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A Framework for Leveraging the Capacities of Digital Technology to Improve the Quality of Life of Older Adults in Urban Public Space Design, Case Study: Zand Street, Shiraz, Iran

***Esmaeil Fotovat*[1], *Seyed Ali Safavi*[2*], *Bahareh Tadayon*[3], *Seyed Mohammad Rashtiyan*[4]**

[1] Department of Urbanism., Tourism, Architecture and Urban Research Center, Isf.C., Islamic Azad University, Isfahan, Iran. Email: e.fotovat@iau.ac.ir
[2] Department of Urban Planning, Art & Architecture Faculty, Tarbiat Modares University, Tehran, Iran. Email: sasafavi@modares.ac.ir
[3] Department of Urbanism., Tourism, Architecture and Urban Research Center, Isf.C., Islamic Azad University, Isfahan, Iran. Email: b.tadayon@iau.ac.ir
[4] Department of Urbanism., Tourism, Architecture and Urban Research Center, Isf.C., Islamic Azad University, Isfahan, Iran. Email: rashtiyan@iau.ac.ir

[*]**Corresponding author:** Seyed Ali Safavi

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Abstract

The current research was conducted with the aim of explaining and presenting a framework for utilizing the capacities of digital technology to improve the quality of the elderly's presence in urban public spaces, focusing on Zand Street in Shiraz through a mixed and analytical approach. This study identifies and prioritizes components enhancing the elderly's presence while analyzing the spatial and functional characteristics of the environment. First, documentary studies and literature reviews were used to extract indicators affecting the quality of elderly presence across physical, social, technological, functional, natural, and managerial dimensions. To understand actual conditions, field analyses including direct observation and environmental surveys of Zand Street were conducted. This stage identified behavioral patterns, spatial strengths/weaknesses, and user interactions with environmental elements and existing technologies. Subsequently, the Analytic Network Process (ANP) measured the relative importance of indicators and analyzed their interrelationships. Data were collected through purposive questionnaires from elderly users with continuous experience in the studied space. Finally, ANP results and field findings were integrated to provide a practical framework for age-friendly public spaces emphasizing real environmental characteristics and user experience. Findings showed that while physical and social dimensions are foundational for active presence, digital technology acts as a facilitating factor. Results also indicated that a safe and accessible environment is a prerequisite for effective technology use and social interaction, while smart urban management can improve the effectiveness of other indicators. This research provides an integrated analytical framework combining spatial design and digital technology, serving as a practical guide for the design and management of age-friendly public spaces.

Keywords

Digital Technology, Quality of Life, Elderly, Urban Public Spaces, Zand Street in Shiraz

Introduction

With the increasing elderly population in the cities of Iran and the world, attention to the quality of urban public spaces as one of the key factors in enhancing the physical, psychological, and social well-being of this group has gained increasing importance (WHO, 2021; Lak et al., 2020). Due to mobility limitations, decreased physical capacity, and a greater need for social interactions, the elderly face challenges in using urban environments that can lead to a decrease in their quality of life and social isolation (Younes et al., 2024). Despite the emphasis on the design of age-friendly spaces, many urban public spaces still lack the features that guarantee the safe, independent, and active presence of the elderly. In recent years, the development of urban digital technologies has provided new possibilities for improving the experience of presence in public spaces. Tools such as smart navigation systems, urban applications, and environmental monitoring systems can play an effective role in improving the quality of life of the elderly by enhancing accessibility, safety, and social interactions (Bastardo et al., 2022; Jonek-Kowalska, 2025). However, a major part of these solutions has been developed individually and without a systematic connection to spatial design principles, and consequently, their impact at the scale of urban public spaces has remained limited.

On the other hand, although the design thinking approach, as a human-centered approach, has a high capacity for deeply understanding user needs and developing creative solutions (Brown, 2009), its application in integrating digital technologies with the design of age-friendly public spaces, especially in the context of Iranian cities, has not been systematically investigated (Figure 1). This gap indicates that there is still no integrated framework to link spatial design components, digital technology, and the specific needs of the elderly (Jonek-Kowalska, 2025). Accordingly, the main problem of this research is how to provide an efficient framework for enhancing the quality of life of the elderly in public spaces by combining digital technologies and urban design principles. In this regard, the present research, focusing on Zand Street in Shiraz, attempts to identify and prioritize the components effective in improving the quality of age-friendly public spaces by utilizing a design thinking approach and analytical methods. This research seeks to provide the ground for practical solutions in the design and management of public spaces while explaining the relationships between indicators such as safety, accessibility, social interaction, visual identity, and smart management. This research is innovative from several perspectives. First, the study offers an integrated conceptual framework that simultaneously incorporates spatial design components, social interactions, and digital technologies to analyze the quality of older adults' presence in public spaces. Second, by combining spatial analysis with the ANP method, the study facilitates the identification of complex relationships and the prioritization of indicators, whereas most previous studies have examined these factors in a unidimensional manner. Third, the focus on the Iranian urban context and the application of the design thinking approach distinguish this research contextually and methodologically.

