

## SMART AND AGE-FRIENDLY CITIES – CASE STUDIES OF SELECTED EU CITIES AGAINST THE BACKGROUND OF GLOBAL AGGLOMERATIONS

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### Abstract

*The concept of smart and friendly cities, making use of modern information and communication technologies, opens up new opportunities for creating environments that are supportive of ageing societies, not only within the European Union. The aim of this article is to present an analysis of selected examples of European cities in comparison with global agglomerations that have successfully implemented solutions promoting the dignified living of senior citizens. The analysis of these cases makes it possible to identify best practices, determine development directions, and draw conclusions relevant to planning the development of other cities, especially in our part of Europe—Central and Eastern Europe, including Poland.*

**Keywords:** *smart cities friendly cities, seniors, senior-friendly destinations, European Union, global agglomerations*

### 1. INTRODUCTION

The demographic changes we are currently witnessing in the world are unprecedented: never before in history has the global population grown so rapidly, while at the same time, average life expectancy has never been so high. Currently, people aged 60+ account for around 12–13% of the world's population, numbering over 1 billion individuals. By 2050, their number is expected to double to 2.1 billion, representing about 22% of the global population. According to WHO and the UN, in 2020 there were 1 billion people over the age of 60, and their number increased to around 1.1–1.2 billion in 2025, with the world's population at 8.27 billion. The percentage share is therefore 13–14%, with a predominance in developed countries. The population of people aged 60+ will reach 2.1 billion, accounting for 22% of the world's total population (projected at around 9.7 billion). The largest increase will occur in developing countries, with the number of people over 80 tripling to 426 million (WHO 2025, UNFPA 2024). The demographic ageing of the population is a consequence of the increase in average life expectancy and the decrease in average fertility rates.

The fact that people, on average, live longer and longer is obviously a positive phenomenon, resulting from civilizational progress (advances in medicine, improvement of working and living conditions). However, it also carries significant economic and social consequences. These include the need to adapt urban planning and access to public services in cities to the requirements of an increasingly numerous populations of elderly people, while simultaneously ensuring appropriate conditions for living, education, and work for those of pre-working and working age. The smart city concept, successfully implemented in many countries, is a response to these challenges.

There are many definitions of smart cities, each emphasizing different aspects—some focus on technological factors, while others highlight social issues. Modern cities are increasingly implementing smart solutions and technologies, with the ultimate measure of their effectiveness being the quality of life of their residents. Therefore, a smart city can be defined as both accessible and inclusive.

This paper analyzes contemporary policies and solutions in the field of smart cities that directly impact the quality of life of older adults and people with disabilities while also benefiting society as a whole.

Building senior-friendly cities supported by digital technologies is not just an obligation but also an investment in the future. Demographic changes in Europe, where an increasing proportion of the population consists of older adults, require taking their needs, expectations, and capabilities into account

in urban planning. A senior-friendly city is one that ensures a high quality of life for its older residents, enabling them to actively participate in social, cultural, and economic life.

This paper presents an integrated approach to the concept of smart cities and senior-friendly communities. Although these ideas are widely promoted by the European Union (EU) and the World Health Organization (WHO), they are often treated separately. In reality, they are closely interconnected both in theory and practice, particularly in the context of promoting healthy and active aging, universal urban design, digital inclusion, and reducing social isolation among seniors.

## **2. AIM OF THE PAPER AND RESEARCH METHODOLOGY**

In the face of economic and technological changes driven by globalization and the process of integration, European cities are confronted with the challenge of simultaneously combining competitiveness and the sustainable development of urban areas. It is highly likely that this challenge will affect issues of urban quality, such as housing, the economy, culture, as well as social and environmental conditions.

However, the present study does not focus on leading European metropolises, but rather on medium-sized cities and their development prospects as capital cities of Central and Eastern European EU countries. Although the vast majority of the urban population lives in such cities, urban studies primarily emphasize “global” metropolises. As a result, the challenges faced by medium-sized cities, which are often quite diverse, remain to some extent underexplored. Medium-sized cities, which must compete with larger metropolises in similar areas, appear to be less well prepared in terms of critical mass, resources, and organizational capacity.

The aim of this study is to analyze selected European cities against a set of purposefully chosen cities worldwide that have successfully implemented solutions supporting dignified ageing. An analysis of these cases makes it possible to identify best practices and to formulate recommendations for the development of other cities, particularly in Central and Eastern Europe, including Poland.

In the study of cities (capital cities) in Central and Eastern Europe, the selection focuses on medium-sized cities. However, there is no universally accepted definition of a medium-sized city. For the purposes of this research, medium-sized cities are understood as those that are less recognizable at the European level but often play a key role at the national and regional levels. As a starting point, cities with populations ranging from 500,000 to 1,500,000 inhabitants were considered.

For the further selection of the analytical sample, two main arguments consistent with the research objective and its time frame were taken into account: the cities should be medium-sized and should be covered by available and relevant databases. For this reason, in the first phase of selection—based on the authors’ own research—six exclusion criteria were developed, namely: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living.

