

Implementation of age-friendly initiatives in smart cities: Probing the barriers through a systematic literature review

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Abstract

Purpose

The purpose of this study is to identify the barriers that hinder the implementation of age-friendly initiatives in smart cities.

Design/methodology/approach

A systematic review of literature was conducted using Scopus search engine. Relevant keywords were used to discover 81 publications in academic journals. The titles, abstracts, keywords and full texts of the publications were examined to select 39 publications that were relevant for identifying the barriers that hinder the implementation of age-friendly initiatives in smart cities. The contents of the 39 relevant publications were analysed to ascertain the key barriers. A system thinking approach was adopted to understand the interaction among the barriers.

Findings

The study identified five key groups of barriers – namely physical barriers and environmental characteristics, technological barriers, social barriers, financial barriers and political barriers – that smart cities encountered or are likely to encounter in implementing age-friendly initiatives. Moreover, practical examples of good age-friendly implementation practices were highlighted.

Research limitations/implications

A limitation of this study is in the number of publications reviewed. Despite the comprehensive review, the number of publications reviewed may not be exhaustive. This is justified by the inapplicability of considering all possible keywords in one review study.

Practical implications

The systemic perspective of the barriers that hinder the implementation of age-friendly initiatives in smart cities would support policymakers in formulating policy recommendations to improve age-friendliness in cities.

Originality/value

This study underscores the variable and dynamic nature of developing age-friendly smart cities and forms novel basis for gaining insights into the multiple factors that can promote the integration of age-friendly initiatives within smart cities.

Keywords

Age-friendly city, Smart city, Urban ageing, Barriers, Systematic literature review, Integrated conceptual model

Introduction

Cities are becoming smarter, at the same time, undergoing demographic and geographical transformations with increasing older adults and urban population. The life expectancies at birth have steadily increased over the years; as a result, the populations in virtually all countries are growing older (United Nations, 2019). As of 2019, 9% of the global population was aged 65 or above in 2019; this percentage is expected to increase to 12%, 16% and 23%, by 2030, 2050 and 2100, respectively (United Nations, 2019). The number of people aged 65 or above in all countries has already outnumbered the number of children aged five years or below and is expected to more than double between 2019 and 2050. Furthermore, persons aged 65 years (1.5 billion) or above would be more than adolescents and youth aged 15 to 24 years (1.3 billion) worldwide (United Nations, 2019). These statistical data show that people aged 65 or above form the fastest growing population in the world.

Concurrently, it is estimated that the proportion of older adults living in urban areas will increase and urban areas are expected to accommodate nearly all of the world population growth (United Nations, 2018). In 2018, urban areas housed 55% (4.2 billion) of the world's population; this number is likely to increase to 68% (6.7 billion) by 2050 (United Nations, 2018). For the foreseeable future, the global population is expected to age. Most of the older adults would be living in urban environments – cities in particular.

Population ageing, coupled with urbanisation, is termed urban ageing, which has critical implications for the development of smart cities (Marston and van Hoof, 2019; van Hoof and Kazak, 2018). Although these transitions to urban ageing offer new opportunities and can be described as the culmination of successful human development, they also pose new challenges. As cities are focused on becoming smart, it is important to keep sight of the current and future needs arising from urban ageing (Buffel and Phillipson, 2016). This means that cities not only need to be smart, they also need to provide the right governance and practice to promote and sustain supportive environments for the engagement and participation of older adults in pursuing active ageing (Nykiforuk *et al.*, 2017). While efforts to create age-friendly cities (AFC) are currently in progress across the globe, many barriers remain in light of cities being far from meeting the needs of the older population. As the first of its kind, this study aims to identify the barriers that smart

cities faced or may face in implementing age-friendly initiatives so that appropriate strategies can be developed to overcome the barriers.

This study offers a deeper understanding of the barriers that hinder smart cities from implementing age-friendly initiatives. It also underscores the variable and dynamic nature of developing age-friendly smart cities and forms a novel basis for gaining insights into the multiple factors that can promote the integration of age-friendly initiatives within smart cities. Such understanding and insights could help policymakers in formulating and implementing suitable strategies and policies to overcome the barriers and improve age-friendliness in cities.

Age-friendly cities and smart cities

The World Health Organisation (WHO) defines an AFC as a city with

“policies, services, settings and structures support and enable people to age actively by: recognising the wide range of capacities and resources among older people; anticipating and responding flexibly to ageing-related needs and preferences; respecting their decisions and lifestyle choices; protecting those who are most vulnerable; and promoting their inclusion in and contribution to all areas of community life” (WHO, 2007, p. 5).

WHO introduced the age-friendly movement to stimulate cities and communities to develop and implement age-friendly initiatives that support active ageing (WHO, 2018). Active ageing refers to the ability to be physically active and continue participation in social, economic, cultural, spiritual and civic affairs in order to enhance the quality of life as people age (Buffel *et al.*, 2012; WHO, 2007). WHO has identified eight sets of indicators for assessing the age-friendliness of cities (WHO, 2007): (1) outdoor spaces and buildings; (2) transportation; (3) housing; (4) social participation; (5) respect and social inclusion; (6) civic participation and employment; (7) communication and information; and (8) community support and health services. Outdoor spaces and buildings, transportation, and housing represent the key features of the physical environment determinants of a city. Social participation, respect and social inclusion, and civic participation and employment represent the key features of the social environment, culture and economic environment determinants. Communication and information, and community support and health services are key features of the social environments and health and social service determinants (WHO, 2007; Plouffe and Kalache, 2010). These indicators are essential features favouring the practical implementation of the age-friendly concept in cities and communities.

