1 in the appendix. The five interviews with staff from local governments and non-profit organizations (NPOs) were mainly used to investigate the services offered by these entities in assisting elderly communities with digital learning and participation.

A qualitative content analysis was performed to investigate the policies and measures implemented by the Chinese governments and how they cooperate with social organizations and commercial companies to address the gray digital divide and enhance digital participation among the elderly. The content analysis focuses on representative policies and reforms and the local community-based training programs that assist elderly individuals in technological participation. By combining the content analysis with interviews conducted with government and NPO staff, this research offers in-depth insights into the Chinese government's multifaceted approach to promote digital inclusion among the elderly in an increasingly digital society.

Findings

The interview findings suggest that most elderly interviewees use various digital devices in their daily lives, including smartphones, tablets, computers/laptops, and

smartwatches/bracelets, with smartphones being the most frequently used and highly valued. One interviewee (64, female, Xi'an) used the metaphor 'key' to emphasize the importance of her smartphone and her anxiety at the thought of living without it: 'It is so important and essential for me, like a key. I can't go out without it and would feel super panicked if I forget to bring it.' This echoes the findings of Yang and Du (2021), who highlight the significant role that smartphones play in helping the elderly connect with the outside world and avoid digital exclusion. Several interviewees mentioned having used more digital devices in recent years. This suggests that the rapid digitalization in China has become a major driving force for the elderly to engage with multiple digital technologies.

Exacerbated digital divide during the COVID-19 pandemic

Our findings emphasize the significant presence of a digital divide among the elderly in various aspects of their daily lives, for example in digital contact, online information seeking, digital finance and transactions, travel and transportation, online shopping and delivery, and digital health care. The COVID-19 pandemic has played a particularly crucial role in exacerbating this gray digital divide. During the pandemic, many interviewees had to engage with multiple digital technologies like QR code scanning and digital payments. However, they were initially unfamiliar with these technologies and often encountered difficulties. More than 60% of our elderly interviewees (34 out of 55) reported experiencing incidents where they were denied entry to public spaces like supermarkets, hospitals, and public transportation because they were unable to show their Health/Travel codes. Our findings support previous studies that highlight similar cases of digital exclusion among the elderly, which suggests the gray digital divide worsened and expanded during the pandemic in China (Song et al., 2021; Wang et al., 2021). Despite the challenges, some interviewees expressed support for mandatory participation in pandemic-prevention technologies such as Health Code. They perceive these technologies as 'necessary' and 'imperative', which makes them feel 'safe' and protected by the government. This indicates that these interviewees believe the benefits of using specific digital technologies outweigh the challenges they faced in technological learning and participation.

The frequent lockdowns and travel restrictions implemented during the pandemic from early 2020 until late 2022 resulted in the local public and private services shifting to online/mobile platforms (e.g. mobile shopping, payment, and checking of pension/insurance). This digital transition presented unexpected challenges for our interviewees, especially those with limited knowledge and experience with digital services. Many interviewees reported feeling 'forced' to acquire various digital skills to survive during the pandemic. One interviewee (67, female, Xi'an) noted, 'I feel I was forced to learn many things because of the pandemic, like paying the fees for water, gas, and electricity on Alipay and WeChat and placing orders online to buy necessities.' The increasingly digitalized lifestyles also heightened the elderly's concerns and anxieties about their future. As the same interviewee expressed, 'I know it's not bad for me to learn them. I'm just worried about the prospect of having to continually learn new skills as our life becomes more mobile.'

