



Shaping age-friendly cities and communities: A geospatial approach to the assessment of four cities in Europe

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ABSTRACT

Public involvement in decision-making processes has become increasingly important in contemporary urban planning. The social valorisation of living spaces is vital for enhancing urban spaces and improving citizens' quality of life. This is particularly relevant to vulnerable groups such as older people, a demographic projected to grow significantly. Ensuring that urban environments are inclusive and accessible for older people is a pressing concern.

This research addresses this challenge by investigating the spatial distribution of urban spaces in four European cities – Kraków, Wrocław (Poland), The Hague (the Netherlands), and Bucharest (Romania) – to evaluate their age-friendliness. Using hotspot analysis, the study identifies areas characterised as “places” (age-friendly) and “anti-places” (age-unfriendly) based on older people's perceptions of public spaces. Data were collected using KoBo Toolbox, an open-source geodata collection tool, followed by geocoding, integration, hotspot analysis with Getis-Ord G_i^* , and the delimitation of “places” and “anti-places”.

The findings show that Kraków's city centre as largely age-friendly, whereas the centres of Wrocław and The Hague's were viewed as anti-places, highlighting areas in need of improvement. In Bucharest, places were primarily located on the city's outskirts, with some overlap between age-friendly and age-unfriendly zones in the east. The study also explored the influence of various urban domains, such as outdoor spaces and transportation, on overall perceptions of age-friendliness. Across all cities, outdoor spaces emerged as a key area for improvement.

This research offers critical insights for policymakers, identifying areas requiring intervention to foster more inclusive urban environments for older people and to inform future age-friendly urban development.

1. Introduction

One of the main factors determining the quality of life for older adults is the urban spaces in which they reside. As the global population ages, creating inclusive and accessible urban environments has become a critical challenge for many cities across the globe. By 2050, the number of people aged 65 years or older is expected to double, surpassing 1.6 billion (United Nations Department of Economic and Social Affairs, 2023; United Nations Department of Economic and Social

Affairs Population Division, 2022), necessitating urban planning that prioritises the well-being of this demographic. As cities gradually adapt to an increasingly ageing population (Beard & Montawi, 2015), the assessment of how urban planning and spatial design interact with age-friendly considerations is increasingly being conducted through geospatial tools and methodologies that capture the complex interactions of older adults with urban environments (Aslanoglu et al., 2024). This research adds to the existing methodologies available to evaluate and assess age-friendly cities and communities (van Hoof et al., 2021; van

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Hoof & Marston, 2021).

The World Health Organization (2007, 2017) has defined age-friendly cities as spaces that provide environments conducive to active ageing through accessible, inclusive, and supportive physical and social built environments, clustered around eight domains: Outdoor Spaces & Buildings, Transportation, Housing, Social Participation, Respect & Social Inclusion, Civic Participation & Employment, Communication & Information, and Community Support and Health Services. These domains highlight the multidimensional nature of age-friendliness, emphasising physical, social, and institutional accessibility. In 2020, Dikken et al. (2020) successfully validated the Age-Friendly Cities and Communities framework, through a series of factor analyses, which identified a previously integrated domain that focuses on the experienced financial situation to capture the economic experiences of older adults (van Hoof and Marston, 2025; van Hoof, Marston & Dikken, 2025), facilitating the development of more comprehensive strategies for enhancing urban environments. The current age-friendly discourse focuses primarily on the older population alone, whereas intergenerational and transgenerational approaches should be propagated in the wider context of age-friendly societies instead (Ayalon et al., 2023; Marston et al., 2022). In other words, we should strive to build cities for all ages (OECD, 2025). Too often, the determinants of active ageing that form the basis of the age-friendly agenda are not understood from a life-course perspective, which recognises that “older people are not a homogeneous group and that individual diversity increases with age” (World Health Organization, 2007, p. 6). Dikken et al.’s (2020) model and accompanying instrument were initially designed to assess the age-friendliness of cities, but subsequent studies found them to be suitable for use across different age cohorts, demonstrating their potential to bridge generational gaps (Yamada et al., 2023; Ziganshina et al., 2025).

Over the last two decades, numerous scholars have critically engaged with the Age-Friendly Cities and Communities framework (Golant, 2014; Keating et al., 2013; Marston & Van Hoof, 2019; Menec et al., 2011; Plouffe et al., 2016; van Hoof et al., 2021), and have outlined and discussed potential areas of improvement. Some of these potential changes were summarised in Plouffe et al. (2016, p. 23), including a warning that the domains of the Age-Friendly Cities and Communities framework are interdependent. Therefore, it should be regarded as dynamic overall. The things that make a community age-friendly are having a good fit between the older person and their living environment, and not conformity with a standard test and a fixed set of features per se (Plouffe et al., 2016). This evolving understanding of age-friendliness underscores the importance of context-sensitive assessments, highlighting the need to evaluate how specific urban spaces support or hinder the well-being of older adults in practice.

In the context of rapid urban transformation, evaluating the quality of urban space has become essential (Stryjewska, 2017). A key conceptual framework in this evaluation is the distinction between “places”, “non-places”, and “anti-places” (Dymnicka, 2011; Łuczak & Leśniak, 2021; Mayer-Wydra, 2017; Paprzyca, 2015).

“Places” are organically developed spaces shaped by historical and social forces, fostering a sense of identity and belonging (Gawel, 2020; Łuczak & Leśniak, 2021). In contrast, “non-places” lack these contextual anchors, emerging from generic urban development that overlooks local identity and community needs (Bierwaczonek, 2016; Gawel, 2020). Contemporary non-places are often characterised by standardised design, high human flow, uniformity, and detachment from social function.

The concept of “anti-places”, though sometimes used interchangeably with “non-places”, offers a more nuanced understanding of urban spaces in decline. Unlike fully detached non-places, anti-places may still allow for intervention and participatory redesign, making them critical targets for urban improvement (Świąder & Łukowiak, 2016). Identifying these spaces requires public input to capture both physical inadequacies and perceived social alienation.

Understanding these categories is crucial within the age-friendly

framework, as they influence older adults’ ability to engage with and feel safe in public environments (Buffel et al., 2018; Wood et al., 2022). Where “places” encourage participation and well-being, “anti-places” are often marked by poor design elements, such as inadequate lighting or inaccessible paths, that deter usage by older individuals. Thus, the creation or remediation of such spaces can significantly impact health, inclusion, and intergenerational interaction in urban settings. Therefore, central to these eight age-friendly domains, outlined by the WHO, are notions such as “places” and “anti-places”, which distinguish between spaces enabling engagement and connection, and those that, through design or neglect, perpetuate alienation and discomfort among older adults (Buffel et al., 2018).

The notion of “places” entails spaces that enable social participation and physical activity, hence enhancing well-being. In this regard, studies identify accessible green spaces and walkable streets with well-maintained recreational places that not only promote physical activity but also stimulate social networks that might prevent isolation (Schmidt et al., 2019). On the other hand, “anti-places” refer to those places that are inaccessible, poorly maintained, or generally poorly constructed, thus giving the place a threatening or hostile feeling and unsafe for older adults (Wood et al., 2022). These “anti-places” can result from design features inconsiderate of the needs of older people, such as a lack of benches, poor lighting, and unsafe crossings. By creating “places” or “anti-places”, we can significantly influence living conditions and, as a result, also the daily habits of our citizens. Offering places with high-quality urban space that addresses social needs can lead to the creation of healthy cities (Yuan et al., 2025), not only allowing people to live longer but also to stay in good health and conditions, implementing the concept of longevity (Labus, 2024).

