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# Smart Lifetime Neighbourhoods: Literature Review and Research Agenda

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Municipalities in European Union are ageing fast. Consequently, the development and financing of smart social infrastructure to support the growing number of older adults with declining functional capacities to postpone their moving to nursing homes so that they live longer in the community is a major challenge for European municipalities. In this context, social innovations based on the digital transformation of health care and social care delivery systems can support older adults to live autonomously and independently in their own communities and postpone or even prevent entering nursing homes. The innovations will enable a more efficient combination of existing societal resources in the communities for the provision of health care and social needs of the ageing members of society who are dependent on the help of others due to illness or functional decline. On the supply side, new scientific (optimisation of supply networks), organisational (self-managed communities) and technological innovations such as robotics, domotics and CPS – based on the Internet of Things and cloud computing – offer new utilities and create new businesses for the supply of goods and services to older people while also providing new job opportunities for younger residents. The aim of this paper is to consider the development and financing of community smart social infrastructure with a focus on Slovenia.

Keywords: ambient-assisted living, lifetime neighbourhood, independent living, assisted living, housing with care, health care, long-term care, ageing population

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## 1 INTRODUCTION

The ageing of the European population is progressing rapidly, and the proportion of inhabitants aged 65+ will surpass one quarter by the middle of the century. Older adults have different needs regarding safety of their environments, which includes their homes and public spaces. According to the World Health Organisation (WHO), physical and social environments are key determinants of whether people can remain healthy, independent and autonomous long into their old age.

Concept of Age-friendly cities was developed by the World Health Organisation (WHO) (Kalache el.al, 2007). Age-friendly urban environment can facilitate health and wellbeing of residents (Fitzgerald and Caro, 2014; Greenfield et al., 2015; Scharlach and Lehning, 2013). Making cities and it neighbourhoods age-friendly is an effective local policy approach for responding to population ageing. The WHO age-friendly cities guide (Kalache, et al, 2008) highlights 8 domains that cities and communities can address to better adapt their structures and services to the needs of older adults: the built environment, transport, housing, social participation, respect and social inclusion, civic participation, employment, communication services, community support and health services. The physical and social environments are key determinants of whether people can remain healthy, independent and autonomous long into their old age. Different models of ‘‘age-friendly community’’ were presented by (Menec and Nowicki, 2014). Age-friendly communities are characterised by social and physical environments that are mutually reinforcing, participatory and apply collaborative governance models with, most importantly, inclusiveness (Lui et al., 2009). This is supported by research findings that professionally facilitated community development with and by older adults in the neighbourhood and can result in more hospitable and supportive community environments for older people by increasing civic engagement and social capital (Austin et al., 2005; Buffel et al., 2012a). Several recent case studies on age-friendly communities (Buffel et al., 2014; Glicksman et al., 2013; Menec et al., 2014; Neal et al., 2014) as well as an evaluation of European Healthy Cities (Green et al., 2015) have also elucidated policy and governance factors conducive to age-friendly communities.

Falls often cause severe injuries and are one of the costliest health conditions among older adults (Stevens and Lee, 2018). Therefore, understanding risk factors and risk drivers influencing probability and severity of risk of falls is of utmost importance for urban planners designing age-friendly cities and neighbourhoods. Understanding risk, Extrinsic factors, or

those pertaining to environmental hazards, contribute significantly to fall incidents and include obstacles to trip over, poor lighting, slippery surfaces, or inappropriate furniture. Hence, an in-depth understanding of the multitude of neuromuscular, cognitive, sensory, sociological and environmental factors that contribute to balance control are necessary for early diagnosis and treatment of elderly who present significant risks of falls (White et al. ,2019).. Therefore, in lifetime neighbourhoods' digital technologies should be deployed for fall prevention reducing risk of falls in community and in transition between community and hospital (Goswami, 2017). Thus, accessibility to age-friendly environments that can accommodate functional capacities of residents and the development of housing with care (HwC) are important factors that can enable older adults to live longer in the community. Creating age-friendly urban environments is therefore one of the most effective approaches to respond to demographic change.