The smart cities concept emerged in response to current challenges faced by cities, such as urbanisation, resilience and sustainability. The smart cities concept aims to modernise urban management through harnessing technological innovations and the benefits of collaboration between government and citizens to confront current civilisation challenges (Hoe, 2016; Winkowska *et al.*, 2019). The ultimate goal is an efficient use of resources to respond to the current challenges. The indicators of a smart city are (1) smart economy; (2) smart people; (3) smart governance; (4) smart mobility; (5) smart environment; and (6) smart living (Winkowska *et al.*, 2019). Smart economy is measured by the ability to transform the city using innovation,

entrepreneurship, local economy, international cooperation, productivity and flexibility of labour market. Smart people (the human and social capital) are characterised by the level of education, affinity to life-long learning, social and ethnic plurality, flexibility, openness and participation in public life. Smart governance indicates the level of participation of citizens in decision-making bodies, the scope of public and social services, transparency of governance, policies and political strategies. Smart mobility is measured by the accessibility of the city (locally and internationally) through the availability of information communication technologies, and sustainable, innovative and safe transport systems. Smart environment indicates the attractiveness of natural conditions, pollution control, environmental protection efforts, and sustainable resource management. Smart living relates to the availability of cultural and educational institutions, living conditions (health, safety, housing), touristic attractiveness and social cohesion (Winkowska *et al.*, 2019; Gil-Garcia *et al.*, 2015).

It is obvious that population ageing is a growing global challenge. Smart cities' main goals have been mainly focused on energy, technology and communication, which are important (van Staaldin *et al.*, 2018). However, it is also important to pay more attention to the changing population of cities. The smart cities indicators are not just goals but also tools to provide an age-friendly environment for all citizens (Winkowska *et al.*, 2019; van Staaldin *et al.*, 2018).

WHO and the European Union have spearheaded the smart cities and AFC concepts; however, these concepts are perceived as separate concepts. Existing philosophical discussion and practical implementation of the principles of universal design demonstrate the nexus between the smart cities concept and the AFC concept in theory and practice (Crews and Zavotka, 2006; Carr *et al.*, 2013). An integrated smart and age-friendly community has the prospect to achieve a more inclusive, responsive and sustainable environment for people of all ages while aiming at a common social, environmental and economic impact in cities. Drawing from Niaros *et al.* (2017)'s global view on making the smart city, AFC could be a source of legitimacy of smart city initiatives, and also serve as a means for citizen-driven transformation. Further, AFC could serve as a new smart city template where knowledge is developed locally and shared as global commons. However, this vision is only achievable when the community-building, learning and innovation potentials of AFC are fully exploited. The nexus between smart cities and AFC concepts is depicted in Figure I. However, the integration of age-friendly initiatives within smart cities is still the challenge that needs more research and discourse.

[Insert Figure I about here]

Methodology

To achieve the research aim, a systematic literature review was conducted to identify the barriers to implementing age-friendly initiatives in smart cities. The search was conducted using Scopus database with relevant keywords. The Scopus search engine covers a broader range of research discipline with the latest development and trends which are very important in guiding future

research directions (Chadegani *et al.*, 2013). It has been widely used in similar reviews as the most effective and credible search engine for conducting a literature review (Zhang *et al.*, 2019; Darko and Chan, 2016). The keywords were selected to reflect different terminologies that describe the age-friendly cities and community concepts. The following keywords were used in conducting the literature search in the Scopus database: ‘barriers’, ‘challenges’, ‘obstacles’, ‘age-friendly city’, ‘elder-friendly community’ and ‘smart city’. The search was limited to only article or review documents. Other document types such as conference publications, articles in press, textbooks and internet materials were eliminated from the search. This is because peer-reviewed academic publications undergo a relatively more robust review process before publication, thus contain the most valuable information for the study.

A total of 81 publications were identified from the Scopus database search that was conducted on 20 November 2019. All the publications were screened to confirm that the search keywords appeared in either their titles or abstracts. The full texts of the publications that passed this criterion were further screened to filter out publications that just happened to mention the keywords in their titles or abstracts but did not entirely or partly discuss matters relating to the barriers to AFC initiative implementation. After screening, 39 publications were considered valid and relevant for the study. Content analysis was conducted to systematically identify and categorise the barriers to AFC initiative implementation reported in the 39 relevant publications. Content analysis is a systematic approach to categorising text data and identifying themes based on a classification process of coding (Hsieh and Shannon, 2005). Based on previous studies (Zhang *et al.*, 2018; Elo and Kyngäs, 2008), a four-step content analysis approach was implemented: (1) de-contextualisation of the text data using the unit of analysis (words, sentences and paragraphs expressing barriers were extracted); (2) re-contextualisation of the unit of analysis (assigning codes to the extracted words, sentences and paragraphs based on their homogeneity); (3) categorisation and compilation of the coded extracts (coded extracts were compiled into five groups of barriers); and (4) assessment of coding consistency (coding was done by two researchers and differences in opinions were discussed until a final consensus was achieved). The barriers to AFC initiative implementation reported in the 39 relevant publications are presented in the subsequent section. The overall research process is shown in Figure II.