“Places” and “anti-places” could also be evaluated from the perspective of intergenerational dynamics: some areas in the city are better equipped for intergenerational contact and activities (for example parks, community centres), whereas others play an inhibitory role in generating intergenerational contacts—for example places labelled ‘for seniors’ will attract less interest from the younger adults (Vanderbeck, 2007). The Age-Friendly Cities and Communities’ framework (Aslanoglu et al., 2025), presents the collaborative views of older adults from Bucharest, Kraków, Wrocław, and The Hague, who agreed on the fact that some spaces are difficult to facilitate intergenerational contacts while still being tailored “for older people”. Consequently, they have advocated for “spaces” that would be tailored for all community members, as cultural centres, community centres, and intergenerational establishments. We believe that such ideas are in line with the notions of “spaces” and “anti-spaces”. Therefore, the identification of best practices in “places” and poor design solutions in “anti-places” is crucial to support local governments in redesigning urban space and offering suitable living conditions for the ageing society.

Considering all of the above, the main objective of the study was to valorise the living spaces of residents in four European cities - Kraków, Wrocław (Poland), The Hague (the Netherlands), and Bucharest (Romania). The study assessed age-friendliness by applying geospatial and sentiment analysis to map how older residents perceive public spaces. “Places” were defined as areas perceived positively, while “anti-places” referred to areas seen negatively. Older participants recorded and audited public spaces in their neighbourhoods, submitting data through geospatial surveys. These submissions were categorised into positive, negative, and neutral perceptions, forming the basis for identifying spatial clusters. Hotspot analysis was subsequently used to detect statistically significant concentrations of sentiment, with results visualised on city maps.

A secondary objective was to analyse the participants’ responses within these delimited areas through the lens of the World Health Organization’s age-friendly domains. Accordingly, positive opinions were evaluated within “places” and negative ones within “anti-places”.

Identifying and addressing these “places” and “anti-places” requires precise and innovative methodologies. Spatial analysis tools, such as

KoBo Toolbox for location-based surveys and ArcGIS for geospatial mapping, allow urban planners to assess the accessibility, inclusivity, and service distribution of urban spaces. These geospatial tools enable the visualisation of age-friendly and age-unfriendly zones, providing actionable insights for targeting improvements. Prior studies have demonstrated their potential to uncover a lack of fairness and justice in urban planning, but further research is needed to evaluate their effectiveness in assessing age-friendly environments across different contexts and cultures (Aslanoglu et al., 2024; van Hoof, van Staaldin, et al., 2025).

The findings provide critical insights for urban planners and policymakers, identifying areas of vulnerability that require targeted interventions while highlighting existing age-friendly spaces that can serve as models for future urban (re)development.

2. Materials and methods

2.1. Data collection

KoBo Toolbox, an open-source, web-based tool, was utilised to gather geodata. It enables the conduction of field surveys, including offline operations, using mobile devices such as tablets and smartphones. The International Federation of Red Cross and Red Crescent Societies (IFRC) and the UN Refugee Agency (UNHCR) are among the most well-known humanitarian organisations that make use of KoBo Toolbox. Designed to be user-friendly, it does not require technical expertise, specialised tools, or payment.

Multiple languages can be added and managed in forms either directly through the online Project Dashboard or by entering the translations into an Excel spreadsheet and uploading it to KoBo Toolbox (Kobo Inc., 2022). KoBo Toolbox facilitates the collection of geodata, along with photos and comments (as was the case in this study), via an integrated map interface that includes geolocation as a data type. Once a survey is completed, the data are automatically synchronised and securely stored in the cloud in an anonymous manner. Thanks to the capabilities of this tool, it was easier for older adults to collect data, while the protection of that data was also enhanced (Aslanoglu et al., 2024). The collected data, including comments, were subsequently used in the hotspot analysis and identifying areas characterised as “places” (age-friendly) and “anti-places” (age-unfriendly).

2.2. Hotspot analysis

2.2.1. Data preparation

2.2.1.1. Geocoding of data. The first stage of the hotspot analysis involved geocoding the data. Geocoding refers to the process of converting location descriptions — such as geographic coordinates — into spatial data points on the Earth’s surface. This transformation enables the creation of geographic features with corresponding attributes, which can then be utilised for mapping and spatial analysis. The geocoding process may be carried out either by manually entering individual location descriptions or by processing large datasets containing multiple entries (Esri, 2021a, 2021e). In this study, tabular data from Kobo Toolbox, which included geographic locations in the form of x and y coordinates, was added to the map using the World Geodetic System (WGS) 1984 coordinate system for geocoding.

2.2.1.2. Sentiment analysis. In this study, older participants actively engaged in the evaluation of urban spaces by submitting photographs along with open-ended comments expressing their personal experiences and perceptions. Each submission, comprising both image and accompanying narrative, was analysed for sentiment. Participants were free to articulate their views, resulting in diverse and sometimes contrasting evaluations of the same or similar spaces. Individual submissions could

reflect positive, negative, neutral, or even mixed sentiments (positive and negative at the same time), for example, praising certain design features while simultaneously highlighting accessibility challenges.

To ensure consistency and analytical rigour, expert analysis was engaged to verify and assign sentiment to each submission (Kisilevich et al., 2013; Mohammad, 2016). For each country participating in the research, a qualified expert reviewed the content provided by the older adults, interpreting the comments in the context of the associated photographs. This process involved carefully assessing the tone and meaning of each statement to classify its overall sentiment, thereby ensuring that the emotional and evaluative nuances in the participants’ reflections were accurately captured. The methodology thus combines grassroots, user-driven insights with expert verification, offering a robust approach to understanding older adults’ lived experiences of urban environments.

2.2.1.3. Data integration. Following the geocoding stage, the next step in data preparation involved data integration using the ‘Integrate’ and ‘Collect Events’ tools. The ‘Integrate’ tool analyses the coordinate locations of feature vertices across one or more feature classes. When vertices fall within a specified distance of one another, they are assumed to represent the same location and are assigned a common coordinate value, effectively collocating them (Esri, 2024b). The ‘Integrate’ tool may be used to ensure spatial accuracy by snapping nearby features together before running the ‘Collect Events’ tool. The ‘Collect Events’ tool is designed to combine coincident points, generating a new Output Feature Class that includes all unique locations from the Input Feature Class. It also adds a field named *ICOUNT*, which stores the sum of all incidents at each unique location (Esri, 2021b). These tools require the definition of an aggregation distance for integration.

In this research, the extent of the nearest neighbourhood (vicinity or street level) was used as the spatial accessibility reference for data integration — 200 m (Damurski et al., 2020). The creation of an age-friendly environment is supported by landscape practitioners, for whom an influential distance threshold can be set at 200 m (Wen et al., 2022).