Though the housing industry has substantially focussed on senior citizens in the last 20 years, this was often not considered an important component of changing urban structures (Hui et al., 2014). For most people, the idea of independence is closely associated with the idea of home. As residents grow older, they are more likely to spend more time at home, and where older adults live is an important determinant of their well-being. However, it is increasingly being recognised that it is not just homes but also the neighbourhoods where residents live that play a significant role in keeping them well and independent as they grow older (Bevan and Croucher, 2011). According to these authors, the main components that make up a lifetime neighbourhood include the following:

1. Supporting residents to develop lifetime neighbourhoods, especially resident empowerment
2. Access
3. Services and amenities
4. Built and natural environments
5. Social networks/well-being
6. Housing

Additionally, to extend this model and develop smart lifetime neighbourhoods, we should also include the following:

7. Ambient intelligence and assistive technologies to develop ambient-assisted living on neighbourhood level

However, considering the pace of population change, it is necessary to develop new economic and social conditions in urban structures; to this end, new types of smart lifetime neighbourhoods could be an acceptable solution, especially when we wish to support longer ageing in place. Moreover, housing is a potential source of both material and environmental well-being (Costa-Font, 2013; Rossi and Weber, 1996; Rohe et al., 2001). The housing needs of older cohorts have been studied by Demirkan and Olguntuerk (2014). Housing needs of older adults are satisfied if the dwelling is specifically designed to meet their physical, emotional, recreational, medical, and social needs. Further, their needs frequently change for the remainder of their lives. For an older adult, the choice between moving to a nursing home and independent living usually depends on how well they can manage daily activities without extra assistance. However, the ability of older adults to carry out activities of daily living and adapt and manage their own life decreases due to deterioration of their physical and cognitive condition. Thus, nurses and other health care professionals should support the self-management abilities of older adults in the community to prevent their dependence and increase their ability to adapt and self-manage the consequences of living with chronic conditions. In this context, Bolscher-Niehuis et al. (2016) have provided evidence on the effects of self-management support programmes on activities of daily living of older adults living at home.

Kano et al. (2018) and Rydin et al. (2012) stated in their article that "the key environmental features which make a city healthy through their contribution to disease prevention and health promotion are increasingly well understood". They listed basic communal infrastructure, adequate housing, accessible public transport, air pollution control and violence prevention, which are elements of a healthy city – also underlined in the reports of WHO and UN-HABITAT (2016). Among sustainable development goals, the listed activities include an important area for creating lasting positive changes, whose results are not systematically measured and evaluated yet. Therefore, models and databases for measurement of the tenure in the community and relocation to nursing home are still sorely lacking. As these authors, as well as Corburn and Cohen (2012) underlined, "Cities are complex systems and urban health outcomes are dependent on many interactions". This makes the analysis of causal associations between the urban environment and population health very challenging.

## 2 PROBLEM IDENTIFICATION

Development of lifetime neighbourhood should follow the directions of the European Disability Strategy which provides the framework for empowering people with disabilities to fully participate in society and ensure they can enjoy their fundamental rights. Following these directions lifetime neighbourhoods should facilitate and promote the participation of disabled people in leisure activities, employment, education, health, social services and achieve the transition from institutional to community-based care.

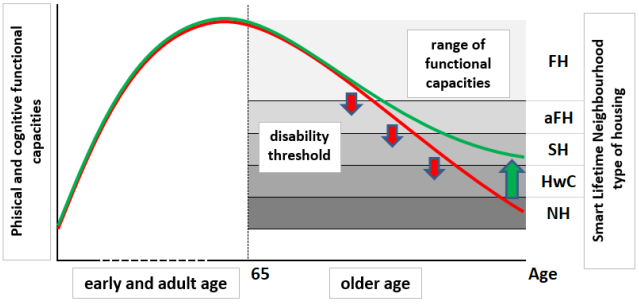


Figure 1: Decline of functional capacities of older adults and support for autonomy and independence that smart lifetime neighbourhoods can provide

Legende: FH – family home, : aFH – adapted family home, HwC – housing with care, SH – shaltered houses, NH – nursing home