[Insert Figure II about here]

Results and Discussion

Barriers hindering the implementation of age-friendly initiatives in smart cities

Physical barriers / Environmental characteristics

Older adults tend to rely on the surrounding environment and local resources to compensate for the physical and psychological effects of the changing characteristics of cities (Sun *et al.*, 2018). The immediate environment is pivotal in the lives of older adults, intimately entwined with one’s

sense of belonging and very influential in promoting active ageing (Park and Lee, 2017). The lifestyle of older adults is conditioned by the building blocks of the surroundings and the relationship with those surroundings (Domínguez-Párraga, 2019). The lack of adaptation of the physical environment and increase in physical problems are the primary causes of the reduction of accessible, inclusive and friendly physical spaces for the older adults with varying needs and capacities (Domínguez-Párraga, 2019). For example, in cities, transport planning focuses on transporting the maximum number of commuters in the minimum amount of time (Chui *et al.*, 2019). However, this may result in competing interests as meeting this focus may pose challenges to providing accessible public transport to the ageing population. Similarly, there has been increasing collapse in public ownership of land in cities – land development in cities focuses on profit maximisation and increasing commercial interest while neglecting physical and social needs of its residents (Chui *et al.*, 2019). With these pressing needs and the competing demands of and for land, adequate provision of free shared spaces for the ageing population is severely compromised in cities (Buffel and Phillipson, 2016). In this case, cities can negatively affect the well-being of vulnerable older adults (Buffel and Phillipson, 2016). Therefore, cities need to be smart in responding to the dynamic needs of older adults by providing opportunities for them to experience the immediate environment without any physical barrier (Emlet and Mocerri, 2012). An age-friendly smart city should meet the needs of the ageing population residing in the physical space and promote community engagement.

Technological barriers

“Ageing and innovation are usually considered to be contradictory phenomena” (Djellal and Gallouj, 2006, p. 303). Nevertheless, innovative technologies are becoming increasingly important for urban ageing (Marston and van Hoof, 2019). At present, numerous technologies have been designed and targeted toward older adults. With the fast-pace of these technological developments, it is important to explore whether these technologies are diffused, adopted or rejected among the older adults. The advancement of technology in today’s world should not be the driving force of gerontechnology – meeting the needs of older adults should rather be the topmost priority. However, the ageing population is largely heterogeneous, and these differences affect the acceptance and use of technology (Marston and van Hoof, 2019). This implies that solely perfecting cities with smart technologies does not guarantee the adoption of technologies by older adults. Moreover, getting these technologies adopted is often very arduous, despite the noticeable benefits of the technologies. Adoption of the technologies is significantly impacted by how the older adults perceive the usefulness of the technologies and the circumstances under which the technologies are being introduced (Rogers, 2003). Therefore, if smart technologies are not carefully assessed and implemented in smart cities, they may pose challenges and hindrance to older adults’ participation in daily life.

As cities are growing smarter and adopting cost-effective automated services, human contact, interactions and older adults’ autonomy are rapidly diminishing. However, older adults in general value human interactions and maintaining autonomy (Chui *et al.*, 2019; van Hoof *et al.*, 2018). Smart cities are unlikely to be realised unless cities proactively intervene for the older adults and

reassess their emphasis towards efficiency, profit maximisation and economic prosperity and at the same time maximise interventions towards a more inclusive age-friendly environment.

Social barriers

The transformation of cities to smart cities, especially spatial reconstruction may hinder older adults from social engagement. Cities that are experiencing gentrification and population turnovers or any other significant degree of transformation can further accentuate the risk of exclusion among the ageing population (Rémillard-Boilard *et al.*, 2017; Cho and Kim, 2016). Older adults who are economically less active may rely on social engagement to build social capital (Yang *et al.*, 2019). Older adults have different preferences or means to socialise, which may affect how cities accommodate and meet individual needs. Also, individual cultural differences may impact older adults' preferences. For example, immigrant older adults may have their preferred cultural activities, while ageing in a city with a different cultural context may not seem friendly to these groups of older adults (Yang *et al.*, 2019; Park and Lee, 2017). Social interaction is the main component of social health contributing to peoples' overall health and well-being (Alidoust *et al.*, 2019; Levasseur *et al.*, 2017). Therefore, smart cities need to address any weak social networks and the diverse needs among older adults. However, this should be perceived as not only a challenge but also an opportunity to construct a diverse smart age-friendly environment that attracts and engages a wider group of older adults in cities (Rémillard-Boilard *et al.*, 2017). Smart cities should endeavour to foster and strengthen the attachment and trust older adults have for the immediate environs.