Primary barriers to learning and using digital technologies

Our findings highlight several main motives for the interviewees' engagement in digital technologies, including (a) maintaining contact with family and friends, (b) staying updated with the latest information, (c) conducting payments and transactions, (d) finding entertainment through social media (e.g. watching short videos and listening to audio novels) to combat boredom and loneliness, and (e) succumbing to social pressure (e.g. fear of being excluded and desire to fit into society). These motivations align with prior research on the reasons behind elderly individuals adopting digital technologies (Wu et al., 2015). Furthermore, our findings indicate that the desire to enhance one's social image, achieve greater autonomy and freedom, and enjoy more convenience significantly drives the elderly to use digital technologies/devices and continuously improve their digital skills. Several interviewees specifically mentioned their desire 'to be more independent and not to rely on others,' particularly in areas like mobile shopping and payment, which motivated them to learn and use various functions and apps. These findings align with previous research in suggesting that learning and using digital technologies empower the elderly and provide them with a greater sense of independence (Hill et al., 2015).

Our interviewees encountered multiple barriers and difficulties when it came to learning and using digital devices, apps, and functions. Table 1 summarizes these challenges.

The aforementioned barriers, including physical limitations, fear and anxiety about digital technologies, insufficient digital skills, limited social networks, and lack of time and motivation for learning and using technology, align with previous research on the challenges faced by elderly people regarding digital participation (Friemel, 2016; Wang et al., 2021). This suggests that these obstacles are commonly experienced by elderly individuals in their digital practices, albeit in diverse socio-cultural contexts.

All the reported barriers affect over 50% of our interviewees and constitute the primary obstacles to their digital participation. Physical problems (89%) and the lack of digital skills and capabilities (84%) were identified as the most prominent and commonly encountered barriers. These factors contribute to the elderly interviewees' reluctance and limited adoption of digital technologies, which lead to digital exclusion within this demographic. According to Van Dijk (2006), the digital divide is influenced by four types of technological access: motivational access, material access, skills access, and user access. As most interviewees had physical access to digital technologies, material access was not identified as a primary barrier. However, the other three types of access, especially skills access and usage access, severely impeded the interviewees' technology participation and increased their risk of experiencing a digital divide and social exclusion.

Our analysis shows that the absence of social networks has an impact on the elderly's digital learning and practices. Many interviewees who maintained close and strong ties with their family and social networks tended to receive better and more efficient support for digital learning and engagement. Thus, they did not identify the lack of social support as a main obstacle. However, interviewees who were unable to receive adequate assistance from their social networks, particularly those without children or families, living far away from their families, and having limited access to local communities and learning opportunities, noted the absence of social support as a significant barrier (60%). We

Table 1. Barriers and difficulties encountered by elderly interviewees in digital learning and practices (n = 55).

Types of barriers	Representative examples/cases	Representative interview quotations	Numbers	Percentage (%)
Physical barriers	<p>Eye-related problems like presbyopia, weak eyesight, and eye fatigue are attributed to the technical design of smartphones and apps (e.g. small and shiny screens)</p> <p>Poor memory</p> <p>Inflexible fingers and hands</p> <p>Disabilities</p>	<p>"It's been easy for my eyes and mind to feel tired in recent years whenever I stare at the screen [of my smartphone] for a long time. I want to learn more, but I don't have the energy. So I have to give up on further learning in many cases." (77, male, Xi'an)</p>	49	89
Lack of digital skills/capabilities	<p>The inability and/or insufficient knowledge and skills to:</p> <ul style="list-style-type: none"> - Register and scan QR codes - Pay bills for living expenses via mobile apps - Use mobile shopping, banking, and food-delivery apps - Search/check necessary information understand and remember complicated functions and procedures 	<p>"I always feel like I need to learn many things from scratch, and I often forget some steps and end up failing in the middle. Some functions are just too hard to learn. No matter how many times [my children] teach me, I still can't remember." (68, female, Hohhot)</p>	46	84
Lack of time	<p>Perceiving the learning of digital devices and skills as too time- and energy-consuming</p>	<p>"I'm busy with my daily life. I have to cook for the whole family and manage endless housework. I also need to take care of my two young grandsons. I don't have any spare time for learning." (64, female, Xi'an)</p>	41	75
Lack of social support	<p>Having limited channels to receive support for their digital learning and practices from families, friends, and society</p>	<p>"I want to learn, but my children are all very busy. They don't have time to teach me step by step. I don't know whom I could turn to for learning and asking questions." (70, female, Nanjing)</p>	33	60
Lack of motivation and interest in digital learning	<p>Limited interest and motivation caused by:</p> <ul style="list-style-type: none"> - Perceiving learning digital technologies as useless (e.g. adding no value to their lives) - Perceived complicated operations and steps and having low confidence in their learning abilities - Fear of learning and trying new technologies (technophobia and anxiety) decreased motivation for learning new things while getting older 	<p>"At my age, I simply have no interest in learning new things like the new functions. I also don't consider it necessary or worth the effort to master all the skills required to use a smartphone. It doesn't add much value to my current life." (67, male, Chongqing)</p>	28	51

