urban science

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An Age-Friendly Neighbourhood Index as a Long-Term Urban Planning Decision-Making Tool

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Abstract: People responsible for shaping the future of cities often seek valuable tools to assist in their decision-making processes. Using objective, quantified, and analysed data proves highly beneficial when determining where to focus interventions at the city level. Various urban indexes have been established to measure different aspects of urban life, ranging from sustainability to liveability. These indexes encompass multiple dimensions of a city, including mobility and walkability, among others. The age-friendly cities initiative developed indicators for assessing the age-friendliness of cities. Some researchers further refined these indicators to focus on urban planning competencies. Building on this foundation, this article aims to present an Age-Friendly Neighbourhood Index (AFNI) validated by a panel of experts using the Delphi method. This index can serve as a valuable tool for urban planners when they need to prioritise interventions to enhance age-friendliness at neighbourhood scale. The article also outlines the necessary data and measurement techniques for these indicators. The AFNI has been applied to a real case study in the city of Santander (Spain). This application assesses the age-friendliness of various neighbourhoods in Santander, demonstrating the challenges in acquiring sub-local quality data and emphasising the need for data-driven urban management.

Keywords: index; age-friendly; urban planning; neighbourhood; measure; data

Citation: Urra-Uriarte, S.; Herranz-Pascual, K.; Molina-Costa, P.; Martin Roncero, U.; Glodeanu, A. An Age-Friendly Neighbourhood Index as a Long-Term Urban Planning Decision-Making Tool. *Urban Sci.* **2024**, *8*, 127. https://doi.org/10.3390/urbansci8030127

Academic Editors: Jianming Cai and Marialena Nikolopoulou

Received: 28 May 2024
Revised: 13 August 2024
Accepted: 22 August 2024
Published: 27 August 2024

1. Introduction

One of the most remarkable accomplishments of humanity is the notable rise in life expectancy. Additionally, a substantial segment of this ageing demographic now calls cities home, contributing to another significant phenomenon—urbanisation.

As the United Nations has been stating for decades, by the year 2050, 68% of the population will live in cities [1], and also by 2050, 16% of the population will be over 65 years old [2]. This scenario will pose numerous challenges as cities must be equipped to address the diverse needs of this population, establishing connections between sustainability, age-friendliness, and health.

Can healthy cities be considered age-friendly, and conversely, can age-friendly cities promote overall health? The European Healthy Cities initiative is at the forefront of adopting inclusive life-course strategies, emphasising the creation of supportive environments for individuals of all ages [3]. This commitment aligns with the Zagreb declaration from the World Health Organization's European Healthy Cities Network: 'A healthy city is a city for all its citizens—inclusive, supportive, sensitive, and responsive to their diverse needs and expectations' [4].

Population ageing trends hold significant relevance for key Sustainable Development Goals (SDGs). These include goals aimed at eradicating poverty, ensuring well-being

and healthy lives across all age groups, promoting gender equality, fostering full and productive employment, reducing inequalities both between and within countries, and creating inclusive, safe, resilient, and sustainable cities and human settlements [5].

Furthermore, understanding how investments in age-friendly environments contribute to the 2030 Agenda's overarching ambition is crucial. This aligns with Sustainable Development Goal 11 but also with broader Sustainable Development Goals (SDGs) and their associated targets, highlighting the interconnected nature of creating cities that promote well-being for all.

The global initiative known as the United Nations Decade of Healthy Ageing (2021–2030) is a collaborative effort that aligns with the final ten years of the Sustainable Development Goals. Its purpose is to enhance the well-being of older adults, their families, and the communities in which they reside. This initiative has emphasised that the age-friendly cities approach serves as a framework for ensuring adequate and affordable housing, along with essential services, and the enhancement of the urban environment. Central to age-friendly cities is the principle of the right to live in safety and dignity, with a focus on fundamental human rights such as a decent home and a healthy urban setting.

Public authorities bear the responsibility of fostering inclusive, age-friendly environments. This involves providing support services that uphold dignity, autonomy, and independence, facilitating older adults to reside in their homes while considering their will and preferences. To achieve this goal, it is key to innovate and to create adequate infrastructure for an age-friendly city. Age-friendly city domains include accessible transport systems for all, green and public spaces, community support and health services, and communication and information (among others). Still, they should also include integrated urban planning, climate change mitigation and adaptation, and disaster risk reduction. Older persons have to be included and taken into account when states implement SDG11.

Emphasising this responsibility, more than 1.542 cities and communities across 51 countries have demonstrated their interest and recognition of the need to create an age-friendly world [6]. The establishment of the WHO age-friendly cities network in 2010, coupled with its continuous expansion, serves as a clear indicator of the collective commitment to this cause. The construction of an age-friendly world is an ongoing process, evolving through the enhancement of every street, neighbourhood, city, and country.

An age-friendly world is envisioned as one that promotes the health and well-being of older adults, facilitating a positive and healthy ageing experience. This approach empowers older people to live fulfilling lives while pursuing what is meaningful to them in a supportive and inclusive environment [7].

The role of urban planning in achieving an age-friendly world is fundamental, as it organises all elements of the urban environment. It is the foundation for articulating, coordinating, and integrating sectoral policies across various fields, including housing, mobility and transportation, green areas, social services, and public health [8].

Nevertheless, several barriers remain to effectively position urban planning within the domain of age-friendly environments, where it should play a crucial role. Urban planning must engage more comprehensively in creating age-friendly cities by educating practitioners on demographic changes and the needs of older adults, promoting established planning techniques, prioritising long-term societal benefits over short-term profits, and developing a coherent age-friendly urban planning theory integrated into planning frameworks and legislation [8].

The objective of this article is to create an Age-Friendly Neighbourhood Index (AFNI) that supports the development of this urban planning theory by providing urban planners and policymakers with a decision-support tool tailored to their expertise and competencies. The AFNI specifically focuses on the sub-city level, emphasising a neighbourhood-scale approach.

Background

The age-friendly cities movement has established a framework for assessing a city's age-friendliness. In 2015, the WHO released the document *Measuring the Age-friendliness of Cities: A Guide to Using Core Indicators* [9], providing cities with a framework and a set of indicators to evaluate their progress in enhancing the age-friendliness of urban environments. Subsequently, in 2018, the WHO regional office in Europe, along with the European Commission, published *Age-Friendly Environments in Europe: Indicators, Monitoring, and Assessments* [10].

Stakeholders within the age-friendly community have raised concerns regarding the survey-based nature of some proposed indicators and assessment methodologies. They underscore the necessity for additional resources to assist practitioners and planners in the evaluation and enhancement of age-friendliness in local environments, thereby promoting healthy ageing in place [11].

Various studies have been conducted to explore and expand on methods for assessing the age-friendliness of cities, building upon existing WHO documentation. One such investigation aimed to assist urban planners in more effectively designing cities, focusing on the selection of indicators within the realm of urban planning competencies [12].

This research established an age-friendly indicators framework based on the WHO document *Age-Friendly Environments in Europe: Indicators, Monitoring, and Assessments*. The new framework was developed with a focus on urban planning competencies. To establish relevant indicators, we initially excluded domains and indicators that did not apply to urban planning. For instance, out of the eight domains proposed by the World Health Organization (Community and Health Care, Transportation, Housing, Social Participation, Outdoor Spaces and Buildings, Respect and Social Inclusion, Civic Participation and Employment, and Communication and Information), we directly incorporated three (Transportation, Housing, and Outdoor Spaces and Buildings). The fourth domain emerged from merging two others: Social Participation and Communication. The framework also incorporated insights from existing urban indexes and research assessing age-friendliness in urban environments. Among these indexes can be found the quantifiable spatial indicators framework, which evaluates local living environments based on each age-friendly cities and communities (AFC) domain [11] and also other models, such as those assessing the vulnerability of public spaces, with a specific focus on addressing the needs of older people [13] among other relevant approaches.

