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Invisible in the smart city: Using participatory design methods for age-friendly solutions

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Older adults face unique challenges and have differing needs when navigating the urban environment. At the same time, civil servants and policymakers in cities are facing difficulties in promoting age-friendly initiatives due to the lack of knowledge, data, and tools about and for older adults. In this context, smart cities can play a key role in increasing the participation of older adults (i.e., 65 years and older) by collecting the data needed to provide knowledge of and design tools for older adults. However, using smart city data to inform policy making is made more difficult by several existing issues such as aggregated nonage-specific big data, lack of data altogether, and a disparity in access and use of digital technology. This paper endeavors to provide a methodology to ensure that the older adults are represented in the collected data and the translation of this data into automatic policy-making decisions. The Participation for Policy for Older Adults (PAR4POA) method introduces older adults' perspectives from the start of the project and its iterative approach means that older adults will share their needs and values with policymakers at different stages of a project. The use of this method enabled the co-creation of smart city solutions targeted to address the needs of older citizens in the context of 3 European regions. The PAR4POA method is specifically altered for the situation of older adults but could easily be used to include other marginalized populations. Ensuring participation in the automatic policy-making arena will empower marginalized populations and provide representation in data previously not provided.

KEYWORDS

participatory design, smart city, ageism, age-friendly cities, digital inclusion

Introduction

Across Europe, the aging population is expected to increase, by 2050 the projected group of those aged between 75 and 80 will have expanded by 56.1%. By 2050, the total population considered to be an older adult (i.e., 65 and older) will increase by 39.3 million individuals ([Ageing Europe Eurostat, 2020](#)). Policymakers and civil servants are aware of these trends and are already experiencing increased demand for services related to older adults. As a result, policymakers are investigating how to support initiatives aimed at older adults to facilitate autonomous and independent living within an urban environment. The choice of an urban context is predicated on the increase in

the European population based in cities (Koceva et al., 2016), subsequently, there is an increase of city-based older adults. Furthermore, the rapid expansion of the very old, by 2050 it is estimated that there will be a half a million centenarians within the borders of the EU-27 (Ageing Europe Eurostat, 2020), is a concern for policymakers. As the very old proportionally make more use of social services for health and social care, pensions, and public finances. Which in turn makes it difficult for public services to provide adequate and appropriate services. Datafication understood here to “describe[] a transformation of social action into online quantified data for tracking and predictive analysis” (Sourbati and Behrendt, 2020, p. 3) is seen as an approach to help policymakers in making data-driven decisions to provide for a better quality of urban living. The Global Age-friendly cities initiative by the WHO determined that 8 domains require attention to improve the quality of living for urban older adults (Rémillard-Boilard, 2018), (see Figure 1).

All these domains can be affected by data-driven decision-making. With mobility as an example: public transport can be adjusted based on usage data or a city can determine its walkability status as being 15 min based on available geospatial data. However, these data-driven approaches encounter several issues when it concerns older adults. For example, the walkability in cities is typically calculated based on the average speed of a pedestrian and does not consider the slower walking speed of an older adult. The walking speed, on average, decreases by 1.2 min/km between the ages of 20 and 60 (Schimpl et al., 2011). It is necessary to ensure the availability of meaningful and reliable data on older adults. This would enable civil servants and policymakers to create policies that are inclusive for older adults. To achieve this, it is necessary to make visible the way the datafication is currently excluding the data of older adults. In this article, we provide a framework to assist the development of new technologies to support policymakers and civil servants to include the needs of older citizens in their decision-making process. This is done by focusing on the data required to feed those systems. We answer the question: how to collect data from older people for better data-driven policy-making to ensure a better autonomous life for the older population?