Financial barriers

Plans to transform cities into smart cities can be too ambitious to the extent that it becomes too complex to integrate age-friendly efforts into existing smart city programs that are geared towards addressing other issues. The plans of some of the ambitious, smart cities usually lean towards economic growth (Yang *et al.*, 2019) therefore put more priority on economically beneficial projects with less priority given to projects that promote the age-friendly movement. An important issue is the affordability of housing – most cities experience increasing demand for housing from both the old and young population and investors (van Hoof *et al.*, 2018). This may increase the prices of houses as cities and investors' aim is usually to maximise profit. High real estate prices may not meet the needs of the older adults who are retired, economically inactive, less affluent and unable to obtain a mortgage (van Hoof *et al.*, 2018; Novek and Menec, 2014). When these issues are not carefully taken into consideration, cities are likely to trigger marginalisation and social exclusion among the older population (van Hoof *et al.*, 2018).

Issues of civic participation and employment opportunities are major challenges in many cities (Parekh *et al.*, 2018; Emler and Moceris, 2012). Age-based discrimination practices, ageist attitude, stereotypes and lack of legal measures to protect older employees from discrimination have made several employers perceive older adults as less productive and incapable thus less able to

contribute to the economy (Chui *et al.*, 2019; Sun *et al.*, 2018). The current economic austerity in most cities can add to the internalisation and rationalisation of age-based discrimination and attitude in companies that seek to maximise profit (Rémillard-Boilard *et al.*, 2017; Buffel *et al.*, 2014). Economic austerity has been identified as a major barrier to developing age-friendly initiatives (Buffel and Phillipson, 2016).

Political barriers

Social participation, inclusion and people-centred sustainable development are fundamental to city planning and social sustainability. However, the older population often has limited opportunities or encounter age-related, cultural, structural, social and economic barriers that hinder their participation (Parekh *et al.*, 2018; Rémillard-Boilard *et al.*, 2017). Cities with weak democratic institutions, political systems and culture that are closed to citizen participation can discourage outspoken older adults claims and participation in policymaking (Tsai *et al.*, 2018; Chao and Huang, 2016). The lack or non-existence of older adult groups and associations can result in lack of understanding and ignorance of their rights. Older adults who are less economically active and have low-income are easily marginalised, deterring them from participating in policymaking. As a result, cities are unable to develop AFC initiatives from the local perspective (Suriastini *et al.*, 2019; Sun *et al.*, 2018). Lack of local perspective might result in cities adopting the theoretical perspective of proportionate universalism that may not meet the actual needs of the older adults (Chao and Huang, 2016; Neville *et al.*, 2016).

The ability to implement long-term age-friendly initiatives may be limited by the politicised governance structure of many cities (Lowe *et al.*, 2018). Change of government creates new political players and new policy directions. Past government's initiatives become redundant, or its resources are reallocated resulting in lack of continuity of age-friendly initiatives (Lowe *et al.*, 2018; Neal *et al.*, 2014; Buffel *et al.*, 2014). In addition, the traditional sectoral divisions of responsibilities and the fragmented nature of the government departments create weak partnership and collaboration among political players and further complicates policy acceptance and implementation (Neville *et al.*, 2016). Creating an age-friendly city is a multi-sectoral challenge; AFC policies need to be aligned across all sectors in a way that is supportive of the AFC indicators (Lowe *et al.*, 2018; Buffel *et al.*, 2014).

[Insert Table I about here]

Integrated conceptual interpretive model of the barriers

The interlinkages among the barriers that hinder the implementation of AFC initiatives in smart cities are shown in the integrated model depicted in Figure III. A system thinking approach (Costanza and Ruth, 1998) was adopted to integrate the existing barriers identified from the literature. In Figure III, the double-headed arrow shows the two-way interaction among the barriers

and the colours are used to differentiate each barrier. Figure III shows that the financial barriers counteract directly with political barriers, physical barriers and technological barriers. For instance, the current economic austerity in most cities reinforces the inadequacy of current policies that support the economic security of older adults. The insufficient land supply in cities contributes to the high competing demand for physical space for meeting varying social needs and capacities. Similarly, the diminishing human contact, interactions and autonomy due to new technologies are linked to the technophobic mindset among the older adults. From Figure III, several profound one-way interactions among the barriers can be observed. For example, an ambitious, smart city initiative that focuses on economic growth, profit maximisation and increasing commercial interest is partly responsible for the poor social climate in cities (Chui *et al.*, 2019). The lack of adaptable physical spaces limits the implementation and adoption of new technologies into the existing city's fabric. Several of the interaction among the barriers are readily comprehensible in Figure III.

[Insert Figure III about here]

Practical examples of good AFC implementation practices

Portland (and later Multnomah County), one of the inaugural members of the WHO's Global Network for Age-friendly Cities and Communities reported on their adopted action plan and organisational structure for developing an age-friendly Portland and Multnomah County (DeLaTorre and Neal, 2017). Based on the WHO's eight indicators, Portland's action plan considered ten indicators which were inspired by the importance they attached to employment and the economy. A working committee was formed for each of the indicators, and the first year of implementation was focused on only three indicators (DeLaTorre and Neal, 2017). One key takeaway from Portland and Multnomah County's strategies is that they considered different age-friendly concepts—the WHO (2007) and Menec *et al.* (2011) frameworks, based on the understanding of the local circumstances and uniqueness of Portland and Multnomah County, specific indicators were derived to suit that particular context. Their experience reinforces the need to approach the development of AFC from a local perspective.

