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SMART PUBLIC SPACES AND ELDERLY CARE: THE ROLE OF DIGITAL TECHNOLOGIES IN ENHANCING QUALITY OF LIFE IN CHINA

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Abstract: As urban areas globally integrate smart public spaces, the elderly population's interaction with these technological environments is increasingly important. This study aims to investigate how smart public space design affects the quality of life of elderly individuals in urban China. Furthermore, it explores digital literacy as a mediator in this relationship, hypothesizing that the elderly's ability to navigate digital technology influences the extent to which they benefit from such spaces. A quantitative, cross-sectional research design was utilized to collect data from 134 elderly individuals (aged 60 and above) living in urban areas of China. A structured survey, based on validated measurement scales from past research, assessed smart public space design, digital literacy, and quality of life. SmartPLS 4.0 was used for data analysis, employing partial least squares structural equation modeling (PLS-SEM) to examine the direct and mediated relationships between the constructs. The findings reveal that smart public space design significantly enhances the quality of life of elderly individuals. Additionally, digital literacy plays a significant mediating role, emphasizing that elderly individuals with higher digital literacy are better equipped to leverage smart technologies in urban spaces. These findings contribute to the growing body of knowledge on age-friendly smart city development and underline the necessity for inclusive design principles. The results also imply that even the most advanced urban infrastructure cannot reach its full potential unless users, particularly the elderly, are equipped with the skills to interact with it effectively. Therefore, improving digital literacy among older adults is not just beneficial but essential in maximizing the impact of smart public environments. Practical implications include the integration of digital education initiatives within smart urban planning frameworks. This dual approach technological enhancement combined with human capacity development - ensures that the elderly population is not left behind in the rapidly evolving digital landscape of urban China. The study recommends policy interventions aimed at bridging the digital divide and promoting social inclusion. Future research may explore longitudinal impacts of digital literacy interventions on elderly wellbeing in smart cities.

Keywords: smart public space design, elderly quality of life, digital literacy, smart city infrastructure, urban aging

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INTRODUCTION

The fast pace of urbanization coupled with the development of digital technology has been a crucial factor in urban space planning and infrastructure. Urban infrastructure in contemporary times is becoming increasingly reliant on smart technologies in attempting to achieve greater accessibility, efficiency, and usability (Hui et al., 2023). In the majority of demographic populations, the older participant will be experiencing distinguishing barriers in accessing the city space in the form of mobility impairment, impairment in cognitive ability, and reduced social contact (Wang et al., 2025). With these barriers, the notion of Smart Public Spaces (SPS) has been being interpreted to take on greater importance, e.g., intelligent seats, green spaces, accessibility upgrade, and sensor-based navigation systems to enhance inclusiveness and quality of life of the older (Carnemolla et al., 2024). Such smart public space technologies are likely to improve autonomy, improve mental well-being, and improve mobility of the older (Ji et al., 2025). Despite such technological advancements, the usability of smart public spaces to enhance the quality of life of the elderly depends on their ability to learn and accommodate digital infrastructure, and thus there is a need for the inclusion of digital literacy as a mediator (Hui et al., 2023). In the absence of digital literacy, the elderly would neither be able to utilize digital kiosks, mobile applications, and navigation systems integrated in intelligent public spaces, and thereby leading to unequal access and usage (Arias Lopez et al., 2023). With greater reliance on technology-driven urban infrastructure, it is therefore crucial to understand how digital literacy acts as a mediator between intelligent public space planning and the quality of life among the elderly to facilitate the elderly to access these technologies to the optimum (Ciampa et al., 2023). More research has explored the impact of smart public spaces on older adults' mobility and well-being (Agboola & Tunay, 2023). Research has all indicated that sensor-based wayfinding smart public spaces have a significant impact on wayfinding by

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older adults, reducing stress and maximizing independence (Alataş & Arslan, 2023). Smart sitting spaces with climate, ergonomic support, and interactivity have also been found to increase relaxation and social interaction in older adults, resulting in general well-being (Arias Lopez et al., 2023). Green spaces in smart public spaces have also been associated with reduced stress, increased cognitive capacity, and increased physical activity in the elderly (Sugianto et al., 2024). Accessibility enhancement features such as digital kiosks, real-time transit information, and automated crossing have also been discovered to increase mobility and accessibility in the urban environment (Cugurullo et al., 2023).

Despite the research showing the advantage of smart public spaces on the quality of life of older people, it also shows that effective utilization of the resources is dependent on digital literacy (Ervianti et al., 2023). It has been proven through research that very digitally literate older people have a greater likelihood of utilizing smart public infrastructure, increasing mobility, social interaction, and psychological well-being (Farias-Gaytan et al., 2023). On the contrary, the individuals who are bounded in digital skills will become frustrated and isolated and will pose accessibility and independent living barriers (Marín & Castañeda, 2023). This emphasizes the necessity of considering digital literacy as an intervening variable in the smart public spaces and older adults' quality of life relationship.

Despite extensive literature on smart public spaces and the well-being of older citizens, there remain some gaps which need to be filled. To begin with, most of the studies have researched physical accessibility and environmental factors with no reference made to digital literacy in accessing smart public infrastructure (Nguyen & Habók, 2024). While some of the studies have made recommendations in terms of benefits of sensor-based navigation and digital kiosks, very few studies have conducted research on digital literacy needs that are needed in the efficient application of them (Novitasari et al., 2023). Second, existing studies have the general inclination towards researching general opinion in urban planning without reference being made to specific issues of older citizens with varied levels of digital literacy (Reddy et al., 2023). Most studies assume the premise that technological advancement naturally brings about inclusivity with no consideration of the digital divide between older individuals and limited exposure to technology (Yu, 2025). Third, while there are a few studies that have explored the direct impact of smart public spaces on the health of older individuals, there are limited studies that have examined the mediating role of digital literacy on the relationship directly (Yazdanmanesh et al., 2023). In the background of increasing reliance on digital infrastructure in cities, it is imperative to fill these gaps by exploring the impact of digital literacy on the extent to which older individuals can gain from smart public spaces (Al-Barakat et al., 2025).