also found that interviewees lacking social support were more likely to be left behind and experience anxiety and fear of learning and using digital technologies. These findings indicate a notable divide among interviewees regarding the social support available to them, which significantly influenced their digital participation. Our findings thus offer implications for addressing the digital divide and developing digital inclusion programs by highlighting the need for specific attention to be paid to elderly individuals who lack social support.

Our findings also suggest that these barriers were intertwined and collectively hindered the participants' digital learning and engagement. For example, the interaction between inadequate digital skills, physical challenges, and a lack of social support considerably exacerbated the interviewees' fear and unease regarding digital learning, particularly in dealing with technological problems when using specific digital devices and functions.

The elderly's attitudes toward digital learning and participation

Our findings underscore the various perceptions and attitudes of elderly interviewees toward digital technologies, China's rapid digitalization, and their digital learning and practices. We broadly categorize them into three types: participants who (a) showed optimism and were proactive self-driven digital learners, (b) perceived themselves as falling behind in terms of their digital literacy and skills, and (c) had relatively negative opinions and concerns about digitalization and digital engagement. Out of the 55 elderly interviewees, 8 exhibited extremely optimistic attitudes and actively participated in digital learning, 5 interviewees considered themselves to be lagging, and 7 showed more negative attitudes. Other interviewees, however, demonstrated mixed attitudes. For example, while expressing optimism about digital learning, they also felt they were falling behind and had concerns about the increasing digitalization. This indicates a significant variation in perceptions toward digitalization and digital learning among our interviewees.

The optimistic interviewees exhibited higher levels of self-motivation, open-mindedness, and a willingness to learn and adopt new technologies. They believed that technologies have greatly improved the convenience and efficiency of their lives and society at large, contributing in substantial ways to social progress and advancement. Several focus group interviewees from Xi'an expressed unwavering optimism about the potential of digitalization and technologies:

Interviewee 1 (66, male): 'Our lives would never have been so convenient without technologies like smartphones and AI robots. We've already benefited a lot. They will continue to bring more benefits to us.'

Interviewee 2 (63, female): 'Definitely, the [AI-enabled] robot machines can significantly improve our lives. I saw on TV they can help with cooking and cleaning and provide us with information like weather and traffic.'

Interviewee 3 (69, male): 'If we go back 10 years, no one could have imagined what we have today, where you can use your smartphone for everything. Owning a smartphone means owning the whole world. You don't even have to go out; you can do everything on it.'

The interviewees recognized the importance of technology and expressed a greater willingness to adopt new technologies. Some demonstrated a strong self-driven approach to learning by actively seeking opportunities to acquire new skills, experimenting with different digital devices, and exploring various sources of information to support their learning. One interviewee (82, male, Qingdao) exemplified this proactive mindset by stating, 'I'm eager to learn and try new functions and always ask my children to teach me. Since the smartphone has become such an indispensable tool, I want to use it more skillfully and enjoy more benefits.' We found that interviewees who received sufficient social support (e.g. from their families) and had access to more available and reliable social networks demonstrated greater optimism and enthusiasm for technological learning and participation.

