Cultivate Smart and Healthy Ageing

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Abstract. The essential criterion for developing an intelligent age-friendly environment is evaluating and monitoring the provision of services. Our research aims to allow the deployment of a broad range of digital healthcare solutions interconnected in an IoT network ecosystem. Through their interoperability, we will be able to cultivate age-friendly smart homes for older adults. Thus, we will enable interpreted living and wellbeing. The intelligent integrations of digital solutions will allow the acquisition and evaluation of health-related data. Standardization, interoperability and scalability of the integration will increase efficiency in healthcare, improving older adults' Quality of Life (QoL). Also, interpreting their needs will allow key stakeholders to optimize the Quality of Service (QoS). The proposed Internet of Health (IoH) framework will encapsulate sustainable and affordable innovative solutions and their benefits for a comfortable, meaningful, and independent life in an intelligent environment. Therefore, the frame mediated by edge computing, in-home and community settings will be able to interact with healthcare networks contributing to hospitalizations and institutional care.

Keywords: Smart-Cities · Internet of Things · Age-Friendly · Internet of Health

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1 Introduction

We propose developing a framework that will enable the development of a wide range of digital solutions and services to support and extend healthy and independent living for older adults. The framework will be made possible by integrating interoperable IoT platforms, which combine intelligent devices to acquire and evaluate data. The information will be about the vital signs, living environment and lifestyle of the elderly. Also, the information collected will determine their needs for independent living. Of utmost importance is ensuring data protection and trust, ensuring anonymity through personalized solutions. In addition, we focus on the interoperability and scalability of IoT networks to maintain remote efficiency in healthcare delivery, bringing well-being to seniors, supporting their families, empowering caregivers, and fostering innovation from care providers. The proposed framework will promote age-friendliness in home and community environments. Home accessibility will be assessed based on the WHO guidelines for housing and health for the elderly. They will also be able to evaluate the provision of services and identify possible psychosocial and physical modifications to enhance their independent living. We will also address age-friendliness in terms of attitudes and cultural values. Age-friendliness requires fostering attitudes and behaviours that promote older people's dignity and worth, a sense of safety, and being active members of society. The aim is to identify the views of older people on how to foster age-friendly behaviours, how the proposed framework can facilitate this and how people can be encouraged to use IoT solutions to promote recommendations for creating age-friendly. The main aim is to consider how older people and their carers should be engaged and empowered to play a more active role in healthcare decision-making to improve the overall quality of care, efficiency, and results. Ambitious but realistic goal setting can add a sense of purpose, drive, and achievement. In addition, they will be able to examine

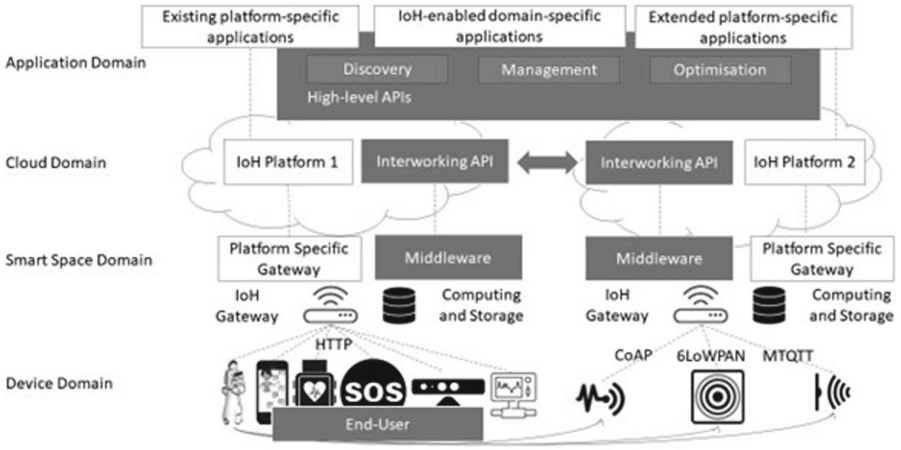

Fig. 1. Architecture of an IoH platform

how the psychology of decision-making and goal setting can be applied to facilitate older people's planning and guide development about the type and extent of information that is optimal to help older people to make decisions.