The purpose of the present research is to examine how smart public space design affects elderly people's quality of life with a focus on the mediating effect of digital literacy. Through analyzing the different elements of smart public spaces, including smart seating, green spaces, accessibility features, and sensor-based navigation, this study aims to learn how these innovations in technology help in the improvement of the well-being and independence of older people. The research also seeks to investigate how digital literacy, the capacity to use and navigate these intelligent systems effectively, mediates the relationship between smart public space design and older people's quality of life. Since older adults have potential barriers to access digital technologies based on different levels of digital literacy, this study will shed light on the extent to which these barriers can affect the efficiency of smart public spaces in enhancing the lives of senior citizens (Chamboko-Mpotaringa et al., 2023). Finally, the research will provide suggestions for policymakers and urban planners regarding the design of inclusive and accessible public spaces that maximize the benefits of smart technologies to elderly groups while also enhancing the digital literacy of older people. By addressing these questions, the study seeks to provide a comprehensive understanding of how technological advancements in urban design intersect with digital literacy to shape elderly quality of life.

The implications of the study are significant to gerontologists, urban planners, and policymakers. By determining the mediating role of digital literacy in affecting the relationship between smart public space and the well-being of the elderly, the study will inform urban design standards towards ensuring maximum accessibility and inclusivity (Basnet et al., 2024). The study will offer prescriptive advice to enhance digital literacy for older persons so that they can maximize the usage of smart city spaces (Charoenkiatkan et al., 2024). Since the globe is shifting toward digital cities, researching the dynamics between older persons and smart infrastructure can help deliver age-friendly cities for enhancing independence, mobility, and well-being (Kim & Oh, 2024). Theoretical models used in this research are based on Technology Acceptance Model (TAM) and Ecological Systems Theory (EST). Perceived ease of use and perceived use are determinants of technology acceptance and use based on TAM arguments (Davis et al., 1989). Digital literacy in this research is a determinant of ease of use and usefulness in accessing smart public spaces and, therefore, the extent to which they achieve quality of life (Reddy et al., 2023). EST, on the contrary, accounts for the way the environment—urban infrastructure and technological facilities—interacts with the person characteristics and the way the interaction influences well-being (Cao et al., 2025). From these two, smart public spaces constitute a microsystem influencing the mobility and social interaction of older adults, and digital literacy is the personal resource that is an interaction mediator (Addas, 2023). Based on the integration of these theories, the research will attempt to construct an integrative model of the combined influence of digital literacy and smart city planning on older adults' well-being. Last, the research will be capable of informing evidence-based intervention design to improve the accessibility and usability of smart public spaces among older adults (Kabir et al., 2023).

LITERATURE REVIEW

In the past few years, the use of digital technologies in urban public spaces has been the prime driving force for enhancing the quality of life among older adults. As cities turn smart, digital interventions in the form of IoT-based infrastructure, AI-based health monitoring, and smart mobility solutions have effectively enhanced accessibility, security, and social inclusion among older adults (Mortaheb & Jankowski, 2023). Empirical evidence supported that AI-based embedded sensor networks and analytics-embedded smart public spaces facilitate timely monitoring of older adults,

ensuring timely medical response and security alerts (Štěpánek, 2023). For example, IoT-based fall detection and AI-based predictive analytics ensure foresight regarding the probable risks to health, thereby preventing hospitalization and overall well-being (Agboola & Tunay, 2023). Additionally, age-friendly smart digital infrastructure for urban planning such as smart lighting, voice-assisted, and auto-navigated systems has assisted in preventing mobility limitations and enhancing independent living (Salazar-Miranda et al., 2023). Mobile apps and digital kiosks with old-age-friendliness further enhance older adults' public place mobility, access to basic facilities, and social activity, reducing social isolation and enhancing better social participation (Hui et al., 2023). Besides physical infrastructure, application of digital platforms and virtual interaction technologies has transformed elder care with remote healthcare, cognitive stimulation, and intergenerational bridging (Goar et al., 2023; Hui et al., 2023). Telemedicine services aided by AI chatbots and wearable health-tracking devices have made it easier for older individuals to access medical consultation across geographical spaces, thereby enhancing health access and care continuity (Arias Lopez et al., 2023). Moreover, intelligent public spaces increasingly integrate virtual reality (VR) and augmented reality (AR) experiences intended for cognitive training, memory, and entertainment, promoting mental health and preventing risk of neurodegenerative disease (Basnet et al., 2024).

The promise of digital literacy programs, even more specifically aimed at preparing older individuals for technology adoption, is also well established in the current literature (Nguyen & Habók, 2024). Governments and planners increasingly appreciate the hidden function of policy frameworks embracing digital equity to ensure that older individuals are not left behind when the public space is digitalized (Novitasari et al., 2023). Through creation of a technologically inclusive space, intelligent public spaces are not only offering physical and psychological comfort but also active aging and lifelong learning, thereby making urban space more sustainable and age-friendly in the long term (Liang et al., 2024).