With this first selection of indicators, various consultations were carried out through a co-creation process with older people and public servants [14] in three European cities and regions (Santander, Helsinki, and the region of Flanders) to verify the relevance of the proposed indicators for both target groups. The newly developed list of indicators was analysed to identify redundancies and groupings, and their feasibility for measurement was assessed using existing municipal data rather than surveys or queries. This approach supports data-driven decision-making in urban planning for ageing populations.

The aim was to create a set of indicators that assist urban planners in addressing the unique needs of older individuals and evaluating the age-friendliness of different neighbourhoods. Consequently, city-level indicators not facilitating neighbourhood comparisons, such as housing programmes and resources available city-wide, were excluded.

The final version of the age-friendly cities indicators framework proposes four domains: Outdoor environments, Transport and Mobility, Housing, and Social Participation and Communication, with a total set of 36 indicators (Table 1).

The next step is to use this set of indicators as the basis for establishing the Age-Friendly Neighbourhood Index (AFNI).

Table 1. Age-friendly cities indicators framework.

DOMAIN	TARGET TOPIC	INDICATOR
DOMAIN 1: Outdoor environments	Neighbourhood walkability	Number of rest places and distance between rest places
		Level of appropriateness (comfort) of benches/public furniture for the older adult population
		Number of accessible washrooms, availability of (public) toilets
		Safe crosswalks
		Safe walkways
		Existence of sheltered zones
	Accessibility of public spaces and buildings	Proportion of new and existing public spaces that are fully accessible by wheelchair
		Proportion of public buildings (of a certain type/function) that are fully accessible
		Access to public open space (a public space is a space to which people normally have unrestricted access and right of way)
	Public safety	Reported rate of crimes (per year) committed against older people
		Numbers of physical incidents of older people (occurring in public places)
	Greenery and Water	Location of public green
		Presence of water in public domain
	Temperature, climate, noise, and AQ	Temperature/relative humidity
		Presence of 'quiet' zones or zones
		Presence of clean air
DOMAIN 2: Transport and Mobility	Accessibility of public transportation stops	Housing and public transportation
		Comfortable bus shelters
	Accessibility of priority vehicle parking	Priority parking at public buildings
		Special parking permits for older and disabled people
		Maintainance of parking lots in winter
	Urban accessibility solutions	Urban accessibility solutions' schedule
		Short-time parking lots
	Traffic levels	Traffic volume
		Safe biking infrastructure

Table 1. *Cont.*

DOMAIN	TARGET TOPIC	INDICATOR
DOMAIN 3: Housing	Availability and affordability of housing	Protected flats for older people
		Public housing options
	Accessible housing	Accessible housing
DOMAIN 4: Social Participation and Communication	Accessibility of participation opportunities	Accessibility to community-based activities
		Access to neighbourhood houses/community centres
		Accessibility to cultural and educational facilities
		Accessibility to sites of worship
		Accessibility to leisure services
		Accessibility to convenience stores
		Accessibility to health centres
	Internet access	Internet access

Urban indices serve as valuable instruments for evaluating the efficacy of policies and the overall quality of life in metropolitan areas [15]. Social indicators, defined as "statistics and all other forms of evidence that enable us to assess where we stand and are going with respect to our values and goals" [16], are crucial components of these measurements. Although public authorities currently utilise diverse data sources, the rise of novel metrics and the growing involvement of citizens in data utilisation underscore the heightened significance of urban data.

Tools for city indicators can be developed using either a single indicator or composite indices comprising multiple indicators. These tools may also integrate data from diverse sources or rely on primary data. The design of these tools, including choices in indicators and their weighting, as well as the target audience, is often influenced by the specific focus of existing city indicator initiatives [17]. Researchers and stakeholders focused on monitoring policy effectiveness have crafted diverse urban frameworks to gauge sustainability levels [18], the economic complexity of cities [19], the quality of life [20], or the smart city approach [21] in these regions, among others.

Access to urban data introduces novel opportunities for both citizens and decision-makers. City rankings, grounded in performance metrics, offer a valuable tool for evaluating policy effectiveness and fostering the exchange of best practices. However, these indicators come with inherent limitations. Composite indices condense the multifaceted nature of a city into a single metric, risking the oversight of unique climatic, economic, social, and cultural contexts. Furthermore, such rankings often focus on successful cities rather than incentivising improvement for not-so-advanced cities.

Conversely, these indices often overlook sub-city level data, which could prove highly beneficial for enhancing service delivery to citizens. Consider a scenario where decision-makers need to make well-informed choices within a city, rather than merely comparing it to others. In such cases, the absence of sub-city data within these indexes becomes a notable limitation.

Recognising this gap, this paper describes the process followed to define an Age-Friendly Neighbourhood Index (AFNI). The AFNI is a tool designed to assess the age-

friendliness of neighbourhoods within a city, from the perspective of the urban planning competencies.

The AFNI holds significant utility for urban planners and policymakers, as it informs their decision-making processes concerning the development of inclusive cities that cater to the needs of all residents. It operates at the neighbourhood scale, affording decision-makers the capacity to discern disparities in age-friendliness across different neighbourhoods and within specific domains. By doing so, it facilitates a strategic approach to prioritising interventions based on the targeted domains for enhancement or the specific neighbourhood needs that warrant attention. Predicated upon quantitative indicators and objective data, the proposed index serves a crucial function: it substantiates the rationale underpinning decisions taken by public authorities.

This paper is structured to effectively address the research objectives by organising it into distinct sections. The "Methods" section presents the methodologies and tools employed, elucidating the expert consultation process by the Delphi method built upon an existing initial proposal indicators framework. Subsequently, the "Results" section unveils the ultimate proposal of the Age-Friendly Neighbourhood Index (AFNI), offering a thorough exploration of its domains, topics, and indicators along with guidance on measurement. To evaluate the practical application of the AFNI, this study computes the AFNI for the city of Santander, Spain. Moving into the "Discussion" section, the results are critically assessed within the context of the research objectives, emphasising key findings, exploring implications, and addressing any encountered limitations or challenges. Finally, the "Conclusions" section succinctly summarises the significant findings, reiterates the research's importance, and provides insights into potential avenues for future research and practical applications.

2. Materials and Methods

This section describes the process followed to define the Age-Friendly Neighbourhood Index (AFNI), its topics and indicators, and the weights of each of them.

The AFNI definition´s initial step involves selecting a pre-existing set of indicators derived from prior research [12], already explained before. To delineate the AFNI, it has been necessary to ascertain the weight assigned to each indicator within the overall index. The determination of varied weights, as the validation of the proposed structure for the different domains, topics, and indicators of the AFNI has been achieved through the utilisation of the Delphi method.

The Delphi method was used to establish the weights of the different domains, topics and indicators in which the AFNI is structured. The Delphi method is a structured communication technique, originally developed as a systematic, interactive forecasting process which relies on a panel of independent experts who provide anonymous opinions and feedback. It is a flexible technique that serves to enrich consensus. In Delphi, the judgments are summarised and sent again to refine the problem in a varied range of fields [22]. The main characteristics of the Delphi method are anonymity, interaction, controlled feedback, and the statistical aggregation of a group of responses [23].