The building stock in Europe today is not fit to support autonomous living that would allow residents with declining functional capacities to stay independent longer in the community (EC, 2015). Therefore specialised housing units with embedded Ambient Assisted Living Technologies should be developed with neighbourhood level assistance centres supporting provision of integrated health and care services. the Designers of the health and care systems in lifetime neighbourhood should take into account dispersion of users which influences cost of services due to travel time and also reduce the lead times in the system (Bogataj and Grubbström, 2012). Optimal location of service centres is required for affordability and efficiency of supply systems (Bogataj and Bogataj, 2007). Therefore, in the optimisation procedures of AAL systems, management of time delays due to greater distances between clients ( Bogataj and Bogataj, 2004, 2007; Bogataj and Grubbström, 2013; Bogataj et al., 2005, 2011; Usenik and Bogataj, 2005), could significantly improve efficiency of the system and create value for the community and influence the higher value of the rural real estate (Bogataj et al., 2011, 2012, Lisec et al., 2008) and improve other costs of communal infrastructure (Kovačić and Bogataj, 2013; Kovačić et al, 2015, 2017).

Up till now, research shows that health and mobility of older adults can be improved with adaptation of built environment (Rosso et al. 2011) which also facilitate physical activity (Cerin et al., 2017). Further, health and functioning capacities of older residents depends on social dimensions of neighbourhood environments (Yen et al. ,2009). Cornwell and Laumann (2015) underlined the importance of social and psychological factors that influence health and wellbeing of older adults living in neighbourhood. Moreover, built environment and characteristics of community influence public and private expenditures for health care and long term care Wood (2017).

## 3 IDENTIFIED GAPS

The research challenges of smart lifetime neighbourhoods, however, are similar to those for urban health—an insufficient understanding of the actual holistic effects of physical and social environment interventions and of the various dimensions of social sustainability (Peterlin, et al., 2018), inequity and exclusion that affect older adults (Buffel et al., 2012b; Scharlach and Lehning, 2013). Sustainable provision of leisure (Grah, 2020) and wellbeing in for ageing urban population is not achieved yet. Thus, more local knowledge and evidence are needed on how the physical and social environment can be improved in a coherent manner to affect the health and well-being of older adults and other people in the community and prevent older adults from being systematically excluded from society. Notwithstanding the numerous difficulties in evaluating community-based initiatives, more rigorous research, routine evaluation and evidence of effectiveness are necessary to advance scientific knowledge, improve practice and persuade policy makers to support these initiatives when appropriate. Also, better integration of health and social care is needed to realise a triple win: better quality of care, more sustainable and more efficient delivery systems, and creation new jobs in the networks of the optimal hierarchical structure of functional areas and regions ( Drobne and Bogataj, 2012, 2014, 2015, 2017, Janež et al., 2016, 2018). Optimal care coordination between primary, community to hospital, care, integrated with social care and families is detrimental to the quality of these networks and increasingly required as a precondition to the LTC sustainability.

## 4 RESEARCH AGENDA

Quality of built environment of neighbourhoods and homes, available support networks and assistive technologies, functional decline and family status are important factors that can influence the timing of relocation to a nursing home. This timing may be accelerated or decelerated by quality of built environment, support networks and assistive technologies that in combination influence the disability threshold.

Relocation usually occurs because of various reasons. This necessitate using a multivariate model that is jointly modelled with the timing decision for relocation decision-making. More specifically, after a substantial decline of functional capacities, there is a threshold when an older adult needs to improve his/her dwelling and environment or move to assisted living facility and finally, to a nursing home. They have to this choose between these two options.

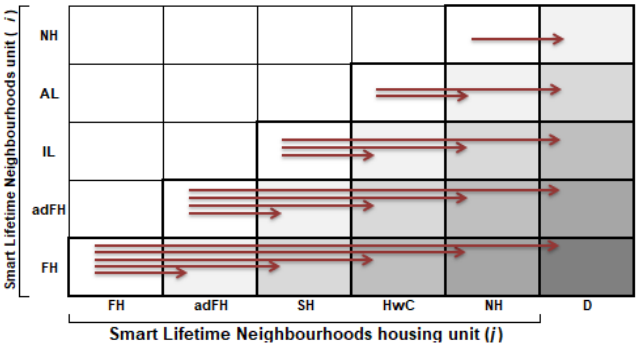


Figure 2: Possible transitions between different types of dwellings in smart lifetime neighbourhood