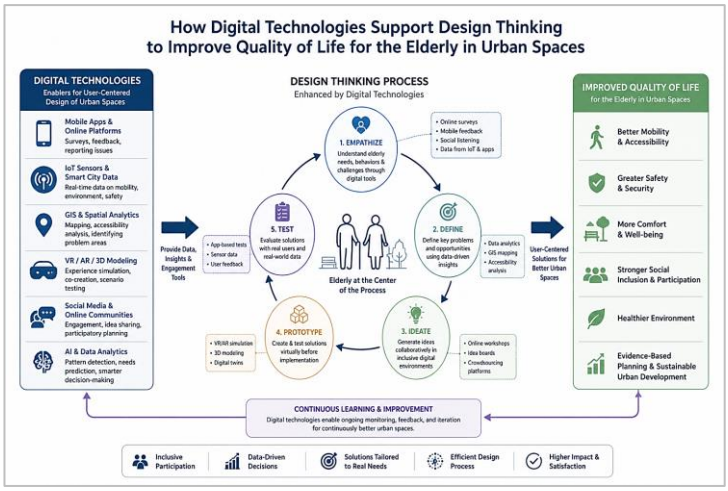

Figure 1: *The relationship between the use of digital technologies in the design thinking process of elderly-centered urban spaces*[1] (Source: Authors)

[1] The figures in the manuscript were prepared based on the research findings and were illustrated with the assistance of ChatGPT/DALL·E.

Theoretical Foundations and Literature Review

Urban public spaces, as the main context for social interactions and daily activities, play a decisive role in enhancing the quality of life of citizens, especially the elderly. By providing the possibility of active presence, social interaction, and aesthetic experience, these spaces can help improve the mental and physical health of the elderly (Gehl, 2011; Buffel et al., 2018). However, the increasing trend of the aging urban population, along with challenges such as reduced mobility, feelings of unsafety, and limited access to services, indicates that conventional patterns of public space design do not meet the needs of this group (Beard et al., 2016). In recent years, urban digital technologies have been proposed as one of the novel solutions for enhancing the quality of public spaces. Tools such as smart information systems, environmental sensors, and urban service applications provide capacities to improve accessibility, increase safety, and strengthen social connections (Batty et al., 2012). Nevertheless, a significant portion of existing studies has examined technological functions individually and has paid less attention to the systematic integration of these technologies with user-centered urban design principles. Also, in many of these studies, the specific characteristics of elderly users, including perceptual and mobility limitations and behavioral patterns, have not been adequately incorporated into the design process (Peek et al., 2014). International studies show that the application of smart technologies can lead to increased participation and independence of the elderly. For example, Younes et al. (2024) and Liu (2025) have emphasized the role of digital technologies in redefining public spaces and promoting social equity in smart cities. Furthermore, case studies in Japan (Kawaguchi et al., 2024) and other countries point to the positive impact of digital tools on increasing the presence and interaction of the elderly. However, these studies have predominantly been conducted in developed contexts, and their generalizability to different social and spatial contexts, particularly in developing countries, is accompanied by ambiguity. In Iran as well, although some studies have addressed the role of technology in improving the quality of life of the elderly (Ahari & Maqami, 2021), their focus has mostly been on educational or individual aspects, and its connection with urban public space design has received less attention. Moreover, a specific framework for integrating spatial design indicators with digital technology components to enhance the quality of life of the elderly has not been presented. Based on this, the main gap of the current research can be considered the lack of an integrated framework for analyzing and prioritizing the design components of public spaces based on digital technology, with an emphasis on the needs of the elderly. In this regard, the present research, focusing on indicators such as safety, accessibility, social interaction, visual identity, and smart management, which have been derived from the literature and field studies, attempts to explain the role and relative importance of these components in enhancing the quality of life of the elderly in urban public spaces through an analytical approach. Accordingly, the evaluation indicators in the current research have been extracted, and Table 1 presents them separated by domains:

Table 1: *Quality of life indicators for the elderly* (Source: Authors based on research sources).

Criterion	Indicators	Description
Permeability and connectivity	Easy access to routes, presence of safe pedestrian paths	Ability of older adults to move independently in urban spaces
Public realm and behavioral setting	Accessibility for people with mobility limitations, appropriate design of urban furniture	Ensuring the presence of all older adults in public spaces
Visual identity and character	Design consistent with urban culture, understandable visual signs	Creating a sense of place and a positive visual experience
Safety and security	Adequate lighting, environmental surveillance, reduction of environmental hazards	Reducing accident risk and increasing the sense of security
Social interactions	Seating spaces, places for social interaction	Encouraging social interactions and active presence
Technology and digital systems	Smart information systems, sensors, urban applications	Improving access to urban information and services

Mixed land use	Combination of service, recreational, and cultural uses	Creating diverse opportunities for activity and interaction
Energy-Efficiency	Efficiency in energy use and environmental resources	Maintaining sustainability and the health of the urban environment
Integration with nature	Green spaces, shading elements	Enhancing psychological well-being and environmental health
People and smart management	Data management and optimization of urban services	Data-driven decision-making to improve QoL