In the second stage, the authors made further adjustments and refinements to the sample of cities with regard to data availability and quality. Some cities that are in fact medium-sized but are located in densely populated areas were also included, as their functional catchment areas slightly exceed 1.5 million inhabitants. Ultimately, for the purposes of the analysis, five capital cities of Central Europe were purposefully selected (Warsaw, Vilnius, Prague, Budapest, and Bratislava), along with one city as a reference benchmark—Barcelona, Spain.

The study employed literature review methods, comparative analysis, and statistical methods. Quantitative data on development trends of smart, age-friendly cities in Western Europe (WHO) and Central and Eastern Europe (including Poland) were drawn from databases of Eurostat (the Statistical Office of the European Union), the United Nations (UN), the Organisation for Economic Co-operation and Development (OECD), and Poland’s Central Statistical Office (GUS)

### 3. SMART, SENIOR-FRIENDLY CITIES - A REVIEW OF SELECTED GLOBAL CONCEPTS

At the beginning of the 21st century, the modernization of urban spaces became a key topic of discussion. Local administrations, particularly in urban areas, must meet the growing expectations of various social groups, including citizens, consumers, workers, entrepreneurs, investors, and community members (Sikora-Fernandez, 2019). In the context of demographic changes, city modernization must take into account aspects such as population aging, increased life expectancy, the growing needs of people with disabilities regarding the elimination of architectural barriers and infrastructure accessibility, depopulation of certain districts, and declining birth and fertility rates (Klimczuk & Tomczyk, 2019; European Commission, 2015, 2010).

According to the United Nations (Abaya, 2015), the phenomenon of "double aging" is particularly significant, referring to the rapid increase in the number of both older adults (75–84 years) and the oldest-old (85+ years). Projections indicate that the number of people over 80 years old will rise from 120 million in 2013 to 392 million in 2050 (UNPD, 2013). These changes will increase the demand for healthcare, caregiving, and social services in cities (OECD, 2015; European Commission, 2013, 2015). It is important to note that population aging significantly reduces the potential for informal care, which has traditionally been provided primarily by families.

The aging of societies brings a range of significant social, economic, political, and cultural consequences, posing a challenge that requires the implementation of innovative solutions to enable sustainable development. Special attention should be given to older generations, as demographic projections indicate a sharp increase in the number of people of retirement age in Central and Eastern Europe (Zralek, 2014). In recent years, the Visegrad Group countries—Poland, the Czech Republic, Hungary, and Slovakia—have increasingly felt the effects of these changes, including the depopulation of major cities (European Commission, 2025). This process primarily affects urban centers that served as industrial hubs during the period of real socialism. In Poland, for example, between 1995 and 2013, only six cities recorded population growth: Kraków, Olsztyn, Rzeszów, Warsaw, Zielona Góra, and Białystok (Zralek, 2014). Ongoing urbanization in Central and Eastern Europe necessitates the adoption of modern socio-technical solutions in urban systems while simultaneously integrating the concept of active aging into all aspects of social life. Active aging allows for the full utilization of the potential of older adults and their engagement in society (WHO, 2002). Creating an age-friendly environment that includes educational and social infrastructure is a key element in supporting the activation of senior citizens.

Demographic changes require the development of innovative solutions in the areas of employment, healthcare, work-life balance, participation in culture, recreation, and sports, as well as the adaptation of public services such as transportation, telecommunications, social housing, and environmental protection. The aging of society also stimulates the development of technological and social innovations, including products and services known as "calm technologies" – solutions that do not demand the user's attention, "ambient technologies" – seamlessly integrated into the living environment, and "smart technologies" – simplifying the delivery of advanced services to users. The term "smart" primarily refers to devices and processes that utilize modern technologies in an intuitive way, supporting social engagement (Szczepański 2024).

The key objectives of the "Europe 2020" strategy (European Commission, 2010), adopted by the European Union in 2010, include smart, sustainable, and inclusive growth. The European Commission's report, *The Growing Silver Economy in Europe* (European Commission, 2015), highlighted that 110 European regions have identified healthy and active aging as a priority in the area of smart specialization for the coming years. This signifies an increased focus on supporting sectors within the silver economy, which encompasses the production and distribution of goods and services tailored to aging societies (European Smart Cities 2025, Klimczuk & Tomczyk, 2016). Key sectors of the silver economy include cosmetics and fashion, senior tourism, service robotics, healthcare and wellness (including medical equipment, pharmaceuticals, and telemedicine), functional food, security, culture, lifelong learning, entertainment, smart and autonomous transport (e.g., self-driving vehicles), assistive technologies, and banking and financial services tailored to older adults.