Background

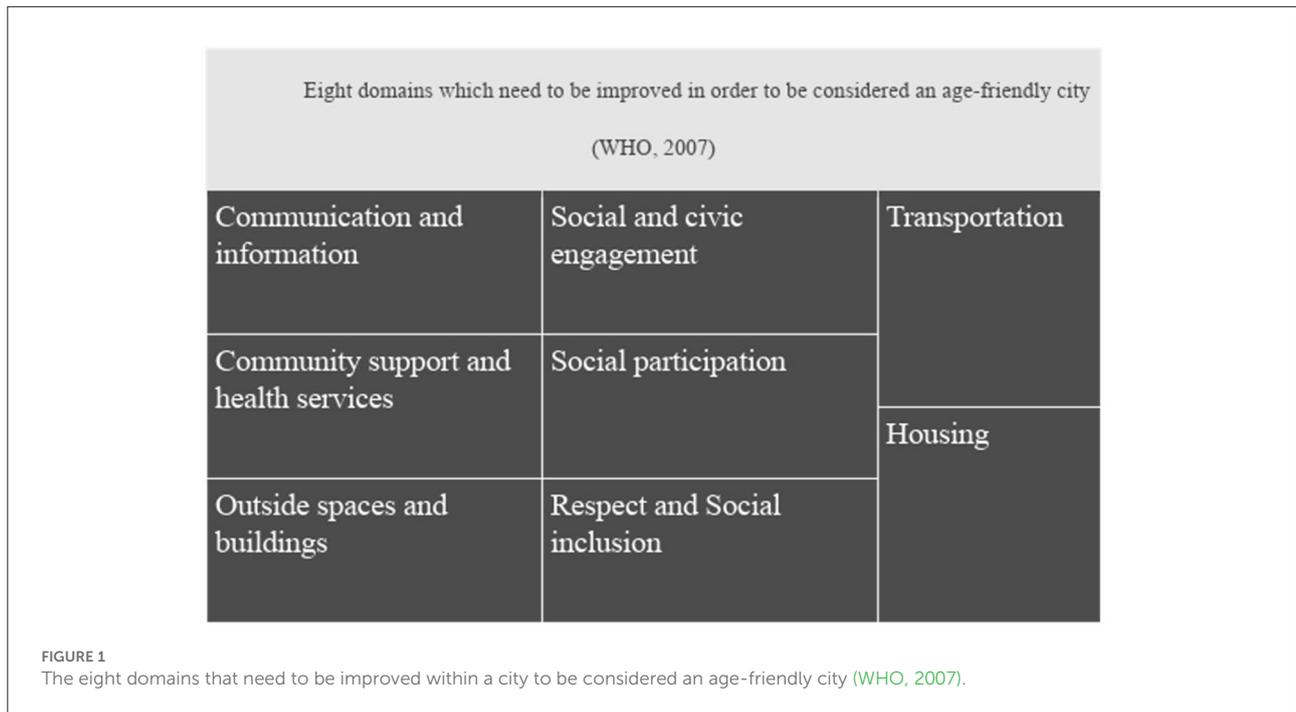
Age-friendly and smart cities

As previously mentioned in 2007 the WHO developed the concept of age-friendly cities. In this section we will explore age-friendliness in the context of smart cities and provide examples of initiatives as encountered in Spain, Finland, and Belgium. The smart city makes use of various data sources and processes them to provide better tracking ability and predictive analysis for the various actors within the city (Sourbati, 2020; Sourbati and Behrendt, 2020; Smets et al., 2021). A survey

examining the potential applications of data and smart cities in Flanders (Dutch-speaking region of Belgium) highlighted the concerns Flemish cities have in using smart-city data in policy making (Walravens et al., 2019). The smart city has potential to assist in policy making in all areas of Figure 1 by providing data to enhance the services and to contextualize its use by the older adult (Arup, 2015). This potential to impact all areas is important for older adults, as a case study of the city Brussels found that older adults felt heard in policy making concerning (health) care-related policy areas, but felt silenced in connection to other policy areas (Vanmechelen et al., 2012). Using data from smart cities could ensure that older adults' data contributes in policy making and their daily experiences in an urban environment are therefore taken into account when policy making decisions are made. There have been initiatives to combine the data of smart cities with the needs of older adults in the past. In Madrid, for example, the smart city infrastructure was used to help monitor frailty risk of older adults aging-in-place (Abril-Jiménez et al., 2020), and similarly in Finland the city of Oulu investigated the potential of the smart-city to assist in the care of their older adult population (Skouby et al., 2014). The potential for technology for the improvement of the lives of older adults is clear, however, as mentioned by the older adults in Brussels, these example initiatives are related to care and their experiences in other areas of smart cities are not explored as much. This is evident in the case of smart mobility in which the ageist assumptions in regards to the interest and ability of older adults in technology has resulted in exclusion of those age over 75 in surveys (Sourbati and Behrendt, 2020, p. 1407). Mobility, housing, and physical environment are all areas that can influence the experience of an older adult within the city and are areas in which data from smart cities can and will be used to make policy decisions. And more broadly speaking participation in public life, another indicator of a age-friendly city, takes different forms within a smart city. This because in smart cities it involves the use of your data in (automatic) policymaking. In the next section, the treatment of the data of older adults will be discussed in the context of data justice as this framework assists in contextualizing the potential problems of a relative invisibility of your data in regards to data processing.

Datafication and older adults

Dencik et al. (2019, p. 873) state that data and “the way it is generated, collected, analyzed and used, is a product of an amalgamation of different actors, interests and social forces that shape how and on what terms society is increasingly being datafied”. The examination of this amalgamation is needed to understand how irregularities and inaccuracies in algorithmic outcomes can be prevented. Data justice proposes the centering of a plurality of voices and the acknowledgment that the actual lived experience in a certain context is best explained by



those experiencing it, as a means to inform and examine the different actors, interests, and social forces (Costanza-Chock, 2018; Dencik et al., 2019). Subsequently, in the context of urban spaces the involvement of actual users or citizens of a city will reveal their lives and experiences in particular urban spaces. The data justice movement is not alone in acknowledging that a lack of inclusion in the design process is the cause of inequality and unfairness in algorithmic outcomes. Indeed the call to include the principles of the critical feminist thought (Bardzell and Bardzell, 2011; D’Ignazio and Klein, 2020), the decolonization of data science (Mohamed et al., 2020) and calls to ensure that outcomes for different groups are made visible (Buolamwini and Gebru, 2018) are examples of similar initiatives. These have in common that they ask the AI tech community to reflect on an existing power structure that can be found within society. Thus, avoiding a perpetuation or enhancement of existing social inequalities within new technologies. The involvement of the data subjects themselves and a reflection on their position by the creators of algorithms is one of the ways which is suggested to examine and acknowledge these power structures (van Leeuwen et al., 2021).