By contrast, the second type of interviewees held a more pessimistic attitude toward their digital learning. They viewed themselves as significantly left behind and unlikely to catch up. One interviewee (67, male, Chongqing) used the term 'digital refugee' (数字难民) to describe himself and others who struggled to use digital technologies, 'I feel like we're digital refugees in this [digital] age. We're already so far behind. No matter how hard we try, it's too late for us to catch up.' The term 'digital refugees' was originally coined by Fryer (2006) to refer to elderly individuals who subjectively leave or are objectively excluded from the digital world. This group of interviewees also showed a more resigned attitude of 'letting it rot' (摆烂) toward digital learning, such as 'Since I've already fallen so far behind, I've given up on learning and don't want to work on improving my digital skills.' Furthermore, some interviewees showed reluctance, resistance, and even objection toward learning how to use digital devices and acquiring new skills. They perceived the new devices/functions as 'too complicated to learn' or considered it 'useless to acquire many digital skills.' They also believed that 'digital technologies are designed primarily for young people but not the elderly.' These perceptions were identified as pivotal factors shaping their unwillingness and rejection of digital learning and engagement. The perception that technologies are designed for young people aligns with Millward (2003), who observed similar attitudes among older adults.

The third type of interviewees held more negative attitudes toward accelerated digitalization and digital engagement. They perceived the rapid development of technologies as having more disadvantages than advantages, leading to multiple concerns about their digital participation. According to McDonough (2020), a negative attitude refers to feelings of discomfort and anxiety about using digital technologies. Some interviewees expressed worries that the exceptionally rapid digitalization in China triggers and exacerbates social issues like division, exclusion, and discrimination. They also raised concerns about increased anxiety and an addiction to digital devices, as well as added pressure on people's daily lives. As one interviewee (82, male, Qingdao) noted, 'I don't believe digital technologies can solve many problems but instead would create more problems. Digitalization is happening too fast and triggers a lot of anxiety. Many people are left behind. I don't think it's good for the long-term development of society.' Additionally, some interviewees voiced concerns about privacy and safety. They worried about the potential risks of personal information being leaked, exposure to digital frauds, scams, and deception, as well as fake information and rumors, especially relating to health, medicine, and the pandemic. These privacy concerns and the associated distrust

in technologies, as suggested by prior research, could serve as major barriers to technology adoption and participation among the elderly (Hill et al., 2015; Lee and Kim, 2019).

Our findings suggest that multiple factors, including age, pre-existing digital skills, learning abilities, education levels, desire for digital learning, social environment, and support, collectively contribute to shaping the diverse opinions of our interviewees regarding digitalization and their digital engagement. The paradox between some interviewees' expressed desire for digital learning and their actual practices is also highlighted. Despite recognizing the importance and benefits of digital technologies and desiring to improve their digital skills, some interviewees were discouraged by the perceived difficulties and time-consuming nature of digital learning, limited social support, actual health constraints, and fear of technologies, resulting in limited engagement. Therefore, addressing the concerns of the elderly regarding digital participation becomes significantly important. In addition, providing support to alleviate these issues could be a crucial step toward facilitating digital inclusion. The findings further highlight the significance of social support in the elderly's digital practices. Those who could rely on their families and social networks for support were better able to navigate the rapid digital transformation and adapt to the digital society, while those with limited social networks received less support, experienced more difficulties and concerns, and were more prone to be left behind.

Digital inclusion and the gap in digital outreach

Our analysis of the digital inclusion policies and measures implemented by the Chinese government suggests that the government has made multiple efforts at different administrative levels to address the digital divide and exclusion among the elderly population. These efforts include introducing tailored policies and implementing digital inclusion programs at both national and local levels to fulfill the demands of the elderly and facilitate their digital participation. Our findings align with prior research, underscoring the responsiveness of the Chinese government in releasing timely policies and measures to effectively tackle emerging social issues and cater to the interests and needs of its citizens (Qiaoan and Teets, 2019).