Methodology

Urban public spaces play a key role in enhancing the quality of life of the elderly; however, many of these spaces do not respond to the specific needs of this group. In recent years, digital technologies have been proposed as a novel tool for improving the quality of presence in public spaces, but the lack of an integrated framework for combining these technologies with age-friendly urban design is considered one of the fundamental gaps in this field. The current research was conducted with the aim of explaining and prioritizing the components effective in improving the quality of the elderly's presence in public spaces, with an emphasis on the capacities of digital technology, on Zand Street in Shiraz. In this regard, the research, utilizing a mixed approach in the first step, alongside extracting the important indicators related to the components involved in the extent and manner of the elderly's presence in urban spaces, proceeded to survey the interactions of the elderly in the study area by recording behavioral patterns, places of presence, and movement paths, and refined the indicators obtained from the library studies. In the next step, key indicators in physical, social, technological, functional, natural, and managerial dimensions were identified, and by utilizing the Analytic Network Process (ANP) method and an analytical approach, their relationships and relative importance were investigated.

The research population included the elderly present on Zand Street in Shiraz who had the experience of using the public spaces of this street. Purposive sampling was conducted to select individuals who had the most experience and interaction with the urban environment and digital technologies. The final sample size was determined to be 50 elderly individuals based on the principles of statistical sampling and recommendations related to ANP analysis.

As the data collection tool, a standard questionnaire was designed, which included indicators of the elderly's quality of life, the extent of presence in public spaces, and interaction with digital technology. Before implementation, the questionnaires were reviewed by experts in the fields of aging and urban design to ensure content validity, and the reliability of the tools was confirmed using Cronbach's alpha coefficient.

For data analysis, first, the data collected from the questionnaires were summarized using descriptive statistics, including mean, standard deviation, and frequency distribution, and an overall picture of the status of the elderly's quality of life was presented. Then, to determine the weight and relative importance of various indicators of the elderly's presence in public spaces and the capacities of digital technology, the Analytic Network Process (ANP) was used. This method makes it possible to examine the complex relationships between indicators and sub-indicators in a network format and to determine the weight of each factor based on its priority and mutual impact.

The validity and accuracy of the ANP analysis were examined using Consistency Ratio (CR) indices to ensure that the weightings were logically valid and reliable. Finally, the results of the ANP analysis were integrated with the descriptive data to provide an operational framework for utilizing digital technology in enhancing the quality of life of the elderly in urban public spaces.

Case Study: *Zand Street, Shiraz*

Zand Street, as one of the main and historical axes of the city of Shiraz, plays an important role in the spatial, social, and functional structure of the city and, due to the high concentration of service, commercial, cultural, and administrative land uses, is considered one of the busiest public spaces in this city. This street, located in the central part of the city, serves as an urban spine, connecting various historical and contemporary parts of Shiraz, and daily hosts a diverse range of citizens, especially the elderly (Figure 2). Section of Zand Street and its surrounding spaces, which, in terms of accessibility, diversity of land use, and pedestrian presence, is considered one of the most dynamic urban segments of Shiraz. The existence of medical centers, banks, shopping centers, small green spaces, public transportation stations, and historical elements in this area has turned it into a daily destination for the elderly; such that this age group constitutes a significant portion of the permanent users of this space (Figure 3).

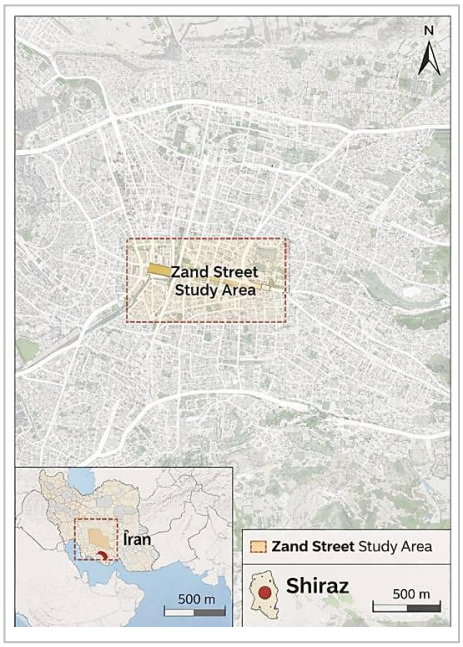

Figure 2: *Location of Zand Street in the physical structure of Shiraz* (Source: Authors)

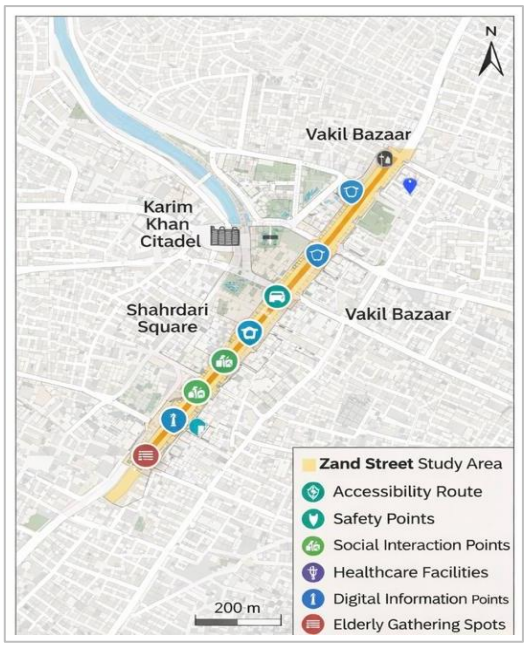

Figure 3: *Detailed study area on Zand Street* (Source: Authors)

Physically, Zand Street has a relatively suitable width for vehicular traffic, wide sidewalks, diverse urban furniture, and active frontages. However, challenges such as the conflict between vehicular and pedestrian movement, the lack of seating spaces tailored to the needs of the elderly, the poor legibility of paths for people with disabilities, and the lack of sufficient digital infrastructure in some points have reduced the quality of the elderly's experience of presence in this space (Figure 4 and Figure 5).