Ensuring fair and accurate representation in data is complicated and has many facets. In the case of older adults, it involves ensuring that data is collected and processed in the first place. As their data tends to be discarded or remains uncollected (Rosales and Fernández-Ardèvol, 2019). During research into pedestrian crossings, researchers found that older adults tended to be unable to cross in the allotted time as their data was not taken into account while calculating the required time to

cross at the traffic lights (Asher et al., 2012). Furthermore, by doing a dedicated exercise the researchers were able to capture the data of those that would usually avoid crossing the road at the traffic lights (Asher et al., 2012). Older people tend to receive less accurate predictions in recommender systems as either their data is treated as an outlier or the design of the system is unable to gather their data (Rosales and Fernández-Ardèvol, 2019, 2020). D’Ignazio and Klein (2020) call this lack of data collection being part of a data desert. Some examples of how older adults are treated in data collection and processing: older adults are often excluded due to a set age limit in surveys, it is impossible accurately capture their aged experience in general surveys, or they are taken as a homogenous group without taking into account the difference in the experience of multiple generations (Asher et al., 2012; Mahler, 2020; Rosales and Fernández-Ardèvol, 2020; Sourbati and Behrendt, 2020). Mahler (2020) especially expresses strong concern for the effect a lack of (correct) data can have on the human rights of older people. For example, these data deserts can have an impact on policy decisions, since representation within the data is not achieved and budgetary decisions might be unable to address the underlying cause. A real-life example of the consequences of a lack of data was described by Eubanks (2019) regarding an algorithmic decision-making system to detect child abuse in Allegheny County (Pennsylvania, USA). This system was less likely to detect severe abuse of children from more affluent areas, since their data was not collected to the same degree as people from a less affluent background, as those marginalized “face higher levels of data collection when they access public benefits,

walk through highly policed neighborhoods, enter the health-care system, or cross national borders” (Eubanks, 2019, p. 18). In essence, there was a data desert about children from more affluent backgrounds in the systems used to calculate abuse risk.

Involving older adults as experts of their own experience can result in different choices in the collection and processing of data as their perspectives would counter the knowledge gap that is present in the younger researchers/policymakers. Furthermore, to make meaningful age-friendly data-driven policy decisions it is necessary to have disaggregated demographic data to be able to identify the heterogeneous group of older adults instead of one age bracket (i.e., 65-plus). Big data “disregards groups that behave differently to the mainstream, something which is more common among older people” (Rosales and Fernández-Ardèvol, 2020, p. 1081). Big data has issues predicting groups that differ from the mainstream and this has resulted in older adults being deprioritized (Rosales and Fernández-Ardèvol, 2020), as this age cohort has differing needs and concerns from the mainstream. This last makes them less likely to be considered in standard data-driven decision systems. To illustrate this, one such need is the availability and easy reachability of health care services. As older adults tend to make more use of these services (Ward and Ozdemir, 2012). This could mean that the calculations of the reachability of a General Practitioner are calculated while not considering fair representation by older adults. This would result in reachability figures that do not consider the walking speed and number of visits by older adults and would predict a lighter burden on the older individual than is experienced.

The algorithmic treatment of older adults is relatively underexplored. Rosales and Fernández-Ardèvol (2019, 2020) investigated how ageism, discrimination based on age, was embedded within big data and digital platforms. They found that ageism was mostly present in the treatment of data. This was blamed on the homophily of program teams and incoherent algorithms. Older adults are often seen as digitally unskilled (Sourbati, 2015; Sourbati and Loos, 2019; van Leeuwen et al., Under review) and this impacts the way systems are prepared for their data. As Rosales and Fernández-Ardèvol (2019) argue the algorithms are used to disguise that corporations are insufficiently prepared to either provide the expected user experience to those digitally unskilled users or for unexpected users and uses. Manor and Herscovici (2021) coined this specific type of ageism: “Digital Ageism” and it manifested in stereotyping and disregarding older adults’ actual needs in interviews with user experience experts. This group is responsible for ensuring the accessibility of applications and websites.