At the national level, the Chinese government has implemented various policies and schemes since the late 2020s to promote digital inclusion among the elderly. One notable reform initiative is elderly-oriented digital adaptation (数字适老化改造). In December 2020, the Ministry of Industry and Information Technology released its Special Action Plan for Aging and Accessibility Adaptation of Internet Applications (Gov.cn, 2020), which mandates online and mobile platforms in China to optimize their design, features, and functions to cater to the demands of elderly users. Following this guideline, many online/mobile platforms have developed and released elderly-oriented (or elderly-friendly) app versions (i.e. elderly versions; People's Daily, 2021). Our platform analysis of both elderly and general versions of different apps reveals that elderly versions are designed with more conspicuous icons, simplified interface and feature/function navigation, larger font sizes, voice search functionality, and the option to link accounts with their children's accounts, such as the family account (亲情账户), which enables children to provide technological assistance to their elderly family members when needed.

Table 2. Technical features and adaptations of elderly versions.

Name of app	Type of app	Adapted features/functions for the elderly app versions	Aims of adaptive measures
Weixin 微信	All-in-one social app	<ul style="list-style-type: none"> • Simplified interface design with reduced functions and information 	<ul style="list-style-type: none"> • Making it more convenient for the elderly to understand, remember, and operate the functions within the app
Douyin 抖音	Short video and live streaming	<ul style="list-style-type: none"> • Streamlined access navigation 	<ul style="list-style-type: none"> • Catering to the elderly's diminished physical capabilities (e.g. impaired eyesight and reduced hand and finger flexibility)
Taobao 淘宝	Mobile shopping	<ul style="list-style-type: none"> • Increased font, picture, and icon sizes 	<ul style="list-style-type: none"> • Enabling timely and effective assistance from other family members (especially the younger generation) to support the elderly
Industrial and Commercial Bank of China (ICBC) 工商银行	Mobile banking	<ul style="list-style-type: none"> • Voice search functionality 	
Zheliban 浙里办	Local mobile government app	<ul style="list-style-type: none"> • Family agents or accounts: Family members, such as children, can act as agents to apply for or register specific services or functions on behalf of their elderly family members (e.g. conducting digital payments, applying for hospital registration, and booking appointments) 	
Baidu Map 百度地图	Travel and transportation		
Eleme 饿了么	Food delivery		

Table 2 summarizes the technical features of the elderly versions of several apps and provides examples that illustrate how platforms have made adaptations to meet the needs of their elderly users.

With the increasing prevalence of mobile payments and the greater safety it provides through contactless transactions, especially during the pandemic, some commercial stores have adopted it as the only acceptable payment method. However, this poses many challenges for elderly people who may lack the digital capabilities to use QR codes and conduct mobile payments. The Chinese authorities quickly responded to this problem when the People’s Bank of China (2020) announced it would require all commercial places to accept cash from customers not using mobile payment. These measures effectively alleviate the pressure on the elderly in terms of digital participation, reflecting the government’s responsiveness and adaptiveness in addressing the consequences of rapid digitalization and the gray digital divide.

Many local governments have also implemented strategies to simplify digital participation for the elderly, thus alleviating the challenges of living in an increasingly digitalized society. For example, as scanning QR codes became a prevalent requirement for accessing public spaces and facilities during the pandemic, some local governments responded by introducing the ‘reverse QR code scan (反向扫码)’ policy. This approach

allows individuals to print out their QR codes (e.g. Health Codes) on paper or save the codes on their smartphones in advance. They can then show these codes to staff in public places if required, and the staff can scan their prepared codes. This approach is particularly helpful for those who may not know how to scan QR codes or cannot scan them on the spot, thereby alleviating concerns about potential scanning failures. For those who do not use smartphones, alternative means such as ID cards are permitted for accessing public places/services instead of QR codes. Several interviewees highlighted the benefit of this policy, as it greatly eased their burden and anxiety when going outside, particularly for those who were unfamiliar with QR technologies.