In the context of the silver economy and smart development, the concept of smart cities refers to urban areas that extensively utilize information and communication technologies (ICT) to optimize city operations. These technologies enable, among other things, the reduction of infrastructure maintenance costs (e.g., roads, bridges, subways, airports, ports, public transport, and sewage systems), efficient resource management (e.g., energy, water, and gas), optimal use of urban space, and increased social participation in city governance processes (Klimczuk & Tomczyk, 2016). Related concepts associated with smart cities include cyber cities, digital cities, electronic communities, information cities, knowledge-based cities, and intelligent urban spaces (Klimczuk & Tomczyk, 2016). It is worth noting that in 2012, the European Innovation Partnership on Smart Cities and Communities (European Commission, 2015) was established to integrate cities, industry, small and medium-sized enterprises (SMEs), the financial sector, research institutions, and other stakeholders in knowledge exchange, international partnership building, and the development and implementation of innovative solutions for smart cities.

Smart homes and the technologies installed within them play a particularly important role in the concept of smart cities, aiming to facilitate the lives of older adults and support their daily activities (Abaya 2015). Smart homes offer solutions such as mobile applications, and monitoring and automation systems that include lighting, heating, ventilation, alarm systems, video surveillance, fire protection systems, emergency power, and the management of renewable energy production and storage (OECD 2015).

The idea of smart cities is a response to the new needs of residents and civilizational challenges (e.g., aging population, mobility, environmental protection) and encompasses all the aforementioned concepts. The idea of a city that is "smarter" than in the past assumes the optimal use of the potential of various city and resident capitals, and the integration of resources through the creation of new solutions and the implementation of best practices to improve the quality of life (Klimczuk, Tomczyk 2016). A smart city, which is also senior-friendly, can be defined by services such as:

- smart energy grids enabling users to reduce their energy consumption,
- traffic control to reduce congestion and increase traffic flow,
- pedestrian traffic surveillance to enhance safety levels,
- remote health monitoring of patients, including through telecare, which optimizes the involvement of medical staff and ensures rapid assistance,
- vehicle telematics systems linked to technical and informational infrastructure for the use of galvanic cell-powered cars,
- a registry monitoring the activities of municipal services, including the public transportation system (Klimczuk, Tomczyk 2016).

One of the key visions of smart and senior-friendly cities assumes that these types of agglomerations can achieve higher operational efficiency through the application of advanced tools and algorithms aimed at strengthening the competitiveness of enterprises (European Commission Apr 2015). Nevertheless, despite the growing number of technological solutions aimed at improving the quality of life of residents, the concept of a smart city cannot be implemented in isolation from the real needs of the local community. Effective management of urban space requires an approach that emphasizes the agency of residents, as an excessive dominance of the technocratic model can lead to a sense of dehumanization and a limitation of citizens' autonomy, which consequently hinders even the most innovative initiatives. In the concept of smart cities, the needs of residents are the starting point for designing solutions that support the development of sustainable and functional urban spaces.

An alternative approach assumes that smart cities should be based on the human and social capital of their residents (Klimczuk, Tomczyk 2016). In situations where public administration, local governments, or the private sector are unable to adequately adapt innovations to the individual needs of residents, activating local communities through grassroots initiatives becomes a crucial mechanism. Examples of such activities include time banks, local currencies, barter systems, neighborhood care circles, cohousing, car sharing, and various models of social entrepreneurship (Klimczuk, Tomczyk

2016). This type of approach to smart cities is also closely related to the concept of the "creative class," which includes knowledge workers, intellectuals, artists, and freelancers, who play a key role in the restructuring of cities and regions in the context of the development of the cultural and creative industries (e.g., science, engineering, research, art, design, and media). Within this concept, senior-friendly cities are described as spaces that support "creative aging," i.e., engaging older people in creative activities, which promotes the transition from perceiving old age as a problem to recognizing it as a social asset (Burlington 2016).

Smart cities also focus on the integration of community activity data and big data analysis, enabling the creation of personalized solutions tailored to the specifics of local conditions. City administration collects extensive digital data resources, which – thanks to advanced processing and analysis methods – constitute valuable material for decision-makers responsible for urban planning. Enhancing the quality and efficiency of databases is made possible by the increasingly widespread use of the "Internet of Things" (IoT) concept, which expands the information network to include devices and systems (e.g., home electronics, machines, sensors) capable of communicating both with users and with each other (Klimczuk, Tomczyk 2016).

Considering the above, a smart city can be defined by the development of six areas:

1. "smart economy," understood as competitiveness, measured by indicators describing the innovation climate, entrepreneurship, the image of the local economy, productivity, labor market flexibility, the city's embedding in international cooperation networks, and the ability to continuously transform the city,
2. "smart people," meaning the human and social capital of the city's residents. Indicators used to measure this area include education level, the tendency for lifelong learning, social and ethnic diversity, flexibility, creativity, cosmopolitanism, openness, and participation in public life,
3. "smart governance," broadly understood as social participation. Indicators in this area include citizen participation in decision-making bodies, the scope of public and social services, management transparency, public policies, and political perspectives,
4. "smart mobility," related to both transportation and the use of information and communication technologies. Indicators include local, national, and international accessibility of the city, the presence of ICT infrastructure, sustainable, innovative, and safe transportation systems,
5. "smart environment," meaning the approach to natural resources. Indicators in this dimension include the attractiveness of natural conditions, pollution levels, environmental protection, and sustainable resource management,
6. "smart living," defined as quality of life. This area includes factors affecting the lives of city residents, such as the availability of cultural and educational institutions, health conditions, personal safety, housing quality, tourist attractiveness, and social cohesion.