Smart public space design and quality of life of elderly

In recent years, the integration of digital technologies in public spaces has been at the forefront to enhance the well-being of aging communities, especially in urban areas (Carnemolla et al., 2024; Ervianti et al., 2023). Some of the key elements of smart public spaces include intelligent seating, green spaces, enhanced accessibility, and sensor-activated navigation (Yazdanmanesh et al., 2023). All the studies conducted so far have consistently shown that these attributes have the power to significantly impact old age welfare, both physical and mental (Cavada, 2023; Mortaheb & Jankowski, 2023). Greenspaces, for instance, have long been shown to be critical in reducing stress, improving cognitive ability, and promoting physical activity, particularly in the elderly (Hui et al., 2023; Salazar-Miranda et al., 2023). Similarly, the inclusion of smart seating and accessibility features such as ergonomic benches, automated temperature-controlled seating, and voice-directed information systems has been found to improve comfort and reduce physical discomfort for elderly individuals, with a resulting perception of control and well-being (Addas, 2023; Agboola & Tunay, 2023). Sensor-based navigation, another of the major features, enhances mobility by offering real-time assistance to the elderly, guiding them within public spaces and alerting them to potential obstacles or threats (Shiu, 2024). Such technologies are not only designed to enhance physical well-being but also to alleviate psychological pressure, allowing elderly individuals to move around in city spaces independently (Spicer et al., 2023). However, since the potential effectiveness of these intelligent interventions is so high, existing research focuses on very narrow geographic areas or small populations, limiting the generalizability of their findings (Cugurullo et al., 2023; Sugianto et al., 2024).

Empirical work on smart public spaces reveals highly valuable insights but also a number of limitations. For instance, research on green spaces has evidenced positive impacts on the health of the elderly, with elderly populations in urban communities reporting lower depression and anxiety levels when they regularly interact with nature (Kabir et al., 2023). These studies rarely consider the influence of technological attributes, including sensor-based navigation or intelligent seating, which are inherent to the concept of smart public spaces. Equally, studies on accessibility technologies, including digital wayfinding systems, have stressed enhancements in elderly mobility but did not extensively consider the socio-economic gaps that could influence how elderly people engage with these technologies (Goar et al., 2023). Another glaring omission in literature is that of digital literacy and how older adults, especially those without much technological competence, would be incapacitated from harnessing these advancements (Marín & Castañeda, 2023; Shiu, 2024). In addition, whereas research such as that by (Reddy et al., 2023; Salazar-Miranda et al., 2023) centers on smart mobility solutions, they tend to ignore the wider ramifications of deploying such technologies in socio-economically mixed urban settings, where technology access is constrained. Therefore, it is crucial that future research explore the intersection of digital equity, accessibility, and user-friendliness, ensuring that all elderly individuals, regardless of their technological literacy or socio-economic status, can fully benefit from smart public spaces.

H1: Smart public space design has a significant impact on quality of life of elderly

Digital literacy as mediator

The increasing body of empirical evidence underscores the important contribution that smart public spaces make to the quality of life of older adults (Alataş & Arslan, 2023). Some of the critical components like smart seating, green spaces, accessibility elements, and sensor-based wayfinding have been found to enhance mobility, social interaction, and overall health (Arias Lopez et al., 2023). For instance, smart seating systems with ergonomic features and IoT sensors can be designed to become more comfortable and safer by adapting to the body needs of the user and notifying them of potential risks, which significantly reduces the risk of falls and discomfort (Ervianti et al., 2023). Similarly, the presence of green spaces within cities has been linked to various health advantages including decreased stress, improved cognitive functioning, and increased physical activity, all leading to improved quality of life among elderly individuals (Reddy et al., 2023). It has also been shown

by research that accessibility enhancements, including voice-controlled systems and electronic kiosks, allow older people to move around public areas with greater confidence, lessening the social participation barriers and promoting a feeling of independence (Farias-Gaytan et al., 2023). Furthermore, sensor-based navigation systems that provide real-time route instructions and emergency calls have been known to decrease fear of getting lost, promote autonomy, and lower anxiety levels in the elderly (Carnemolla et al., 2024). Despite the positive results, other research also shows the limitation of the interventions, notably in terms of digital literacy (Yu, 2025). Major groups of older adults, especially from rural and low-income communities, are not provided with the access to utilize such advanced technologies, which can reduce their ability to efficiently use smart public spaces (Charoenkiatkan et al., 2024). This emphasizes the importance of special digital literacy interventions that provide older individuals with the competencies to communicate appropriately with smart city infrastructure.

Based on these findings, the mediating function of digital literacy in the relationship between smart public space design and the quality of life of the elderly becomes more apparent. Digital literacy is a critical element in the provision that older adults can effectively use the imbedded technologies in smart public spaces (Lee & Moon, 2023). There is evidence that greater digital literacy among older adults results in increased uptake of technologies such as sensor-based navigation, smart seating, and mobile applications designed to enhance accessibility and social interaction (Basnet et al., 2024). By increasing their ability to navigate and utilize these digital technologies, older persons can potentially live more independently and be more social, which helps generate improved physical and psychological health (Yu, 2025). The majority of older adults, particularly those with limited educational levels or who come from rural origins, will be limited in their capabilities regarding the utilization of such technology (Nguyen & Habók, 2024), minimizing how much they can actually make use of the elements of smart public space features (Nguyen & Habók, 2024). This shortage of digital literacy entails higher degrees of intervention in the way of digital literacy education for groups of the older generation (Charoenkiatkan et al., 2024; Lee & Moon, 2023). Evidence shows that enhancing digital literacy among older people strengthens not just their ability to engage in public spaces but also has various broader effects on their social integration and well-being (Hui et al., 2023). With the increasing application of digital technology in urban areas, closing the digital literacy gap becomes essential to empower all older individuals to benefit from the advancements of smart public space innovation.

H2: Digital literacy among elderly mediates the relationship between smart public space design and quality of life of elderly

Theoretical foundation for the analysis of the relationship between smart public space planning, digital literacy, and quality of life in old age is based on the Technology Acceptance Model (TAM) and Ecological Systems Theory (EST). TAM, as proposed by (Davis et al., 1989), posits that the usage and acceptance of technology by an individual are determined by perceived ease of use and perceived usefulness (Charoenkiatkan et al., 2024).