Following the Delphi method, 32 professional experts were invited to participate in the study. The selection process for these experts adhered to two primary criteria: ensuring diversity in professional profiles pertinent to the development of the index, and including experts whose professions, while not originally focused on age-friendliness, have been working with relevant approaches. The fields of expertise deemed relevant for this study included Sociology, Gerontology, Built Environment, Urbanism, Architecture, and Policy. The invited experts are leaders in the field of age-friendly environments, hailing from various European universities, research and innovation centres, private companies providing care services for older people, consulting firms for policymaking, and organisations representing the interests of older individuals in Europe. This diverse group was selected to ensure that the interests and needs of older people were thoroughly incorporated into the index definition process.

From the initial set of invited experts, a panel of 18 professional experts from 7 different countries (Spain, Netherlands, UK, Belgium, Portugal, Italy and Slovenia) was formed. The fields they covered were Built Environment, Urbanism and Architecture (50%), Policy (28%), and Sociology and Gerontology (22%). In total, 72% of the experts consulted had a PhD in their respective fields.

To establish the weights of the different domains, topics, and indicators, participants had to distribute 100 points among the different elements of the category they were referring to, which is called a constant sum scale [24]. To facilitate this task and to overcome any difficulties in doing the sum mentally, which would mean leaving the survey without completing it, a sliding scale was used. Based on the responses, the system automatically distributes the points proportionally to the length of the bars completed.

The expert validation process with the Delphi method was carried out over three interactive rounds (from 7 November 2022 to 17 February 2023):

- In the first round, the experts participated by filling in a questionnaire in which they had to indicate the weights of the different indicators within each topic, the topics within each domain, and the 4 general domains considered. In addition, they were asked if they considered that any element was missing in the proposed battery. The working group then integrated the experts' contributions, resulting in a second version of the battery of indicators.
- In the second round, the second version of the battery was presented to the experts individually so that they could first validate the new proposals for the elimination and addition of elements and propose weights for the new ones (detailed in the next section). With the contributions of the experts in this second round, the final version of the battery of indicators with their corresponding weights was drawn up.
- In the last round, the final version was submitted to the experts for overall validation. The experts' assessments collected in this phase were integrated into the third version of the weighted indicator battery.

3. Results

After three rounds of expert consultation, the final results were obtained, and the weights for the AFNI were established. The weights for each of the indicators, topics, and domains correspond to the average of the weights assigned by the 18 participating experts and are presented in Table 2 jointly with the first set of indicators presented to the experts.

As can be observed in Table 2, from the initial set of indicators presented to the experts during the Delphi method, certain adjustments were made based on their feedback. As a result, some topics were consolidated, and specific modifications were applied to certain indicators to enhance their specificity. The topics of Greenery and Water and Temperature, climate, noise, and air quality from Domain 1 have been consolidated in the AFNI after the experts' suggestions for the topic called Environmental conditions.

Table 2. Domains, topics, and indicators presented to the experts and results of the Delphi method about weights for domains, topics, and indicators of the AFNI.

Domains	Topics	Indicators	Domains	Topics	Indicators Weights	
D1: Outdoor spaces and buildings			0.25	D1: Outdoor spaces and buildings		
	Neighbourhood walkability			0.24	T1.1: Neighbourhood walkability	
		Rest places			0.2	1.1.1. Rest places
		Benches			0.2	1.1.2. Benches
		Public toilets			0.2	1.1.3. Public toilets
		Crosswalks			0.1	1.1.4. Crosswalks
		Walkways			0.2	1.1.5. Walkways
		Sheltered zones			0.1	1.1.6. Sheltered zones

Table 2. *Cont.*

Accessibility of public spaces and buildings		0.22	T1.2: Accessibility of public spaces and buildings	
	Accessible public spaces		0.4	1.2.1. Accessible public spaces
	Accessible public buildings		0.4	1.2.2. Accessible public buildings
	Accessible open space		0.3	1.2.3. Accessible open space
Public safety		0.22	T1.3: Public safety	
	Rate of crimes against older people		0.4	1.3.1. Rate of crimes against older people
	Physical incidents in public spaces		0.6	1.3.2. Phyisical incidents in public spaces
Greenery and Water		0.32	T1.4: Environmental conditions	
	Location of public green		0.2	1.4.1. Location of public green and water
	Presence of water in public domain		0.2	1.4.2. Temperature
Temperature, climate, noise, and AQ			0.2	1.4.3. Light areas
	Temperature/ relative humidity		0.2	1.4.4. "Quiet" zones
	Presence of 'quiet' zones		0.2	1.4.5. Clean air
	Presence of clean air			
D2: Transport		0.16	D2: Transport	
Access to public transport stops		0.32	T2.1. Access to public transport stops	
	Housing and public transportation		0.7	2.1.1. Housing and public transportation
	Bus shelters		0.4	2.1.2. Bus shelters
Access to priority vehicle parking		0.18	T2.2. Access to priority vehicle parking	
	Priority parking in public buildings		0.4	2.2.1. Priority parking in public buildings
	Special parking permits		0.4	2.2.2. Special parking permits
	Maintenance in winter		0.2	2.2.3. Maintenance in winter
Urban accessibility solutions		0.18	T2.3. Urban accessibility solutions	
	Urban accessibility solutions' infrastructures		0.6	2.3.1. Urban accessibility solutions' infrastructures
	Short-time parking lots		0.4	2.3.2. Short-time parking lots
Traffic levels		0.32	T2.4. Traffic levels	
	Safe biking infrastructure		0.5	2.4.1. Safe biking infraestructure
	Traffic volume		0.5	2.4.2. Traffic volume
D3: Housing		0.34	D3: Housing	
Availability and affordability of housing		0.62	T3.1. Availability and affordability of housing	
	Public housing options		0.6	3.1.1. Public housing options
	Protected flats for older people		0.4	3.1.2. Protected flats for older people
Accessible housing		0.38	T3.2. Accessible housing	
	Accessible housing		1	3.2.1. Accessible housing

Table 2. *Cont.*

D4: Social Participation and Communication		0.24	D4: Social Participation and Communication		
Accessibility of participation opportunities			0.53	T4.1. Accessibility of participation opportunities	
	Access to community-based activities			0.2	4.1.1. Access to community-based activities
	Access to community centres			0.2	4.1.2. Access to community centres
	Access to cultural and educational facilities			0.1	4.1.3. Access to cultural and educational facilities
	Access to sites of worship			0.1	4.1.4. Access to sites of worship
	Access to leisure services			0.1	4.1.5. Access to leisure services
	Access to convenience stores			0.1	4.1.6. Access to convenience stores
	Access to health services			0.1	4.1.7. Access to health services
Internet access			0.47	T4.2. Internet access	
	Internet access			1	4.2.1. Internet access

Moreover, a new indicator that was not included in the initial framework has been added, indicator *1.4.3. Light areas.*

3.1. The Final Proposal of the AFNI: Domains, Topics, and Indicators

The WHO [25] already described the eight domains that define an age-friendly city. In the age-friendly cities indicator´s framework (Table 1) that is the basis for the AFNI, only four out of eight of them have been included (Outdoor Spaces and Buildings, Transport, Housing and Social Participation and Communication), since the scope was referring to those domains under the competencies of urban planning.

This section expands upon the comprehensive elucidation of the domains, their associated topics, and the corresponding indicators within the AFNI.