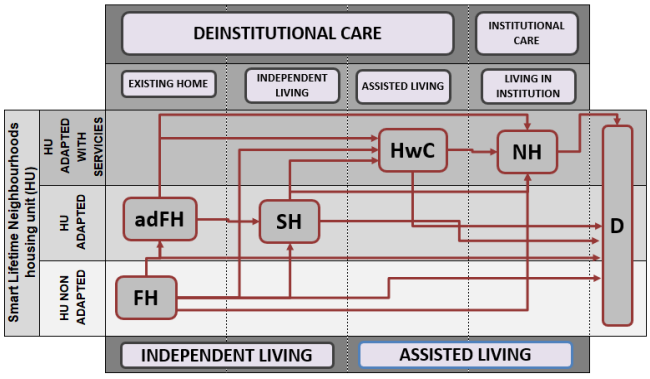


Figure 3: The graph of different paths between different types of dwellings from existing home (EH) to nursing home (NH) in the multiple decrement model

Moreover, changes in the environment can lower the disability threshold as seen from figure 1, thus, decreasing the number of disabled individuals in a given neighbourhood (Kalache and Kickbusch, 1997).

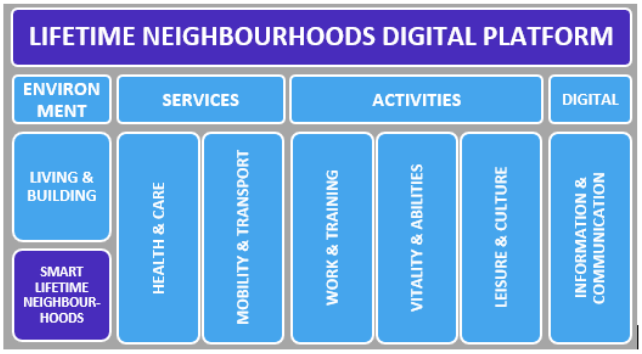


Figure 4: Digital platform supporting actve and healthy ageing in Lifetime Neighbourhoods

Information and communication technologies embedded in digital platform of Lifetime neighbourhood should support active and healthy ageing, providing opportunity for social engagement and health for residents keeping them vital long into their old age and mitigating decline in their abilities and functional capacities, providing opportunities for leisureand culture. It should support risk management, provide safe and secure environment including barrier free buildings and public spaces facilitating physical activity and social inclusion, integrated health and care provision in the community, facilitate mobility of older adults with declining functional capacities , support work of professional and informal carers and support family members providing care

## 5 CONCLUSION

Therefore, when studying systems that support urban growth in aging societies, the following indicators should be considered in both gravity and competing risk models to simultaneously bring new insight to the supply chain, required community logistics, digital infrastructure, ambient intelligence technologies, assistance centres, health care and long-term care services provided and housing market. Multi-state transition/competing risk models have been developed through the last quarter of the century. The model will facilitate evaluation of better attractors in gravity model as well as improve demographic projection according to age cohorts in smart lifetime neighbourhoods. The model of aging with decrease of functional capacities will have more disability thresholds, wherein thresholds are determined by the different levels of ambient intelligence and assistive technologies' support and housing requirements according to modified (extended) care dependency scale and categorised facilities as presented in figure 1. Nowadays, only institutional care facilities are more diversified according to people's needs and can be categorised as follows: (1) the classical nursing home (NH), orientated towards medical care aspects for care-dependent elderly with a high level of care; (2) sheltered housing (SH), where the elderly still live independently on their own but have specific common facilities and special low-level services that are highly dependent on the available ICT tools; and (3) adapted housing, meaning structural alteration of a care-dependent person's own home to suit their care needs – barrier-free living. Such barrier-free living in smart lifetime neighbourhoods as also in urban space should be divided in additional sub-categories (different sub-groups according to functional capacities) and integrated with tailor-made digitally supported intermediate care services in combination with day care and short-term care facilities and external supply chains for the elderly. The same care dependency classification should be used in completing risk/multi-state transition model in housing and facility classification and other supply networks destinations.