2.2.1.4. Spatial autocorrelation validation. Before conducting a hotspot analysis, it is essential to verify the spatial autocorrelation of the data. For this purpose, the integrated dataset should be utilised. Incremental Spatial Autocorrelation (ISA) is employed for this verification, measuring spatial autocorrelation across a range of distances. ISA can optionally generate a line graph showing these distances alongside their corresponding z-scores, where z-scores indicate the strength of spatial clustering. Statistically significant peak z-scores highlight the distances at which spatial clustering is most pronounced. These peak distances are often optimal for use in tools requiring a Distance Band (Esri, 2021d), as in hotspot analysis.

2.2.2. Hotspot analysis

Hotspot analysis using geocoded data provides in-depth information across various domains, including human activities, land use patterns, population dynamics, and energy usage (Alessa et al., 2008; Cesario et al., 2022; Karimi et al., 2015; Shi et al., 2023). Hotspot analysis identifies statistically significant hotspots and coldspots in the data. This method uses vectors to detect clusters of high (‘hot’) or low (‘cold’) values. It relies on statistical techniques to determine areas of significant occurrence, thereby reducing subjectivity in the final visualisation. Regions are designated as hotspots based on their statistical significance—z-scores (standard deviations) and p-values (probability)—with confidence levels of 90 %, 95 %, and 99 % used to indicate the reliability of these classifications (Geospatiality, 2016).

This research employed Hotspot Analysis (Getis-Ord G_i^*) using ArcGIS software (ArcMap, 10.8.2 version). The Getis-Ord G_i^* statistic is used to identify clusters of high and low values by examining a user-

defined neighbourhood around each feature in the dataset. This method compares values within the defined neighbourhood to the overall values in the entire dataset. The output of this analysis is the GI^* value.

Positive GI^* values indicate that the neighbourhood contains values significantly higher than the dataset average, designating the area as a hotspot. Conversely, negative GI^* values suggest that the neighbourhood contains significantly lower values, indicating a cold spot. This statistical approach enables the precise identification of spatial clustering patterns, highlighting areas of notable intensity or scarcity in the weighted distribution of data (McKenzie, 2022).

However, conducting hotspot analysis entails certain minimum requirements and limitations. First, the input dataset should contain at least 60 points to ensure sufficient data basis for meaningful analysis. Following aggregation and integration processes, the dataset must still retain a minimum of 30 points to proceed. Additionally, the output from the integration stage must show variation in the *ICOUNT* field to capture meaningful spatial patterns. Without this variability, the analysis may not effectively identify significant clusters or hotspots in the data (Esri, 2024a). In this research, the input data obtained by older adults were categorised as positive, negative, and neutral. Accordingly, each of these groups was required to meet the aforementioned criteria.

Hotspot analysis was employed to detect statistically significant clusters of high (hotspots) and low (coldspots) sentiment values, highlighting areas strongly associated with either positive or negative experiences (Esri, 2024a; Geospatiality, 2016). In this research, the focus was mainly on hotspots, representing clusters of highly positive or highly negative responses. These were interpreted as “places” (good

practices for age-friendly design) and “anti-places” (priority areas for intervention), respectively.

Neutral submissions, while collected, played a limited analytical role in this study. Though neutral areas may indicate average or contextually ambiguous experiences, they do not offer the same actionable insights as clearly positive or negative clusters. As such, they were not the basis for identifying either model environments or intervention targets. This decision is supported by prior urban studies suggesting that effective urban policy is best guided by strong positive exemplars or problematic zones, rather than areas marked by indifference or ambiguity (Buffel et al., 2018; Schmidt et al., 2019).

2.2.3. Heat maps – places and anti-places

The resulting hotspot analysis requires a transition from point-to-surface information. This was achieved through data interpolating using the Inverse Distance Weighted (IDW) technique, which creates a raster surface based on point data (Esri, 2021c).

The resulting heat maps enabled the identification of so-called “places” and “anti-places” within a given community — in this case, older adults (Świąder & Łukowiak, 2016). The heat maps depicted hotspots of facilities marked as positive represent “places”, or age-friendly areas. Conversely, the heat map surfaces showing hotspots of facilities characterised as negative represent “anti-places”, that is, areas considered unfriendly to older people.

Finally, the input data were analysed with reference to the associated domain — i.e., the characteristic or topic under which residents’ submissions were categorised (e.g., ‘Outdoor Spaces & Buildings’,