Figure 4: *Condition of sidewalks and urban furniture on Zand Street* (Source: Authors)

Figure 5: *Example of interference between vehicle and pedestrian traffic* (Source: Authors)

From a social perspective, Zand Street provides an important context for the social interactions of the elderly. Being present in this space for daily activities, social meetings, walking, and participating in urban life plays a significant role in maintaining the mental and physical health of this age group. However, environmental limitations and the absence of smart support systems, including digital information systems, smart signage, and technology-based urban services, have caused a part of the potential capacities of this space for enhancing the quality of life of the elderly to not be fully realized.

Therefore, Zand Street, as a prominent example of an urban public space, provides a suitable context for evaluating the impact of digital technology on the quality of life of the elderly. The functional, social, and physical characteristics of this axis, along with the significant presence of the elderly, allow for a detailed analysis of the relationship among the quality of the urban environment, the extent of presence, and the role of digital technologies in improving the urban living experience of the elderly. This approach ensured that the research results have empirical and objective backing, and the proposed analytical framework possesses a high capability for generalizability to other urban public spaces with similar conditions.

Findings

1. *Findings extracted from behavioral studies*

Given the physical, functional, and social characteristics of Zand Street, this area was selected as the primary context for the research data collection. The research process was conducted in a mixed manner and in several stages. In the first stage, documentary studies and a review of theoretical background led to the extraction of components affecting the quality of life of the elderly in urban public spaces. In the second stage, field surveys including behavioral observation, recording the patterns of the elderly's presence, analyzing the physical condition, and evaluating the level of existing urban services in the study area were carried out. In this stage, the status of accessibility, safety, spatial quality, environmental legibility, social interactions, and the level of utilization of digital technologies in the space of Zand Street were systematically documented (Figure 6).

Figure 6*: Pattern of presence and gathering of elderly people in the study area*[1] (Source: Authors)

[1] The images in the article are taken from real images that have been reproduced by ChatGPT to prevent the display of real faces.

In the third stage, by integrating the theoretical findings and field data, the analytical framework of the research was formulated. This framework enabled the measurement of the extent to which the quality of life of the elderly in the public space of Zand Street is realized, as well as the evaluation of the role of digital technology in improving this quality. Thus, the research indicators were formed not abstractly, but based on the existing spatial and behavioral realities in the study area (Figure 7), and were directly used in the final analysis.

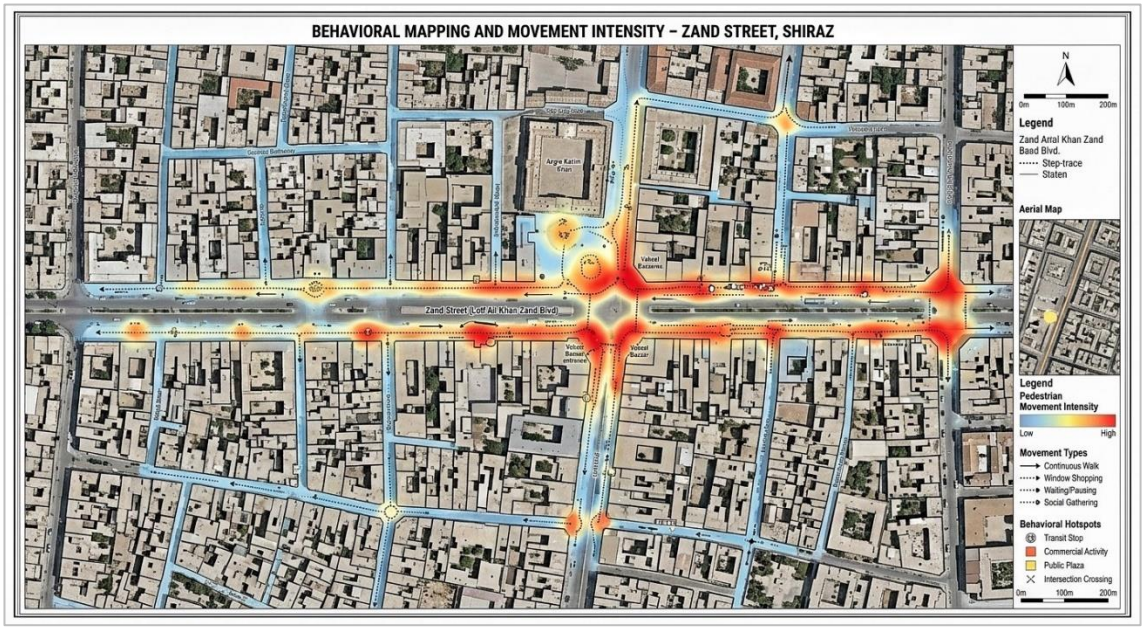

Figure 7*: Density and presence and movement of elderly groups in the area of Zand Street, Shiraz*[1] (Source: Authors)