In summary, the idea of a smart city emphasizes the close links between cities and new technologies, as well as the pursuit of sustainable development by highlighting the importance of simultaneously supporting economic growth, social development, and environmental protection, including a senior-friendly city.

#### **4. ANALYSIS OF SMART CITIES IN EUROPE AND THE WORLD FROM THE PERSPECTIVE OF THE COMFORT OF LIFE OF OLDER PEOPLE**

In the face of advancing demographic changes and the growing percentage of older people, an increasing number of countries are implementing strategic reforms aimed at adapting urban spaces to the needs of seniors. In response to these challenges, the World Health Organization (WHO) established the WHO Global Age-friendly Cities and Communities Network in 2010. This initiative supports cooperation and the exchange of experiences between cities and communities around the world. Currently, the network comprises 541 cities from 37 countries, providing a platform for the implementation of innovative

solutions that promote active and healthy aging (<https://www.who.int/publications/i/item/WHO-FWC-ALC-18.4>, 2018).

The analysis indicates that one of the most advanced examples of a senior-friendly smart city is Singapore. This city-state has been developing for many years in accordance with a long-term strategy focused on modern technologies and improving the quality of life of residents. Singaporeans describe their city as Smart Nation or Smart City, and the full implementation of this concept is planned for 2030. In the latest Global Smart City Performance Index, Singapore ranked first, taking into account key categories such as mobility, healthcare, safety, and productivity. Singapore is a global leader in the digitization of public services. Residents can complete most formalities online, and seniors have access to advanced platforms that enable real-time health monitoring. The intelligent traffic management system, based on camera and sensor technology, effectively reduces congestion, and ultimately, a significant reduction in car traffic is anticipated through the development of autonomous transportation (<https://globalcitieshub.org/en/who-global-network-for-age-friendly-cities-and-communities/>, 2024).

Also worthy of particular attention is Songdo in South Korea – a modern district of the city of Incheon, designed from the ground up as a Smart City. Currently, smart city solutions are being implemented in almost every major metropolis in the world, but Songdo stands out with its unique urban model. Also known as New Songdo City or Songdo International Business District (SIBD), this city was built on an artificially created island near Incheon. It is part of the Incheon Free Economic Zone and is connected by a 21-kilometer road bridge to Incheon International Airport. Songdo was designed to compete with global business centers such as Shanghai, Hong Kong, and Singapore. Development plans include not only extensive office infrastructure, but also modern schools, hospitals, and residential complexes. Additionally, the city offers unique attractions such as replicas of New York's Central Park and Venetian canals, which are part of a strategy to increase its attractiveness to residents, including seniors. Songdo is a model example of a city of the future, combining innovative technologies with a high quality of life for residents (<https://globalcitieshub.org/en/who-global-network-for-age-friendly-cities-and-communities/>, 2024, 2023).

Senior-friendly cities in Europe include Barcelona, Helsinki, Vienna, and Rome ([www.smart-cities.eu](http://www.smart-cities.eu), 2015).

**Barcelona** is one of the pioneers, offering older people the opportunity to explore the culture, history, and beauty of the region by implementing a range of innovative solutions, such as:

- a network of sensors monitoring air quality and noise levels, allowing for the creation of safe walking routes,
- mobile applications facilitating navigation around the city, access to information about services and events,
- activity centers for seniors offering a variety of activities and workshops.

It is also a senior-friendly city due to:

- an extensive public transport system: buses, trams, and the metro are adapted to the needs of older people, with low-floor vehicles and accessible stations,
- tourist attractions - major attractions such as La Sagrada Família and Park Güell are adapted to the needs of older people and people with disabilities.
- promenades and parks - Barcelona offers many places for walks, such as the Barceloneta Beach promenade, which are senior-friendly.

**Helsinki** - a senior-friendly city that also focuses on sustainable development and the integration of older people, with its priority being to ensure the accessibility of public transport and create friendly public spaces.

