Social infrastructure of Silver Economy: Literature review and Research agenda

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Abstract: The term Silver Economy encompasses a vast range of concepts and areas of interest related to both the challenges and opportunities that the ageing population represents. Social Infrastructure is a subset of the infrastructure sector and typically includes assets that accommodate social services and support networks. Housing and utilities with the added value of 850 billion EUR per year represent the highest share of European Silver economy. Investments in housing and age-friendly built environment should be made with the criterion to accommodate declining functional capacities of ageing residents. Their functional capacities are decreasing and require the development of specialised housing stock for independent living in a community. The structure of housing stock and the development of supply networks and services for older adults, including nursing and social care, do not follow the dynamics of population ageing. Based on the literature review we present the dynamics of publications for the most frequently discussed types of dwellings in connection with 'older adults' in the journals indexed by Web of Science (WoS). In this article, we present a literature review of specialized housing solutions and other dwellings for older adults and further research agenda to develop optimization and control theory models supporting optimal planning, operations and control of services for older adults based on ambient intelligence, some of them based also on the geographic information technology and model to measure and forecast the demand for specialized housing stock and services in ageing society for which even the documents of the European Commission state that has not been developed yet. Industrial engineering and production research has the potential to significantly improve the efficiency of supply networks for older adults and mitigate the rising expenditure for health care and long-term care in ageing societies.

Keywords: LTC services, housing stock, risk management, population ageing, multiple decrement model

1 INTRODUCTION

The European population has been ageing rapidly. Silver Economy is dedicated to older adults age 50 or above. In 1950, only 22% of the European population was in the age group 50+. Today they already make 38% of the population; and within only 35 years the percentage of older adults of age 50 and above will increase to 46% of the population.

Social Infrastructure is a subset of the infrastructure sector and typically includes assets that accommodate social services and support networks. Older adults have different needs than younger population due to declining functional capacities. The housing needs of older adults are satisfied if their dwellings are specifically designed to meet their physical, emotional, recreational, medical and social needs. According to the World Health Organization (WHO), physical and social environments are key determinants of whether people can remain healthy, independent and autonomous long into their old age (WHO, 2007). The housing needs of older adults are supposed to frequently change in their remaining lives. Falls often cause severe injuries and are one of the costliest health conditions among older adults (Stevens and Lee, 2018). However, many falls are preventable. Accessibility to an age-

friendly environment that can accommodate the functional capacities of residents and the development of housing with care are both important factors that can enable older adults to live longer in their communities. Creating age-friendly urban environments is, therefore, one of the most effective investments that can be made as a response to demographic change. Older adults as the fastest growing demographic group in Europe will influence the structure of demand for products and services, and therefore the share of production processes and services for older adults will increase. Older adults have increasing needs for the safety of their environment and their homes and require products and services that are suitable for their functional capacities. This paper contributes to silver economy knowledge from the perspective of industrial engineering and production research. As stated in the recommendation of the International Association of Gerontology and Geriatrics (2009), 'it is important to recognize the need for a range of specialized dwelling options for this (65+) population and to maximize opportunities for older adults to age in place in their own home.

2 LITERATURE REVIEW

The building stock in Europe today is not fit to support older adults with declining functional capacities. 70% of houses in the UK and 90% of those in Germany are not suitable for older adults who desire to live independently and autonomously in their own community, have emerging functional impairments and chronic diseases (EC, 2015). The same report estimates that only in Germany, there is a need for the adaptation of more than 2.5 million houses.

Figure 1: Evolution of functional capacity of people from birth to old-age
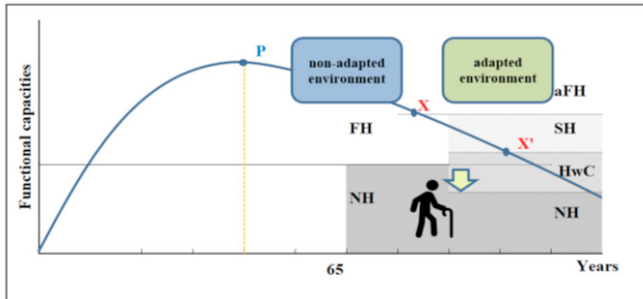
Legende: FH – family home, HwC – housing with care, SH – sheltered houses, NH – nursing home P – max of functional capacities, X – before adaptation, X' – before adaptation

Since different terms in the field of specialised housing stock for older adults are used in various parts of the world (Ghavarskhar et al., 2018), we first looked at 'Web of Science', particularly the dynamics of the number of articles in the indexed journals (SCI) by types of specialised housing solutions related to the topics 'older adults'. The dynamics of publications for the most frequent topic related to housing and care in connection with 'older adults' are given in Table 1 and Figures 1 and 2.