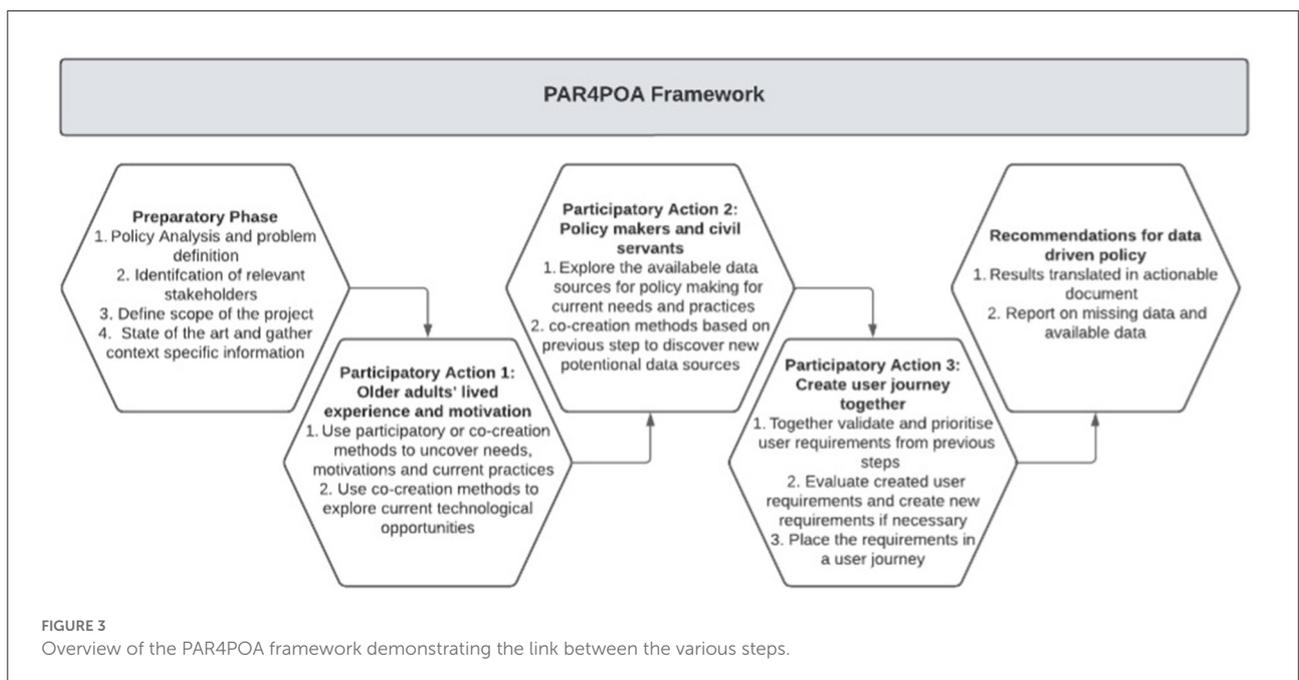
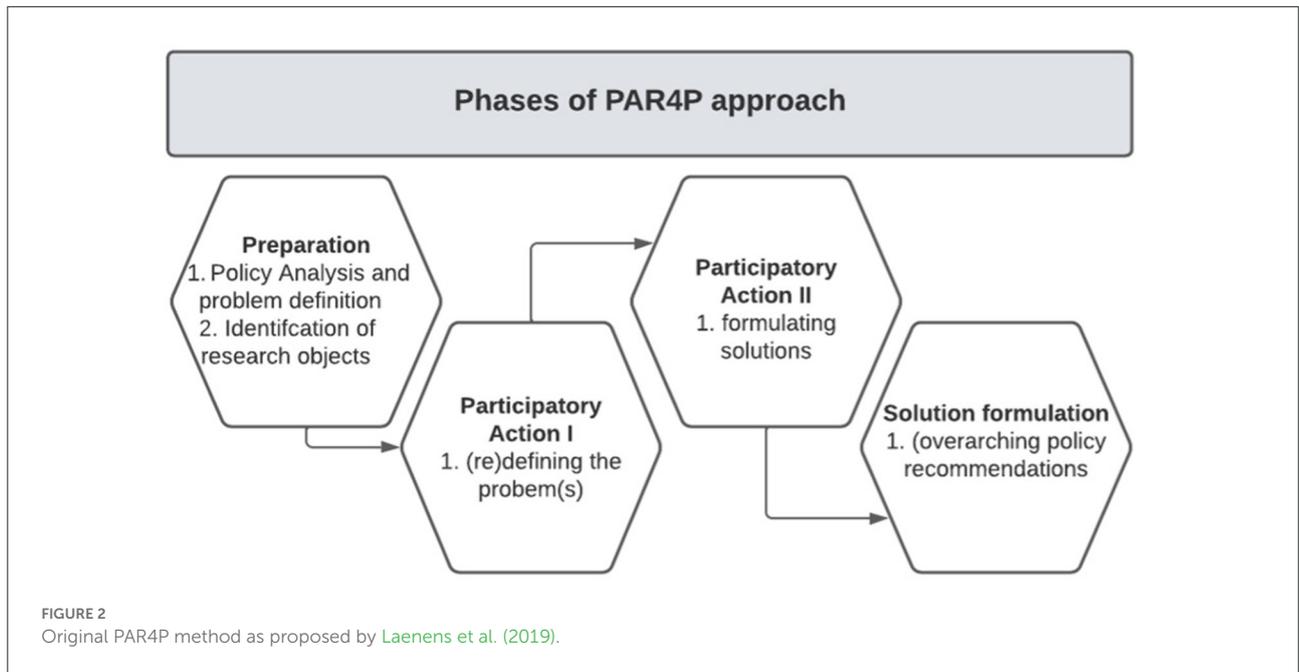
It is possible to avoid the previously mentioned negative algorithmic experiences. For example, Bardzell and Bardzell (2011) argue that the critical feminist method can be applied to Human-Computer-Interactions research (HCI). This would ensure that different lived experiences are considered while designing a system. To achieve this, it would be necessary

to involve older adults and other non-mainstream groups throughout a project. The study by Doyle et al. (2019) was key in the development of a health management app. This qualitative study was used to ensure that the eventual platform would conform to the specific needs of older adults managing multimorbidity. Similar to this study it is possible to use co-creation to receive insight into older adults’ needs. It can be the basis of “intensive and equal collaboration between various stakeholders operating on different levels, ranging from older adults, caregivers, nurses, psychologists, managers, teachers, policymakers, and scientists” (Luijkx et al., 2020, p. 2). An argument has been made that it is necessary to design with empathy for older adults. This would result in age no longer being treated as an antagonist, but as a co-conspirator (Ferri et al., 2017). Although this argument was aimed at designers of assistive technology the same principle applies on a broader scale. Empathy with older adults would involve ensuring their input and interests are considered when designing for a more inclusive policy.

Laenens et al. (2019) provide an argument for using the Participation Action Research approach for the development of Policy (PAR4P). Their approach consists of an iterative action plan where various stakeholders are involved within the design cycle, (see Figure 2). The key to the PAR4P approach is that it involves the participation of various stakeholders throughout the process and not solely at the beginning. The inclusion of older adults throughout a design process is rare according to a systematic review of the co-creation participation by older adults (Fischer et al., 2020). The PAR4P approach has been adjusted before for a data-driven policy action (Sillevis Smitt et al., 2022). Participatory design has three domains of knowledge that need to be included; current practices, technological options, and practices with new technologies (Kensing and Munk-Madsen, 1993; Van Mechelen et al., 2019). These domains remain essential within PAR4P as the iterative process investigates the current practices within the policy domain and the needs of stakeholders, while the co-design element within PAR4P explores both the current technological opportunities and possible practices with new technologies or knowledge.