Domain 1, *Outdoor Spaces and Buildings,* refers to the external environment and the impact it has on mobility and quality of life. The well-being, autonomy, and overall quality of life for older adults are significantly influenced by the external surroundings they navigate outside their homes. An ideal living environment for ageing in place is characterised by a good-quality urban landscape featuring well-kept recreational spaces, green spaces, abundant rest spots, carefully designed and secure pedestrian pathways, and a safe overall atmosphere.

This domain is constituted by different topics, each of them measured by various indicators. The topics included in Domain 1 are Neighbourhood walkability, Accessibility of public spaces and buildings, Public safety, and Environmental conditions. Each of these topics is composed of several indicators.

For the first topic, Neighbourhood walkability, six indicators have been selected (Table 2).

The first of them is *Rest places*, which are places where people can stay and rest, and usually consist of street furniture, such as benches, fountains, and public and accessible bathrooms. The following indicator is *Benches*. The appropriate benches are those made of wood, given its exceptional flexibility and thermal neutrality, in contrast to stone or metal, which exhibit greater rigidity and thermal load, resulting in a less comfortable sensation [26]; they should also have backrests and armrests. The third indicator is *Public toilets*. A recent research study revealed a favourable correlation between the availability of public amenities, such as public toilets, and the engagement of older adults in public transport and walking [27]. Consequently, these facilities promote mobility and diminish sedentary behaviour among older people, ultimately enhancing their overall quality of

life [28]. The next indicator of this topic is *Crosswalks,* that must be sufficient in number and safe for people with different levels and types of disability, with non-slip markings, visual and audio cues, and adequate crossing times [29]. *Walkways* refer to the streets at the neighbourhood level with pedestrian paths that meet locally accepted standards (accessible, well maintained, wide enough, non-slippery). The last one *Sheltered zones* identifies the places where people can find protection in the public urban space from rain or sun.

For the second topic, *Accessibility of public spaces and buildings*, three indicators have been identified (Table 2).

The first two indicators associated with this topic pertain to the physical *accessibility of public spaces* and *public buildings*, characterising them as fully accessible. The third indicator addresses the possibility to *access of open spaces* within a reasonable walking distance. To establish a suitable walking distance for older adults, the WHO's recommendation for individuals aged 65 and above, which suggests engaging in aerobic activities in approximately 10 min sessions, serves as a reference [30]. Taking this guideline into consideration, it is posited that an open space should be reachable within a 10 min duration for optimal accessibility for older adults.

The third topic is *Public safety*. The WHO recognises that the domains encompassing outdoor spaces, buildings, transportation, and housing (integral components of a city's physical environment) significantly influence the safety and security of older people [25]. This impact is particularly noteworthy in terms of accident and incident prevention, as well as safeguarding against criminal activities. Multiple investigations have demonstrated that the perception of safety and security is a nuanced and multifaceted phenomenon. This can be categorised into two primary domains: one influenced by intentional acts and negligence, and another influenced by non-intentional acts [31]. With that approach, two indicators have been identified (Table 2).

The first of the two indicators seeks to assess the *incidence of crimes* targeting older people within the city, aiming to discern variations in safety levels among different neighbourhoods. The second indicator is associated with non-intentional acts, focusing on *physical incidents* in public spaces, such as falls or car accidents.

The fourth and last topic of this first domain is *Environmental conditions*. While the impact of environmental conditions has been acknowledged, its significance has heightened, particularly in the current context of heatwaves triggered by climate change. Recent research conducted in a hot and humid region of China has established that the influential factors affecting the older people's utilisation of outdoor spaces during periods of heat within the community, in descending order of significance, comprise temperature, relative humidity, human traffic flow, and noise levels [32]. While the order may vary in different geographical and social contexts, the clear impact of environmental conditions on how older adults perceive and utilise urban spaces remains evident. Inside this topic, five indicators have been identified (Table 2).

The *location of public green and water* reflects the recommendation from the WHO that defines it as the percentage of citizens living within 300 m of a public open area of a minimum size of 0.5 hectares [33]. Additionally, influential factors include the *temperature, humidity*, and *lighting* of public spaces, directly tied to the concept of bioclimate, which holds particular importance by encompassing atmospheric influences on the human organism. Bioclimate focuses on thermal elements such as short-wave and long-wave radiation, wind, humidity, and air temperature, all of which significantly contribute to determining human comfort, thermal stress, and overall health [34]. The significance of *noise* and *air quality* as relevant indicators is rooted in their connection to environmental noise, air pollution, and water pollution—integral components of environmental degradation. These factors pose substantial hazards to both physical and mental health, emerging as primary threats to overall well-being [35].

Within Domain 2, *Transport and Mobility*, the focus is on ensuring convenient access to public transport stops that are both comfortable and affordable. This initiative aims to facilitate active ageing among the city's older population, allowing them to stay engaged

with their community while having easy access to health and social facilities—an integral aspect for preserving functionality and preventing additional disability [36]. The domain also considers alternative mobility models like walking or biking, recognising their role in promoting active ageing and community engagement. Additionally, the planning of traffic and parking facilities within a city should be mindful of the needs and preferences of older people.

The four topics of Domain 2 are Access to public transport stops, Access to priority vehicle parking, Urban accessibility solutions, and Traffic levels, and each of them has its corresponding indicators.

For the first topic—*Access to public transport stops*—two indicators have been selected. The first one, *Housing and public transportation,* emphasises convenient access to public transportation stops within walking distance. It is recommended that public transport stops be reachable within a 10 min duration to ensure optimal accessibility for older adults. This aligns with the rationale outlined in the indicator concerning *Access to open public space* in Domain 1. The second aspect, concerning *bus shelters*, pertains to the attributes of the current bus shelters in the neighbourhood. These shelters should be accessible, equipped with seating, and protected from the sun, rain, and snow. This ensures that passengers can wait safely and comfortably, regardless of the prevailing weather conditions [37].

The following topic is *Access to priority vehicle parking*, and it is measured through three indicators.

The set of indicators within this topic aims to assess the extent to which individuals with special needs are provided the opportunity to access facilities. Priority parking denotes designated parking spaces intended for individuals meeting specific criteria, such as those with recognised disabilities. The first indicator examines the presence of priority parking spaces in both new and existing public buildings. The second indicator focuses on the ratio of reserved parking spaces in the neighbourhood to the number of residents holding special parking permits. While the third indicator may not be applicable in certain climates, it is crucial in northern countries, where special plans for winter weather in neighbourhoods include the maintenance of parking lots. This ensures they remain free of snow and ice, enhancing safety for older adults.

The subsequent focus within this domain is on *Urban accessibility solutions*, encompassing two distinct indicators. Urban accessibility solutions denote initiatives aimed at rendering cities accessible for all residents, specifically targeting persons with disabilities and older people. Urban mobility can play a crucial role in supporting measures to enhance urban systems, ensuring they are safe, accessible, inclusive, affordable, smart, resilient, and emission-free.

The indicator labelled *urban accessibility solutions infrastructure* pertains to structures like mechanical ramps or urban elevators installed within the city. These installations aim to assist residents in overcoming physical barriers in the urban environment. This indicator is particularly relevant in urban contexts where topography poses a significant challenge for older adults to access various city locations or services. The implementation of such solutions is crucial for ensuring physical accessibility within neighbourhoods. The second indicator, *Short-time parking lots*, highlights the necessity of having designated areas for short-term parking near various points of interest. This addresses the need to accommodate individuals who cannot reach these locations without a brief car ride.

The last topic of Domain 2 *Transport and Mobility* is related to *Traffic levels* and contains two different indicators.