Our findings suggest that providing training opportunities, such as digital training workshops, programs, and volunteer services, to the elderly communities has become an increasingly common and essential aspect of the local governments' efforts toward digital inclusion. Interviews with local government officials reveal that collaborations between local governments and NPOs have facilitated the organization of various training activities to help elderly residents better engage with digital technologies and improve their digital skills. One local government official (38, male, Xi'an), responsible for organizing the digital training workshops, noted, 'We aim to help [the local elderly community] master the fundamental skills of using smartphones. Our classes are free and open to everyone. We teach them everything they need, like how to buy and order things online, hail taxis, seek information from reliable sources, pay fees, and use certain functions and apps. [. . .] We also set up volunteer stops within our community to assist them.'

However, our findings highlight a common challenge: Not all elderly individuals are interested in training. While some elderly residents were enthusiastic about attending these workshops, others showed limited interest. Some local governments used various incentives (e.g. gifts like eggs and oil) to encourage the local elderly residents to attend. However, attracting uninterested elderly individuals proved to be a challenge. One interviewee (32, female, Qingdao), a local government staff member responsible for advertising the workshops and managing the elderly's participation, described the predicament of 'tempting' the elderly, stating, 'We tried everything to boost their attendance, like sending them brochures and telling them they could receive gifts. But they simply aren't interested. Some people came only for the gifts; they just grabbed them and left.' According to the digital divide model (Van Dijk, 2006), the lack of motivational access (i.e. lack of interest in using digital technologies) can result in a digital divide. The dilemma noted by the local government interviewees and the barriers reported by our elderly interviewees both highlight how the lack of motivational access can be a primary factor causing digital exclusion. Our findings also support the argument of Jaarsveld (2020) that improving motivational access among elderly individuals is an essential initial step toward promoting digital inclusion.

However, most elderly interviewees had limited awareness of the digital inclusion policies and programs offered by local governments and rarely participated in them. This highlights a gap in digital outreach between the Chinese government's numerous efforts and the elderly interviewees' knowledge of and participation in these opportunities, further implying the possibly limited influence of these digital inclusion measures on the elderly. Out of the 55 elderly interviewees, only 6 mentioned they had 'heard something'

about elderly-oriented digital adaptation but had a limited understanding of it. The majority indicated they knew little about the digital reform and training opportunities provided by local governments but expressed a strong desire to attend training sessions and volunteer services to improve their digital skills. Only four interviewees had actually attended digital training workshops. Despite appreciating these training opportunities, they perceived the workshops as ‘not very useful’ because of the relatively short duration of the sessions/classes for learning sufficient skills, the fast teaching pace of the trainers/facilitators, the noisy environment, and the little attention paid to each participant’s problems. It is worth mentioning that, as our study focuses on a relatively small group of elderly participants, the identified gap in digital outreach may not represent all elderly groups. Digital inclusion programs and training opportunities may have varying outreach rate or result in different communities and districts. However, our findings still reveal the unexpected challenges in facilitating effective digital inclusion programs.

Instead of relying on collective training workshops to acquire digital skills, more than 90% of the elderly interviewees strongly preferred seeking assistance from their families when encountering digital challenges. Even those who received limited support from their families still preferred turning to family members for help. This preference stemmed from their belief that they need multiple repeated guidance and a considerable amount of time to master the skills, and they felt more comfortable and relaxed when seeking help from their families. Our findings highlight the crucial role of social support from families in the elderly’s digital engagement. This aligns with prior research that highlights family support as the most appealing way for digital learning (Friemel, 2016). Interestingly, while nine interviewees viewed digital learning as their own responsibility, the majority (84%) believed the government should be held accountable for assisting the elderly in their digital learning and participation and ensuring they are not left behind. They tended to attribute the digital exclusion of the elderly to the government’s decisions to accelerate digitalization and build a digital society.