Participatory action research for policy with older adult

In the following section, we will argue how to integrate both the principles of PAR4P and empathy for older adults within a framework for participatory design for data-driven policymaking for older adults. The PAR4POA approach is different from other participatory innovations as it focuses on an iterative approach and can be used in all stages of a design process. This means that PAR4POA can be used to inform the initial design choices of a research project as well as the creation of a product, for example. Furthermore, as shown in Figure 3 the



involvement of older adults and civil servants occurs on multiple occasions, ensuring that not only information is collected but there is also opportunity for creating shared knowledge and insights into the lifeworld of the older adults through discussion. The PAR4POA framework is introduced in the context of the H2020 URBANAGE project, which aims to address the needs of an aging population in the urban environment through the use of disruptive technologies and the development of digital twins for civil servants (for a comprehensive introduction to

digital twins see De Maeyer and Markopoulos, 2020). These self-same principles could be adjusted for other marginalized groups or even multiple groups at the same time. In the case of the URBANAGE, this framework was used in a broader context where the final goal was not policymaking, but the development of data-driven decision tools or digital twins for civil servants. A “Digital Twin refers to a digital replica of potential and actual physical assets (physical twin), processes, people, places, systems and devices that can be used for various purposes”

(De Maeyer and Markopoulos, 2020, p. 251), thus to create a digital twin pertaining to the life world of an urban older adult it is necessary to understand their needs and priorities to decide which data needs to be collected and which barriers are experienced while living in a city which need to be alleviated. In other words, there is a lack of identifiable data of older adults within smart city data. This can be addressed by creating a shared understanding of the day-to-day life of older adults and to identify where and how their data is or can be collected. In the project, researchers conducted the preparatory phase and three co-creation workshops with older adults and civil servants in each of the pilot sites: Santander in Spain, Helsinki in Finland, and the Flemish region in Belgium. For the Belgian test case, a regional approach was chosen to test regional open data opportunities. Each workshop corresponds, respectively, to the second, third and fourth phase described in the figure below. This section will follow the phases as shown in Figure 3 and will conclude with our recommendations on how to adjust these same principles for further marginalized groups.

Preparatory phase

Before involving older people in the participatory workshops, it is essential to conduct an action consisting of a series of preparatory steps aimed to gather relevant knowledge about the domain and context in which the data-driven decision-making will be conducted. This step is necessary to ensure that the participatory actions are productive and have a structure that delineates the scope of the research without limiting the contributions and creativity of older adults who take part in the workshops. The described steps do not happen chronologically, they can be taken in conjunction and can influence each other. Firstly, conducting desk research makes it possible to identify all the well-known issues and good practices from the literature (SOTA). Furthermore, it enables the team to acknowledge the known criticalities of the specific context where the data-decision making will be conducted. This process will result in meaningful insights into the various possible domains in the lives of the older adult on which the project could focus. Secondly, a policy analysis of the current policies in place is essential to understand the current policies in place in the various domains concerning older adults. There are several ways of obtaining this insight, to illustrate it is possible to conduct a quick scan analysis of policies (Iordache et al., 2017) or to conduct a series of expert interviews with various domain experts and/or policymakers (Sillevis Smitt et al., 2022). Both of these steps help construct an overview of the current state of the problem domain and the key challenges the project could address. Thirdly, a general scope of the project needs to be determined, this is necessary to ensure that there is structure in the project and to delineate but not limit the future envisioned user involvement. In essence,

this means that the scope should provide enough freedom for older adults to share their lived experiences, provide creative insight, and ensure that the various needs and motivations of older adults are captured. To illustrate this, we will use the H2020 URBANAGE project; here the scope was determined to be what are the challenges and barriers limiting the aging population in conducting an independent life living in an urban environment setting. When the scope has been determined it is necessary to identify what are the domains related to the project. In the case of H2020 URBANAGE, we identified domains such as urban planning, healthcare, wellbeing, accessibility mobility, ICT, and greenery. Following the identification of domains, a list of city departments and other stakeholders responsible for these domains was constructed. This list was key in making sure all the relevant actors were involved from the beginning and were offered the opportunity to provide valuable feedback and contribute substantially to our understanding of the possibilities and ramifications of the policy within an urban context. There are various ways in which the relevant stakeholders can be identified; this can be done in a workshop with policymakers, *via* surveys, or during expert interviews. It is possible and recommended to interview various older adults or organizations dedicated to older adults as part of these expert interviews. These interviews will further assist in (a) creating a definition of the older adult as used in the context of the project and (b) to determine strategies for fair representation of the older adults in all shapes and forms. This can mean the involvement of organizations fighting poverty to provide participants to represent those older adults living in poverty or it consists of including transport and/or alternative access to the workshops for those living with disabilities. During URBANAGE a combination of these techniques was employed, to be exact surveys and interviews with local experts were used. The information that has been gathered during these steps determines the various future steps within this framework. Furthermore, URBANAGE set-up guidelines for its project sites to ensure that the offer of the workshops was engaging, accessible, and useable for a variety of different older citizens. The guidelines ensured that possible barriers were addressed as part of the recruitment process. Other steps that were taken was an intake survey prior to the workshop to obtain a basic demography of the possible participants. Based on the guidelines and survey each pilot site selected participants recruited *via* city departments and older citizen organizations, this resulted in a heterogenous group of participants.

Participatory action 1: Older adults' lived experiences and motivation

This action involves the first co-creation elements of this framework. Involving older adults in technology design is not

new, we will discuss various best practices in this section that can assist in ensuring that older adults' needs, lived experiences, motivations, and technological opportunities are uncovered, again we will use the H2020 URBANAGE project as an example.