The initial indicator considers the attributes of the *biking infrastructure* within the neighbourhood, if it exists, and assesses the proportion of it that adheres to safety standards and regulations. The second indicator focuses on the presence of *calm traffic zones*, identifying areas where intentionally lower speed limits are set to promote safety, encourage pedestrian activity, and cultivating a more liveable environment.

The third domain of the index is *Housing* in the AFNI. The housing conditions of older people are often linked to their quality of life and whether they can age independently and

actively in their community. Appropriate housing design and its proximity to community and social services allow older residents to live comfortably and safely, while housing affordability gives them peace of mind [38]. This domain has two topics, the first one is *Availability and affordability of housing*, and the second one is *Accessible housing*.

The first topic in this domain includes two indicators.

The initial indicator examines the availability of *public housing options* for rent at the neighbourhood level. The second one assesses the presence of dedicated *affordable multipurpose housing* and ageing-in-place options within the neighbourhood.

The second topic of the third domain refers to *Accessible housing*. Housing accessibility influences activities of daily living (ADLs) both within and outside the home, with the impact becoming increasingly significant as functional capacity diminishes [39]. This indicator talks about the physical accessibility of new and existing houses. It measures the number of residential buildings that have wheelchair-accessible entrances (i.e., sufficient width, ramp).

The fourth and last domain included in the AFNI is *Social Participation and Communication*. Engaging in community-based leisure, social, cultural, and spiritual activities promotes the ongoing integration of seniors into society, contributing to their sustained involvement and awareness. However, their participation in such activities is influenced by factors such as accessibility to transportation and facilities, awareness of available activities, and affordability [40]. Conversely, staying connected with events, news, and activities requires timely, accessible, and practical information—an integral aspect of active ageing, especially given the information overload trend in urbanised cities. Cities should ensure older people have access to information in a format that is easily accessible, considering the diverse needs and resources of older people [41].

This domain has two different topics, the first one being the *Accessibility of participation opportunities*. Participation in socio-cultural activities is a positive indication of older people's social participation and inclusion and generally includes leisurely participation in formal or informal religious, cultural or other social activities with friends, relatives or neighbours.

The initial indicator focuses on the opportunity and capacity of individuals to participate in a diverse array of events, programmes, and engagements within their local community. Achieving this requires public venues and buildings where these events take place to be fully accessible.

The remaining indicators concern the proximity of people to various services, including community centres, cultural and educational facilities, places of worship, leisure services, convenience stores, and health services. As previously established in the indicators for *Access to Open Public Space* (Domain 1) and *Housing and Public Transportation* (Domain 2), establishing an appropriate walking distance for older adults suggests that all these services should be reachable within a 10 min duration from residential buildings for optimal accessibility for older adults.

The other topic of this domain is *Internet access*. Digital access poses a significant challenge for older people, rendering them a particularly vulnerable demographic and exacerbating generational gaps [42]. As the digital society continues to evolve, the phenomenon of digital exclusion has become more conspicuous, emerging as a distinct subtype of social exclusion.

Numerous obstacles impede the cultivation of digital competencies among older people with several falling beyond the purview of urban planners. These encompass factors such as the apprehension towards new technologies, the perception of not requiring information and communication technology (ICT) usage, self-marginalisation within the information society, the intricacies of new media, personal attitudes towards lifelong learning, physical constraints, and economic determinants [43]. However, those infrastructural limitations lie within the competencies of urban entities, obligating them to guarantee internet access for all citizens.

3.2. Measuring the Indicators

All indicators incorporated within the AFNI are specifically formulated to evaluate the age-friendliness of diverse neighbourhoods within a city. Additionally, these indicators are designed to assess the effectiveness of various actions or interventions once implemented.

To assess the indicators, the acquisition of reliable data is imperative. Emphasis on the significance of data is evident in the most recent guide released by the WHO [7], aimed at guiding national authorities and stakeholders involved in the establishment or maintenance of national programmes for age-friendly cities and communities. The guide recommends the formulation of methodologies for the collection, compilation, analysis, and dissemination of disaggregated data. The data should be appropriately disaggregated based on variables such as age, gender, disability, and other locally relevant strata of inequality. Furthermore, it is stressed that the data must undergo regular analysis, be consistently published, and be made readily accessible to the public.

Our primary objective is to determine the specific data requirements for measuring the 36 indicators outlined in the Age-Friendly Neighbourhood Index (AFNI). Additionally, we aim to establish the methodologies by which these indicators will be measured, enabling us to compute the age-friendliness score for each neighbourhood. Table S1 (included in Supplementary Material) is a comprehensive table that summarises the indicators, the necessary data for their measurement, and the proposed evaluation methods. Given the challenges often encountered in collecting sub-city level data, we have opted for straightforward measurement approaches. If additional data become available, measurement methods may undergo refinement and modification to enhance the accuracy of results.

Three distinct criteria have been chosen for assessing the indicators. The first criterion relies on percentage-based measurements. The percentage is applied in varying ways depending on the evaluated indicator. For instance, when assessing benches, which are closely tied to their characteristics, the measurement criterion involves calculating the proportion of neighbourhood benches that meet specific requirements, as explained in the previous section.

In other cases, indicators are linked to access to various services, such as community centres. In these instances, the assessment method for determining whether a neighbourhood provides suitable access to its residents involves measuring the percentage of residential structures that can reach the service within a reasonable walking distance and an appropriate timeframe. To gauge this distance, researchers have considered the average walking speed of older adults, as explored in various studies [44]. Calculating it using isochrones [45] allows for the incorporation of urban features that influence pedestrian mobility, such as slopes and urban infrastructure.

Table 3 presents the indicators measured following this approach.

The second criterion followed to measure some other indicators was based on yes or no responses. This means that if the measured neighbourhood has specific services or infrastructure, it is considered age-friendly. If the service or infrastructure is present and adequately covers the neighbourhood, the indicator assumes its maximum value. Conversely, if the service or infrastructure is absent, the indicator takes on a value of zero. Table 4 presents the indicators measured using this criterion.

The third criterion for measurement involves utilising various measurements or calculations, often resulting in composite indicators (Table 5). These indicators draw upon data from diverse sources and are formulated through mathematical operations.

For indicators about environmental conditions, calculations are based on pre-established values, such as the Air Quality (AQ) index for assessing clean air. To gauge the availability of rest places, one must determine the quantity and locations of benches within each neighbourhood, distinguishing between street and recreational areas. These data allow for the measurement of bench density per square metre and the spacing between benches to compare with the recommendations for public furniture in the public space [46], and the adherence to regulatory standards regarding their distribution per person or square metre [47].

Table 3. Indicators measured based on %.

T1.1:Neighbourhood walkability
1.1.2. Benches
1.1.3. Public toilets
1.1.4. Crosswalks
1.1.5. Walkways
T1.2: Accessibility of public spaces and buildings
1.2.1. Accessible public spaces
1.2.2. Accessible public buildings
1.2.3. Accessible open space
T1.3: Public safety
1.3.1. Rate of crimes against older people
1.3.2. Phyisical incidents in public spaces
T1.4: Environmental conditions
1.4.1. Location of public green and water
1.4.4. "Quiet" zones
T2.1. Access to public transport stops
2.1.1. Housing and public transportation
2.1.2. Bus shelters
T2.3. Urban accessibility solutions
2.3.1. Urban accessibility solutions' infrastructures
T2.4. Traffic levels
2.4.1. Safe biking infraestructure
T3.2. Accessible housing
3.2.1. Accessible housing
T4.1. Accessibility of participation opportunities
4.1.1. Access to community-based activities
4.1.2. Access to community centres
4.1.3. Access to cultural and educational facilities
4.1.4. Access to sites of worship
4.1.5. Access to leisure services
4.1.6. Access to convenience stores
4.1.7. Access to health services
T4.2. Internet access
4.2.1. Internet access

Table 4. Indicators measured based on yes or no responses.