**Vienna** - renowned for its high quality of life, investing in the development of infrastructure for older people, such as elevators in residential buildings and wheelchair ramps. Vienna is senior-friendly thanks to solutions such as:

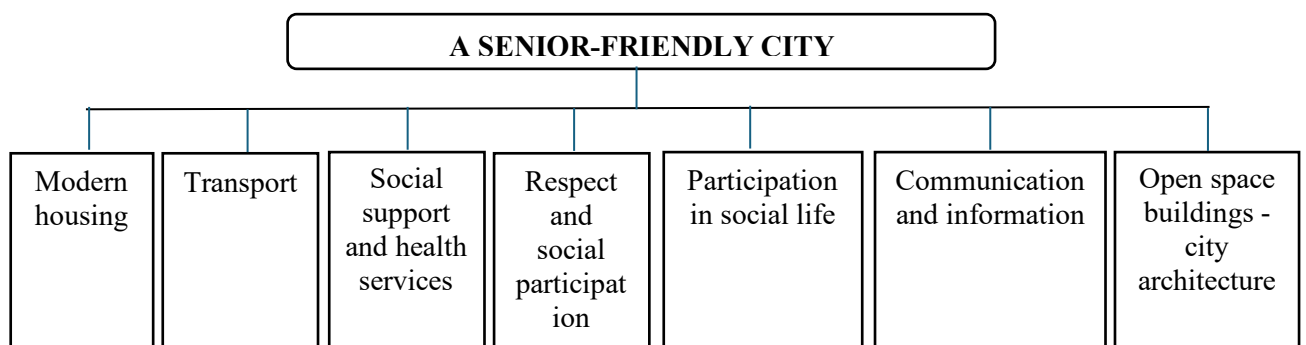
- accessible cultural attractions: Schönbrunn and Hofburg Palaces offering tours adapted to the needs of older people and people with disabilities, with elevators and ramps,
- friendly sidewalks and infrastructure: the city invests in infrastructure to ensure that sidewalks are wide and accessible, making it easier to get around on foot,
- café culture: Viennese cafes are ideal places to relax, easily accessible and often surrounded by greenery.

**Rome** - a city where history meets modernity. This is an ideal city for seniors, which has introduced solutions such as:

- a well-developed public transport system including buses, trams, and the metro, making it easy to get around the city,
- accessible tourist attractions adapted to the needs of older people and people with disabilities, offering elevators and ramps,
- pedestrian-friendly facilities - investments in infrastructure that facilitates walking.

In summary, according to the World Health Organization (WHO 2015) and based on our own analyses and assessments, senior-friendly cities are those that enable seniors to age actively and healthily, shaping the quality of life of older people by optimizing the physical and social environment (Figure 1). This means, among other things:

- accessibility of public transport: a well-developed communication network with stops equipped with appropriate information and facilities for older people,
- safe public space: sidewalks without obstacles, well-lit streets, meeting and recreation places,
- availability of services: proximity to shops, pharmacies, medical facilities, and easy access to information about available services,
- social life: the possibility of participating in social life, access to various forms of activity, e.g., interest groups, sports activities,
- modern housing, solutions that facilitate movement, supporting technologies: the use of information and communication technologies to facilitate daily life, e.g., alarm systems, telecare.



**Fig. 1.** Key factors shaping the identity of age-friendly cities

Source: own study based on Global age-friendly cities; a guide, WHO, 2007.

## 5. RANKING OF SMART AND AGE-FRIENDLY CITIES AND COMMUNITIES ON THE EXAMPLE OF CENTRAL AND EASTERN EUROPE - RESEARCH METHODOLOGY AND RESULTS

*City architecture - buildings and apartments.* One of the first examples of implementing smart and senior-friendly urban solutions in Central and Eastern Europe is the development of infrastructure that supports residents' physical activity. Spaces such as tennis courts, health trails, and cycling routes are becoming an integral part of urban areas. Many Polish cities are witnessing an increase in the number of facilities enabling seniors to engage in regular physical activity. Universities of the Third Age (UTAs) often run sports sections that make use of newly established facilities in city parks, along rivers (e.g., the Warta River waterfront in Poznań), and near town squares, senior clubs, and cultural institutions. Many of these investments are carried out as part of participatory budgets and social participation programs.

The real estate market in Central and Eastern European countries offers numerous examples of housing developments dedicated to seniors, aligning with the concept of smart living and smart economy. Developers and institutions specializing in elderly care recognize the growing demand for housing tailored to the needs of this social group (Kirejczyk, Brzeski, Kozłowski 2015). The adaptation of buildings primarily involves eliminating architectural barriers such as the absence of elevators, narrow corridors, or inaccessible entrances, significantly improving the comfort and safety of seniors.

Another innovative solution that could be applied in Central and Eastern European countries is the HomeShare model, developed in Burlington, Canada (Burlington Age Friendly Seniors Council 2025). This concept is based on two individuals from different households sharing a living space, including a living room and kitchen. The model allows residents to exchange services, share responsibilities, reduce housing costs, and mitigate social isolation.

In Poland, after 2014, several innovative technological solutions were implemented as part of the smart city concept. Cities such as Bydgoszcz, Rzeszów, and Poznań have been developing advanced intelligent transport systems. Poznań, Ostrołęka, and Warsaw are investing in smart heating networks, while Bydgoszcz, Szczecin, and Kraków are introducing remote management technologies for urban lighting (Klimczuk, Tomczak 2016). Gdańsk is considered the most advanced "smart city" in Poland, being one of the first to implement innovative solutions under the ACCUS project (Klimczuk, Tomczak 2016). This project includes intelligent traffic control, modern urban lighting systems, and automatic vehicle identification, contributing to improved safety and transport efficiency in the city.