2. *Findings extracted from the elderly questionnaire*

In this section, the data collected from the standard questionnaires with the aim of investigating the indicators of the elderly's quality of life and their level of presence in the public spaces of Zand Street were analyzed. The data analysis was divided into two main parts:

Descriptive statistics indicating the overall status of indicators and sub-indicators. Inferential statistics used to determine the importance and relationship of the indicators with the quality of the elderly's presence and the role of digital technology. Data analysis was performed using statistical software, and its aim was to provide an accurate and reliable picture of the current situation and determine the key indicators affecting the presence of the elderly in public spaces.

To present an overall picture of the status of the elderly's quality of life on Zand Street and their level of presence in public spaces, first, all studied indicators and sub-indicators were analyzed using descriptive statistics. The results included the mean, standard deviation, and frequency distribution of each indicator so that the general trend and the strengths and weaknesses of the indicators could be identified (Table 2).

Table 2*: Descriptive statistics of quality-of-life indicators for the elderly*

Main Dimension	Criteria	Mean	Standard Deviation	Min	Max	Description
Physical	Permeability and connectivity	4.1	0.6	3	5	*Accessibility of routes and connection to other points*
	Public realm and behavioral setting	3.8	0.56	3	5	*Quality of interaction in public spaces and citizens' behavior*
	Visual identity and character	3.9	0.58	2	5	*Visual characteristics of the environment and their impact on sense of belonging*

[1] This map is based on the behavioral patterns of the elderly by the authors and its graphics were prepared with the help of (Nano banana 2).

Social	Safety and security	4.0	0.62	2	5	*Sense of physical and psychological safety in the environment*
	Social interactions	3.7	0.64	2	5	*Opportunities for communication and interaction with others*
Technology	Technology and digital systems	3.2	0.73	1	5	*Information systems, applications, and interactive technologies*
Functional	Mixed land use	3.5	0.61	2	5	*Diversity and coordination of land uses in the space*
	Energy efficiency	3.6	0.59	2	5	*Optimal use of resources and environmental performance*
Environmental	Integration with nature	3.8	0.62	2	5	*Presence of green space and connection with the natural environment*
Managerial	People and smart management	3.9	0.60	2	5	*Planning, urban services, and technology-oriented management*

The analysis of the research findings shows that the quality of the elderly's presence in urban public spaces is the result of a multidimensional interaction among spatial, social, and technological components and cannot be reduced to merely one specific dimension. Here, the superiority of the physical and social dimensions in the results indicates that physical infrastructures and contexts for social interaction continue to play a foundational role in shaping the elderly's experience of presence. This finding is consistent with theoretical approaches in urban design, particularly Gehl's (2011) perspective, which emphasizes the importance of the quality of public spaces in strengthening social activities and presence. At the spatial level, indicators such as permeability, accessibility, and environmental legibility are proposed as prerequisites for the active presence of the elderly. The results of this research show that the existence of continuous, obstacle-free, and comprehensible paths not only facilitates the physical movement of the elderly but also strengthens their sense of independence and psychological security. This issue is aligned with the findings of Pourjafar et al. (2010) and Young et al. (2019), who introduced accessibility as one of the key factors in improving the quality of life of the elderly. On the other hand, the role of safety and security in the social dimension can be interpreted beyond a mere physical factor, as a perceptual and psychological component. Findings show that safe environments lay the groundwork for increasing social interactions and the active participation of the elderly. This indicates the existence of a reinforcing relationship between spatial security and the quality of social interactions; such that weakness in either of these dimensions can also reduce the efficiency of other components. This result is consistent with the studies of Giovanna De Roza et al. (2022), which emphasize the role of security in reducing the social isolation of the elderly.

Accordingly, the research results imply that design interventions in public spaces, especially in Zand Street of Shiraz, must go beyond mere physical improvements and simultaneously pay attention to enhancing the quality of social interactions and the purposeful utilization of digital technologies. Actions such as improving accessibility, increasing safety, strengthening interactive spaces, and deploying smart systems will only be effective if implemented within an integrated approach based on understanding user behavior.

One of the most important achievements of this research is the emphasis on the systematic and integrated nature of the quality of the elderly's presence in public spaces. The analysis of the relationships among indicators shows that different components affect each other not only independently but also in the form of an interactive network. For example, accessibility and safety are prerequisites for utilizing technology and the formation of social interactions, while smart urban management can strengthen the efficiency of all these components. These findings demonstrate that linear and one-dimensional approaches in the design of public spaces are unable to respond to the complex needs of the elderly, and adopting an integrated and

multi-layered approach is an unavoidable necessity. In this regard, the proposed framework of the current research attempts to provide an operational model for the analysis and design of age-friendly public spaces by integrating spatial, social, and technological components.