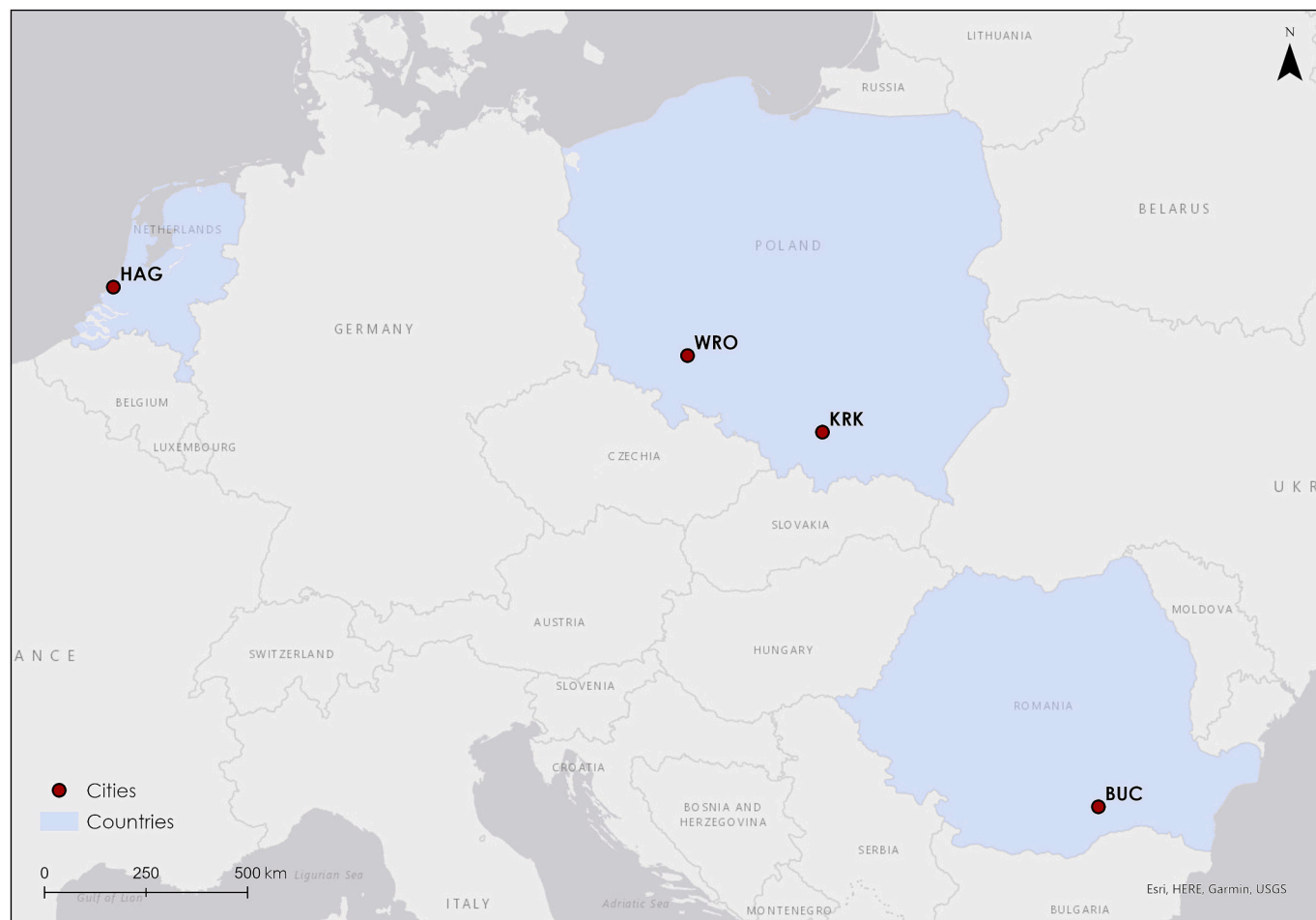


Fig. 1. Location of study areas – The Hague (HAG), Bucharest (BUC), Kraków (KRK), and Wrocław (WRO). Source: Own elaboration using ArcGIS Pro.

‘Transportation’, ‘Community Support & Health Services’). Negative submissions by domain on “anti-place” areas and positive submissions by domain in “places” were verified using the ‘Spatial Join’ function available in GIS software. The integration of these data, showing the overlaps between given sentiment submissions and (anti-)places, represents a mixed-methods approach, allowing a preliminary understanding of the cultural, social, or policy-specific reasons behind the identified hotspots and coldspots.

2.3. Study areas

The research was conducted for four European cities (Fig. 1): The Hague (the Netherlands), Bucharest (Romania), and Kraków, and Wrocław (Poland). The age-friendliness of these locations has been described in various studies (Ivan et al., 2020, 2024; Klimczuk & Tomczyk, 2016; Perek-Białas et al., 2024; van Hoof et al., 2018; van Hoof et al., 2020; van Hoof et al., 2022; van Hoof et al., 2024).

Bucharest (Romanian: București), the capital city of Romania and the largest city in the country, has a population of 1,716,983 inhabitants, according to the 2021 census (Romanian National Institute of Statistics INS, 2023), spread over a surface area of 237.9 km², with a population density of 7218 inhabitants/km². The median age of the population is 44 years. There are 333,088 people aged 65 years and above living in Bucharest, which is 19.4 % of the total population. This percentage is similar to the percentage of the older population (65+) in Romania (19.6 %). In fact, the ageing process in the municipality of Bucharest follows the same trends as in the national average, with a 3.5 % increase in the ageing population from 2011 to 2021 (World Bank, 2023). The number of people 85 years and above (also called the oldest-old) is the segment of the population that has seen an exponential increase during the past 10 years. The municipality of Bucharest has six districts, called Sectors (from Sector 1 to Sector 6), and these districts have a separate political and administrative organization, each with a different mayor and a Local Council that administers district life, from businesses to schools, parks, cleaning services, and streets. As a result, different areas of the city are relatively heterogeneous in terms of population density and opportunities for intergenerational contact.

The municipality of **The Hague (Dutch: Den Haag/’s-Gravenhage)**, the third largest in the Netherlands and seat of government, has a population of 566,731 (1 January 2025) (Den Haag, 2024), of which 86,199 were aged 65 years and over. This means that 15.2 % of the urban population is older people. A total of 66,168 people were aged between 65 and 79 years old, and 20,031 were aged 80 years and over. The average age of the inhabitants of The Hague is only 39.4 years, which is a clear sign that the population has not aged as much as other municipalities in the country. Of the older people in The Hague, 95.5 % age in place and live in the community (81,000 persons). This percentage decreased with age, as 92.4 % of the people aged 75 years and over still live in the community. Older people in the municipality are not evenly spread across the city. The districts of Loosduinen, Scheveningen and Haagse Hout have the highest populations of older people (van Hoof et al., 2024). The municipality offers a wide range of services to older people and is responsible for important age-friendly action domains such as home care under the Municipal Support Act and the quality and maintenance of outdoor spaces.

The municipality of **Kraków**, is Poland’s second largest city, both in terms of population and surface area. Kraków’s population (before the Russian invasion of Ukraine) was estimated at about 800,000. The average age of the city citizens is 37.5 years, with about 60 % of the population being under 45, whereas the number of older citizens (65 or more) amounts to more than 20 %. Among 204,400 people over 60 years old, 139,680 (18 %) were in age of 60–74 years, and 44,815 (6 %) in age 75–85 years old, and 19,915 (3 %) of the Kraków population were over the age of 85 years. However, there is a district like Nowa Huta (former district with steel industry company) where almost 30 % of this population is of 60+. The Local Programme of Social Activity and Integration

of Older People (PASIOS), launched in Kraków in 2015, was one of the first initiatives in Poland to address the challenges of an ageing society in a complex and unique way. Through the Programme, a network of about 58 Senior Activity Centres was established in the city of Kraków.

The city of **Wrocław**, the capital of the Lower Silesian Voivodeship, ranks as Poland’s third-largest city in terms of its population and fifth-largest in terms of its surface area. Wrocław’s population is about 700 thousands, resulting in a ratio of 113 women per 100 men. The median age of residents was 39.8 years. Almost 59 % of Wrocław’s citizens were under 45 years old, while those aged 65 and above constituted nearly 20 % of the city’s population. Wrocław was one of the first cities in Poland to introduce the “Older People Friendly Places” programme. There is also a Wrocław Older Persons’ Card which offers discounts to older citizens of the city. Additionally, there are other projects such as Taxi 75+ which offers free taxi transportation for older persons in need.

These four study areas—The Hague, Kraków, Wrocław, and Bucharest—offered diverse urban contexts for testing the proposed methodology, each with varying spatial characteristics and socio-demographic conditions. The insights gained from older adults’ submissions provide valuable, though context-dependent, perspectives on the perceived age-friendliness of different neighbourhoods.

3. Results

3.1. Input data for hot spot analysis

Each dataset collected for the analysed cities (Table 1) was verified and prepared for further analysis. As part of this process, entries located outside the city boundaries—such as those recorded in locations beyond the city or even the country—were excluded. Additionally, entries for which comments indicated discrepancies in their location (e.g. notes that the object was not situated within the city), as well as test entries, were removed from the dataset.

Each dataset was subjected to sentiment analysis (Table 2, see also Appendix 1), whereby sentiment was assigned as positive, negative, and neutral. Both positive sentiments—for delimiting places—and negative sentiments—for delimiting anti-places—were considered in the analysis. It was also important to account for cases (notably Polish cities) where certain objects were simultaneously assigned positive and negative characteristics, without being classified as neutral. In such instances, the object was included in both the positive and negative datasets. The data were also verified against technical requirements and limitations: a minimum of 60 entries was required for input data prior to integration, and a minimum of 30 entries was required for the integrated dataset.

In the case of Wrocław and The Hague, limitations related to the number of data points at the input stage and/or after data integration, combined with a lack of variance in these data (ICOUNT), prevented the conduct of hotspot analysis. As a result, this hindered the surface delimitation representing “places”.