In the research context, smart public space design, for instance, smart seating, green areas, accessibility, and navigation through sensors, is high-tech urban infrastructure that improves the quality of life of older individuals. But how much the smart aspects are being used to optimal capacity relies on digital literacy, as dictated by TAM's principle that technology use is mediated by user competence and perceived ease of interaction (Basnet et al., 2024). Digital literacy is an intervening variable by facilitating elderly people in mobilization, access, and benefits realization from smart public spaces to maximize their well-being (Arias Lopez et al., 2023). Furthermore, Ecological Systems Theory (Chong et al., 2023) provides a broad framework by focusing on how environmental stimuli, including physical and technology systems, interact with individual characteristics in influencing development and well-being. The theory asserts that the quality of life of an individual is a function of interacting with the near environment (microsystem) and broader societal institutions (macrosystem), for example, city planning and digital equity policies (Shiu, 2024).

Smart public space as part of physical infrastructure is part of the microsystem, and digital literacy is one of the most fundamental individual-level factors explaining the level of usage of these spaces. When older adults possess required levels of digital literacy, they better fit into sensor-based wayfinding, smart seating adjustments, and accessibility features, and they enjoy greater mobility, autonomy, and social inclusion (Yu, 2025). Without digital literacy, older adults fail to enjoy the technological innovation, thus sustaining accessibility inequalities in cities and internet use (Kabir et al., 2023). Applying TAM's technology adoption model and EST's environmental determinisms (Figure 1), this model accurately explains smart public space designs' impacts on older adults' quality of life and how digital literacy serves as a critical transitional factor in mediating this advantage.

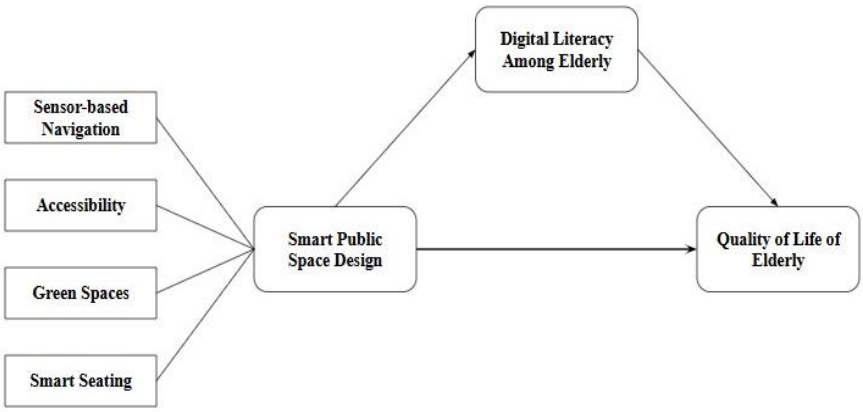

Figure 1. Conceptual framework

METHODOLOGY

This study used a quantitative, cross-sectional design to investigate the impact of smart public space design on the quality of life of older adults in urban China, mediated by digital literacy. With the growing use of smart urban infrastructure, this study sought to establish the impact of technological innovations in public spaces - e.g., smart seating, green spaces, accessibility, and sensor-based navigation - on the health of older adults. This study targeted older adults aged 60 and above living in Chinese urban cities where smart public spaces are becoming an increasingly integral part of lives. 134 respondents were interviewed, and data were collected in public parks, community centers, and transport hubs where smart technology is extensively used. Convenience sampling was applied owing to the availability of older adults in digitally augmented public spaces. The survey instrument used validated measures from the literature to guarantee the reliability of measurements. Constructs were assessed with multiple items per dimension, and ratings were made on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The independent variable, intelligent public space design, was operationalized on four dimensions: intelligent seating, green space, accessibility, and sensor-integrated wayfinding. The four dimensions were all measured using three indicators to measure users' feelings of comfort, usability, and accessibility. The dependent variable, quality of life, was gauged by six items capturing physical well-being, emotional happiness, and social interaction. The mediator, digital literacy, included seven items that captured the capacity of the elderly population to make use of technology, interact with intelligent infrastructure, and utilize digital platforms in city spaces.

To ensure ease of response and understandability, the survey was administered electronically and in hard copy, to suit participants with varying levels of comfort with digital media. Data collectors offered assistance in interpreting survey items where necessary, to reduce the likelihood of misinterpretation or non-response bias. Data collection was from among older adults who actively use smart public spaces, to ensure that responses reflected real experience with digital infrastructure. SmartPLS 4.0 was used to analyze data and test the measurement and structural models. Construct reliability and validity were initially tested using Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). Discriminant validity was tested using the heterotrait-monotrait (HTMT) criterion to confirm that the constructs were sufficiently different. Structural model analysis tested direct and mediated relationships using path coefficients, t-values, p-values, and R^2 values, to verify the statistical significance of the hypotheses. The methodological approach provided robust insights into how smart public space design enhances elderly well-being, both directly and through digital literacy. The integration of validated measurement scales, a structured sampling process, and advanced statistical techniques ensured a rigorous and reliable analysis of the research problem. By focusing on urban China’s smart city initiatives, this study contributes to a deeper understanding of the role of digital infrastructure in supporting aging populations.

RESULTS

Table 1 establishes construct validity and reliability of Smart Public Space Design (SPSD), Quality of Life (QOL), and Digital Literacy (DL) with satisfactory convergent validity and internal consistency. Cronbach's Alpha values for all the constructs are greater than the suggested 0.7 value, indicating high reliability, while SPSD = 0.933, QOL = 0.898, and DL = 0.891.