*Social and civic participation and employment.* According to the guidelines of the World Health Organization (WHO 2027), one of the key elements of age-friendly cities is the active participation of residents in social life. Social participation not only enhances the quality of life for seniors but also contributes to building social capital and smart city management. In Poland, two significant models support this idea.

The first model involves participatory budgeting, a mechanism in which residents decide how to allocate a portion of municipal funds for social projects. Among the initiatives submitted for funding, there are often programs aimed at seniors, frequently implemented by non-governmental organizations. Voting on projects typically takes place once a year, both in traditional forms (e.g., at municipal offices) and online, increasing accessibility for different groups of residents.

The second model of cooperation between local governments and seniors is the establishment of senior councils, which serve as consultative and advisory bodies. Their main objective is to engage older adults in co-deciding on the development of cities, municipalities, and rural areas. Senior councils also promote values such as intergenerational solidarity and strengthen civic participation (Błądowski, Szatur-Jaworska, Szweda-Lewandowska, Kubicki 2012). By 2014, at least 76 senior councils operated in Poland (Sikora-Fernandez 2019). Although they cannot represent the interests of all elderly individuals, they provide an essential platform for dialogue between seniors and public administration, fostering the development of innovative solutions and services tailored to the needs of an aging population.

Senior civic engagement can also be supported through less formal initiatives. An example of such an approach is Cité Seniors in Geneva, Switzerland, which operates as an information and meeting center dedicated to older adults. This facility provides a space for social interaction, organizes events, workshops, and educational courses covering both digital skills and artistic development. Cité Seniors collaborates with a network of senior-led non-governmental organizations, bringing together thousands of members.

Similar models can be found in the United Kingdom, particularly in Manchester and Newcastle, where strategies have been developed to promote active citizen participation in decision-making processes. These strategies also support the development of centers of excellence in aging research, which operate in collaboration with local universities.

*Urban and suburban transport.* Support for senior-friendly initiatives also includes adapting public transportation to meet their needs. A smart city not only provides free public transport for seniors but also implements advanced information systems that make it easier for them to use public transit. Key elements include clear information boards with large fonts, transparent delay notification systems, and intuitively designed transport websites, helping older adults plan their journeys and navigate urban spaces more effectively.

When designing mobility solutions, it is essential to consider key life stages of seniors, which can affect their transportation needs. These factors include retirement, relocation to smaller and more accessible housing, health issues, loss of a driver's license, the passing of a spouse, and family roles, such as caring for grandchildren (European Commission. A Compilation of Good Practices 2013).

To facilitate senior mobility in public spaces, cities should implement solutions such as lowered curbs, smooth road and sidewalk surfaces, safe pedestrian crossings equipped with adjustable traffic lights and sound signals, as well as strategically placed benches for rest. Another crucial aspect is clear urban signage, senior-friendly public transport stops (with benches and shelters), and accessible public restrooms.

One of the innovative solutions supporting smart mobility for seniors is dedicated city taxis, which are already operating in some European cities. Czech cities, such as Český Krumlov, Plzeň, and Bohumín, are pioneers in this field, offering older adults a special transportation service after registering in the city and paying a symbolic fee. This model serves as an example of effectively adapting transportation to the needs of an aging society, enhancing seniors' independence and quality of life.

*Communication and Information.* One of the key areas defining a smart city is efficient communication and support for smart mobility and economy. The smooth transfer of information between municipal institutions and citizens can be facilitated through various digital tools. In Central and Eastern European countries, an increasing number of seniors are adopting new technologies; however, their overall engagement in digital services remains relatively low. While more older adults now use mobile phones and email, there is still a need for further education and promotion of digital solutions tailored to their needs (Klimczuk, Tomczak 2016; Szczepański 2024).

The use of modern technologies in communication between citizens and local authorities is becoming standard in an increasing number of Polish cities. For example, seniors can register for e-administration systems for free via online forms, making access to public services more convenient. Thanks to such solutions, they can receive mobile notifications about important events, the status of administrative processes, and changes in local infrastructure.

One example of innovative solutions in the field of urban open data is the "Open Gdańsk" project. This system provides residents with free access to a wide range of public information generated by the city and its organizational units. Available data include: budget expenditure register, resident petitions, city plot maps, list of properties available for development, tree planting location selection tool, waiting times at municipal offices, public transport timetables waste collection point database, tourist accommodation catalog, wi-fi hotspot locations, cultural event database, contact details of community organizers, cycling path traffic data, infrastructure issue reporting system.

Thanks to such initiatives, smart cities can not only enhance transparency in public administration but also support the digital inclusion of seniors, improving their access to key urban services and information.