However, the situation in The Hague is particularly noteworthy. For the sentiment “negative”, despite not meeting the requirements for the data at the input and after integration, and considering the presence of spatial correlation, it was possible to reprocess the hotspot analysis and delimit the surface representing “anti-places”.

Table 1
Characteristics of input data for hotspot analysis.

	Kraków, Poland	Wrocław, Poland	The Hague, the Netherlands	Bucharest, Romania
Input data	226	190	285	732
Usable data	165	161	258	657

Table 2
Sentiment analysis and data compliance with requirements and restrictions.

	Kraków, Poland			Wrocław, Poland			The Hague, the Netherlands			Bucharest, Romania		
	Input	Integrated	SA	Input	Integrated	SA	Input	Integrated	SA	Input	Integrated	SA
positive	76	31	no	63	20	no	50	17	no	282	52	yes
negative	59	22	no	104	33	no	34	16	yes	129	40	yes
neutral	31	N/A	N/A	1	N/A	N/A	174	N/A	N/A	246	N/A	N/A

SA (spatial autocorrelation) - indicates whether the presence of spatial autocorrelation was verified in the ISA report. Orange indicates deviations from the requirements and constraints for hotspot analysis, but the analysis is still feasible. Red signifies a complete failure to meet the criteria, making the analysis impossible or obtaining a result that was not characterised by variability.

3.2. Hotspot analysis

The results (Fig. 2; full-size maps can be found in Appendix 2) indicated that hotspot analyses for places (positives) and anti-places (negatives) were only possible for Kraków and Bucharest. In the case of Wrocław and The Hague, hotspot analyses could only be conducted to identify anti-places, based on negative sentiment.

The findings show that in Kraków, the city centre was rated positively, meaning this area can be considered a “place”, i.e., age-friendly. Conversely, in Wrocław and The Hague, the city centres were marked as anti-places, highlighting areas where changes are necessary to create a more age-friendly environment. In Bucharest, the outer areas (east and west of the city centre) were found to be more accommodating to the needs of older residents. It is also noteworthy that in the eastern part of the city, an area identified as less age-friendly (anti-place) partially overlaps with the area designated as a place (on the eastern edge of the city).

A difference is apparent between the assessments for Bucharest and Kraków: in Bucharest, the areas further from the centre were identified as “places” (and “anti-places”), whereas in Kraków, they were marked as anti-places.

3.3. Places and anti-places

The results (Fig. 3; full-size maps can be found in Appendix 3) show that in the case of Kraków, there is minimal overlap between the areas designated as “places” and “anti-places”, covering only 0.11 km². The area identified as age-friendly (“places”) spans over 25 km², while “anti-places” cover more than 17 km². In the case of Wrocław, the “anti-place” zone represents an area of over 78 km².

In the case of The Hague, the “anti-place” zone represents an area of over 5 km². In the case of Bucharest, the overlapping area (intersection of “places” and “anti-places”) covers nearly 40 km², reducing the anti-place area to almost 2 km² and the place area (age-friendly zones) to 62 km².

It is worth noting that in addition to sentiment (Fig. 4), domains were also assigned to the spatial data. This made it possible to determine in which areas (domains) the space was classified as a “place” or an “anti-place”.

For Kraków, in the case of places (age-friendly areas), the following domains were highlighted as positive aspects of the space: Social Participation (11 responses), Civic Participation & Employment (8), Respect & Social Inclusion (6), and Outdoor Spaces & Buildings (4). On the other hand, for anti-places, the negative aspects were primarily associated with Outdoor Spaces & Buildings (10 mentions), as well as Transportation (7).

In the case of Wrocław, the negative assessment of space (anti-place) was mainly connected with such domains as Outdoor Spaces & Buildings (29 responses), Community Support & Health Services (9), Communication & Information (8), Respect & Social Inclusion (5), Civic Participation & Employment (5), Social Participation (4), Transportation (3), Housing (2).

For The Hague, there were 15 negative opinions about space, and all of them were connected with the domain of Outdoor Spaces & Buildings.

Residents of Bucharest, in contrast to those of The Hague, most positively evaluate Outdoor Spaces & Buildings, with 33 positive mentions in areas designated as places. Other positively rated features of these places include Transportation (21 mentions), Finance (21), Community Support & Health Services (20), Social Participation (17), Respect & Social Inclusion (14), Housing (13), Civic Participation & Employment (12), and Communication & Information (9). Among the anti-places, the following were rated as negative: Community Support & Health Services (3), and Outdoor Spaces & Buildings (1).

The area identified as the most unfriendly to older people in urban spaces across all cities was the domain of Outdoor Spaces & Buildings, with the highest number of comments from residents of Wrocław, followed by older people from The Hague, Kraków, and finally Bucharest. Another commonly mentioned domain, excluding The Hague, was Community Support & Health Services, with residents of Wrocław providing the most feedback, followed by Bucharest and Kraków. Transportation was also highlighted as a significantly negative domain, noted by residents of both Kraków and Wrocław.

4. Discussion

To date, the age-friendliness of cities has mainly been assessed through qualitative (Carroll et al., 2020; Chui et al., 2019; Novek & Menec, 2014; Yeh, 2022) and quantitative (Dikken et al., 2020; Ivan et al., 2024; Pavlovski et al., 2024; Perek-Białas et al., 2024) methodologies, with the exception of the use of GIS methodology (such as Jelokhani-Niaraki et al., 2019). The research in this paper addresses the unique age-friendliness of four European cities simultaneously (rather than just a single city) through a geospatial approach, using hotspot analyses based on input from older persons evaluating cities by sharing their geotagged photos with comments.

First, these analyses showed that in each city there could be places considered by older citizens as friendly (“places”) or unfriendly (“anti-places”), and the distribution of these could have different contexts of origin (such as photos from the centres or suburban areas, as well as deprived areas; Carroll et al., 2020). Second, a great variety in perceived age-friendliness was confirmed, particularly in city centres, both in terms of positive and negative viewpoints. This was also observed in the outskirts of cities. These findings suggest that age-friendliness needs to be analysed at very small units of geolocations. In this case, geolocations were created by latitude and longitude, which were derived from the photos and the annotated comments essential for analysis. Such detailed analysis is necessary to understand the qualitative aspect of other survey results, such as survey findings, and not just at the city level.