T1.1:Neighbourhood walkability
1.1.6. Sheltered zones
T2.2. Access to priority vehicle parking
2.2.1. Priority parking in public buildings
2.2.3. Maintenance in winter
T2.3. Urban accessibility solutions
2.3.2. Short-time parking lots

Table 4. *Cont.*

T2.4. Traffic levels
2.4.2. Traffic volume
T3.1. Availability and affordability of housing
3.1.1. Public housing options
3.1.2. Protected flats for older people

Similarly, the assessment of special parking permits necessitates calculating the number of designated priority parking spaces within a neighbourhood and the quantity of special parking permits issued.

Table 5. Composite indicators.

T1.1:Neighbourhood walkability
1.1.1. Rest places
T1.4: Environmental conditions
1.4.2. Temperature
1.4.3. Light areas
1.4.5. Clean air
T2.2. Access to priority vehicle parking
2.2.2. Special parking permits

3.3. Study Case: Testing the AFNI in a Real Case

Applying the AFNI in a practical scenario within the city of Santander has served as a crucial test, providing essential insights into the feasibility of utilising the Index in a real-world context. This application has enabled the identification of potential barriers and challenges in measuring indicators, often stemming from issues like the unavailability of pertinent data.

Santander is a city located in the north of Spain. Its older population constitutes 26.6% of the city, higher than the regional average (23.5%), which is among the highest ones in the country (ca. 20% according to 2023 data [48]). From the geographical point of view, the rugged topography of Santander makes access to certain population centres challenging, creating significant differences in elevation between its various streets and neighbourhoods. The geographical features of Santander, along with its population profile, present a challenge for the city to meet the needs of all its residents. In recent years, efforts have been made to enhance urban accessibility and overcome the barriers the city's topography poses for pedestrian mobility. Santander is part of the age-friendly cities network [49], actively working to address the needs of its older citizens. Particularly, Santander has served as a pilot city in the European project URBANAGE [50], which explores the use of disruptive technologies for urban planning to create age-friendly cities.

Within the framework of this project, the Age-Friendly Neighbourhood Index (AFNI) has undergone testing in the context of Santander. This city comprises 32 neighbourhoods, each characterised by distinct features related to population profiles, construction ages, typologies, orographic conditions, and historical urban development periods.

During the current research phase, only selected indicators of AFNI have been measured. This limitation arises from data availability constraints. Nevertheless, the measured indicators span all four domains of AFNI, ensuring comprehensive coverage. From the list of AFNI indicators presented in Table 2, the indicators used to calculate the AFNI of the different Santander neighbourhoods are included in Table 6.

Table 6. Indicators from the AFNI measured in Santander.

D1: Outdoor spaces and buildings
T1.1:Neighbourhood walkability
1.1.1. Rest places
1.1.2. Benches
1.1.3. Public toilets
T1.2: Accessibility of public spaces and buildings
1.2.2. Accessible public buildings
1.2.3. Accessible open space
T1.4: Environmental conditions
1.4.1. Location of public green and water
D2: Transport and Mobility
T2.1. Access to public transport stops
2.1.1. Housing and public transportation
D3: Housing
T3.1. Availability and affordability of housing
3.1.2. Protected flats for older people
D4: Social Participation and Communication
T4.1. Accessibility of participation opportunities
4.1.2. Access to community centres
4.1.3. Access to cultural and educational facilities
4.1.4. Access to sites of worship
4.1.6. Access to convenience stores

These indicators collectively cover 30% of the AFNI (Table 7). Nevertheless, the four domains of the index are represented, and the measured indicators align with key requirements identified by older adults for using public spaces during the co-creation process of the URBANAGE project [51]. This assessment provides an initial and reasonably accurate view of the age-friendliness of the neighbourhoods in Santander. However, ongoing monitoring and evaluation are still necessary.

Table 7. Maximum value of the AFNI measured in Santander.

DOMAIN	**Points**	**%**
D1: Outdoor spaces and buildings	10.84	11%
D2: Transport	3.40	3%
D3: Housing	9.14	9%
D4: Social Participation and Communication	6.45	6%
Total	*30*	30%

When calculating the percentage of domains to be measured compared to the total maximum achievable value based on the current set of indicators, certain domains carry more weight than others, as observed in Figure 1. Specifically, D1 (*Outdoor spaces and buildings*) and D3 (*Housing*) have significant importance. Interestingly, these domains also align with the complete AFNI, where they hold substantial weight.

These indicators have been measured as detailed in Section 3.2.

The AFNI is calculated for all the neighbourhoods of Santander and is visualised in a digital twin of the city (Figure 2), offering an interesting overview of the overall situation of the urban age-friendliness.

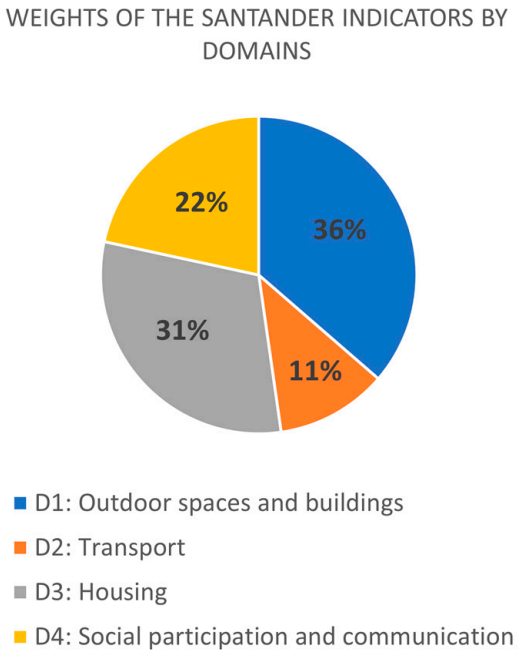
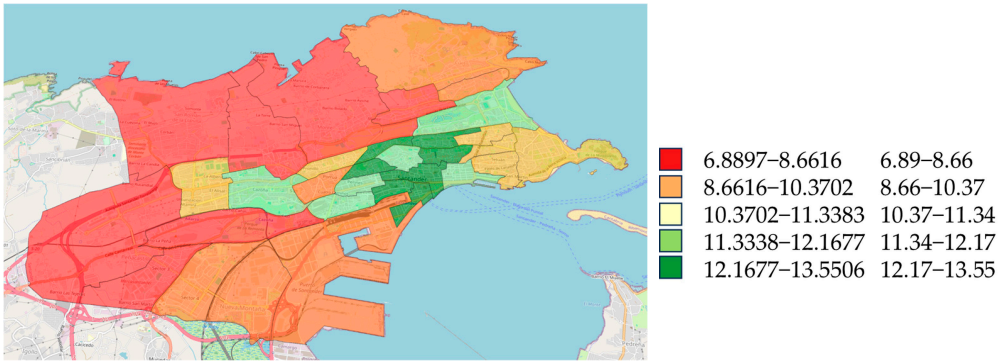


Figure 1. Graphical representation of the weighting of the AFNI in Santander.



(**a**) (**b**)

Figure 2. (**a**) The visualisation of the AFNI values of the different neighbourhoods of Santander in the local digital twin; (**b**) the values of the AFNI by colours.

