COST Action CA 16226

Indoor living improvement: Smart Habitat for the Elderly (Sheldon)

WG 3 report_November 2018

Editors:

Signe Tomsone (LV)

Petra Marešova (CZ)

Contribution by WG 3 members (*alphabetic order*):

Husić Jasmina Baraković (BiH)

Sabina Baraković (BiH)

Hrvoje Belani

Nuno Garcia (PT)

Jonathan Gomez-Raja (ES)

Lucía Gonzalez (ES)

Marcin Kautsch (PL)

Veronika Kotradyva (SK)

Ondrej Krejcar (CZ)

Birgitta Langhammer (NO)

Joana Madureira (PT)

Oscar Martinez Mozos (ES)

Ana Mendes (PT)

Sarmite Mikulioniene (LT)

Emanuele Naboni (DE)

Dobrinka Peicheva (BG)

Jelena Ristic (RS)

Lina Seduikyte (LT)

Martin Weigl (AT)

Comentado [ST1]: We have more persons listed in our group but not all were active in relation to report preparation.

Content

1. Introduction

Developed countries are currently undergoing demographic changes which entail the rising number of senior citizens. This particular demographic group is prone to suffering from numerous chronic diseases. The link between old age and chronic disease e.g. is illustrated by USA population reference bureau [1], according to which up to 19 million people need to provide day-to-day primary assistance to their elderly family members.

There are already a number of technologies in use, including digital devices, smart sensors, and intelligent applications, that assist elderly people with their everyday needs in their own homes. Developing a strategy for an integrated technological solution would resolve many issues faced by elderly patients and would lead to improving their quality of life, health, and safety[2], [3], [4].

The aim of COST Action CA 16226, Indoor living improvement: Smart Habitat for the Elderly (Sheldon), Working group 3 was:

- to explore the specific needs of elderly,
- to specify quality of live in context of environment,
- to describe social, economic and technological consequences related to the care of elderly,
- to review policies in different countries,
- to find good practices examples from different countries,

in order to promote safe, comfortable and healthy living at home.

As the result of the group work, we prepared the report on the state of the art, where we explored needs of older persons in relation to healthcare and smart living spaces, and tried to map existing policies and practices regarding healthcare and smart living spaces in order to propose topics for future studies.

[1] Population Reference Bureau, America ′s Aging Population., 2011 (accessed on April 5, 2015). Available from: http://www.prb.org/pdf11/aging-in-america.pdf
[2] Maresova P, Klimova B, Novotny M, Kuca K. Alzheimer's and Parkinson's disease: expected economic impact on Europe - a call for a uniform European strategy. J Alzheimers Dis 54(3): 1123-33 (2016).
[3] Maresova P, Mohelska H, Dolejs J, Kuca K. Socio-economic aspects of Alzheimer´s disease. Curr Alzheimer Res 12(9): 903-11 (2015).
[4] Zdravevski E, Lameski P, Trajkovik V, Kulakov A, Chorbev I, Goleva R, et al. Improving activity recognition accuracy in ambient assisted living systems by automated feature Engineering, IEEE Access, Volume: PP Issue: 99, DOI: 10.1109/ACCESS.2017.2684913 (2017).

2. Needs of elderly

The physical needs of the elderly could be viewed from the point of view of professionals:

- Health: maintenance of physical function, social activities
- Physical: independence in activities of daily living, mobility, falls, sight (light), hearing (socialization), teeth (nutrition)
- Psychological: anxiety, depression, worsened cognitive function (e.g., dementia)
- Social: safety, accessibility, participation

Or from the point of view of older adults:

- Dependence
- Loneliness
- Living conditions
- Economic issues
- Person's involvement in decision making about solutions in problematic situations

It is important that the elderly maintain physical activity and capacity through training and exercise. In addition, their living environment should be adapted with safety precautions, telecommunication, virtual reality training, and indoor design that inspire to move. These are important tools to achieve that older individual can live at home for as long as possible.

Needs of elderly are described below in three categories: from physical, mental and contextual point of view.