Healthcare platforms will intelligently enable semantic interoperability of the Internet of Health (IoH). The interconnection of digital healthcare solutions in an Internet of Things (IoT) network combined with services like Smart Home and Smart Mobility will enhance sustainability in Smart Cities and cultivate age-friendliness. Health-related data could be acquired remotely for evaluation. Thus, the users will have the opportunity of remote vital signs monitoring. However, to incentivize data sharing, we need to ensure that the exchange will be secure between trusted parties. Therefore, a middleware platform could support the secure exchange of data and services. Simple in terms of time complexity and robust in terms o secureness, novel cryptography methods could be deployed to assure data sovereignty [33,34]. As presented in Fig. 1 the IoH network ecosystem could perform in four domains. Within the application domain, the middleware platform will allow the integration of digital devices, healthcare services, and intelligent digital solutions [35]. The data will be accessible through the decryption key for interpretation through the cloud domain. Hence, it will provide consistent and valid access to virtualized IoH digital solutions. The intelligent space domain will deliver services for engaging innovative IoH devices in intelligent environments, allowing dynamic configuration of digital solutions. Finally, the device domain regards the devices that will consist of the IoH platform. The intelligent interaction with the innovative ecosystem of the smart urban environment will leverage their roaming capabilities [36].

First, we set out to conduct a systematic review of the literature on older adults experiencing permanently or temporarily reduced functionality and capabilities. Then, based on their disability, we provide the corresponding suggestions to promote digital solutions adapted to their needs. The areas we investigated were the following age-related impairments: Changes in visual function, Hearing loss, Sense of touch, temperature perception, levels of mobility limitation, balance and age-related cognitive ageing and memory changes. We then develop guidelines for presenting digital solutions. Finally, we implemented a survey using a focus group of 30 older people to assess their satisfaction with providing services in their community.

2 Literature Review

We conducted a literature review based on age-related impairments and we elaborate the guidelines which derives.

2.1 Changes in Visual Function

Initially the changes in visual function deteriorate gradually during the aging process. The most common visual impairments are: Presbyopia [1,2]; Ametropia [3,4]; Glare sensitivity; Cataract [5]; Dark adaptation [6–8]; A complex process

mediates colour perception between neurons [9] and Tunnel vision [10–12]. The guidelines for visual presentation which derives from these changes are as follow: Raise illumination on reading surfaces; Use the matte screen surfaces; The need for stimuli should be large, simple, unobstructed, and in the central field of vision; Make things distinctive by increasing size (minimum font 12 points), using warm colors (avoid Violet, Blue, and Green) and by increasing contrast (50:1 contrast, e.g., LCD Screen) such as white text on black background [13]; Use fonts such as Arial, Helvetica, Times, Bookman, and Book Antigua without a script and decorative fonts distinctly; The uppercase letters attract attention but are not easy to read in long sections of text.

2.2 Decline in Hearing

The decline in hearing during aging cause the following auditory impairments: Presbycusis which is a common type of sensorineural decline of hearing through natural aging (i.e., Sound perception diminishes by 2.5 dB per decade up to age 55 and then accelerates to 8.5 dB per decade) [14]; Frequency discrimination performances deteriorate in an approximately linear manner with age (e.g., perception of high frequencies diminishes with age, especially in men) [15]; Different stimuli can cause sound localization disorientation in each ear due to age-related hearing loss and auditory selective attention affects performance in a multitasking environment and is the reason why it is difficult for seniors to process distinct sounds at a fast pace [16]. Based on barriers that we have already elaborated we conclude to the following guidelines for auditory presentation: An average conversational speech is about 50 dB due to that sound signals should be at least 60 db; The volume must be easy to adjust with simple gestures; Sound alerts should be within the frequency range of 500 to 2000 Hz, which is the standard speech range; It would be beneficial to avoid using synthesized or robotic speech patterns; It is necessary to signal an alert sound at a frequency higher than 2000 Hz we must use a longer duration (i.e., >0.5 s); To avoid high-frequency sounds, we can use cross-sensory channels such as vibration and flashing light [17]; Procurement of headphones will be an excellent solution to eliminate background sounds and disorientation and we need to maintain a high "signal-to-noise" ratio to eliminate reverberation.

2.3 Sense of Touch, the Perception of Temperature, Mobility Limitation Levels, and Balance

Aging has an impact on the sense of touch, the perception of temperature, mobility limitation levels, and balance. Therefore, we studied the most significant limitations which occur through aging process. Pressure sensitivity diminishes through aging, so it is harder to sense when the finger has made full contact with a surface or when a small feeling has been depressed [18]; Reduced thermal sensitivity because of limited nerve ending function and heat retention [19]; Reduced mobility capacity caused by loss of muscle strength, tone, and flexibility [20]; Balance impairment due to arthritics and tremor that occurs with aging