## REFERENCES

1. Allignol, A., Schumacher, M., & Beyersmann, J. (2011). Empirical Transition Matrix of Multi-State Models: The etm Package. Journal of Statistical Software, 38(4), pp. 1–15.
2. Andersen P. K., Abildstrom S. Z., Rosthøj S. (2002). Competing risks as a multi-state model. Andersen P. K., Abildstrom S. Z., Rosthøj S. Statistical Methods in Medical Research, 11(2), pp. 203–215. https://doi.org/10.1191/0962280202sm281ra
3. Andersen, P. K., Borgan, O., Gill, R.D., Keiding, N. (1993). Statistical Models Based on Counting Processes.
4. Austin, E. J., Saklofske, D. H., & Egan., V. (2005). Personality, well-being, and health correlates of trait emotional intelligence. Personality and Individual Differences, 38(3), pp. 547–558.
5. Bevan, M., & Croucher, K. (2011). Lifetime Neighbourhoods. London: Ministry of Housing, Communities and Local Government, Department for Communities and Local Government.
6. Bogataj, D., Ros-McDonnell, D., & Bogataj, M. (2016). Management, financing and taxation of housing stock in the shrinking cities of aging societies. International journal of production economics, ISSN 0925-5273. [Print ed.], Nov. 2016, vol. 181, pp. 2–13.
7. Bogataj, M., Bogataj, L. (2004). On The Compact Presentation Of The Lead Times Perturbations In Distribution Networks, International Journal Of Production Economics, 88 (2), pp 145-155.
8. Bogataj, L., Bogataj, M., Ferbar Tratar, L. (2005). Controllability of supply chain, controlled in Laplace - transformed space. International journal of applied mathematics 19(3):. 17-41.
9. Bogataj, M., Bogataj, L. (2007). The study of optimal additional investments in capacities for reduction of delays in value chain. International journal of production economics 108: 281-290.
10. Bogataj, M., Grubbström, R. W. (2012). On the representation of timing for different structures within MRP theory, International journal of production economics, 140 (2), pp. 749-755
11. Bogataj, M., Grubbström, R. W. (2013). Transportation delays in reverse logistics. International journal of production economics, 143(2): 395-402.
12. Bogataj, M., Grubbström, R. W.., Bogataj, L. (2011). Efficient location of industrial activity cells in a global supply chain. Internationa.l journal of production economics, 133(1):. 243-250