2.1 Personal needs of elderly related to physical health (*Birgitta Langhammer)*

Biological changes

Biological characteristics, such as VO2, muscle mass, sensory function (eye sight, hearing, fine motor function, etc.), memory, and neuro-motor function (speed, coordination, dual-task) decrease with age[5]. These biological changes are can be influenced by lifestyle from early to old age. Inactive and unhealthy lifestyle decreases biological reserves and leads to poor health and disability[6], whereas an active healthy lifestyle maintains an independent lifestyle and leads to maintenance of reserves[7], [8], [9], [10]. VO2max decreases approximately 5- 15 % per decade beginning at

[5] Spirduso W. Physical Dimensions of Aging. Champaigne: Human Kinetics; 1995.
[6] Bouchard C, Blair SN, Haskell WL. Physical activity and health. Human Kinetics 2nd ed 2012, 2007.
[7] Shepherd RJ. Physical activity, fitness and health: the current concensus. QUEST 1995;47: 288-303.
[8] Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C et al. Physical activity and public health. A recommendation from the centers for disease control and prevention and the American College of sports medicine. The Journal Of The American Medical Association. 1995:273:402–407.
[9] Myers J, Prakash M, Froelicher V, et al. Exercise capacity and mortality among men referred for exercise testing. N Engl J Med. 2002; 346: 793–801.

25-30 years of age. This decline can be attributed to age; reductions are noticeable in maximal cardiac output and in maximal arteriovenous oxygen (a-v O2). However, older adults have a 10 to 30 percent higher VO2max if they were performing endurance training as young adults. The increase in VO2max in older adults is reflected in improvements in both maximal cardiac output and arterio-venous O2 difference. The magnitude of these VO2max adaptations in older adults depends on the training intensity[11],[12],[13]. VO2 may be viewed in terms of the Metabolic Equivalent of Task (MET), or simply metabolic equivalent, which expresses the energy (cost) of physical activities. At rest, 1MET is equivalent to 3.5ml/min/kg.

One can distinguish a "cut-point" between high and low levels of endurance capacity, which is 18.3ml/min/kg[14]. A lower level <13 ml /kg/min indicates a need for help in activities of daily living[15].

Muscle mass is reduced for 40% in persons at 70 years of age. Strength, in terms of 1 repetition maximum, decreases from the age of 50 by 1-2 % every year. Power, that is, strength / time, decreases by 3.5 % per year[16]. This decline can be slowed down by exercise.

Disuse of skeletal muscle that is, inactivity, increases muscle loss resulting in more pronounced muscle atrophy. Other contributing factors affecting muscle mass in ageing are neuromuscular realignment (changes in motor units and innervation of fibres), reduction in growth factors, and changes in muscle protein turnover[17].

Below you can see possible outcomes in muscle mass and strength throughout a lifetime (Figure 2.1.).

[10] Penedo FJ, Dahn JR. Exercise and well-being: a review of mental and physical health benefits associated with physical activity. Curr Opin Psychiatry. 2005;18:189–93.
[11] Maessen MF, Verbeek AL, Bakker EA, Thompson PD, Hopman MT, Eijsvogels TM. Lifelong Exercise Patterns and Cardiovascular Health. Mayo Clin Proc. 2016 Jun;91(6):745-54.
[12] Larsson EB, Wang L, Bowen JD, McCormick WC, Teri L, Crane P et al. Exercise is associated with reduced risk for incident dementia among persons 65 years of age and older. Ann Intern med. 2006;144:73–81.
[13] Roh J, Rhee J, Chaudhari V, Rosenzweig A. The Role of Exercise in Cardiac Aging: From Physiology to Molecular Mechanisms. Circulation Research 2016; 22, 118 (2): 279-95.
[14] Morey MC, Pieper CF, Cornoni-Huntley J. Physical fitness and functional limitations in community-dwelling older adults. Med Sci Sports Exerc. 1998 May;30(5):715-23.
[15] Spirduso WW, Cronin DL. Exercise dose-response effects on quality of life and independent living in older adults. Medicine and Science in Sports and Exercise. 2001;33(6):598–610.
[16] Skelton DA, Greig CA, Davies JM, Young A. Strength, power and related functional ability of healthy people aged 65–89 years. Age and Ageing. 1994;23(5):371–377.
[17] Liu CJ, Latham NK. Progressive resistance strength training for improving physical function in older adults. Cochrane Database of Systematic Reviews 2009, Issue 3. Art. No.: CD002759. DOI: 10.1002/14651858.CD002759.pub2.