cause diminished static postural control and diminished dynamic balance [21,22]. We design guidelines for diminished temperature, touch sensation, movement restriction, and balance instability as follow: Avoid 3D touch screens; Use less complicated virtual devices [23]; Use supplemental sensory cues to warn of high temperatures; Prefer textured surfaces instead of smooth surfaces to complement the touch feel; A sound alert that a button on the screen or computer key has been depressed; Provide time for discrete movement tasks; Avoid multiple rapid steps (e.g., adjust double-click speed of computer mouse, tracking rate on scroll ball); Simple task movements for senior with tremor; Prefer levers than knobs; Large buttons rather than small ones; Use solid color carpets in case of sensor mat; Avoid unsecured objects (e.g., unsecured end-of-aisle displays present obstacles to motorized or static ambulatory aids.) in the case of robot assistant [24].

2.4 Cognitive Aging and Age-Related Changes in Memory

Short-term memory can be set to cache and manipulate stimuli no longer available to the senses. With aging, fewer discrete information bits processed at a given time, and information overload may occur [25]; Prospective memory refers to remembering to take a planned action in the future. Aging men can not jeopardize spontaneous recovery processes, but the ability to deactivate completed intentions is impaired [26]; Semantic memory refers to a long-term memory portion that processes ideas and general facts that do not come from personal experience. Semantic memory performance in the elderly reduces in processing speed and executive function [27]; Procedural memory defines as a type of long-term memory and unconscious memory of skills and how to act. Procedural memory usually does not decrease with age, but it takes longer for older people to learn new skills [28]; Age reduces attention, but the reduction does not include all components of attentive functioning equally [29]; Spatial cognition is a complex, multifaceted set of processes engaged in a large variety of tasks [30]. Spatial navigation is impairing after the age of 60, with acceleration in decline after 70 [31]; Language comprehension difficulties are interpreted as limitations on processing ability so that the requirements for simultaneous recording of superficial meaning and concurrent execution of integrative and constructive processes reduced with age [20]. The guidelines to accommodate age-related cognitive changes are as follow: Provide simple instructions into discrete short messages; Provide event reminders but without too many unnecessary gadgets; Procedures should be simple, intuitive steps with a slow pace and opportunities for practice; Avoid visual clutter or ambient noise and use simple screens with small dis-tinct signals; Avoid redundant information and use a predictable linguistic structure with clear messages reasonable pace; Use Natural Language Processing (NLP) toolkit [32]. Based on the literature review, we developed Table 1 which refers to the instructions for digital solution educators in older adults.

Table 1. Guidelines for Tutors of Digital Solution

Functional limitation	Guidelines for tutors of Digital Solution
Decline in hearing	Get the listener's attention before you speak Look at the listener as you speak Speak naturally Use simple words and sentence structure Avoid ambient noise Use visual signs and gestures
Cognitive impairment	Provide slow and clean lines of communication Use a calm and focused communication Be aware the listener may lack confidence Evaluate whether the listener understands Find another way to express the information if the listener does not seem to understand
Mobility limitations	Take a seat at the same level and apply eye contact with the listener/speaker Treat the potential wheelchair as part of the listener's/speaker's personal space Use natural lip movements, voice tone, and volume Use condescending language Use non-patronizing language and actions
Visual function impairments	Consult with the person as to the type of communication needed (e.g., large font, disk, Braille, text-to-speech) Use natural volume and tone Ask for feedback to evaluate if the listener understands Check related software and hardware for visually impaired people

3 Age-friendly, Integrated, Intergenerational Neighborhoods

The internet of things (IoT) has become inextricably linked with creating smart cities. As the name implies, smart cities are structured atop more intelligent data. It is a significant challenge because data is frequently an afterthought when it comes to creating new processes and opportunities. Using the right building blocks from the outset is vital, aligned with clear and compelling guidelines about best practices. To achieve scale, we need standards to qualify how we view and measure the world around us and how this data informs our decision-making processes. Figure 2 is designed to align participants around a clear shared goal and guide them to a common destination. Accelerate the construction of a new breed of age-friendly housing in 'smart' socially supportive multi-generational neighbourhoods, development of innovative technologies and service models to improve health and well-being to reduce the financial burden on citizens and the State based on the following aspects:

- Work: Opportunities to work; Provision of training; Work-life balance; Labour market participation;
- Access to healthcare: Distance; Waiting times; Affordability;
- Mental health: Sense of self-worth; Loneliness, isolation; Depression, anxiety; A sense of purpose; Sense of connectedness, belonging;
- Adult education: Information provision; IT literacy;
- Housing: Safe, secure; Connected; Age-friendly; Healthy;
- Services: Healthcare; Transport;
- Neighbourhood problems: Infrastructural issues; Sense of safety; Perception pf vulnerability; Anti-social behaviour;
- Social Support: Family and friends; Neighbours; Community organizations;
- Public Spaces: Pleasant, interesting; Safe; Accessible, close by; Enable self-determination; Foster activity.