13. Bogataj, M., Drobne, S., Tuljak Suban, D. (2012). A fuzzy approach to forecasting the attractiveness of regions for human resources. Industrial engineering : innovative Networks : annals of industrial engineering. London: Springer. cop: 375-384.
14. Bogataj, M., Tuljak Suban, D. Drobne, S., (2011). Regression-fuzzy approach to land valuation. Central European
15. Bolscher-Niehuis et al. (2016). Effects of self-management support programmes on activities of daily living of older adults: A systematic review. International Journal of Nursing Studies. 61, pp. 230-247. https://doi.org/10.1016/j.ijnurstu.2016.06.014
16. Buffel, T., McGarry, P., Phillipson, C., et al. (2014). Developing Age-Friendly Cities: Case Studies From Brussels and Manchester and Implications for Policy and Practice. Journal of Aging and Social Policy, 26(1-2), pp. 52–72.
17. Buffel, T., Phillipson, C., & Scharf, T. (2012a). Ageing in urban environments: Developing "age-friendly" cities. Critical Social Policy, 32, pp. 597–617.
18. Buffel, T., Verté, D., DeDonder, L., et al. (2012b). Theorising the relationship between older people and their immediate social living environment. International Journal of Lifelong Education, 31, pp. 13–32.
19. Cerin, E., Nathan, A., Cauwenberg, J., et al. (2017). The neighbourhood physical environment and active travel in older adults: a systematic review and meta-analysis. International Journal of Behavioral Nutrition and Physical Activity, 4:15, pp. 1–23.
20. Christiansen, M., & Denuit, M. (2013). Worst-case actuarial calculations consistent with single- and multiple-decrement life tables. Insurance: Mathematics and Economics, 52(1), 1-5. https://doi.org/10.1016/j.insmatheco.2012.10.002
21. Corburn, J., & Cohen, A. K. (2012). Why We Need Urban Health Equity Indicators: Integrating Science, Policy, and Community. PLoS Medicine, 9(8), pp. e1001285.
22. Cornwell, B., & Laumann, E. O. (2015). The health benefits of network growth: new evidence from a national survey of older adults. Social Science & Medicine, 125, pp. 94–106.
23. Costa-Font, J. (2013). Housing-related well-being in older people: the impact of environmental and financial influences. Urban Studies. 50(4), pp. 657–673.
24. Demirkan, H., & Olguntuerk, N. (2014). A priority-based 'design for all' approach to guide home designers for independent living. Architectural Science Review, 57(2), pp. 90–104.
25. Deshmukh, S. (2012). Multiple Decrement Models in Insurance, An Introduction Using R, Springer, India.
26. EC. (2015). European summit on innovation for active and healthy ageing, Brussels, 9–10 March 2015 : final report. Brussels: European Commision (EC).
27. Fitzgerald, K. G., & Caro, F. G. (2014). An Overview of Age-Friendly Cities and Communities Around the World. Journal of Aging and Social Policy, 26, pp. 1–18.
28. Goswami, N. (2017). Falls and Fall-Prevention in Older Persons: Geriatrics Meets Spaceflight! Frontiers in physiology 8: 603
29. Grah, B., Dimovski, V., & Peterlin, J. (2020). Managing Sustainable Urban Tourism Development: The Case of Ljubljana. Sustainability, 12(3), 792. https://doi.org/10.3390/su12030792
30. Glicksman, A., Ring, L., Kleban, M., & Hoffman, C. (2013). Is "walkability" a useful concept for gerontology? Journal of Housing for the Elderly, 27, pp. 241–254.
31. Green, G., Jackisch, J., & Zamaro, G. (2015). Healthy cities as catalysts for caring and supportive environments. Health Promotion International, 30, pp. i99–i107.
32. Greenfield, E. A., & Reyes, L. (2015). Continuity and change in relationships with neighbors: Implications for psychological well-being in middle and later life. Journals of Gerontology - Series B, Psychological Sciences and Social Sciences, 70, pp. 607–618.
33. Haberman R. (1983). Elementary Applied Partial Differential Equations. Prentice Hall PTR, 560 pg.
34. Hui, E. C. M., Wong, F. K. W., Chung, K. W. et al. (2014). Housing affordability, preferences and expectations of elderly with government intervention. Habitat International.
35. Kalache, A., & Kickbusch, I. (1997). A global strategy for healthy ageing. World Health. 4, pp. 4–5.
36. Kalache, A., Plouffe, L. et al. (2007). Global age friendly cities Guide. WHO Press, Geneva. Available via http://www.who.int/agei.
37. Kalbfleisch J. D. & Prentice R. L. (2002). The Statistical Analysis of Failure Time Data, Second Edition. Wiley&Sons.
38. Kano, M., Rosenberg, P. E., Dalton, S. D. (2018). A Global Pilot Study of Age-Friendly City Indicators. Social Indicators Research, 138(3), pp. 1205–1227.
39. Lui, C. W., Everingham, J. A., Warburton, et al. (2009). What makes a community age-friendly: A review of international literature. Australasian Journal on Ageing, 28, pp. 116–121.
40. Menec, V. H., & Nowicki, S. (2014). Examining the relationship between communities' "age-friendliness" and life satisfaction and self-perceived health in rural Manitoba, Canada. Rural and Remote Health, 14, 2594, pp. 1–14.
41. Menec, V. H., Novek, S., Veselyuk, D., et al. (2014). Lessons Learned From a Canadian Province-Wide Age-Friendly Initiative: The Age-Friendly Manitoba Initiative. Journal of Aging and Social Policy, 26, pp. 33–51.
42. White, O., Babic, J., Trenado, C., Johannsen, L., & Goswami, N. (2019). The Promise of Stochastic Resonance in Falls Prevention. Frontiers in Physiology, 9, 1865. https://doi.org/10.3389/fphys.2018.01865
43. Neal, M. B., DeLatorre, A. K., & Carder, P. C. (2014). Age-Friendly Portland: A University-City-Community Partnership. Journal of Aging and Social Policy, 26, pp. 88–101.
44. Neath, A. A., & Samaniego F. J. (1996). On the distinguished role of the multivariate exponential

distribution in Bayesian estimation in competing risks problems. Statistics & Probability Letters. 31(1), pp. 69-74. https://doi.org/10.1016/S0167-7152(96)00015-6