*Social integration, social and health services.* According to the definition by the World Health Organization (WHO 2007), age-friendly cities and communities promote social inclusion and active participation of seniors in public life. One of the innovative solutions in this field is time banks, created by non-governmental organizations and municipal social welfare centers. Such initiatives are particularly widespread in Japan under the name "fureai kippu," which means "care tickets." This system, established by the Sawayaka Welfare Foundation, allows people who assist seniors in their daily lives to accumulate and exchange points for care services in the future (Klimczuk, Tomczak 2016). In recent years, this model of social support in various forms has also been expanding to cities in the Asia-Pacific region.

In parallel, modern solutions in the field of telecare and e-health are being developed, which support the health and well-being of seniors. One example of an effective initiative is the AgeWell program, implemented in Cape Town, South Africa (Abaya 2015). Its goal is to reduce social isolation of older adults by employing seniors as caregivers and companions for others. After completing appropriate training, program participants are matched with care recipients based on factors such as gender, language, and interests. The entire process is supported by mobile technologies that enable monitoring of user well-being and facilitate coordination of support from medical and social service providers.

## 6. RANKING OF SENIOR-FRIENDLY CITIES IN CENTRAL AND EASTERN EUROPE

### 6.1. Research Conditions and Results Analysis

As indicated in the previous chapters, this ranking of cities in Central and Eastern European countries focuses on medium-sized cities. The research methodology was described in Chapter 2 of the study. All indicators jointly describing the conditions of a smart city were derived from publicly available data sources ([https://www.smart-cities.eu/download/smart\\_cities\\_final\\_report.pdf](https://www.smart-cities.eu/download/smart_cities_final_report.pdf); 2007), as well as from the authors' own research. In total, 23 indicators were selected for the assessment.

The inclusion of national-level data from five EU countries was necessary both to expand the database and due to the availability of particularly valuable information at this level. Efforts were made to use the most up-to-date data possible; however, due to limitations in data availability, it was also necessary to supplement the dataset with information obtained from other sources through the authors' individual research. This approach made it possible to achieve a final data coverage level of approximately 90% for the five cities.

In order to enable comparisons between different indicators, standardization was required. One of the standardization methods applied was the Z-transformation (Fig. 2).

$$Z_i = \frac{X_i - \mu}{\sigma}$$

where:

- $Z_i$  – transformation (standardization),
- $X_i$  – value of the indicator for the  $i$ -th city,
- $\mu$  – the average value of this indicator for all cities,
- $\sigma$  – standard deviation of this indicator.

**Fig. 2.** Z transformation

Source: own work based on *Smart Cities – Ranking of European Medium-Sized Cities*, [https://www.smart-cities.eu/download/smart\\_cities\\_final\\_report.pdf](https://www.smart-cities.eu/download/smart_cities_final_report.pdf); 2007

The Z-transformation was adopted for the analysis and for determining the ranking of the examined cities. This method converts all indicator values into standardized values with a mean of 0 and a standard deviation of 1. Its advantages include taking into account within-group variability while preserving metric information. Moreover, it is characterized by a high sensitivity to changes.

In order to obtain results at the level of the six dimensions and their corresponding 23 indicators, as well as the final result (ranking) for each city, it was necessary to aggregate indicator values. When aggregating indicators at the dimension level, the degree of data coverage for each indicator was also taken into account. Aggregation at all levels was carried out without additional weighting. The aggregation was additive in nature and was then divided by the number of included values.

This approach also allows for the inclusion of cities for which not all indicators are available—their results are calculated based on the data that are available.

### 6.2. City ranking

Based on the analyses conducted on the cities of Central and Eastern Europe within the European Union, the authors established a ranking, which is presented in Table 1.

No	Determinants and their factors shaping a senior-friendly city	Central and Eastern Europe					Barcelona as a model city
		Warsaw	Vilnius	Prague	Budapest	Bratislava	
1	<b>Urban architecture - buildings and housing</b>						
	- infrastructure to support physical activity (health paths, cycle routes)	4	4	5	5	5	5
	- alternative forms of housing (senior citizens' homes)	3	3	5	4	5	5
	- accessible and safe pavements (with benches for resting without kerbs)	3	2	4	3	4	5
	- lifts	4	4	4	4	4	5
	- support for the renovation and adaptation of housing	2	2	3	3	2	5
2	<b>Social and civic participation</b>						
	- active participation of senior citizens in community life (senior citizens' clubs, senior citizens' councils)	5	4	5	5	5	5
	- acquisition programmes (computer courses, workshops)	4	4	5	5	5	4
	- elimination of social isolation (meeting places and integration)	2	2	4	5	4	5
3	<b>Transport and mobility</b>						
	- low-floor buses and trams with easy access	4	5	5	4	4	5
	- intelligent transport and traffic control	3	3	4	4	4	5
	- adapted bus stops for seniors	4	3	4	5	5	5
	- free or reduced-price public transport	4	4	4	5	4	4
	- senior taxis or transport on request	2	3	3	2	2	5
	- subway	3	1	5	4	1	5
4	<b>Communication and information</b>						
	- modern technologies, information transfer between the institution and the citizen through digital tools	5	5	5	5	5	5