The importance of a collaborative partnership as a strategy for creating AFC has been articulated over the years (Garon *et al.*, 2014; Buffel and Phillipson, 2016 and Rémillard-Boilard *et al.*, 2017). Based on case studies that were conducted in Quebec, Canada, Garon *et al.* (2014) identified three main implementation steps that enhanced the success of implementing the age-friendly concept there. The three-step model included “(1) social diagnostic of older adults' needs; (2) an action plan based on a logic model; and (3) implementation through collaborations” (Garon *et al.*, 2014, p. 73). The success of age-friendliness in Quebec was primarily determined by the collaborative partnership that was created through the forming of a steering committee. The steering committee consisted of members rooted in the community from seniors' organisations and associations, public health and social service institutions, private organisations (senior homes) and municipal

officials. The committee was involved throughout the three steps to achieving age-friendliness. The four key strategies that were shared in Garon *et al.* (2014) findings included:

- (1) Members of the committee should be individuals rooted in the community;
- (2) The diagnostic of older adults' need should be towards a common goal;
- (3) Commitment towards the action plan; and
- (4) Implementation through collaboration.

Conclusion and Recommendations

Urban ageing is a pervasive global phenomenon unparalleled in human history. Supporting active ageing through developing AFC is certain to remain a pertinent political, social and economic issue in many cities due to the demographic and geographic transformations experienced throughout the world. Nevertheless, existing policies, norms and social institutions are inadequate, and cities are far from meeting the needs of the older population (WHO, 2007). Criticism of new urbanism and smart growth initiatives indicates the need for more in-depth deliberation on how smart cities impact the participation and well-being of its older residents (Baldwin and Stafford, 2019; WHO, 2007). Given this phenomenon, this study identified the barriers that hinder cities from implementing age-friendly initiatives to meet the needs of the ageing population. A total of 39 articles were identified through a systematic literature review to provide a holistic perspective on the barriers. The reported barriers in literature are physical barriers and environmental characteristics, technological barriers, social barriers, financial barriers and political barriers.

This section provides possible measures to overcome the barriers to creating an AFC. First of all, creating an age-friendly smart city requires action in multiple sectors by many actors (WHO, 2007). A collaborative partnership needs to be formed between the key actors across all levels of government and non-government institutions. A strong collaborative partnership ensures political and financial commitment to long term age-friendly plans. This is crucial because successful age-friendly initiatives are community-led, and major initiative demands strong financial commitment and political leadership.

The older population are a valuable resource for human development, and smart cities should support their inclusion in the city's fabric in order to harness their full potential (van Hoof *et al.*, 2018). It is recommended that involving the ageing population in smart city development is very important to developing an age-friendly smart city (Rémillard-Boilard, 2017). The older adults should not only be perceived as the beneficiary but active place-markers in cities. Older adults should be engaged as leaders in identifying and prioritising their needs and ensuring their implementation. However, older adults' participation can be affected by the development and implementation approaches adopted in a city. The diversity of cities means there will be no 'silver bullet' implementation and development approach that can meet the needs of all cities. For example, based on the cultural difference in Taiwan, it was recommended that a collectivist approach should be adopted for the city's needs assessment, particularism approach should be

adopted during action planning and top-down approach during the implementation of age-friendly initiatives (Chao and Huang, 2016). This finding implies that cities need to conduct a prior implementation and development approach analysis to identify which approach matches their unique characteristics (social, cultural, political and economic settings).

Developing age-friendly smart cities cannot be achieved without the transformation of financial and government institutions to meet the needs of the marginalised older adults. Marginalised older adults—such as older adults who are retired, economically inactive, living in poverty and health problems—are much less likely to perceive cities as friendly. The financial and government institutions need to recalibrate their focus by developing policies and programs that reduce marginalisation without focusing on profit maximisation. Meeting the needs of the marginalised older adults would not only improve their well-being and quality of life but also make them more socially engaged and brings to light their full potential in contributing to society.

Cities need to be restructured with the older population in mind by providing legal measures to protect older adults from age-based discrimination, ageist attitude and stereotypes (Chui *et al.*, 2019; Sun *et al.*, 2018). It is recommended that cities provide meaningful employment and volunteering opportunities for older adults. Skilled older adults who can volunteer are potentially key players in sustaining and supporting local economies (Neville *et al.*, 2016).

This study has contributed to knowledge by identifying the barriers hindering the implementation of age-friendly initiatives in smart cities. The findings are significant because they provide a clearer global perspective of the barriers for cities to establish key policies and strategies that can promote the implementation of age-friendly initiatives. The study further recommended measures to overcome some of the barriers. It is important to note that this study offered a global perspective; therefore, it may have overlooked the geospatial sensitivity of the barriers and the recommendations to overcome the barriers. However, these sensitivities and variations in cities and countries are more critical when studies are directed towards a particular city. Therefore, it is recommended that future studies should examine the barriers using various city-specific empirical data in order to create the basis for city-specific policy recommendations.