First of all, we meet the term 'nursing home'. Also, the dynamics of published articles focusing on the specialised housing for older adults and similar dwellings, which are united all over the world in their notion of a 'nursing home', was the highest. These dynamics are shown in Figure 2. We see that in the 2012–2015 period, almost 2000 publications dealing with 'nursing home' in connection with the term 'older adults' were made. In the three years from 2016 to 2018, the number exceeded 2000, which means that on average there were annually almost 700 publications.

Sheltered housing is a term used in the United Kingdom to describe specialized housing for the elderly (Gray & Worlledge, 2018) where older adults can live independently, and the term 'housing with care' is used for assisted living. In the United Kingdom and the other EU Member States, there is currently a shortage of specialised housing stock adapted to the functional capacities of older adults (Harding et al., 2018). Managed housing is only structured as part of the social infrastructure in Otero's works with co-authors (2014) as well as in the City of Charles Sturt (2012).

The provision of specialised housing stock for the ageing population is currently the subject of a parliamentary debate at the lower house of the United Kingdom, where the supply of specialised housing units for older adults is significantly below demand (Wood, 2017). Recent studies in the United Kingdom have shown that proper housing without barriers to build environment significantly reduces the number of falls and the associated health care expenditures (Wood, 2017).

Table 1: The dynamics of publications for the most frequently discussed types of dwellings in connection with 'older adults' in the journals indexed by WoS

	The topic used in WoS and topic older people	Up to 1991	1992 - 1995	1996 - 1999	2000 - 2003
A	Extra care housing	0	0	0	0
A1	Housing with care	0	19	38	44
B	Retirement communities	1	10	17	46
C	Retirement housing	0	4	3	11
D	Sheltered housing	2	4	10	16
E	Assisted living	0	2	17	31
F	Residential facilities	1	10	12	39
G	Nursing home	19	108	283	533
	Sum	**23**	**157**	**380**	**720**
	The topic used in WoS and topic older people	2004 - 2007	2008 - 2011	2012 - 2015	2016 - 2019
A	Extra care housing	6	5	13	9
A1	Housing with care	85	106	153	224
B	Retirement communities	50	86	136	170
C	Retirement housing	11	17	43	51
D	Sheltered housing	16	24	23	49
E	Assisted living	90	173	327	326
F	Residential facilities	98	137	250	300
G	Nursing home	772	1261	1958	2074
	Sum	**1128**	**1809**	**2903**	**3203**

Up till now, research on the relationship between built environments and health has provided empirical evidence on mobility and some other physical activities (Rosso et al., 2011, Cerin et al., 2017).

Figure 2: The dynamics of the publication of articles in journals indexed in WoS, where the term 'Nursing home' is used
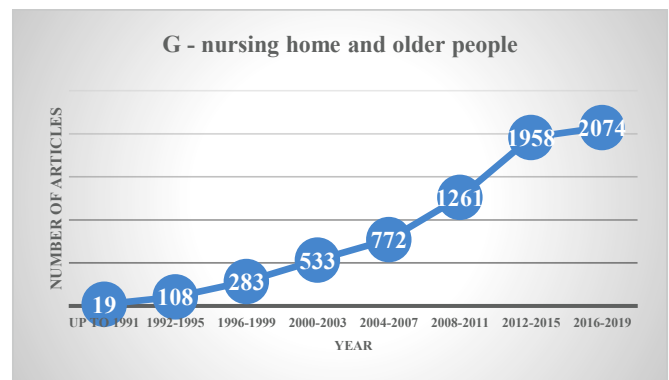
A nearly ten-year-old literature review which also includes the social dimension of the neighbourhood environment that influence the health and functioning of older adults is given in Yen et al. (2009). Nortstand et al. (2012) as well as Cornwell and Laumann (2015) underlined the importance of social and psychological factors but provided no solutions for the measurement of such complex systems that have been developed in the last ten years. Wood (2017) has presented the savings of the UK National Health System (NHS) related to residents of sheltered housing. Since the development of the concept of age-friendly cities by the World Health

Organization (WHO) significant research has emerged on this topic (Fitzgerald and Caro, 2014; Greenfield et al., 2015; Scharlach and Lehning, 2013). Several models of an ''age-friendly community'' have been developed and are not limited to urban settings (Menec and Nowicki, 2014). A review of these models found that the emerging ideal of age-friendly communities is characterized by enabling social and physical environments that are mutually reinforcing, along with a participatory and collaborative governance model and, more importantly, inclusiveness (Lui et al., 2009).