Regarding digital technologies, the research results indicate that this component, despite its lower relative weight, plays a facilitative and mediating role in improving the quality of the elderly's presence. Unlike some technology-centric approaches that propose technology as the main solution, the findings of this research show that the efficiency of digital technologies is highly dependent on the quality of the spatial and social context. In other words, in the absence of a safe, accessible, and interactive environment, technology alone cannot lead to a meaningful improvement in the quality of the elderly's presence. This result is considered an implicit critique of technology-driven approaches in smart city studies and emphasizes the necessity of meaningfully integrating technology with urban design. In this same context, the findings of Kim et al. (2022) and Chen et al. (2013) also show that the effectiveness of urban technologies is maximized when they are designed within the framework of users' real needs and environmental characteristics.

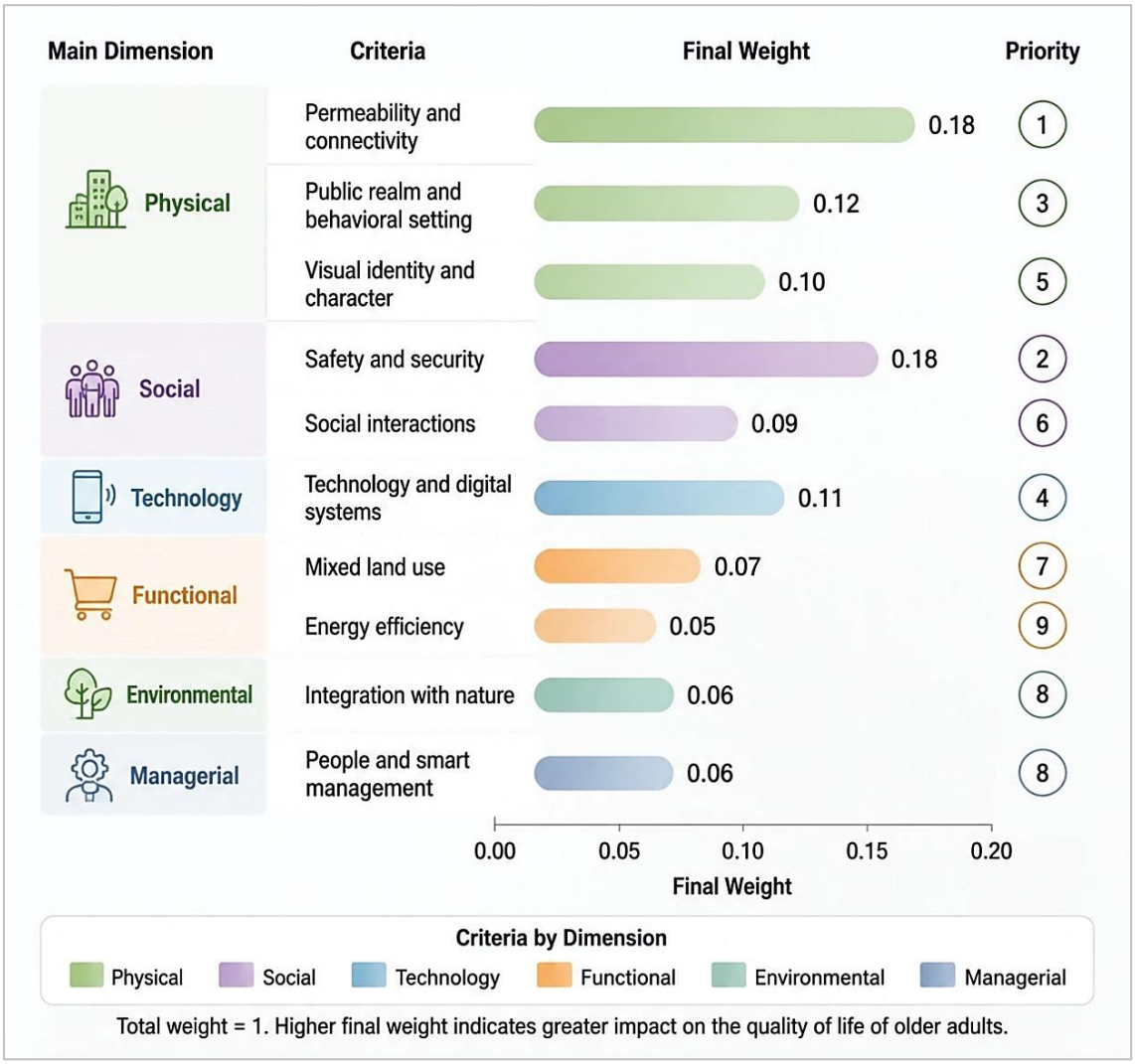

Figure 8: *Final weight and priority of indicators based on ANP.* (Source: Authors)