To ensure that older adults' needs are taken into account it is necessary to acknowledge that the aging population is diverse and their needs are divergent, by ensuring that this is taken into account one of the myths surrounding older adults has been dispelled (Durick et al., 2013). The involvement of older adults will uncover the following four elements: needs, motivations, current practices, and current technological opportunities. The needs of older adults in the policy scope can be uncovered, by using co-creation workshops. Using these workshops, it is possible to not only capture the needs but to enable prioritization *via* consensus within a stated problem domain. This results in either, confirmation from the findings in the first step or uncovers previously unknown needs *via* the lived experience of older adults as they can be viewed as the domain experts on old age. This step counters the aforementioned homophily of design teams (Rosales and Fernández-Ardèvol, 2020). Within the context of aging within an urban context, the goal of a workshop can be to identify the main barriers affecting the autonomy of older people. To achieve this, researchers will have to translate the project scope into questions related to the personal experiences of older adults. During the workshop, participants are invited to reflect on their daily activities in the urban environment at different times of the year, identify the barriers, and describe how and why they are limiting their independence. We can illustrate this with a requirement highlighted by the H2020 URBANAGE project participants, the older adults required public seating arrangements to determine the walkability of a city. This process was key in facilitating the collection, reformulation, and prioritization of relevant insights. The outcomes than were translated into user requirements (data, features) to be validated in the following steps.

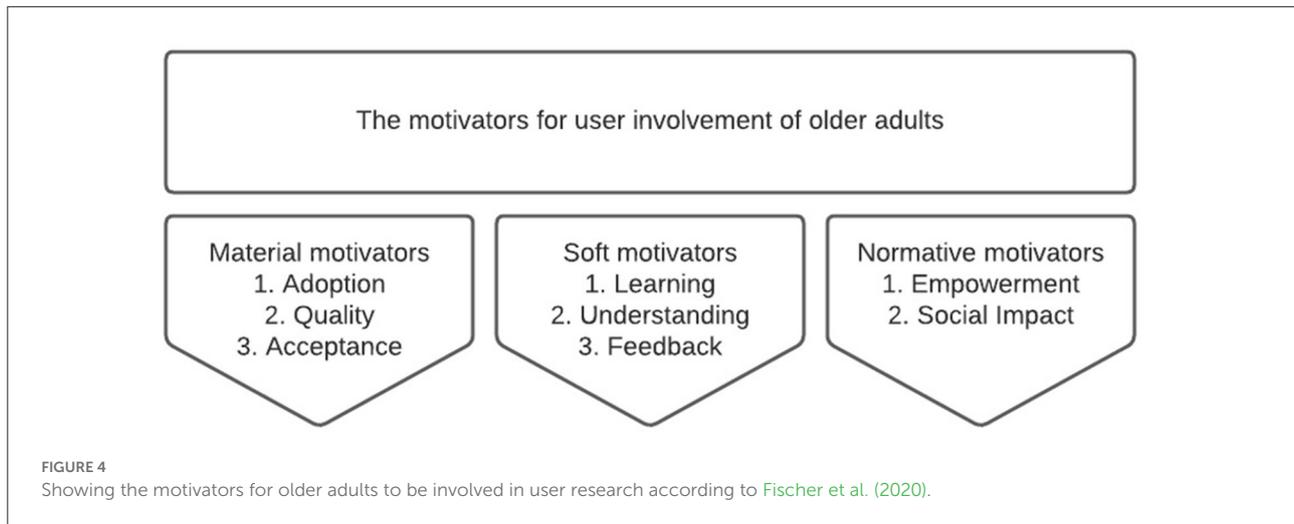
The workshops can also facilitate further understanding of the motivations and how these relate to older adults' needs and current practices. It is necessary to understand the motivation of older people to participate in technology development to ensure the adoption of the technology later. It is possible to distinguish various motivators as seen in Figure 4, this figure is based on a systematic review by Fischer et al. (2020). It is important to uncover these motivations during the co-creation as they might influence the strategy to ensure the future involvement of other older adults. For example, in past co-creation workshops for the creation of health gardens, which enable research into older adults and digital healthcare, we were able to distinguish various motivations for participation which informed our communication to increase user engagement.

The final two elements are interlinked: information about current practices and technological opportunities. The current practices can help determine how older adults currently engage with environments within a city. Furthermore, the

current practices can help determine the usability of existing technological opportunities. If older adults use a technological artifact in a way that produces unusable data, these practices help inform changes needed in the collection *via* existing technological solutions. One hypothetical example to illustrate this: imagine that the data collection happens *via* Bluetooth technology, however, it becomes apparent in the workshops that your target group of older adults have the current practice to turn off this signal while moving through the city. This means that your data collection will not include this target group. Therefore, it is necessary to understand usage patterns and identify possible pitfalls in current data collection and prevent similar shortcomings in future data collection. To facilitate this type of interaction between older adults and developers it is necessary to have a boundary object, this boundary object is a material or organizational structure that works as an information carrier to bridge the gap between the two groups and create a shared understanding of the situation (Heyman, 2019). In the case of URBANAGE we used User Journeys to map the life of an older adult in an urban context. This user journey then reflects their technological practices and interactions with an urban environment on a day-to-day basis, this user journey acts as an information carrier for the next action.