Table 8 and Figure 3 present the neighbourhoods that ranked higher in the AFNI.

Table 8. Neighbourhoods with higher AFNI in Santander and the points per domain.

NEIGHBOURHOOD	DOMAIN 1	DOMAIN 2	DOMAIN 3	DOMAIN 4		AFNI
La Tierruca	5.02	3.32	0	5.22	13.55	points
Los Castros–Fernando de Los Ríos	4.48	3.33	0	5.37	13.55	points
Centro	4.69	3.33	0	4.90	13.18	points
Calle Alta–Cabildo	4.81	3.25	0	4.82	12.87	points
Entrehuertas–Prado–San Roque	4.60	3.27	0	4.88	12.75	points
MAX VALUE × SANTANDER	10.84	3.40	9.14	6.45	30	points

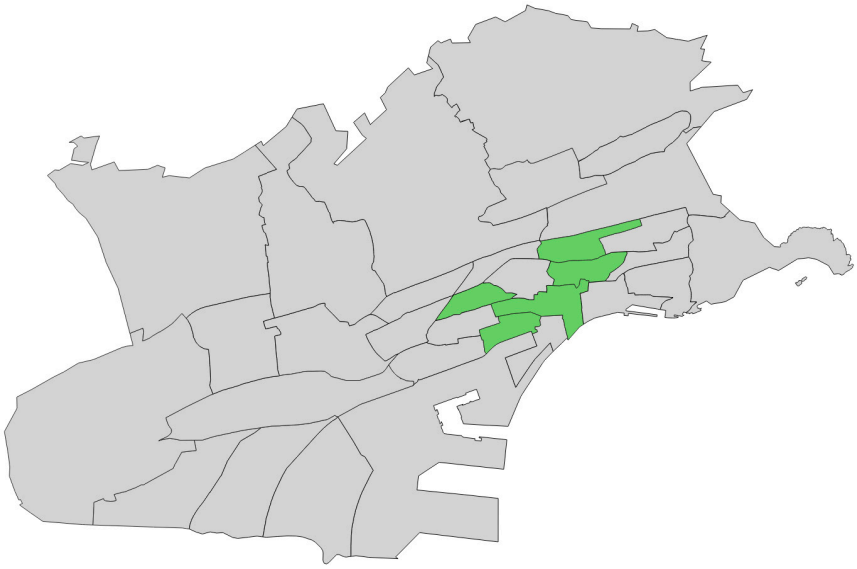


Figure 3. The neighbourhoods with higher AFNI in Santander.

Notably, the neighbourhood with the highest score attains only 13.55 points, which is significantly lower than the maximum possible AFNI value for Santander. Subsequent neighbourhoods exhibit scores of approximately 13 points.

However, relying solely on the AFNI value as a determinant is insufficient. The subsequent crucial step involves delving into the specific domains that contribute to this index (as outlined in Table 7). When utilising the AFNI for informed decision-making, it becomes essential to identify the domains that exhibit deficiencies in addressing the needs of older adults. Furthermore, having this information readily available allows for alignment with city strategies.

Upon examining the city map, it becomes evident that these neighbourhoods are situated in the central area of the city. By analysing the data related to various indicators across different domains, a logical pattern emerges. City centres typically offer greater access to essential services and participation opportunities, as encapsulated by Domain 4. However, it is noteworthy that they also exhibit a deficiency in access to open green spaces, a component of Domain 1. Furthermore, Domain 3, which pertains to housing and is assessed through the existence of protected flats for older adults in Santander, remains a significant unresolved issue. Addressing this housing aspect could have a substantial impact on improving the AFNI across all neighbourhoods.

On the other hand, the neighbourhoods exhibiting the lowest values of the AFNI correspond to those listed in Table 9 and Figure 4.

Table 9. Neighbourhoods with lower AFNI in Santander.

Neighbourhood	Domain 1	Domain 2	Domain 3	Domain 4		AFNI
Camarreal	3.29	3.09	0	0.51	6.88	points
Campogiro–Cajo–La Remonta	4.00	2.58	0	0.79	7.37	points
S-20–La Torre	4.27	2.87	0	0.30	7.43	points
Peñacastillo–Ortega y Gasset	3.50	3.24	0	1.28	8.02	points
San Román de La Llanilla	4.20	3.09	0	1.06	8.35	points
MAX VALUE × SANTANDER	10.84	3.40	9.14	6.45	30	points

Observing the map, these neighbourhoods are situated along the periphery of the city. This spatial arrangement accounts for the significantly lower values observed in Domain 4 (*Social Participation and Communication*), indicating reduced participation opportunities and limited access to services in the areas farther away from the city centre. Conversely,

Domain 2 pertains to transportation, and while the values remain relatively high, they are marginally lower than those observed in the best-ranked neighbourhoods. This discrepancy suggests that these neighbourhoods are not as well-connected in terms of transport infrastructure. Regarding Domain 3, the lack of specific housing options for older adults is also relevant.

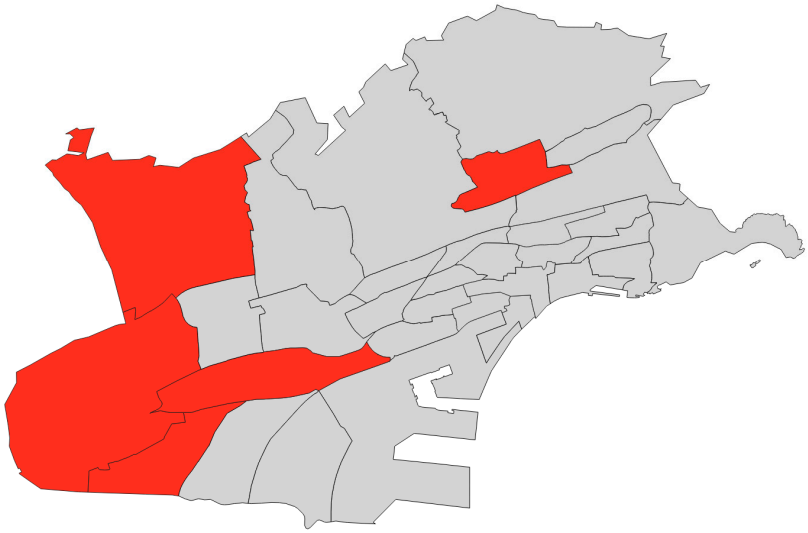


Figure 4. The neighbourhoods with lower AFNI in Santander.

The AFNI provides also a way to rank neighbourhoods based on specific domains. For instance, we can identify which neighbourhoods offer older citizens better opportunities to enjoy outdoor spaces (referred to as "Domain 1") (Table 10). However, it is important to note that the best-ranked neighbourhoods according to the overall AFNI approach may not necessarily be the best in this specific domain.

Table 10. Neighbourhoods with higher punctuation in Domain 1 in Santander.

Neighbourhood	Domain 1	
El Sardinero	6.25	points
Pérez Galdós–Reina Victoria	5.67	points
Cazoña	5.14	points
La Tierruca	5.02	points
El Alisal	4.85	points
MAX VALUE × SANTANDER	10.84	points

For instance, the La Tierruca neighbourhood exhibited the highest overall ranking in the Age-Friendly Neighbourhood Index (AFNI), indicating it as the most age-friendly area within the city. However, when examining specifically Domain 1, La Tierruca's ranking declines to fourth place. Conversely, the El Sardinero neighbourhood secures the top position in Domain 1, yet it ranks 13th out of 32 neighbourhoods in the comprehensive AFNI assessment.