Discussion & Conclusion

In order to explain the factors affecting the quality of the elderly's presence in urban public spaces, the theoretical framework of the research was formed based on the integration of theoretical literature findings and the results of empirical analyses. In this framework, the quality of the elderly's presence is considered a multidimensional phenomenon that is influenced by six main dimensions including physical, social, technological, functional, natural, and managerial dimensions. The physical dimension, as the main infrastructure, includes components such as accessibility, permeability, and visual identity that enable the independent and safe presence of the elderly. The social dimension, by emphasizing safety and social interactions, creates the necessary context for active participation and enhancing the psychological well-being of the elderly. These two dimensions, as foundational pillars, play a decisive role in shaping the quality of presence. Meanwhile, the technology dimension, as a mediating component, plays a facilitative role in improving access to information, urban services, and social interactions. However, its effectiveness is dependent on the quality of the physical and social dimensions. The functional and natural dimensions also play a complementary role in strengthening the experience of the elderly's presence by creating activity diversity, environmental productivity, and improving environmental quality. Finally, the managerial dimension, with an emphasis on smart urban management, provides the ground for the coordination and efficiency of other dimensions. Based on this framework, the relationships among the dimensions are considered in a networked and interactive manner, such that each component, in addition to its direct impact, indirectly affects other dimensions as well. This approach is consistent with the theoretical foundations of smart cities and human-centered urban design and shows that enhancing the quality of the elderly's presence requires adopting an integrated and multi-layered view of environmental, social, and technological components. Figure (9) shows the conceptual framework of the research.

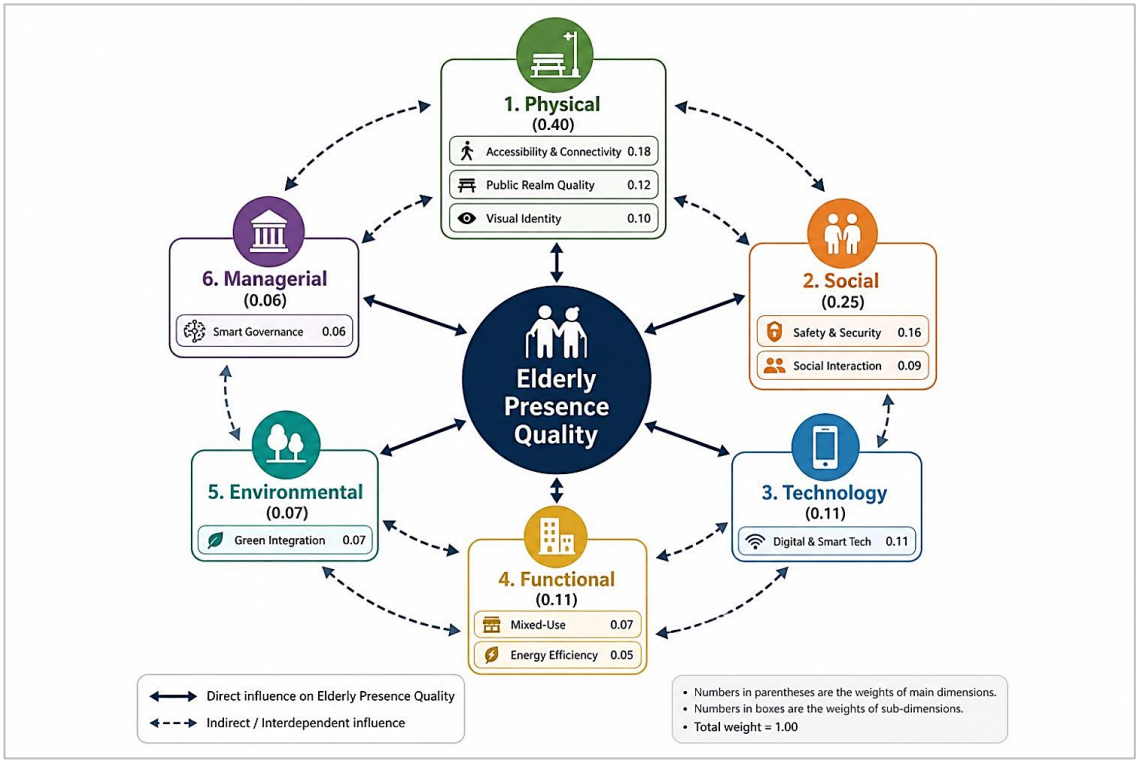

Figure 9: *Conceptual framework of the research.* (Source: Authors)

The findings of this research showed that the quality of the elderly's presence in urban public spaces is a multidimensional phenomenon dependent on the interaction among spatial, social, and technological components. The results from the analyses indicate that the physical and social dimensions, as main

infrastructures, play a decisive role in shaping the active presence of the elderly. Indicators such as accessibility, safety, spatial legibility, and the possibility of social interaction are considered prerequisites for the effective utilization of other capacities, including digital technologies. These findings are aligned with the results of previous studies in the field of age-friendly urban design, but at the same time, they emphasize the importance of an integrated view of these components. In this context, digital technologies, contrary to some technology-centric approaches, act not as a replacement but as a facilitating and reinforcing factor alongside spatial components. The results show that the efficiency of digital tools in public spaces is dependent on the quality of the physical and social context, and in the absence of a safe and accessible environment, their impact will be limited. This highlights the necessity of reviewing how technology is integrated with urban design. From the perspective of innovation, this research, by presenting an integrated analytical framework, has attempted to bridge the existing gap between urban design studies and technological approaches.