Table 1. Construct reliability and validity

Construct	Items	Outer Loading	Cronbach's Alpha	CR	AVE
Smart Public Space Design	SPSD1	0.479	0.933	0.942	0.527
	SPSD2	0.828			
	SPSD3	0.714			
	SPSD4	0.801			
	SPSD5	0.514			
	SPSD6	0.763			
	SPSD7	0.836			
	SPSD8	0.609			
	SPSD9	0.613			
	SPSD10	0.617			
	SPSD11	0.734			
	SPSD12	0.777			
	SPSD13	0.851			
	SPSD14	0.804			
	SPSD15	0.802			
Quality of Life	QOL1	0.851	0.898	0.922	0.664
	QOL2	0.804			
	QOL3	0.802			
	QOL4	0.820			
	QOL5	0.876			
	QOL6	0.877			
Digital Literacy	DL1	0.837	0.891	0.914	0.605
	DL2	0.730			
	DL3	0.737			
	DL4	0.755			
	DL5	0.677			
	DL6	0.712			
	DL7	0.809			

Composite reliability (CR) values also indicate the high reliability of constructs with all of them greater than the suggested value of 0.7, with SPSD = 0.942, QOL = 0.922, and DL = 0.914. Average Variance Extracted (AVE) values for all the constructs are greater than the 0.5 mark, with SPSD being 0.527, QOL being 0.664, and DL being 0.605, with adequate convergent validity. Since all the AVE values are above 0.5, outer loadings greater than 0.4 but less than 0.7 are also acceptable and make the construct valid. In SPSD, even though some items such as SPSD1 (0.479), SPSD5 (0.514), SPSD8 (0.609), SPSD9 (0.613), and SPSD10 (0.617) have lower outer loadings, they still fall within the acceptable limit and therefore validate the construct's reliability and validity. Likewise, in Digital Literacy, DL2 (0.730), DL3 (0.737), and DL5 (0.677) fall within the acceptable limit, validating the construct's stability. These findings confirm the measurement model (Figure 2), ensuring that the constructs are well measured and possess the required reliability and validity for further analysis.

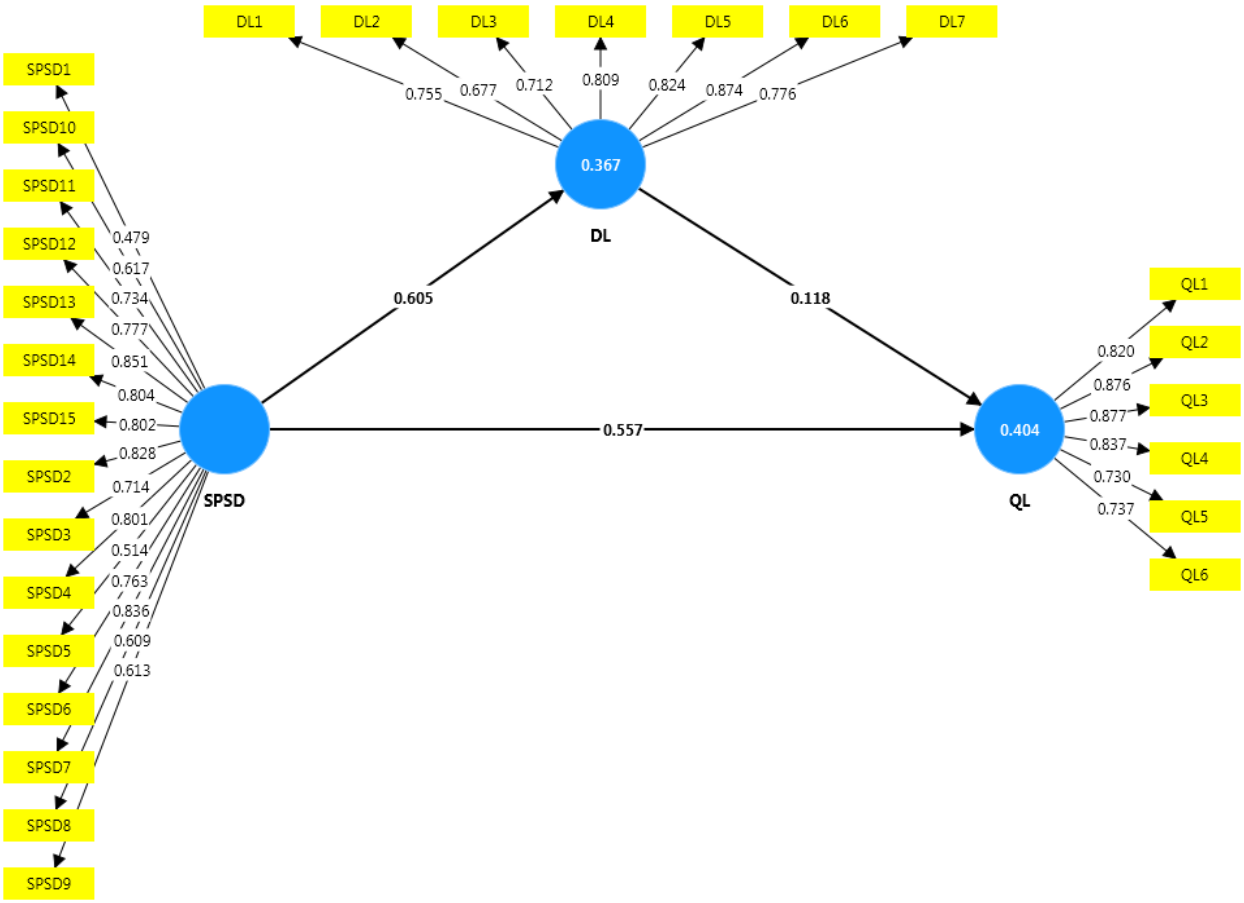

Figure 2. Measurement model

Table 2 assesses discriminant validity through the Heterotrait-Monotrait (HTMT) criterion to guarantee that the constructs are different from each other. HTMT values based on the HTMT benchmark below 0.85 establish good discriminant validity, while values between 0.85 and 0.90 indicate potential problems, and values of 0.90 and above indicate failure of discriminant validity. The HTMT values between constructs in this study are within acceptable range, with SPSD and QOL (0.497), SPSD and DL (0.635), and QOL and DL (0.670) all below the 0.85 threshold. The results validate each construct as measuring a different concept, further supporting the measurement model robustness. The acceptable HTMT values further establish that there is no multicollinearity or over-lap between the constructs, further supporting the theoretical model validity. Table 3 presents evidence regarding the explanatory ability and predictive significance of the structural model. R^2 values provide evidence of the proportion of variance explained by the independent variables in the dependent variables, and Q^2 values provide evidence of predictive relevance using the blindfolding technique.