Third, it is noteworthy that survey participants in each city approached the evaluation of urban spaces differently. In Kraków (Poland), both “places” and “anti-places” were identified, indicating a balanced assessment of positive and negative aspects. In contrast, residents of Wrocław primarily focused on negative aspects, leading mostly to the identification of “anti-places”. It is also worth further exploring

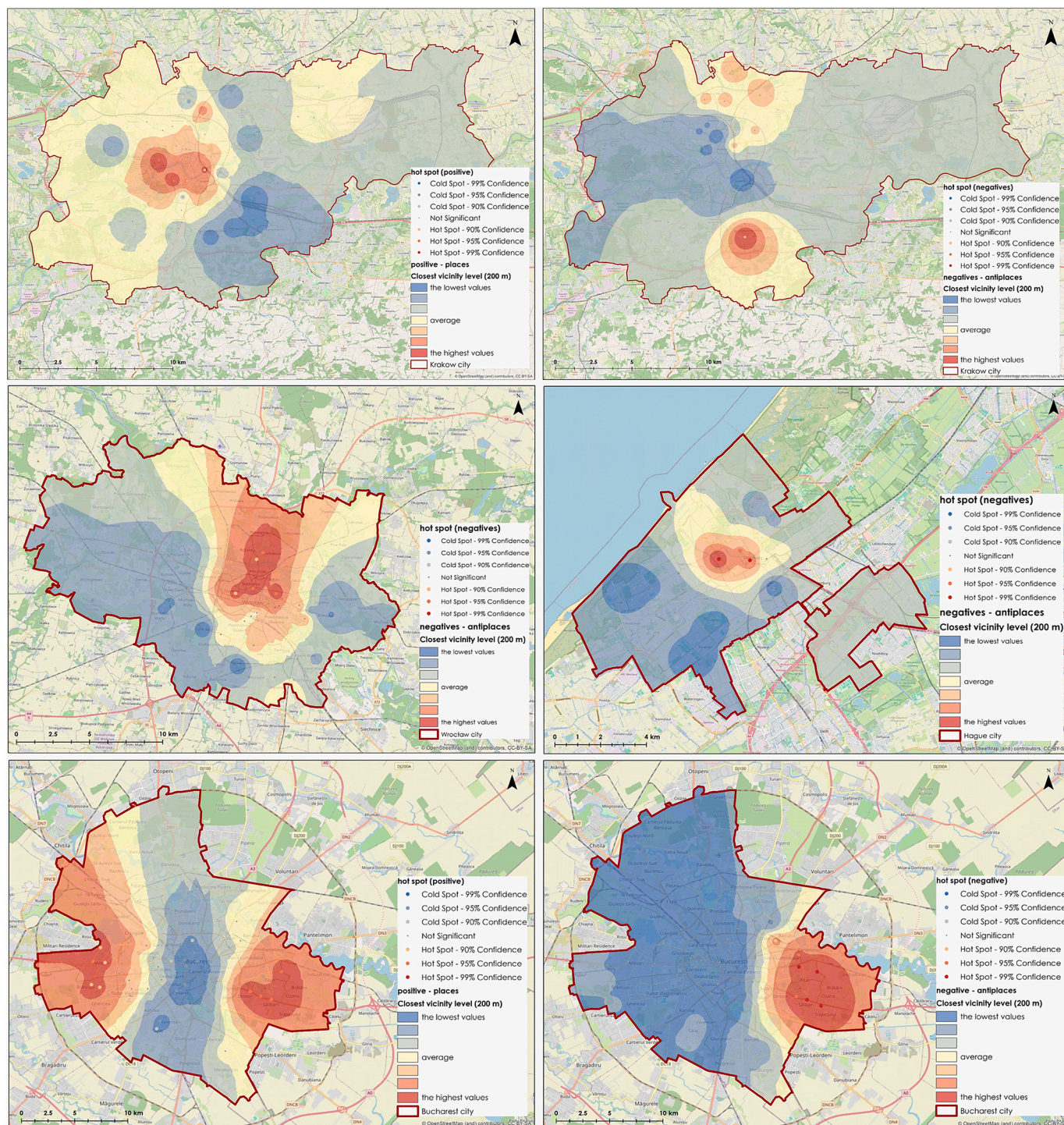


Fig. 2. Hotspots and heat maps. Top-left corner (“places”) and top-right corner (“anti-places”) — Kraków. Middle-left map (“anti-places”) — Wrocław, middle-right map (“anti-places”) — The Hague. The bottom-left corner (“places”) and bottom-right corner (“anti-places”) — Bucharest. Source: Own elaboration using ArcMap.

why both cities, despite being in the same country (Poland), approached the evaluation differently. This difference may be due to the fact that the same project’s team members explained how data should be collected by the older persons, which was later used in the hotspot analysis. In The Hague (the Netherlands), the majority of responses carried a neutral tone. Despite the second largest group of opinions being positive, “anti-places” were still identified due to the spatial correlation and variance in the data. In Bucharest (Romania), the distribution of responses was more balanced, with a similar number of positive (282) and neutral (246)

responses, while negative responses were the fewest (129). However, the most important key message from the analysis is that, across all cities, regardless of their location (country), the domain consistently identified as requiring improvement in age-unfriendly urban spaces was Outdoor Spaces & Buildings. This domain is also highlighted in evaluations of age-friendly cities and communities, with clear recommendations about which aspects should be improved (van Hoof et al., 2021). While the delimitation of “places” and “anti-places” or age-friendly and age-unfriendly areas, reveals meaningful localised patterns, these