Figure 3: Number of articles on specialised housing solutions for older adults (the term 'Nursing home' is excluded).
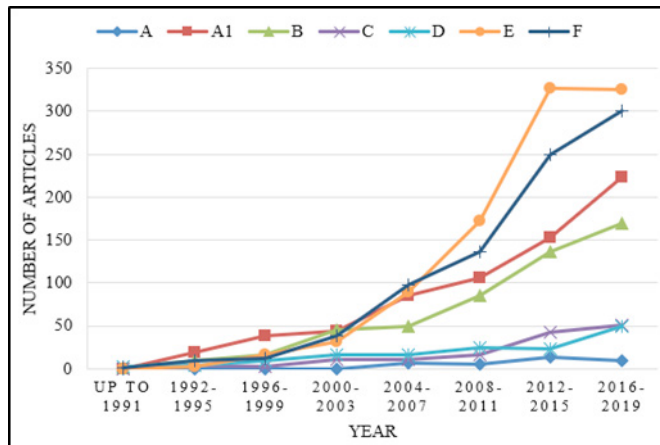
Research findings are the following:

– A positive relationship exists between the built environments and the health of the population (Rosso et al., 2011; Cerin et al., 2017; Liddle et al., 2014);

– An age-friendly community has a positive impact on the health of the community members (Levasseur et al., 2017; Novek et al., 2014);

– Understanding patterns of ageing including the functional decline of residents, the role of the community (Provencher et al., 2014) and the choice of residence after retirement (Bohle et al., 2014) is paramount;

– The ageing of seniors in their own homes affects the quality of their life (Schorr & Khalaila, 2018);

– The importance of social and psychological factors is considerable for the wellbeing of older adults (Cornwell & Laumann, 2015);

– UK NHS has considerable lower health care cost when older adults live in sheltered housing in comparison with older adults living in conventional dwellings and neighbourhoods (Wood, 2017).

– In developing the concept of elder-friendly cities prepared by the World Health Organization (WHO), requirements have emerged regarding the design of relevant databases and related research (Fitzgerald and Caro, 2014; Greenfield et al., 2015; Scharlach and Lehning, 2013);

– There exist several models of the 'elderly friendly community', which are not limited to urban settings (Menec and Nowicki, 2014). An overview of these models has shown that the emerging ideal of elder-friendly

communities is characterized as offering both a social and a physical environment that is mutually reinforcing;

– Participatory and shared management models have a positive impact on inclusion (Lui et al., 2009);

– The professionally managed community development that actively involves older adults can create a more friendly and supportive community environment for older adults by increasing intergenerational cooperation and social capital (Austin et al., 2005; Buffel et al., 2012a);

– Policy and governance factors encourage the development of an elderly community (Buffel et al., 2014; Glicksman et al., 2013; Menec et al., 2014; Green et al., 2015);

– Spatial planning must consider the needs of older adults with dementia (Biglieri, 2018).

Model of interaction between physical and social environment including services and the various dimensions of inequality and exclusion that affect older adults is not developed yet (Buffel et al., 2012b; Scharlach & Lehning, 2013). Community building is considered as one of the possible solutions (Greenfield et al., 2015; Lui et al., 2009).

3   IDENTIFIED GAPS

Several recent case studies of age-friendly communities (Buffel et al., 2014; Glicksman et al., 2013; Menec et al., 2014), as well as an evaluation of European Healthy Cities (Green et al. 2015), have also elucidated policy and governance factors that are conducive to age-friendly communities. The research challenges in this area, however, are similar to those which exist regarding urban health—an insufficient understanding of the actual holistic effects of physical and social environment on the sustainability of social systems and inequity and exclusion that affect older adults (Buffel et al., 2012b; Scharlach and Lehning, 2013).

In the literature review of specialised housing for older adults we have identified the following gaps and further research areas:

Research area 1: Optimization and control theory models supporting optimal planning, operations and control of services for older adults based on ambient intelligence, some of them based also on the geographic information technology Sustainability of supply systems in ageing society could be improved by increased productivity of food supply chains (Kovačić, Hontoria, Bogataj, Ros McDonnell, 2012) and increased efficiency in energy production and consumption (Kovačić and Bogataj, 2017) including investments in cogeneration plants (Kovačić, Usenik, and Bogataj. 2017). Smart distribution networks (Bogataj and Bogataj., 2004) and ambient intelligence could improve the efficiency of delivery and sustainability of distribution systems in the general environment of a shrinking workforce. Better education can significantly improve productivity and sustainability of supply systems (Peterlin, Dimovski, Tvaronavičiene, Grah and Kaklauskas, 2018) especially when supported by smart technologies (Arh, Jerman-Blažič and Dimovski, 2012; Škerlavaj, Dimovski, Mrvar and Pahor, 2010). Interactive learning environments (Škerlavaj and Dimovski, 2007) and knowledge-intensive learning environments (Škerlavaj, Dimovski, Mrvar and Pahor..2010).