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Table I. Key barriers impeding the implementation of Age-friendly initiatives

Barriers	Sub-barriers	References
Physical/Environmental characteristics	Physical accessibility Transportation Characteristics of community change Privatisation of public space	Marston and van Hoof (2019); Kohijoki and Koistinen (2019); Domínguez-Párraga (2019); Chui <i>et al.</i> (2019); Baldwin and Stafford (2019); Rémillard-Boilard <i>et al.</i> (2017); Park and Lee (2017); Bosia <i>et al.</i> (2017); Aboderin <i>et al.</i> (2017); Chan <i>et al.</i> (2016); Buffel and Phillipson (2016); Lowen <i>et al.</i> (2015); Novek and Menec (2014); Bigonnesse <i>et al.</i> (2014); Temelová and Slezáková (2014); Emler and Mocerri (2012); Buffel <i>et al.</i> (2012); McGarry and Morris (2011)
Technological	Implementation Adoption Diffusion	Marston and van Hoof (2019); Chui <i>et al.</i> (2019); van Hoof <i>et al.</i> (2018); Parekh <i>et al.</i> (2018)
Social	Unequal ageing Ageist attitudes Prejudice Stereotypes Social exclusion Passivity	Domínguez-Párraga (2019); Chui <i>et al.</i> (2019); Baldwin and Stafford (2019); Alidoust <i>et al.</i> (2019); Sun <i>et al.</i> (2018); Parekh <i>et al.</i> (2018); Hewson <i>et al.</i> (2018); del Barrio <i>et al.</i> (2018); Rémillard-Boilard <i>et al.</i> (2017); Levasseur <i>et al.</i> (2017); Aboderin <i>et al.</i> (2017); Neville <i>et al.</i> (2016); Walker (2016); Lowen <i>et al.</i> (2015); Isaacson <i>et al.</i> (2015); Novek and Menec (2014); Neal <i>et al.</i> (2014); Buffel <i>et al.</i> (2014); Bigonnesse <i>et al.</i> (2014); Buffel <i>et al.</i> (2012) Barrett and McGoldrick (2013); Kadoya (2013)
Financial	Economic austerity Poor economy Lack of support from the government for ageing programs Economic insecurity among older adults Lack of affordable housing	Chui <i>et al.</i> (2019); Sun <i>et al.</i> (2018); Parekh <i>et al.</i> (2018); Rémillard-Boilard <i>et al.</i> (2017); Aboderin <i>et al.</i> (2017); Buffel and Phillipson (2016); Lowen <i>et al.</i> (2015); Novek and Menec (2014); Neal <i>et al.</i> (2014); Bigonnesse <i>et al.</i> (2014); Buffel <i>et al.</i> (2014); Kendig <i>et al.</i> (2014); Fitzgerald and Caro (2014); Temelová and Slezáková (2014); Barrett and McGoldrick (2013); Buffel <i>et al.</i> (2012)

Political	Administrative procedures Bureaucratic rules Uncertain political players Changes in policy interest Constrained opportunities for older adult participation in policymaking	Parekh <i>et al.</i> (2018); Lowe <i>et al.</i> (2018); del Barrio <i>et al.</i> (2018); Aboderin <i>et al.</i> (2017); Neville <i>et al.</i> (2016); Chao and Huang (2016); Walker (2016); Neal <i>et al.</i> (2014); Buffel <i>et al.</i> (2014); Bigonnesse <i>et</i> <i>al.</i> (2014); Kendig <i>et al.</i> (2014); Garon <i>et</i> <i>al.</i> (2014); Fitzgerald and Caro (2014)
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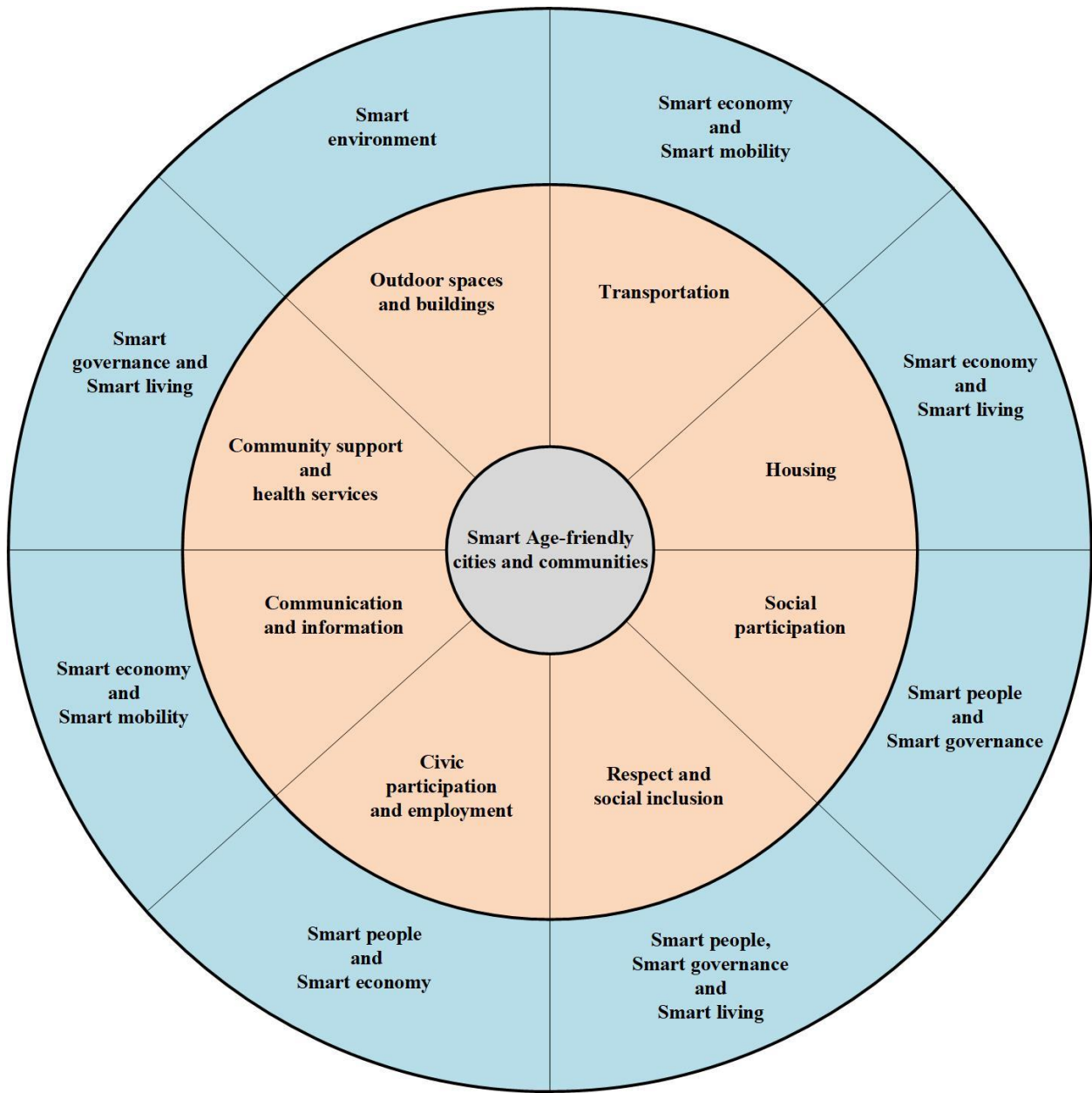