Participatory action 2: Policymakers and civil servants

This action consists of a series of expert interviews and co-creation- and information gathering workshops. The first set of expert interviews or reflections with data experts or employees of the necessary departments of a municipality is necessary to reflect on the user journeys created by the older adults and to help determine which kind of data is already available. This is followed by workshops where policymakers and civil servants are invited to provide feedback on the previous activities with older citizens. The goal is to examine how user requirements are present in existing policy and to explore the existing gaps. Here the first step is to find agreement between possible policy objectives and older adults' needs, as not all needs can and should be translated into policy. After this validation, it is necessary to review the existing data sources to determine if it is possible to use them for data-driven decision-making to create policy. If data sources are not yet available, it will be necessary to determine which data should be collected to achieve the policy objectives. In the H2020 URBANAGE project, a co-creation workshop with civil servants was organized in each pilot city or region. The goal was to capture the active initiatives and needs and to validate, align and prioritize the requirements defined by the older adults in the previous action. Thanks to this structure researchers were able to validate the barriers reported by older adults. One example of this is the lack of availability of



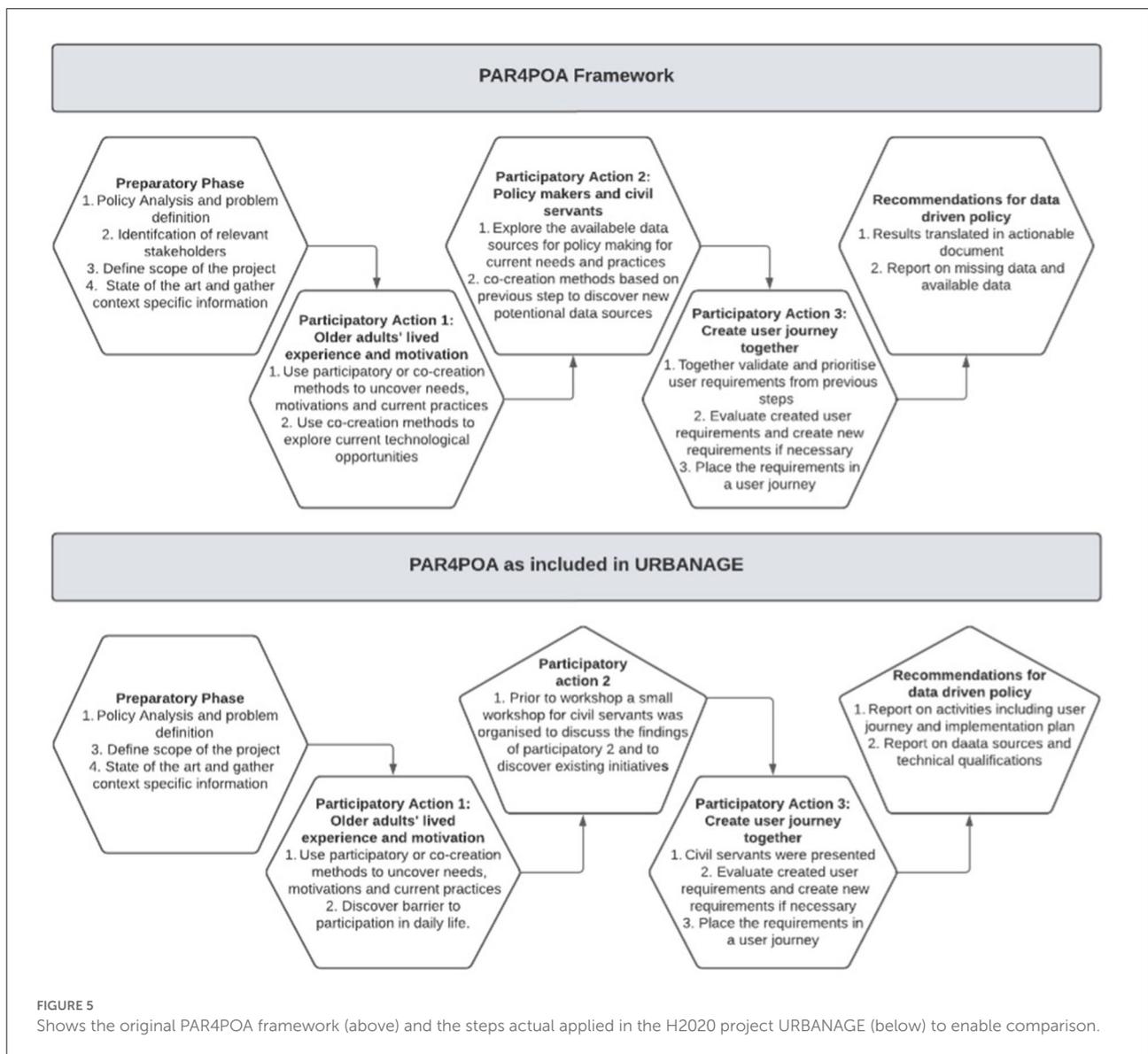
public toilets reported by older adults in the Flanders pilot. Civil servants were able to respond to this requirement, by explaining that the real issue was to communicate to older citizens where these bathrooms are located, subsequently resulting in a dismissal of this requirement. In the cases where civil servants agreed with the requirements of the older adults, the technical feasibility was determined, meaning the existing data was examined and possible technical solutions were discussed for new data collection. An important aspect of this action is that it is necessary to review the currently available data resources. This means that during this workshop it is necessary to include a stakeholder who is aware of the data and its possibilities. By reviewing the available data, it becomes possible to establish where data can distinguish between older adults and others in the population. This action will result in (1) data needs, (2) it will define technical specifications, and (3) will introduce new possible data collection methods that would work in tandem with the existing data and resources.