Integrating spatial analysis with the ANP method has enabled the identification and prioritization of complex relationships among indicators and shows that the quality of the elderly's presence is the result of the systematic interaction of various factors, not merely the superiority of one specific dimension. This approach can be used as a model for analyzing public spaces in other urban contexts. Based on the research results, the planning and design of age-friendly public spaces, especially on Zand Street in Shiraz, requires the adoption of an integrated approach wherein improving the physical quality of space, strengthening social interactions, and purposefully utilizing digital technologies are considered simultaneously. Actions such as improving accessibility, increasing safety, designing interactive spaces, and deploying smart urban systems can lead to an improvement in the experience of the elderly's presence and an increase in their social participation. Despite this, the current research faces limitations including a focus on a specific area and a limited sample size. Therefore, generalizing the results to other urban spaces requires caution. It is suggested that in future research; by expanding the scope of study and comparing different urban spaces, the efficiency of the proposed framework be further evaluated, and also the role of emerging technologies in this field be investigated. Overall, this research, by emphasizing an integrated approach in combining spatial design and digital technology, has taken a step towards enhancing existing knowledge in the field of age-friendly public spaces and can be used as a basis for urban design and planning decision-making.

Recommendations

Considering the findings of this research and the operational framework provided for enhancing the quality of the elderly's presence in Zand Street, Shiraz, several future research paths are suggested. First, it is recommended that similar studies be conducted in other urban environments with different social and cultural contexts to examine the validity and generalizability of the proposed framework. This can allow for the comparison of different indicators and weightings in diverse urban environments and strengthen the flexibility of the framework.

Second, future research can gather more perspectives from the elderly, citizens, and urban managers by expanding the sample of experts and using participatory methods. Combining quantitative and qualitative methods can help identify new or overlooked indicators and make the framework more comprehensive and operational.

Third, attention to novel technologies and digital tools in age-friendly urban environments can be the subject of future studies. With the introduction of smart technologies, the Internet of Things, and urban applications, the possibility for greater utilization of public spaces and increased interaction of the elderly with the environment is provided. Future research can evaluate the direct impact of these technologies on the indicators of the elderly's presence.

Fourth, future studies can further investigate environmental and sustainability dimensions. Given the importance of green spaces and harmony with nature in the experience of the elderly's presence, a more

detailed analysis of the effects of the natural environment on the psychological and physical well-being of the elderly can enrich the framework.

Finally, integrating the findings of this research with urban planning and policymaking can lead to providing a practical guide for designing age-friendly streets and public spaces, and future studies can evaluate the direct effects of this operational framework in actual implementation and utilization.

Operational and design-oriented suggestions for enhancing the quality of the elderly's presence on Zand Street in Shiraz are presented in (Figure 10).

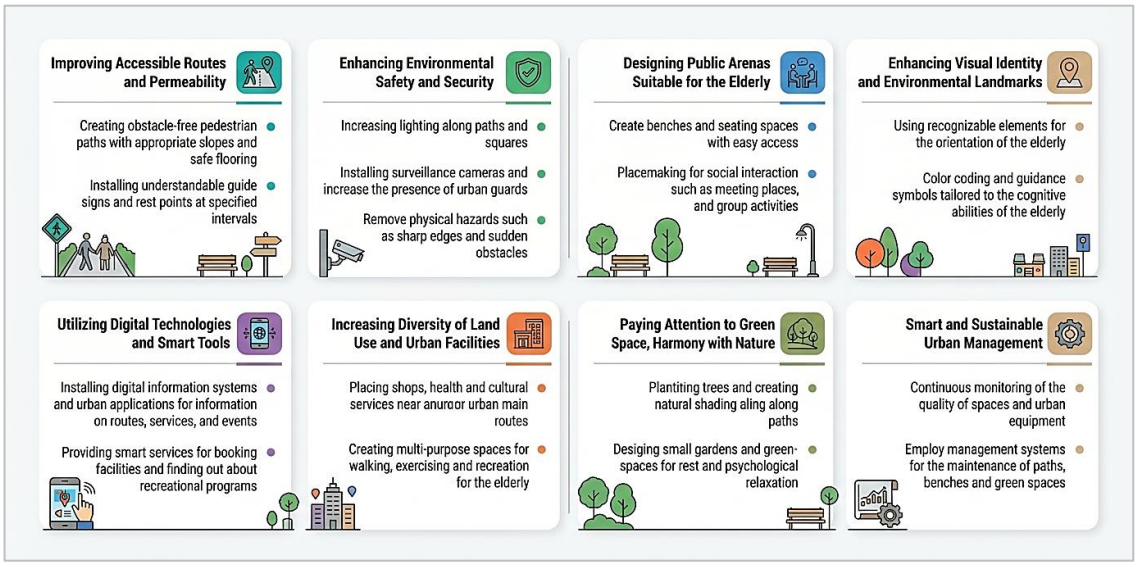

Figure 10: *Operational and design-oriented suggestions for enhancing the quality of the elderly's presence on Zand Street in Shiraz* (Source: Authors)

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