Figure I. The nexus between smart and age-friendly city

Source: Elaborated by the authors based on (Klimczuk and Tomczyk, 2016; Winkowska *et al.*, 2019; Gil-Garcia *et al.*, 2015).

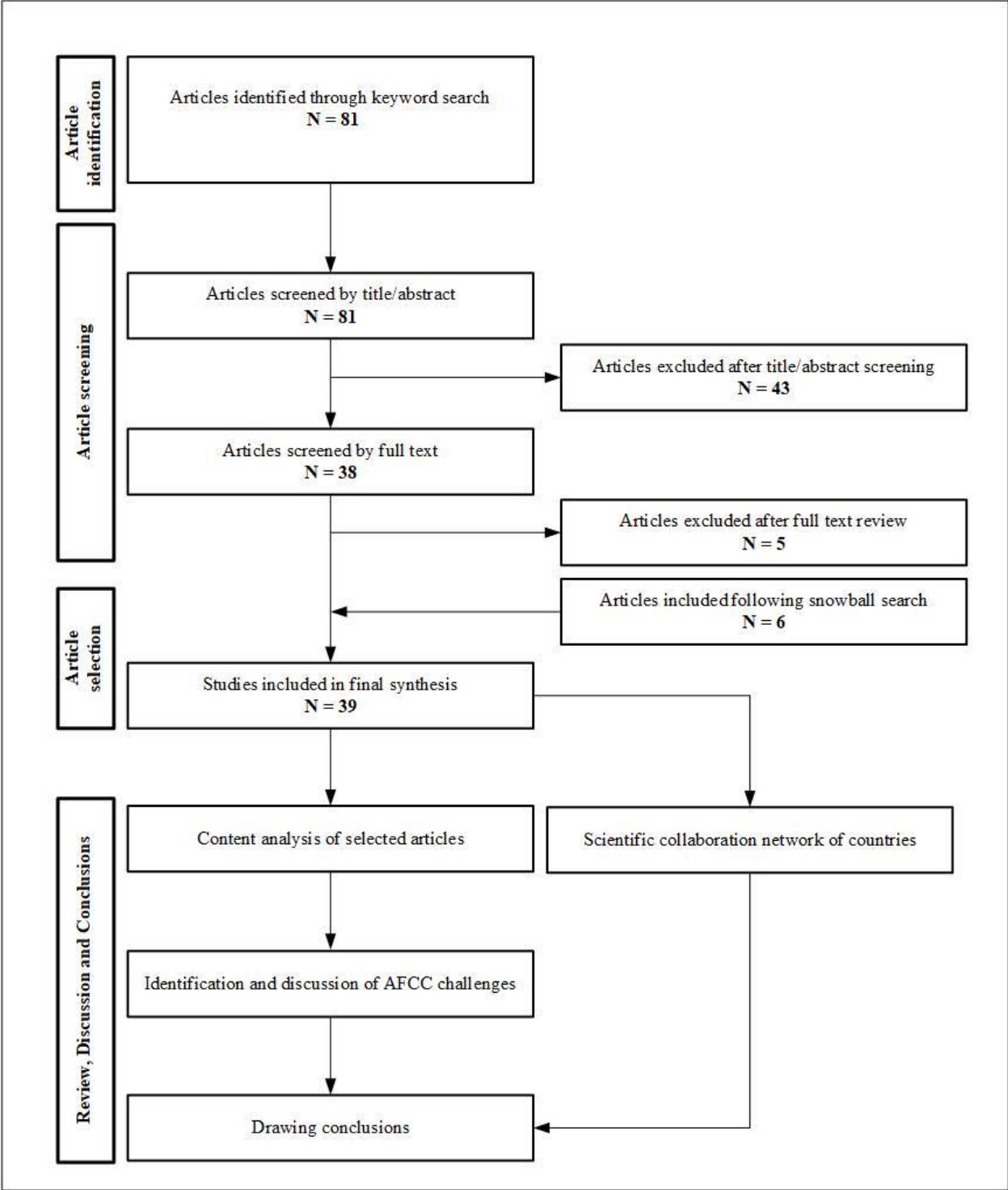