Could support faster dissemination and acquisition of knowledge among organisations providing facilities and services to older adults. Intra-organisational learning (Dimovski, Škerlavaj, Kimman and Hernaus, 2008) could contribute to faster adaptation of products and services to needs of older adults and improve organisational performance (Dimovski, and Škerlavaj, 2005; Hernaus, Škerlavaj, and Dimovski, 2008). Improved supply chain coordination (Bogataj and Bogataj, 2001) and optimal location of activity cells (Bogataj and Usenik, 2005) taking account of transportation delays (Bogataj and Grubbstrom, 2012) where sustainability is improved by efficient location of industrial activity cells (Bogataj, Grubbstrom and Bogataj, 2011) and reverse logistics (Kovačić and Bogataj, 2013; Bogataj and Grubbstrom, 2013). Improved management of resources will influence land valuations (Bogataj, Tuljak Suban and Drobne, 2011). Increase in land values can support the development of specialised housing for older adults using Public Private Partnerships (Temeljotov Salaj, Roumboutsos, Verlič, and Grum, 2018). Ambient assisted living supported by ambient intelligence and other smart technologies will increase the productivity of nursing and social work (Roblek et al., 2019; Božič and Dimovski, 2019). Satisfaction (Grum, 2017), safety and wellbeing of residents in a smart retirement community could be supported by facility management services (Temeljotov, Salaj, A. et al.,2015) wich will create additional value for community residents (Bjørberg, Larssen, Boge and Temeljotov Salaj, 2017) and therefore increase value of housing units in the community (Nahtigal and Grum, 2015).

Research area 2: Model of the database for supporting the development of supply networks, specialised housing with care and lifetime neighbourhoods using a multi-state competing risk approach. According to Bevan and Croucher (2011), the main components that make up a lifetime neighbourhood are the following: (a) supporting residents to develop lifetime neighbourhoods, including especially resident empowerment, (b) access, (c) services and amenities, (d) built and natural environments, (e) social networks/well-being and (f) housing. The authors state that a comprehensive model supporting the development of specialised housing solutions for older adults and lifetime neighbourhoods does not yet exist.

Research area 3: Model of social value creation with the development of supply networks and housing with care. Wood (2017) has been researching the social value of sheltered housing by bringing together all the qualitative and quantitative data related to the savings generated by the residents of the sheltered housing for the National Health System (NHS) while lowering the demand for healthcare and social care services. The report, which is a review of the existing evidence, found that sheltered housing saves the UK's cash-strapped NHS and its social services at least £486m per year. But the author states that there does not yet exist proper model for measurement of social value created through the development of age-friendly environments and specialised housing stock for older adults.

Research area 4: Financial and fiscal mechanisms supporting the development of specialized housing with care. Financial and fiscal mechanisms for financing the development of specialised housing stock for older adults offering a higher standard of barrier-free living in lifetime neighbourhoods, including the provision of housing with care in the cities and towns, does not exist yet (WHO, 2007).

Research area 5: Human resources supporting supply networks and facility management of specialized housing with care. European workforce will shrink for 14 million workers in the next half-century. Ageing and shrinking will reduce available human resources in general (Žnidaršič, Dimovski, 2009; Grah et al., 2018; Dimovski, V, Grah, B., Colnar, S. (2019)) and produce a shortage of nurses in particular. Therefore, the employment policy will operate in an increasingly sensitive environment, which will need to be well understood (Temeljotov Salaj, Maamari, Baričič and Lohne, 2015; Temeljotov Salaj et al., 2015, Nahtigal and Grum, 2015, Boge et al., 2018, 2019; Boge and Temeljotov Salaj, 2017). Empirical research enables the advance of knowledge of the effects of demographic trends (Janež, Bogataj, Drobne, 2016). Specialised housing solution and ambient intelligence can mitigate the increase in demand for nurses and improve wellbeing of older adults. Here NPV evaluation methods for investments in specialized housing stock and supply networks are needed (Usenik and Bogataj, 2005; Bogataj and Bogataj, 2007).

4   CONCLUSION

More concrete knowledge and evidence is needed on how the supply chains, services and physical and social environments can be improved in a coherent manner in order to influence the health and well-being of older adults within a community, mitigate rising public health care and long term care expenditure and prevent systematic exclusion of older adults from society. Despite numerous difficulties in assessing community initiatives, further research, routine evaluation and the evidence of effectiveness are needed to deepen the knowledge, improve the practice and convince the policymakers to support these initiatives wherever appropriate. Industrial engineering and production research has potential to significantly improve efficiency of supply networks for older adults and mitigate the rising expenditure for health care and long term care costs in ageing societies.

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