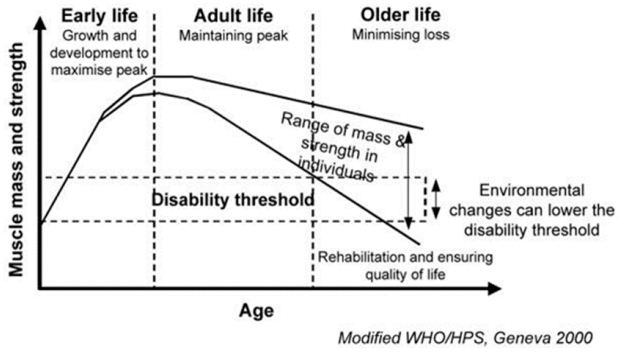

Figure 2.1. Outcomes in muscle mass and strength throughout a lifetime

To maintain physical balance, complex internal and external processes need to work in tandem. In ageing persons, balance is worsened due to one or several of these processes functioning inadequately[18], [19]. The internal processes, that are all equally important, are shown in Figure 2.2.

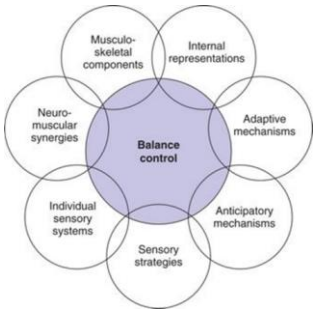

Figure 2.2. Internal processes related to balance control (Shumway-Cook & Wollacott, 2016[20])

Balance is also affected by external context or environmental influences, such as physical surroundings, noise, stress, and other stimuli. Both the internal and the external processes are modifiable.

Multimorbidity

Illnesses, trauma and the combination of several incidents may lead to specific disabilities that limit independence in activities.

[18] Gillespie LD, Robertson MC, Gillespie WJ, Lamb SE, Gates S, Cumming RG, Rowe BH. Interventions for preventing falls in older people living in the community. Cochrane Database of Systematic Reviews 2009, Issue 2. Art. No.: CD007146. DOI: 10.1002/14651858.CD007146.pub2.
[19] McClure RJ, Turner C, Peel N, Spinks A, Eakin E, Hughes K. Population-based interventions for the prevention of fall-related injuries in older people. Cochrane Database of Systematic Reviews 2005, Issue 1. Art. No.: CD004441. DOI: 10.1002/14651858.CD004441.pub2.
[20] Falls. Accessed URL https://rctom.hbs.org/submission/improving-care-for-those-who-cared-for-us/ cited 161018

Living at home – physical factors

Falls can have serious consequences; about 1/3 of adults over the age of 65 falls each year. The risk of falls increases proportionately with age. At 80 years, over half of seniors fall annually. For a person, falls can be fatal. For the society, great costs are generated for the proper care and rehabilitation (Figure 2.3.).

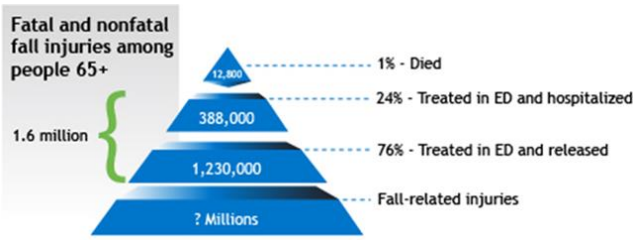

Figure 2.3. Costs of falls (https://rctom.hbs.org/submission/improving-care-for-those-who-cared-for-us/)

The reasons why older people fall are complex (Figure 2.4.).

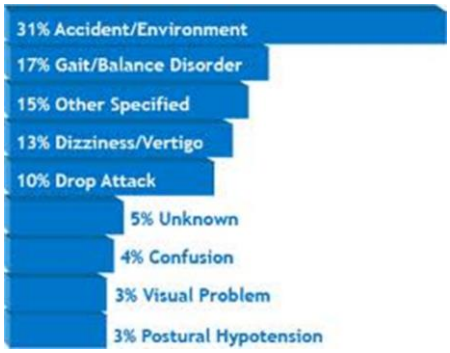

Figure 2.4. Reasons for falls

On the individual level, exercise and training are recommended to maintain endurance, strength, and balance. Equally important is to adapt the environment and make use of assistive devices in order to lower the disability threshold. The most favourable solution is to combine the two.