Figure II. Overall research process and flow

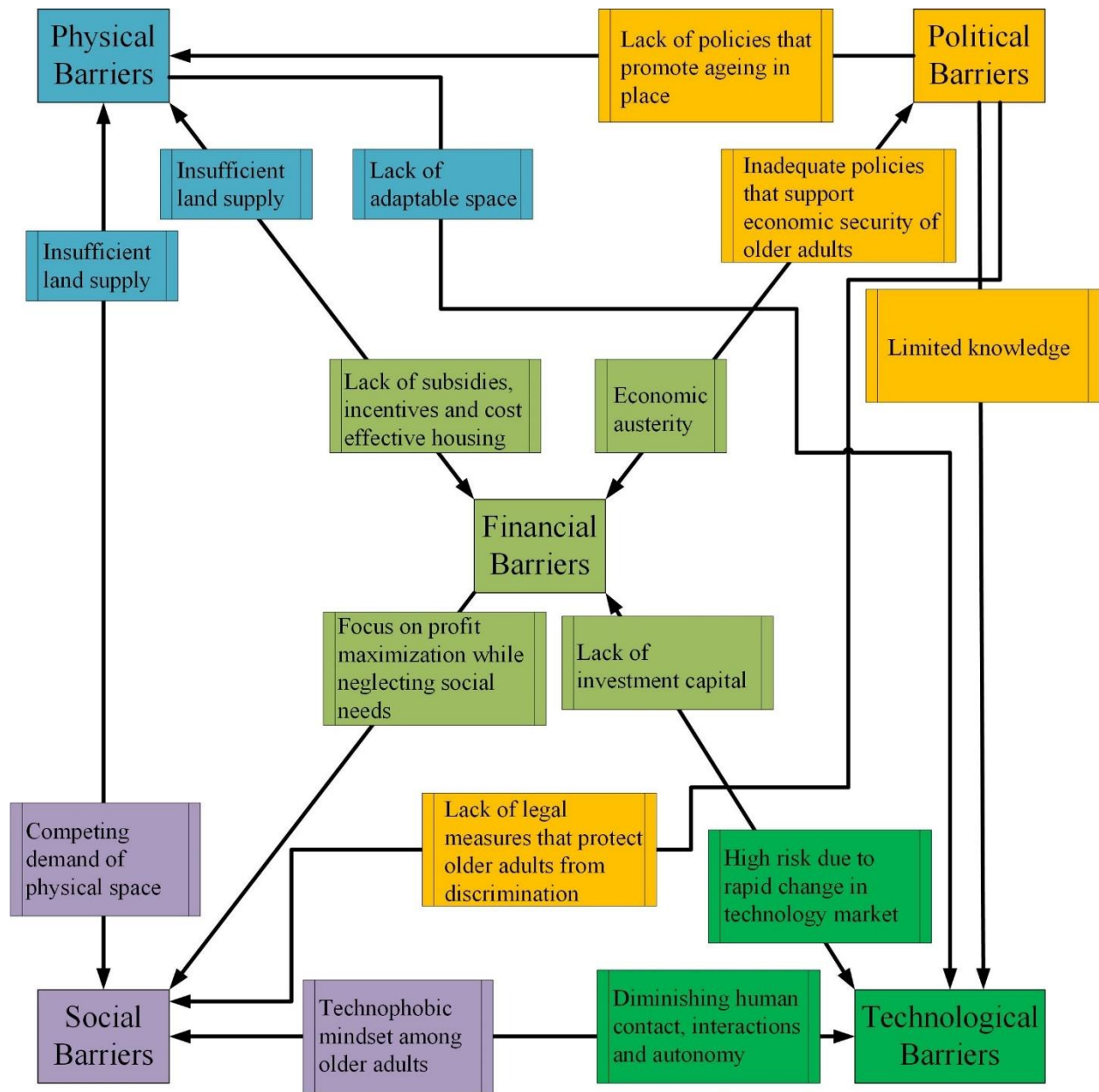


Figure III. Integrated conceptual interpretive model of the barriers hindering the implementation of age-friendly initiatives