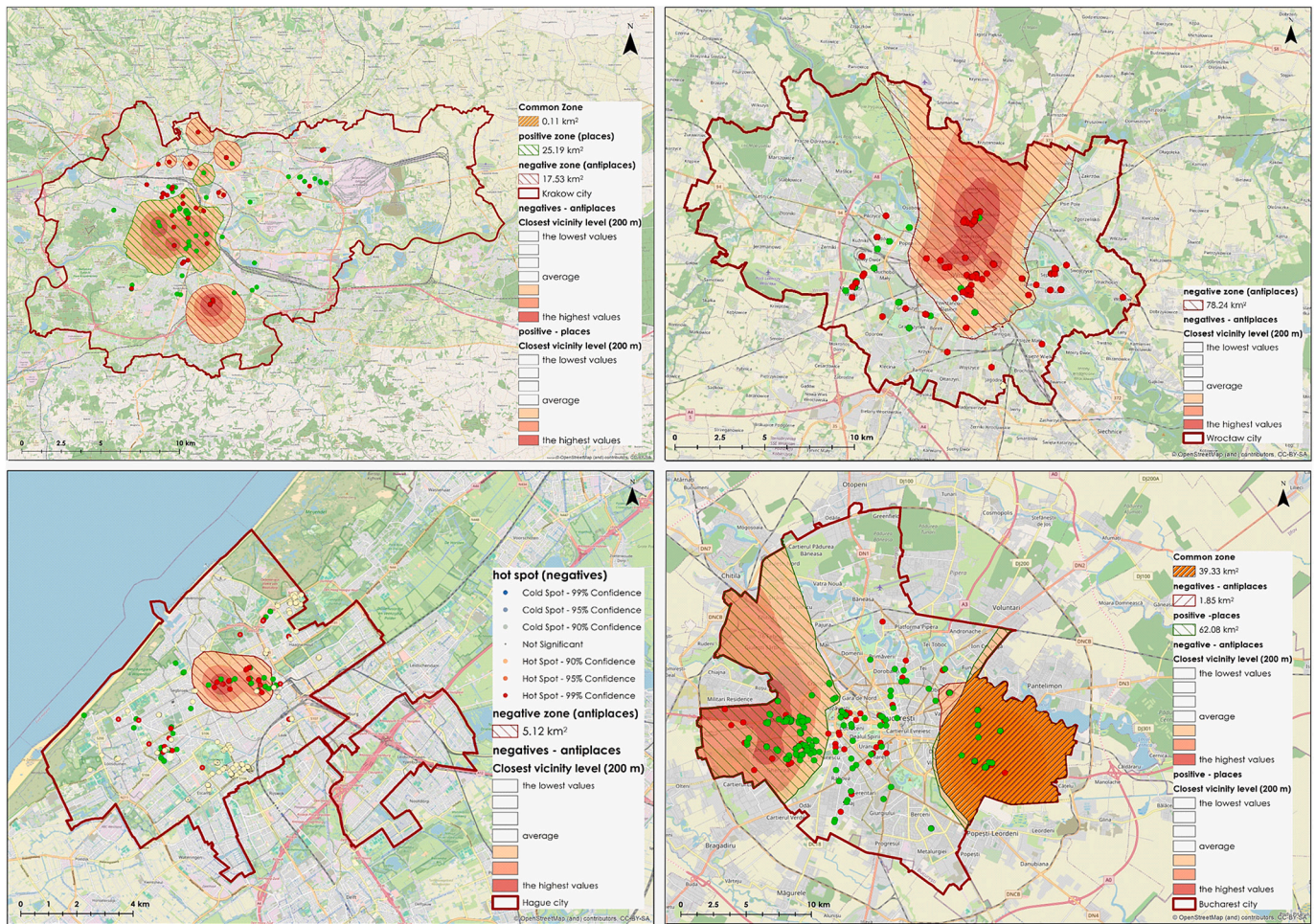


Fig. 3. “Places” and “anti-places”.
Source: Own elaboration using ArcMap.

findings are not intended to be universally representative. Instead, they serve as a basis for further contextual interpretation and targeted interventions.

The findings of this study complement a series of studies conducted in the previous years in the same cities, using a translated and validated survey instrument called the AFCCQ (Dikken et al., 2020) - Age-Friendly Cities and Communities Questionnaire (Ivan et al., 2024; Perek-Bialas et al., 2024; van Hoof et al., 2022, 2024). In these studies, the age-friendliness of the four cities was assessed by older people through a quantitative survey, which also led to the identification of several personas based on salient characteristics of older people, including those living in prosperity and those living with impaired mobility and chronic diseases. The current study aligns with the relatively lower scores on age-friendliness for some boroughs or sections, including that of the city centre of The Hague (van Hoof et al., 2022, 2024). This was also found in a photoproduction study conducted by the same city by van Hoof et al. (2020), where many negative elements or hindrances emerged in the city centre. In fact, many city centres are considered not friendly for citizens, not only older ones, but regardless of age (Temelová & Dvořáková, 2012). Therefore, it may be concluded that the current analysis not only supplements but also enriches the existing body of knowledge and evaluation on age-friendliness with data gathered in an alternative way.

As such, this approach, with a mixed-methods approach of data collecting (quantitative and photoproduction, qualitative with more advanced econometric analysis), needs to be further developed. This is of particular interest to the over 1700 cities, communities, and other

governmental bodies that have joined the Global Network for Age-Friendly Cities and Communities of the WHO in recent years. These bodies have indicated a formal commitment to enhancing the age-friendliness of their environment by engaging in a continuous cycle of progress, involving improvement, active engagement, and understanding what citizens perceive as positive or negative in their living areas. Assessment and evaluation are an integrated and important part of this cycle (World Health Organization, 2023). This geospatial analysis, designed to gather relevant data from the perspective of older persons (Gardiner & O'Brien Webb, 2023), represents the latest addition to the set of methods, tools, and instruments outlined by van Hoof et al. (2021).

As the World Health Organization stated in 2015 (World Health Organization, 2015, p. 65), “age-friendliness is a complex, dynamic and multidimensional concept which is also highly context-dependent”, and which “does not easily lend itself to standardization of measurement”. Therefore, it is of great importance that as many methodologies as possible are developed to guide policymakers at the community, city, and other levels of government in making their jurisdictions as age-friendly as possible through concerted evidence-informed actions (van Hoof & Marston, 2025). Buckner et al. (2018, 2019) and Webster et al. (2024) have addressed the challenges of evaluating age-friendly community initiatives and have raised awareness developed concrete ways to improve the collection of evidence. As Dikken et al. (2020) and van Hoof et al. (2021) have pointed out before, the lack of measurability of the actual age-friendliness of cities and communities has been a major challenge in advancing the ideals of the age-friendly movement and its

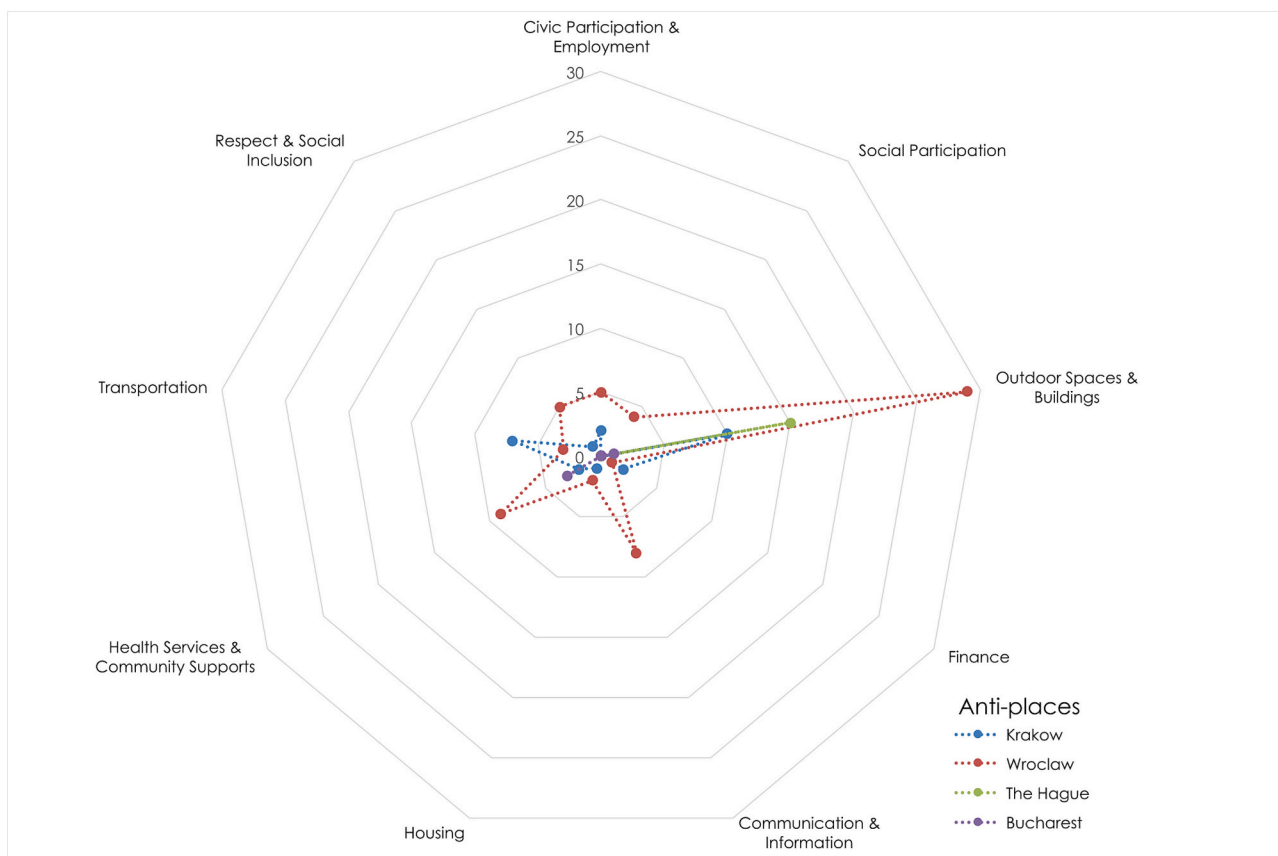


Fig. 4. Negative responses of participants identified at anti-places (upper part of the figure); positive responses of participants identified at places (lower part of the figure). Analysis according to domains. Source: Own elaboration.

local initiatives.