	- e-government and telephone alert system	5	5	5	5	5	5
	- a simple public information system, support for devices and applications	3	4	4	3	3	5
5	<b>Social integration, social and health services</b>						
	- easy access to clinics and specialists	4	4	5	5	4	5
	- homecare and telemedicine	3	5	5	5	4	4
	- education on mobile technologies	3	4	4	3	3	5
6	<b>Security of public and residential spaces</b>						
	- developed network of emergency telephones	5	5	5	5	5	5
	- educational programme on risks (shelters, alarm signals, fraud, cyber security)	3	4	5	5	5	5
	- citi monitoring and police patrols	4	5	5	5	5	5
	<b>transformation Z-index</b>	<b>-1.2041</b>	<b>-0.9388</b>	<b>0.6531</b>	<b>0.2857</b>	<b>-0.22449</b>	<b>1.449</b>
	<b>ranking of cities in Central and Eastern Europe</b>	<b>5</b>	<b>4</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>A city to follow</b>

Legend: rating of cities on a point scale, where 1 means low rating and 5 means high rating

**Table 1.** Rankings, determinants, and indicators of cities shaping the quality of life of seniors in Central and Eastern European countries

Source: own study based on the authors' own research and literature studies

Considering the concept of active aging and the increasing lifespan of seniors, the role of this group in society is evolving – from passive recipients of services to active participants in social life. Smart cities are seen as dynamic ecosystems where human, social, and cultural capital – including the resources of seniors – can be effectively used to solve local community problems. Due to the availability of free time and the growing desire to engage in social activities, older people can play a key role in building innovative support models. Therefore, it is crucial to pay attention to the development of social innovations, the non-governmental organization sector, and the social economy in the context of aging societies.

In the final ranking, the cities of Central and Eastern Europe were positioned below the benchmark city, i.e., Barcelona. The highest score was achieved by Prague, while Warsaw ranked the lowest. Within individual cities, a similar pattern can be observed in the development of the six determinant indicators. The ranking also allows for a preliminary assessment of the strengths and weaknesses of each city and highlights areas that need continuous improvement, so that they can achieve solutions comparable to those in Western European countries and cities become fully adapted to providing a dignified life for seniors.

The examples presented in point 6 illustrate the multidimensional nature of implementing the concept of age-friendly smart cities. This model is based on the synergy between the human factor in the context of an aging population, modern technological solutions, and elements integrating technology with society, such as local governments, social leaders, non-governmental organizations, and the private sector offering innovative technologies.

Age-friendly smart cities are a complex structure in which a proper balance between "soft factors" (socio-political) and "hard solutions" (technological and infrastructural) plays a key role. Such cities and

communities should be based on a reliable diagnosis of the needs of the aging population, conducted by central institutions and local government units. An aging policy that takes into account the development of smart cities and communities should be treated as an integral part of social policy covering the entire life cycle. Implemented solutions and achieved results must serve to build a "society for all ages," in accordance with the guidelines of the United Nations. This approach enables the creation of cities and communities that not only meet the needs of seniors but also contribute to improving the quality of life of all residents, regardless of their age and life situation.

The analysis of the presented concepts and case studies of age-friendly smart cities allows for the formulation of three key research areas requiring further exploration:

1. It is necessary to develop more integrated theoretical approaches to social and technological innovations related to the aging population in cities and communities. In particular, the interactions between technological solutions, social policy, and the participation of seniors in social and economic life should be considered.
2. An important research issue is the analysis of the degree of organization of older people, their participation in the popularization and implementation of innovations. These studies should include the identification of barriers to the development of senior initiatives and their impact on aging policy, both at the local and national levels.
3. It would be valuable to conduct comparative studies of various implementations of the concept of age-friendly smart cities. This analysis should take into account the dependencies between these implementations and welfare state models and innovative economy development strategies. Comparing the experiences of different countries could provide important insights into effective political and urban planning strategies.

## 7. CONCLUSIONS

The future of senior-friendly smart cities requires an interdisciplinary approach that integrates technological, social, and economic aspects. The effective implementation of the smart city concept should not be limited to the development of infrastructure and digital technologies but should also include the active involvement of seniors in decision-making processes and the adaptation of social policies to address the challenges of an aging population.

It is also essential to strengthen cooperation between the public sector, private sector, and social organizations, enabling the successful implementation of solutions tailored to seniors' needs. In this context, monitoring the effectiveness of policies and adjusting them to changing demographic and technological conditions will be crucial.

In the long term, senior-friendly smart cities should serve as a foundation for building an inclusive society, where all age groups have equal opportunities to participate in social and economic life. The integration of modern technologies with proactive social policies can contribute to enhancing seniors' quality of life and reinforcing their role in the society of the future.

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