45. Promislow, S. D. (2015). Fundamentals of Actuarial Mathematics, Third Edition. John Wiley & Sons, Ltd., Chichester.
46. Rohe, W., Zandt, S. van, & McCarthy, G. (2001). The social benefits and cost of home ownership: a critical assessment of research. Working Paper No. LIHO-01.12, Joint Center for Housing Studies, Harvard University, Harvard.
47. Rossi, P. H., & Weber, E. (1996). The social benefits of home ownership: empirical evidence from national surveys. Housing Policy Debate. 7, pp. 1–81.
48. Rosso, A. L., Auchincloss, A. H., & Michael, Y. L. (2011). The urban built environment and mobility in older adults: A comprehensive review. Journal of Aging Research, 816106, 10 pg.
49. Rydin, Y. (2012). Healthy cities and planning. Town Planning Review, 83, pp. 1.
50. Scharlach, A., & Lehning, A. (2013). Ageing-friendly communities and social inclusion in the United States of America. Ageing Society, 33(1), pp. 110–136.
51. Stevens, J. A., & Lee, R. (2018). The Potential to Reduce Falls and Avert Costs by Clinically Managing Fall Risk. American Journal of Preventive Medicine, 55(3), pp. 290–297.
52. UN. (2016). Urbanization and Development: Emerging Futures, World Cities Report 2016. Nairobi: United Nations (UN), Human Settlements Programme, UN-Habitat.
53. WHO (2002), Active ageing: a policy framework, Geneva
54. Wood, C. (2017). Social Value of Sheltered Housing. London: Demos.
55. Yen I. H., Michael, Y., & Perdue, L. A. (2009). Neighborhood Environment in Studies of Health of Older Adults. A Systematic Review. American journal of preventive medicine 37(5), pp. 455–63. DOI: 10.1016/j.amepre.2009.06.022
56. Janež, P., Drobne, S., Bogataj, M. (2018). Forecasting dynamics of daily commuting to work to other municipality in the case of changing taxation policies. Closing the gap between practice and research in industrial engineering, (Lecture notes in management and industrial engineering). Cham: Springer. pp. 105-112.
57. Janež, P., Bogataj, M., Drobne, S. (2016). Impact of the real estate taxation and municipal revenue on dynamics of internal migration : case study for city Municipal of Ljubljana Geodetski vestnik, 60(4): 644-684.
58. Kovačić, D., Bogataj, M. (2013). Reverse logistics facility location using cyclical model of extended MRP theory. Central European Journal of Operations Research 21(1): 41-57.
59. Kovačić, D., Usenik, J., Bogataj, M. (2017). Optimal decisions on investments in urban energy cogeneration plants - extended MRP and fuzzy approach to the stochastic systems. International journal of production economics, vol. 183, part b, pp. 583-595
60. Kovačić, D., Hontoria, E., Ros Mcdonnell, L., Bogataj, M. (2015) Location and lead-time perturbations in multi-level assembly systems of perishable goods in Spanish baby food logistics. Central European journal of operations research. 2015, vol. 23 (3), pp. 607-623.
61. Lisec, A., Drobne, S., Bogataj, M. (2008). The influence of the national development axes on the transaction value of rural land in Slovenia Geodetski vestnik 52(1): 54-68.
62. Nižetić, S., Djilali, N., Papadopoulos, A., Rodrigues, J.J.P.C., 2019. Smart technologies for promotion of energy efficiency, utilisation of sustainable resources and waste management. J. Clean. Prod. 231, 565e591
63. Peterlin, J., Dimovski, V., Tvaronavičiene, M., Grah, B., Kaklauskas, A. (2018). The strategic process of developing social aspects of sustainability through the vision reflection in business education. Technological and economic development of economy, 24(4), 1718–1736.
64. Škerlavaj, M., Dimovski, V. (2007) Towards network perspective of intra-organizational learning: bridging the gap between acquisition and participation perspective. Interdisciplinary journal of information, knowledge, and management, 2, 43–58.Škerlavaj, M., Dimovski, V., Mrvar, A., Pahor, M. (2010). Intra-organizational learning networks within knowledge-intensive learning environments. Interactive learning environments, 18(1), 39–63.
65. Usenik, J., Bogataj, M. (2005). A fuzzy set approach for a location-inventory model. Transportation planning and technology, 28(6): 447-464.