Participatory action 3 create user journey together

The third participatory action involves older people and civil servants. The goal is to validate, prioritize, and collect missing user requirements. In this activity, civil servants and policymakers are paired in groups with older adults and are invited to place the different user requirements in a user journey and to include new requirements if needed. This will facilitate civil servants to understand the barriers from the older people's perspective and facilitate older people into prioritizing the requirements according to their daily experience. In the URBANAGE project, each couple of participants was given a user journey and asked to indicate the moments or objects that influenced their route positively and negatively. To do so,

they were invited to use a set of elements representing the prioritized requirements (e.g., data sources and functionalities) collected during the previous workshops. Each user journey was accompanied by a question designed following the project and the pilot scope. In Flanders, for example, older people were asked to describe their route from their home to the doctor or supermarket during extreme weather conditions (snow, rain, ice, and heat). For that, they were given positive and negative elements such as dangerous steps, unsafe sidewalks, greenery, good and bad furniture, and acceptable walking distance. If the older adults identified an influential element was missing participants were able to create new tokens to represent that element. Thanks to this activity the URBANAGE pilots were able to validate the features and data sources to be integrated. Moreover, the outcomes of this activity also informed the different stakeholders about the existing data gaps related to older citizens. The input and participation are essential to this project as it aims to address the needs of the older population in the urban environment through the use of disruptive technologies and digital twins.

This participatory action is the moment where the iterative nature of this framework is tested. Within this workshop the policymakers and the older adults together review the reprioritizing done in the previous action separately by the policymakers and civil servants. It includes the presentation of the available data sources and a review of the user journeys taking into account this new knowledge of where and how data is gathered. The two groups together review and refine the adjusted user journeys and recalibrate the journeys to incorporate previously discarded priorities if deemed necessary. In our example, we used the user journeys as a necessary boundary object to enable discussion and to create a shared medium for older adults and civil servants to create understanding and enable easy adjustments. Using the user journeys, it is possible to reflect on their daily practices.



The result of these sessions will be readjusted and validated user journeys that can form the basis for the recommendations for the next step. As these user journeys are informed by both older adults and civil servants it can also lead to further informed communication strategies for public outreach regarding initiatives.

Recommendations for data-driven policy

In this phase the results of the activities of the previous phases are translated into an actionable document, for example, one or more user requirements reports. The actionable document should briefly describe the methodology, the main outcomes of the desk research, the outcomes of each activity, and

finally, it should contain an analysis of the final requirements as determined by older adults and civil servants. This will be the base for an implementation plan. To facilitate the technical team in prioritizing data sources to be integrated and features to be developed, it is important to include a list of the prioritized user requirements. In this way, the technical team will be able first to assess which data sources need to be integrated or reused. In the case of the URBANAGE project, this actionable document consisted of two reports, one related to the activities themselves and one reporting on the results which in this instance ultimately resulted in an implementation plan. The user requirements report also provided meaningful insights about common needs and challenges in all the pilot sites faced by older people and civil servants. For instance, in all the pilot sites older people reported issues related to the

lack of maintenance of the urban infrastructure, the presence of obstacles on the sidewalks, and the lack of resting places. When addressing the needs of older citizens in the urban environment, civil servants reported common technical, urban, and communication challenges. Among the technical challenges, they reported issues related to the lack of data, the difficulty in filtering extensive data sources, and the difficulty of linking different data sources coming from different departments and urban scales. These technical challenges often result in a lack of urban or policy action as civil servants are not aware of what spaces are not accessible for older adults or where they should prioritize policy and interventions. In addition, the lack of good communication channels with older people is making it difficult for them to inform older people about the different existing initiatives and resources. This further complicates information collection about the older citizens' needs and preferences. It is recommended to organize an event to share the findings of the actionable document, these dissemination events ensure that the reports act as a new boundary object for those in different departments on a city level and participants can see tangible results of their active participation ensuring that they remain engaged for future activities. The URBANAGE project on the basis of the earlier mentioned guidelines organizes dissemination activities to ensure continued engagement from all participants. The activities are held periodically both reporting on work in progress and achieved goals. This gives the participants a clear idea of the value of their input to the project overall and to present them with the estimated impact their participation will have. Furthermore, these events can act as a moment of reflection and accountability as the various stakeholders can discuss the project's achievements and objectives in a neutral setting.

Conclusion

The invisibility of older adults in the datafication of urban life can become a problem if this incomplete data is used for policymaking. Therefore, the representation of those vulnerable to digital exclusion should be a focus when introducing data-driven decision-making for creating policy. The PAR4POA framework and the use-case of URBANAGE present a means to ensure that the needs and requirements of older adults are considered when creating data-driven policy. Our framework was partially incorporated in the URBANAGE project, here the successful participation of older adults informed a final report that will enable policymakers and civil servants in the pilot areas to make informed choices in their future data-driven policymaking.

Figure 5 shows the idealized PAR4POA framework and the actual steps taken in the URBANAGE project. Although

not completely implemented in the URBANAGE project the framework was tested sufficiently to state that its use should enable representation of older adults' data within policy making. Ideally, we would propose the use of the PAR4POA with various groups within one project to ensure that the various lived experiences and needs of citizens are considered while developing tools for automatic policymaking. The inclusion of older adults within the smart-city data will enable policymakers to provide solutions that are significantly able to improve the urban experience for older adults. At the same time by using this method the policymakers will be able to datify social actions and habits that were previously invisible to them. This last will ensure that predictions and analysis based on the available data would be more accurate. The PAR4POA as envisioned here has not yet been fully tested as Figure 5 shows and future research should be done to reflect on the effectiveness of the full application of this framework in different settings. We finish this article by restating that inclusion of older adults within datasets used for policy making is essential. Especially as their inclusion would ensure that older adults remain able to fully participate in smart cities and enjoy an autonomously existence.

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.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

CL took the lead in writing the article and was in charge of organizing and editing. JD contributed in both content as well as writing. IM and AJ provided feedback and advice on writing as well as editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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