Table 2. Discriminant validity (HTMT Criterion)

Constructs	SPSD	QL	DL
Smart Public Space Design			
Quality of Life	0.497		
Digital Literacy	0.635	0.670	

Table 3. Coefficient of determination and predictive relevance

Constructs	R2	Q2
Quality of Life	0.404	0.372
Digital Literacy	0.367	0.349

The results show that Smart Public Space Design explains 40.4% variance in Quality of Life ($R^2 = 0.404$), and 36.7% variance in Digital Literacy ($R^2 = 0.367$). The values reflect a moderate explanatory ability of the independent variables. Furthermore, the Q^2 values for Quality of Life (0.372) and Digital Literacy (0.349) are positive, which supports that the model has adequate predictive relevance. Since Q^2 values greater than zero reflect that the model has predictive power, results affirm the ability of the model to predict and explain the constructs well.

Table 4 shows the result of hypothesis H1, testing the direct relationship between Smart Public Space Design and Quality of Life. The path coefficient (β) of 0.557 is a strong positive correlation, showing that improved smart public space design has a strong positive relationship with improved elderly quality of life.

The t-value of 5.475, which is larger than the critical value of 1.96, and the p-value of 0.000, which is smaller than the 0.05 significance level, confirm that this relationship is statistically significant. These findings confirm H1, supporting previous studies that highlight the need for good infrastructure, green spaces, and accessibility features to improve elderly well-being. The strong positive coefficient suggests that urban developers and policymakers must prioritize inclusive and technology-facilitated public spaces in order to enhance elderly well-being.

Table 4. Direct Path Analysis

Hypothesis	Relation	Path Coefficient (β)	t-Value	p-Value
H1	Smart Public Space Design → Quality of Life	0.557	5.475	0.000

Table 5 examines H2, stating that digital literacy mediates the influence of Smart Public Space Design on Quality of Life. The measure records a path coefficient (β) value of 0.269, indicating a statistically significant indirect influence of SPSD on QOL through digital literacy. The t-value of 5.75 is greater than the typical cut-off, and the p-value of 0.000 indicates that mediation effect is statistically significant.

Table 5. Mediation Analysis

Hypothesis	Relation	Path Coefficient (β)	t-Value	p-Value
H2	Smart Public Space Design → Digital Literacy → Quality of Life	0.269	5.75	0.000

The above finding supports H2 and indicates that more digitally literate older individuals take the most advantage of the benefits provided by smart public spaces, resulting in an equivalent improvement in the quality of life. This has serious implications and emphasizes the importance of digital training programs as well as end-user-friendly technical interfaces to enable older individuals to make effective use of smart public spaces. The statistically significant mediation effect supports the contention that technological adoption is not infrastructure-dependent but also user-capability-dependent and therefore promotes efforts to enhance older individuals' digital literacy, as shown in Figure 3.