Frailty

A growing body of evidence indicates that biological aging or frailty influences many negative health-related outcomes, however, frailty is likely poorly understood and under-recognized by the public-at-large.[21] The conceptual model suggests that culture, knowledge about aging, and stereotypes influence adults' beliefs and perceptions. Ageing adults determine their health priorities, and then subconsciously or

[21] Parish, Abby, Jennifer Kim, Kanah May Lewallen, Sally Miller, Janet Myers, Robbie Panepinto, and Cathy A.
Maxwell. 2018. "Knowledge and perceptions about aging and frailty: An integrative review of the literature." Geriatric Nursing. doi: https://doi.org/10.1016/j.gerinurse.2018.05.007.

consciously determine which of these are controllable. If deemed controllable and important, the elderly may participate in health behaviours to mitigate the age-related decline. If deemed uncontrollable or less important, adults may focus their efforts on accepting them. Some findings suggest that frailty is a subjective term and that subjects often optimistically do not identify themselves as frail.

Due to the decline of immune functioning related to age and chronic disease, older adults are a well-recognized susceptible group. In this context, the aging phenomenon offers great opportunities as well as great challenges for all societies, namely to ensure that the increase in longevity is accompanied by good health and quality of life, while balancing socio-economic costs. Frailty is an age-related syndrome characterized by a state of increased vulnerability with reduced physiological reserves required to respond to stressors[22]. This syndrome is the most common condition in older adults leading to disability, institutionalization, and death. Higher prevalence of frailty in elderly community dwellers has been recorded in several studies. Frailty prevalence may range between 20% and 30% among adults aged 75 years or more. Several factors that may contribute to the condition have been suggested, however, a definitive explanation is still missing as well as evidence of why frailty develops in some individuals and not in others. Environmental factors, such as air pollution and other contaminants, have been associated with certain age-related disorders, such as Alzheimer's disease, for example. These factors may also play a role in the development of frailty syndrome, especially if considering the fact that numerous factors likely contribute to the onset of this condition. Therefore, environmental exposure should also be considered when studying the potential risk factors for the development of frailty. It is essential to understand the frailty status of people before the clinical symptoms develop. In this way, timely interventions can be organized that can sometimes reverse the symptoms. Furthermore, an early frailty assessment may lead to a more effective response of the healthcare system and thus reduce socio-economic costs of a long–term care. Different areas, such as environmental health and social sciences, should be considered in frailty aetiology. Bio-gerontology aims to define biological markers of aging (and frailty) – that are more revealing than chronological age - to recognize the biological age of populations, groups, and individuals. Currently, there are several gaps in the scientific literature regarding frailty syndrome, specifically in their definition, gold-standard models, causal-effects, prevention, and treatment.

[22] Lage, Bruna, Armanda Teixeira-Gomes, Ana Mendes, Vanessa Valdiglesias, João Paulo Teixeira, and
Solange Costa. 2018. Frailty syndrome – an emergent concern of unknown causes. In Elderly Care: Options, Challenges and Trends, edited by Dennis L. Nielsen. New York, USA: Nova Science Publishers, Inc. [Available by the author]

Examples of Interventions from Norway[23], [24]:

Safety: "safety alarm", telecommunication, personal assistant, adapting the environment: streets, shops, public places possibility to admit yourself into a "Safety department" in community-based care
Accessibility: home adaptations: lighting, furniture supports, etc.
Independence-mobility: care from the municipality, assistive devices
Social participation: group activities, senior centres, independent organisations,
Primary care: health interventions: medical and when in need of special support provided by private services or municipality services
Living at home after acute illness
Specialist services: acute
Municipality services: rehabilitation, short-term care and, if needed, long-term care
"*Hverdags rehabilitering*" = "everyday rehabilitation"[25]
Living in an institution
"your home away from home" [26], [27]

- Physical activity: maintenance of function
- Wellbeing: the facilities – buildings, one's own room, design of interior spaces – that inspire to move (for long enough but not excessively)
- Health: teeth / nutrition
- Mobility: falls

Environment:

- inside: micro climate, comfort, wellbeing, quality of life
- outside: physical accessibility, mobility, adaptations
- person-environment interaction ("connectedness")
- climate: inside (comfort) / outside (mortality)

Summary:
With advanced age, biological and physical reserves are reduced and it is vital for the elderly to remain active to maintain their abilities and capacities. Multimorbidity may speed up the decline in older adults and lead to their dependence in many activities.