This approach builds on previous studies that embraced the notions of citizen science (Barrie et al., 2019; Buffel, 2019), photovoice and photoproduction studies (Mysyuk & Huisman, 2020; van Hoof et al., 2020), in which older people are either active agents involved in studying their city and eventually achieving social change or improvements to the urban landscape, collecting data in a visual form, such as images and photographs. The current study significantly contributes to other studies that focused on spatial indicators concerning the assessment of the age-friendliness of cities and communities, such as the work by Davern et al. (2020).

Summing up, the present study offers valuable insights through hotspot analysis of urban areas about the identification of critical zones that require intervention. One of the strengths of this study is in the practical application of spatial data to highlight issues relevant to urban ageing and accessibility, with immediate policy intervention recommendations.

5. Limitations

As a limitation, the uneven number of submissions from participants results in many gaps in spatial coverage, particularly in certain neighbourhoods. Such gaps constrain on generalisation of findings and could create biases in the identified hotspots. There could also be an analysis of the context of comments more qualitatively, but this part of the study will be explored in the future.

A large enough volume of submitted data by older persons (through their voluntary engagement over a longer time, as data were collected over up to 6 months) plays a key role in having data which are important to give indication what kind of “places” could be considered as age-friendly which ones are “anti-places”. Such work could not be done in an easy way comparable with other known studies, especially since the GIS-based ageing analysis was done regarding socio-environmental vulnerability mapping of geriatric depression risk (Ho et al., 2017) or hotspot analysis for delimitation of “blue-zones” - longevity regions (Huang & Jacquez, 2017). This highlights that there is still room to use more hotspot analysis for such evaluation of (un-)friendly places of cities. Also, a relatively large number of participants would enhance the results by providing various coverage across different areas, and the photos submitted per participant met the minimum required size for this analysis. At the same time, it is important to continue receiving new data to keep the datasets up-to-date, also from new waves of older persons.

Another limitation is that submissions could be indicated for not only one domain. Here, a significant amount of time was spent by the project team to explain and conduct a series of group trainings and individual consultations with older participants to ensure the quality of submissions with instructions on how to choose a certain domain and evaluate accordingly. Inaccurate or incomplete data submitted can limit the depth of the research and the precision of the patterns it uncovers; however, the team made considerable efforts to minimise this potential bias.

To address these limitations, more comprehensive participant coverage should be adopted to enhance the accuracy of the spatial analysis. Also, combining the current study’s methodology with both qualitative and quantitative ones (van Hoof et al., 2021) would provide a deeper understanding of hotspots by connecting participants’ experiences with spatial patterns. However, while it was possible to do this for one city – for example, The Hague – in this study, comparing four cities was already challenging. The qualitative context of submissions is planned for further analysis, and as such, it is outside the scope of this paper.

Last but not least, it could be added that network analysis could also provide a more detailed revelation of the connections between hotspot areas and written explanations, which will be developed further with use of more advanced methods, such as automated approaches, e.g. machine learning (ML), artificial intelligence (AI) in data analysis

procedures (Bobicev & Sokolova, 2017; Mohammad, 2016; van Atteveldt et al., 2021), and it may expedite the processing of the gathered data (photographs and written explanations and improve spatial projections, both of which would subsequently facilitate decision-making).

6. Conclusions

The current study demonstrates the value of hotspot analysis in providing insights for policymakers and urban planners, highlighting which areas of the city require immediate interventions and which policy areas should be prioritized, following the age-friendly city framework. By utilizing geospatial data, municipalities and other relevant stakeholders can implement evidence-based policies using a bottom-up approach that relies on citizens’ views and experiences throughout the city. Urban policies often lack insights from the citizens’ perspective, and policymakers need tools to facilitate continuous and comparable evaluations. The KoBo Toolbox and the approach presented in the current study offer methods to assess urban policies by engaging citizens from different areas of the city.

The current work utilizes the data provided by older adults in all four cities where the KoBo Toolbox has been tested: The Hague, Kraków, Wrocław, and Bucharest. Their perspectives are valuable as auditors of “places” and “anti-places,” as they have lived in the city for a significant amount of time and possess first-hand experience of the age-friendliness of their urban communities. Our study demonstrated that older adults can effectively use such data-gathering tools and, after proper training, can offer valuable insights. They are also motivated to contribute their inputs and participate in evaluating age-friendliness, which supports better community development.

Our findings indicate that Kraków’s city centre was perceived by participants of the study as rather age-friendly, while the centres of Wrocław and The Hague were viewed as “anti-places.” In the centre of Bucharest, there was observed a substantial overlap of “places” and “anti-places”. The tool is sensitive enough to provide input for various areas and neighbourhoods, enabling the monitoring of city life at the micro level, provided that sufficient and high-quality inputs are gathered from the various groups of older citizens. The results do not aim to create a generalised picture of all places and anti-places in the city, but rather to identify what could be seen as age-friendly or not, and to respond with an adequate system of intervention. Additionally, the contextual interpretation of the data produced by the hotspot analysis resides with the expertise of city planners, who could utilise this tool alongside other data they may have at the neighbourhood level.

Nevertheless, cities differ in terms of the level of urbanisation in different areas, the structure of the population, the density of the older population in various neighbourhoods, and the economic development of some areas in contrast to others. Such information may reveal which aspects of the hotspot analysis are comparable between different communities and which are not. However, policies implemented in a certain neighbourhood may result in more “places” and fewer “anti-places”, as this study demonstrates.

CRedit authorship contribution statement

Małgorzata Świąder: Writing – review & editing, Visualization, Resources, Investigation, Data curation, Writing – original draft, Software, Methodology, Formal analysis, Conceptualization. **Rengin Aslanoglu:** Writing – review & editing, Software, Methodology, Writing – original draft, Resources, Data curation. **Grzegorz J. Chrobak:** Writing – original draft, Resources, Writing – review & editing, Software, Data curation. **Loredana Ivan:** Writing – review & editing, Validation, Funding acquisition, Writing – original draft, Supervision. **Jolanta M. Perek-Białas:** Writing – original draft, Supervision, Writing – review & editing, Validation, Funding acquisition. **Jeroen Dikken:** Writing – review & editing, Validation, Writing – original draft. **Joost van Hoof:** Writing – original draft, Supervision, Writing – review & editing,

Validation, Funding acquisition. **Jan K. Kazak:** Writing – review & editing, Validation, Funding acquisition, Writing – original draft, Supervision.

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Declaration of competing interest

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Appendix. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cities.2025.106247>.

Data availability

The results and some input data will be available on a geportal dedicated to the project.

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