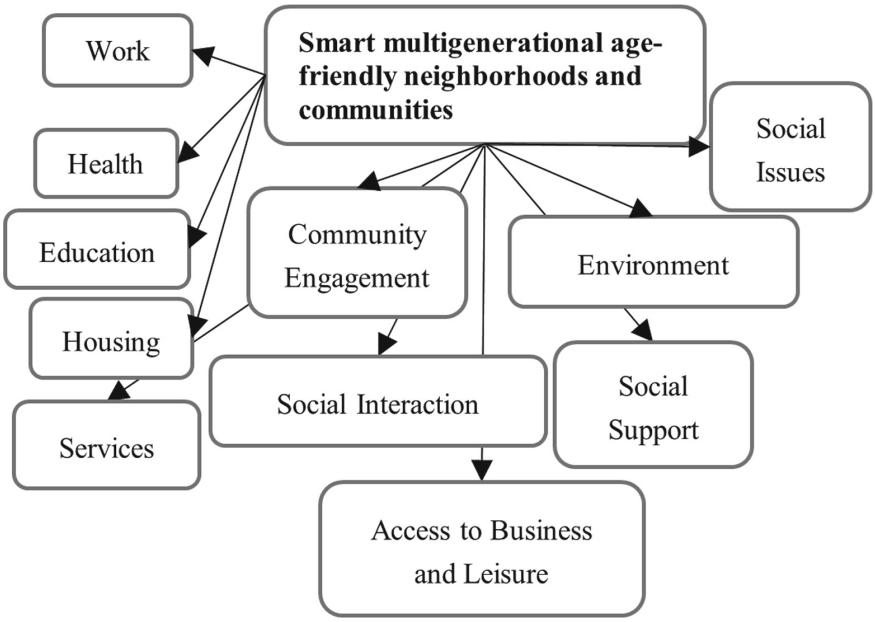

Fig. 2. Dependencies

4 Evaluation Results

We have implemented a survey among 30 older adults living in different districts of an urban environment through the Place Standard tool. We evaluated the provision of services by the community Fig. 3 and Fig. 4 show the responses

obtained and plot them in two diagrams. The mean and median conclude with a look at the services performing well and where there is room for improvement. From the results, we conclude that all sections of service provision to the elderly need improvement.