The table with the full list of measured indicators of the 32 neighbourhoods of Santander is included in Table S2 (it can be found in Supplementary Materials).

The data provided by the Age-Friendly Neighbourhood Index (AFNI) provide substantial utility to urban planners and policymakers in Santander. This index functions as a diagnostic tool, enabling the identification of specific needs across various neighbourhoods. It not only delivers a comprehensive overview of the age-friendliness of different areas but also delineates their strengths and weaknesses within distinct domains, such as outdoor spaces, transportation, housing, and access to participation and communication opportunities.

4. Discussion

Undoubtedly, the utilisation of AFNI in Santander yields valuable insights. However, a comprehensive tool requires a broad spectrum of measured indicators. In the present study, limitations in accessing certain data have constrained the index's scope, despite efforts to encompass all relevant domains prioritised by older adults themselves.

Moreover, it is essential to strategise how to address unmeasured indicators to maintain the index's integrity. Treating unmeasured indicators as non-existent or assigning them zero values would distort results, as it does not reflect the absence of a measure but rather the lack of measurement.

In the described case study (Section 3.3), the index's value is recalibrated to consider the highest possible score achievable if all measured indicators attained maximum values. Consequently, the optimal score for the index is adjusted to 30 instead of 100. This approach serves as an interim solution while efforts are directed towards obtaining data necessary to measure all indicators, topics, and domains comprehensively in future research endeavours.

During the development of the Age-Friendly Neighbourhood Index (AFNI), the non-inclusion of the residents' age demographic as an indicator was deliberated. The age of residents in a specific district does not inherently define its age-friendliness. Cities must strive to be age-friendly, irrespective of the current resident demographics, ensuring they are equipped to address the evolving needs of the population over time. Once the AFNI is calculated, comparing the results with the demographic profiles of residents in each neighbourhood becomes valuable. This comparison facilitates informed decision-making by highlighting the urgency of addressing specific issues in certain neighbourhoods.

The construction of the index itself, following the example set by the WHO, in domains, topics, and indicators, allows for decision-making interventions focused on a specific domain, such as the design and implementation of a park, and observing how they would improve the index. Alternatively, it also enables micro-interventions at the level of urban acupuncture, such as the installation of a public restroom, which would affect only a specific indicator.

The AFNI serves as an instrumental analytical tool for urban planners to ascertain areas necessitating enhancements in age-friendliness and to prioritise resource allocation accordingly. Moreover, it enables the precise identification of specific domains requiring improvement within various neighbourhoods. This facilitates anticipating future needs by considering both current and projected demographic trends within these neighbourhoods. Policymakers can formulate policies and regulations that address the needs identified through the application of the index, such as implementing affordable housing initiatives.

5. Conclusions

Recognising urban indexes as valuable tools for policymakers, the proliferation of various urban indexes across different domains also poses a challenge, as there is a lack of uniformly accepted methods for conducting comprehensive and impartial evaluations of cities. Many existing city indicator initiatives tend to prioritise specific aspects, influencing the tool's design, including the selection and weighting of indicators, as well as the intended audience. This lack of a widely accepted and universally agreed-upon ranking system not only contributes to chaos but also introduces confusion regarding which indexes should be considered reliable. Basing the construction of the AFNI on globally accepted frameworks of indicators, such as the World Health Organization's age-friendly cities framework [10], enables cities to build on existing structures, avoiding confusion and allowing for adaptation to their specific needs.

As the other indexes the AFNI can not be implemented directly in any context, the adaption to the specific local context is needed, as recommended by the WHO [10], particularly in instances where the selection of the indicators for the quantification across multiple domains needs a high degree of contextual specificity.

The adaptation process necessitates the consideration of various contextual variables to align it with the urban reality. These variables could encompass meteorological conditions,

such as the presence of snow during the winter season or heat waves during the summer. The city's orography, which significantly impacts the mobility choices of the inhabitants, is another crucial factor. Furthermore, the socio-cultural background, encompassing the citizens' use of urban spaces and the diverse municipal regulations, for instance, the influence of restaurant and bar terraces on the accessibility of urban pedestrian pathways, must also be factored into the equation.

Access to data is also a challenge when measuring the indexes; currently, new data sources such as big data, social media platforms, and smart city platforms are used. These data can then feed directly into public services, such as public transport management systems, or can be made public through open data initiatives and platforms. Demands for transparency, accountability, and citizen participation are closely connected with data services.

However, obtaining disaggregated data and ensuring the quality of metadata remain challenging tasks. When evaluating age-friendliness, for example, simply knowing the geolocation of a bench is insufficient. We must also consider details such as the bench material, the presence of a backrest or armrest, maintenance status, and the quality of the surrounding pavement. Collecting this comprehensive information would make the bench data more meaningful for the AFNI.

Decision-makers can utilise the Age-Friendly Neighbourhood Index as a powerful tool to enhance transparency and accountability within their governance processes. Incorporating this index into decision-making frameworks enables urban planners and policymakers to publicly disclose the criteria and metrics used for evaluating age-friendliness. This transparency cultivates a deeper understanding among citizens, empowering them to grasp the rationale behind decisions related to neighbourhood planning and development. Moreover, the index's quantitative indicators and objective data serve as a verifiable foundation, allowing decision-makers to demonstrate the reasoning behind their choices. This clarity reduces ambiguity and fosters trust in the decision-making process.

Additionally, the index provides a measurable benchmark for decision-makers to assess neighbourhood performance. The regular monitoring and reporting of age-friendliness scores enable decision-makers to hold themselves accountable for progress or setbacks. When decisions affect neighbourhood age-friendliness, decision-makers can cite the index to justify their actions, bolstering accountability by directly linking decisions to well-defined criteria within the index. Furthermore, the index's reliance on objective data mitigates the potential for subjective biases or hidden agendas, reinforcing the perception of decision-makers as stewards of the public interest.

Prospective research trajectories could focus on automating AFNI computations, utilising cutting-edge digital technologies, such as local digital twins. This could metamorphose it into a dynamic instrument, capable of facilitating the simulation of diverse interventions and their potential repercussions on AFNI. Urban planners would then be equipped with a simulated environment to conduct experiments with various implementations and prioritise them based on the outcomes of the simulations.

In summary, the Age-Friendly Neighbourhood Index serves as a powerful tool, not only for evaluating neighbourhoods, but also for promoting openness, trust, and responsible decision-making in the pursuit of inclusive and age-friendly urban environments by advocating for environmental justice.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/urbansci8030127/s1, Table S1: Indicators, related data and measurement proposal. Table S2: Measured indicators for Santander.

Author Contributions: Conceptualisation S.U.-U. and P.M.-C.; methodology, S.U.-U. and K.H.-P.; supervision P.M.-C. and U.M.R.; investigation, S.U.-U., K.H.-P., and A.G.; writing—original draft preparation, S.U.-U. and K.H.-P.; writing—review and editing, S.U.-U., K.H.-P., P.M.-C., and U.M.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by funding from the URBANAGE project from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101004590.

Data Availability Statement: The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author/s.

Acknowledgments: We would like to express our sincere appreciation to Asel Villanueva, Amaia Lopez de Aguileta, Mauricia Benedito, Andoni Aranguren, and Sergio Campos for their invaluable contributions to this research. We extend special thanks to all the experts who generously contributed their time and expertise to the Delphi method process. Their valuable insights and perspectives were instrumental in shaping the outcomes of this study.

Conflicts of Interest: The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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