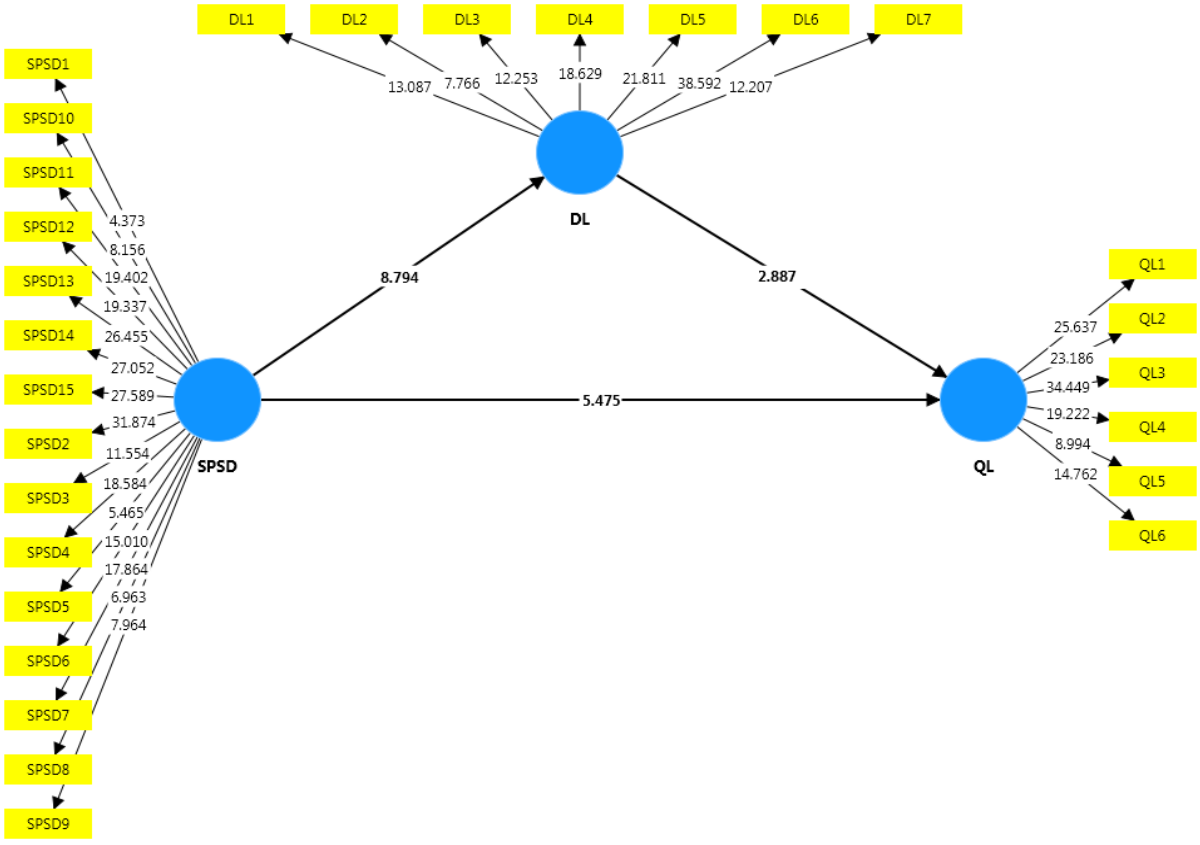

Figure 3. Structural Model

DISCUSSION

The fast pace of smart technology development has revolutionized urban areas, defining a new paradigm of public space design focused on inclusivity, accessibility, and improved quality of life (Zhao et al., 2024). With aging populations in societies across the globe, the contribution of smart public spaces to the mobility, autonomy, and social interaction of the elderly has been under the limelight. This study adds to this debate by empirically investigating the contribution of smart public space design, including smart seating, green space, accessibility, and sensor-aided navigation, to the quality of life of elderly citizens (Agboola & Tunay, 2023). It also investigates the mediating influence of digital literacy, the realization that technologically enhanced space is full of promise but whose potential is still subject to the ability of elderly users to access and use it. The findings affirm the contribution of good public space design to the well-being of the elderly but note that the association is exponentially increased when elderly citizens have the digital competencies to optimize the use of smart infrastructure (Spicer et al., 2023). By combining urban planning, gerontology, and technology adoption theory, this study gives a comprehensive explanation of how smart urban infrastructure can be leveraged to improve the lived experience of the elderly. The discussion below critically interprets these findings and places them within the existing academic literature while explaining their implications for policymakers, urban planners, and technology developers.

The findings of this study affirm that intelligent public space planning, smart seating, green areas, accessibility, and sensor-based way finding immensely improves the well-being of older people. This agrees with current research that has established that smart technologies in well-designed cities enhance mobility, social contact, and health of elderly individuals (Hui et al., 2023). Implementation of sensor-based way finding system has been successful in enhancing wayfinding, stress relief, and independent mobility among elderly, a stepping point to independence and well-being (Kabir et al., 2023). Installation of smart seating systems by means of ergonomic adjustment, climatic control, and interactive communication capability has worked to enhance comfort and ease of social contact, enhance emotional well-being and sense of belonging (Lim et al., 2024). Green space integration within smart public space design has proven to be effective in alleviating psychological distress, enhancing cognitive function, and calming the mind, in agreement with previous research that has proved the therapeutic use of urban green space among older adults (Mortaheb & Jankowski, 2023). The results of the study are also consistent with the reality that enhanced accessibility features such as automatic pedestrian signals, digital signs, and real-time transit information enhance the independence of elderly people, thus making them have easy and confident access to public space (Reddy et al., 2023). Total results are therefore in line with the hypothesis that sophisticated public space design is a crucial determinant of quality of life for older individuals via enhanced mobility, inclusivity, and psychological comfort.

The findings in this research further contribute more proof to the premise that digital competence is an essential mediator of smart public space design effect on well-being among old adults. The research also adds more proof that innovation of urban infrastructure using technology is not the worth if individuals do not have the proper abilities to gain ultimate utilization from technological innovations. This is consistent with current research evidence indicating that digitally literate older people are better placed to be able to make use of sensor-based navigation, touch-screen kiosks, and real-time public transport information to maximum benefit, and therefore maximize maximum autonomy and overall well-being (Ervianti et al., 2023). The findings draw attention to the point that elderly individuals with proper digital skills encounter fewer barriers of access, and hence are optimally placed to gain maximum value from smart sitting spaces, touch-screen health monitoring kiosks, and other digital services within the public environment (Yazdanmanesh et al., 2023). In addition, digitally highly literate people also possess higher self-efficacy and the propensity to actively use smart urban spaces to optimal advantage, thereby resulting in optimal mobility, more social relations, and more psychological well-being (Basnet et al., 2024). On the other hand, however, this research also validates the reality that older individuals with poor digital literacy are likely to be left behind in the benefits of smart public spaces because of the risk of struggle or intimidation in using sensor-based navigation, touch-screen kiosks, and other digital technology (Kim & Oh, 2024). These results empirically add evidence to the hypothesis that digital literacy is a strong predictor of the level to which older persons can utilize and benefit from smart public places.

The findings of this study highlight the significance of a multi-dimensional approach to elderly-friendly urban planning, where physical infrastructure and digital empowerment go hand in hand. The acceptance of H1 suggests that smart public space planning has a direct influence on the well-being of older adults, reiterating the significance of age-inclusive design features such as smart seating, green spaces, and sensor-based way finding. The acceptance of H2 also reiterates that digital literacy is the key facilitator in realizing the full potential of smart public spaces, reiterating that infrastructure is crucial but not enough without attempts to overcome the digital divide among elderly groups. The implications of these findings have far-reaching implications for urban development policy, suggesting that future smart cities must incorporate not only technological innovation but also digital training programs and accessible interfaces to ensure equal access. With urban sprawl continuing, the integration of smart public spaces with digital literacy programs will be essential in creating an inclusive environment where older adults can live with dignity, autonomy, and enhanced well-being. This study, therefore, presents a starting point in redefining smart urban spaces as dynamic ecosystems empowering aging groups through physical and digital accessibility, paving the way for future research and policy innovation in this critical field.

Implications

This work contributes important theoretical insights by synthesizing urban planning, gerontology, and technology adoption theory to analyze the effects of smart public space design on older people's quality of life with the mediating

variable of digital literacy. This work extends the Environmental Press Theory (Hui et al., 2023) by demonstrating that smart public spaces, in terms of attributes such as intelligent benches, green areas, accessibility enhancement, and navigation using sensors, are able to shape the built environment in such a way that it modulates environmental demands and encourages the well-being of older people. The study also extends Technology Acceptance Models (Charoenkiatkan et al., 2024) by proving that digital literacy is the prime facilitator in the maximization of smart urban infrastructure benefits, proving the perceived ease of use and usefulness of technology to be the sine qua non determinants for older people to participate in intelligent environments.