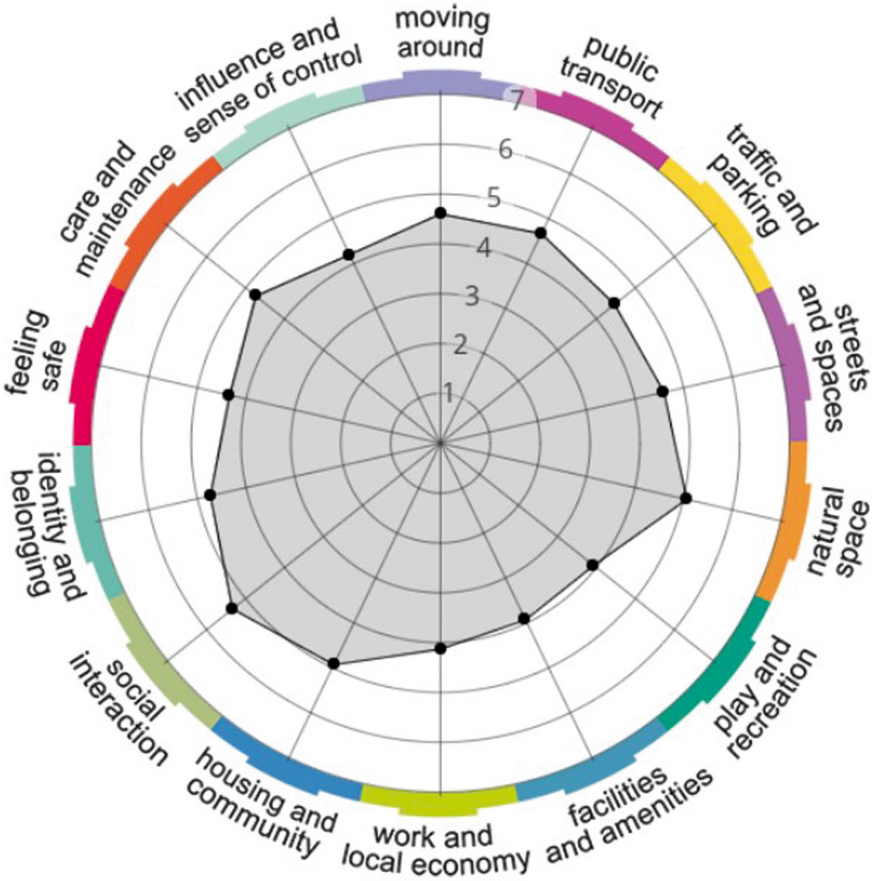

Fig. 3. Mean Results

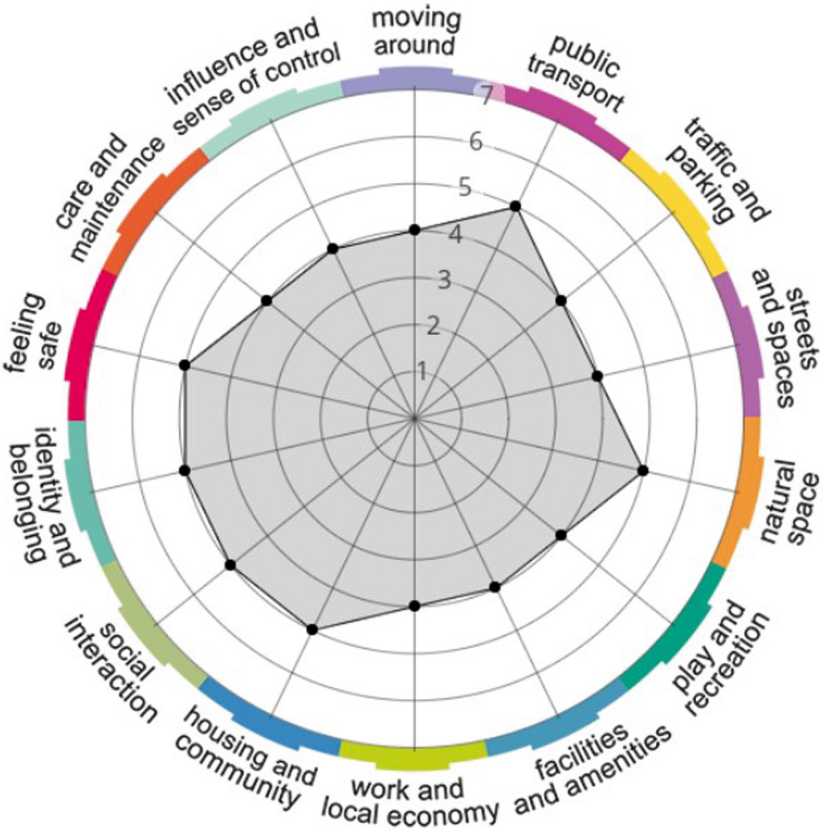

Fig. 4. Median Results

5 Conclusion and Future Work

Assessing age-friendliness in the city is a fundamental step in encouraging older adults' quality of life. We envisage that this research work will align with developing new standards for intelligent multi-generational neighbourhoods. Accessibility at home will be informed by the WHO Housing and Health guidelines, enabling older individuals to rate their private living space accessibility and identify possible psychosocial and physical modifications that will help sustain independent living. Therefore, age-friendliness necessitates cultivating attitudes and behaviours that promote the dignity and worth of older people, their sense of security and belonging, and being wanted and valued members of society. Ageing in place means more than continuing to live among the comforts and memories of home. Given the likelihood that we will live with the threat of pandemics for the foreseeable future, how might we pool resources to design age-friendly urban environments where public space doesn't become a no-go zone but remains a safe and habitable communal meeting point? Challenges lie at the

heart of ongoing discussions with architects, designers, planners, social housing organizations, developers, health and social care service providers, technologists, local governments, researchers, and other AAA stakeholders. They are working cooperatively to inform the intelligent development of smart multi-generational neighbourhoods. For future research, we evaluate the age-friendliness of smart multi-relationship cities using further principles. The growing growth of smartphones with GPS and online social networks provides useful citizen involvement tools in resolving urban issues. Future research may provide more effective and user-friendly tools for assessing the age-friendly friendliness of the smart city. Thus, smartphones equipped with GPS enable citizens to enter geographical data related to the city environment into the system using any network, anywhere, and at any time. This marvel empowers the procedure of evaluating and monitoring the age-friendliness of a smart city.

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