Conclusion

The COVID-19 pandemic has played a pivotal role in driving the global adoption of digital technologies but has also exacerbated the digital divide and inequalities among different societal groups. This study focuses on the case of China to examine the gray digital divide and digital inclusion. Our findings reveal that elderly interviewees faced numerous challenges in their digital practices, such as accessing digital transactions, digital health care, and QR codes. The key barriers contributing to their digital exclusion include physical restrictions, lack of digital skills, interest, time and energy, and social support and networks. These findings align with and enrich previous research (Friemel, 2016; McDonough, 2020) while also underscoring that the lack of social support and available networks impeded the elderly’s ability to adapt to a rapidly digitalized society. Moreover, these factors have exacerbated their anxiety and pressure regarding digital participation. Based on their individual experiences with digital technologies, the elderly interviewees demonstrated varying attitudes toward digital learning and participation, ranging from optimism and a strong desire for digital learning to

viewing themselves as ‘digital refugees’ who are significantly left behind, and developing concerns about and distrust toward digitalization and digital participation.

Our findings also emphasize the significant efforts made by both central and local Chinese governments to reduce the gray digital divide and facilitate digital inclusion among the elderly. This highlights the responsiveness and adaptiveness of the Chinese authorities in adopting a more advanced and pioneering approach by developing prompt policies and programs to tackle emerging social issues and meet the needs of their citizens, thereby aligning with prior research (Qiaoan and Teets, 2019). However, despite these efforts, the majority of our elderly interviewees demonstrated little awareness of the government’s digital inclusion policies and measures and rarely participated in these activities. This underscores a significant gap in digital outreach and the possibly limited impact of authorities’ digital inclusion efforts on the elderly interviewees’ digital participation, which governments may need to address to boost the effectiveness of their digital inclusion initiatives.

This article contributes to the existing studies on the digital divide and digital inclusion, particularly in the Chinese context, where population aging and digital exclusion among the elderly have become increasingly prominent but have received limited scholarly attention. This research provides in-depth insights into the Chinese government’s efforts to enhance digital inclusion for the elderly population, thereby adding to the literature on adaptive and responsive authoritarianism. Moreover, the case study of China provides valuable practical implications for other countries to tackle the gray digital divide and related social issues. Specifically, our findings shed light on the gap in digital outreach, highlighting the importance and providing practical insights for policymakers and organizers of digital inclusion programs to develop effective strategies for increasing awareness and engagement among the elderly population.

This research has several limitations. Firstly, the sample size of elderly interviewees ($n=55$) is relatively small, which restricts the generalizability of the results. Most interviewees had physical access to digital technologies and devices, thus excluding financially disadvantaged elderly and those residing in remote areas with limited access to digital technologies. Their experiences of digital participation and exclusion may differ from those included in this study. Secondly, while this study includes elderly interviewees from different age groups, the majority were between 60 and 70 years old (65%). Therefore, their experiences of digital exclusion may not fully represent all age groups within the elderly population in China. To provide a more comprehensive understanding of the issue, future research should increase the sample size and examine the gray digital divide across a more diverse array of age groups, genders, locations, educations, occupations, and income levels.

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Note

1. Zheliban is a local mobile government app launched by the Zhejiang government in 2019. The elderly version of Zheliban was released in January 2022 (Zhejiang Daily, 2022).

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Appendix

Table A1. Sociodemographic information of the elderly participants ($n = 55$).

Items	Number	Percentage (%)
Age (years)		
60–65	20	36
66–70	16	29
71–75	8	15
76–80	7	13
81–85	4	7
Gender		
Male	22	40
Female	33	60
Districts		
East	26	47
Central	9	16
West	20	36
Education		
Uneducated	4	7
Elementary school	8	15
Middle high school	19	35
Senior high school	15	27
Bachelor's degree	9	16