Finally, this work supports Active Aging Theory (Agboola & Tunay, 2023) by proving that public space design as well as digital empowerment increases mobility, social contacts, and life satisfaction among older individuals. The study also extends Smart City and Inclusive Design Theories (Shiu, 2024) by empirically proving that digital inclusion is the bottom-line driver that makes the smart city an age-friendly city, proving that it is not only the establishment of technologically advanced spaces that needs to be prioritized by urban planners but also facilitating the use of such facilities by older people. Through the identification of a causal link between physical space, digital know-how, and well-being outcome, this research extends interdisciplinary theories that integrate the domains of urban planning, human-computer interaction, and gerontology, thereby ultimately offering an equitable understanding of the potential of the use of smart technologies to create an inclusive, sustainable, and age-friendly city.

The findings of this research offer important practical implications for urban planners, policymakers, technology developers, and eldercare service providers to enhance the quality of life of aging populations through smart public spaces.

First, the research highlights the importance of municipal governments and urban planners giving high priority to age-friendly smart public space design, with the promise that such facilities as smart seating, green spaces, improved accessibility, and sensor-based wayfinding are well integrated into cityscapes to support elderly mobility, comfort, and social interaction.

Second, in consideration of the mediating effect of digital literacy, governments and local community organizations need to introduce targeted digital literacy training programs to enable elderly individuals with skills to effectively use and navigate smart public infrastructure. Public-private partnerships can play a crucial role in developing user-friendly digital interfaces and assistive technologies specifically tailored for elderly users, with the promise that they can navigate smart navigation systems, digital kiosks, and other urban digital solutions with confidence.

Third, healthcare and social service providers need to leverage smart public spaces to enhance telehealth access, emergency response systems, and AI-based health monitoring tools to enhance elderly safety and well-being in outdoor spaces. Technology companies need to design intuitive, accessible digital tools to support older adults, such as voice commands, simplified touch interfaces, and AI-powered assistance to support usability.

Finally, policy interventions need to ensure that smart city projects are inclusive and equitable, particularly in bridging the digital divide among elderly individuals of different socioeconomic backgrounds. By facilitating cross-sector collaboration, cities can effectively develop age-friendly smart spaces that are not only physically accessible but also empower older adults with the digital competence to fully participate in urban living, thus contributing to a more sustainable, inclusive, and technology-enabled aging society.

Limitations and future directions

Although it has been of productive benefit, this study has certain limitations that must be taken into account. Firstly, the study used a cross-sectional design, which prevents causal inferences between smart public space design, digital literacy, and quality of life from being drawn. Future research may use longitudinal or experimental designs to consider in more detail how enhancements in smart urban infrastructure and levels of digital literacy affect elderly well-being across time. Secondly, the study relied mainly on self-reported measures, which are potentially susceptible to social desirability bias or recall error. Using objective measures—e.g., monitoring digital activity, mobility behavior, or physiological measures of health—may provide more comprehensive and persuasive evidence of how elderly individuals utilize smart public spaces. Thirdly, the study is geographically limited within China, and results may not be entirely generalizable to other cultural or urban contexts where smart city development, levels of digital literacy, and elderly care policy may vary significantly. Future research may use comparative analyses between countries or urban-rural areas to identify how contextual factors affect the effectiveness of smart public spaces in enhancing elderly quality of life.

Besides, this study is primarily focused on physical and virtual dimensions of accessibility in smart public spaces but not on psychosocial or behavioral determinants that can influence elderly technology interaction. Future studies will need to examine cognitive processes, technological resistance, and psychological adaptation comfort levels in utilizing smart urban infrastructure. Additionally, although digital literacy is the main mediator as established by this study, social connectedness, perceived value of technology, or technology anxiety are other variables that can further elucidate how elderly can take advantage of smart city policies.

Future studies should also investigate intersectionality dimensions, e.g., gender, socioeconomic status, and medical conditions, to assess how various elderly segments utilize smart public spaces. Lastly, technological advancements, e.g., AI-based urban planning, IoT-based elderly monitoring, and smart assistive technologies, are in rapid development, and hence ongoing studies should assess how innovative digital technologies can further support elderly independence and urban participation. Closing these research gaps and further extending future studies will allow researchers to create more integrated, inclusive, and technology-enabled urban spaces that can best address the needs of the aging population.

CONCLUSION

This research provides a comprehensive examination of how intelligent public space planning, digital literacy, and adoption of urban technologies together shape older adult well-being. Synthesizing evidence from urban planning, gerontology, and technology acceptance theory, the research empirically demonstrates that intelligent public space facilities such as smart seating, green spaces, accessibility upgrades, and sensor-guided wayfinding play a significant role in enhancing older adult well-being. Furthermore, the findings confirm digital literacy as the crucial mediator, affirming that it is not sufficient to plan technologically advanced public spaces unless older adults also have the associated digital competences to effectively make use of them. The findings have important theoretical and practical implications, challenging urban planners, policymakers, and technology developers to adopt an inclusive, human-centered approach in planning smart cities that are not only physically accessible but also digitally accessible.

Though it makes important contributions, the research identifies limitations such as cross-sectional design limitations, the use of self-reported measures, and geographical coverage, suggesting potential directions for future research in longitudinal assessments, objective behavioral monitoring, and cross-cultural comparisons.

With the world becoming increasingly urbanized and digitalized, this research underscores the urgent need to link smart technologies with forward-looking elderly care systems, so that aging populations can fully participate in and benefit from the digital revolution of public spaces. By advancing technological empowerment and inclusive urban planning, societies can plan age-friendly smart environments that facilitate mobility, independence, social interaction, and overall life satisfaction of older adults in the digital era.

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