[23] Idland G, Pettersen R, Avlund K, Bergland A. Physical performance as long-term predictor of onset of activities of daily living (ADL) disability: a 9-year longitudinal study among community-dwelling older women. Archives of Gerontology and Geriatrics 2013;56(3):501-6.
[24] Lohne-Seiler H, Hansen BH, Kolle E, Anderssen SA. Accelerometer-determined physical activity and self-reported health in a population of older adults (65-85 years): a cross-sectional study. BMC Public Health. 2014; 14:284-294.
[25] Hverdagsrehabilitering. Cited 161018 Accessed URL https://www.helsebiblioteket.no/omsorgsbiblioteket/hverdagsrehabilitering
[26] Crocker T, Forster A, Young J, Brown L, Ozer S, Smith J, Green J, Hardy J, Burns E, Glidewell E, Greenwood DC. Physical rehabilitation for older people in long-term care. Cochrane Database Syst Rev. 2013 Feb 28;(2):CD004294. doi: 10.1002/14651858.CD004294.pub3
[27] Grönstedt H, Frändin K, Bergland A, Helbostad JL, Granbo R, Puggaard L, Andresen M, Hellström K. Effects of individually tailored physical and daily activities in nursing home residents on activities of daily living, physical performance and physical activity level: a randomized controlled trial. Gerontology 2013; 59 (3):220-9.

2.2 Personal needs of elderly related to mental health (*Oscar Martinez Mozos*)

We are currently experiencing unprecedented levels of ageing in the population in regions around the world, especially in the EU and Japan. By 2060 there will be around 151 million people aged over 65 years in the EU[28]. Increased longevity is a positive result of improved living conditions and healthcare, but it presents formidable challenges for public and private budgets and services as well as for elderly and their families. Older citizens in Europe and Japan wish to stay in their homes for as long as possible and enjoy an active and healthy ageing. The number of older adults living alone has increased to 13.14% in EU[29]. However, those in later stages of life are more at risk for age-related impairments, such as poor mental and physical health, frailty, and social exclusion that have considerable negative consequences for an independent life. Moreover, it will be difficult to cover all demands for home assistance in the near future due to shortages of available health workers and doctors to provide personal home care as a result of a high life expectancy (currently 79 years in EU) and low birth rate (1.6 in EU), leading to a projected ratio of older people against the rest of population of 50.2% in EU by 2060[30], [31]. Therefore, there is an urgent need for new and innovative forms of support and health care for older people wishing to stay at home. Compared to the rest of the population, older people are more likely to experience psychological distress due to bereavement, a drop in socio-economic status with retirement, or a disability[32]. Depression affects 12% of the elderly in EU (11.3 million) and it is the main illness in older people ahead of dementia[33]. Symptoms of depression in older adults are often overlooked and untreated because they coincide with other problems encountered by older adults, therefore, extra care should be taken. Symptoms include impairment of quality of life, inability to enjoy life, tiredness, decreased motivation, lack of concentration, and lowered functional capacity together with feelings worthlessness, helplessness, hopelessness, and guilt.[34]. Depression has a direct impact on physical health and vice versa. Older adults with physical health conditions such as heart disease, diabetes arthritis, or kidney disease have higher rates of depression [35], [36], [37], [38]. Conversely, untreated depression in an

[28] EUROSTAT statistics explained, http://ec.europa.eu/eurostat/statistics-explained
[29] EUROSTAT statistics explained, http://ec.europa.eu/eurostat/statistics-explained
[30] www.oecd.org
[31] Ageing and life-course, http://www.who.int/ageing/en/
[32] Ageing and life-course, http://www.who.int/ageing/en/
[33] Copeland, J. R., Beekman, A. T., Braam, A. W., Dewey, M. E., Delespaul, P., Fuhrer, R., ... & Magnusson, H. (2004). Depression among older people in Europe: the EURODEP studies. World Psychiatry, 3(1), 45-49. [EC04] European Commission (2004). Actions Against Depression, European Communities, ISBN: 92-894-825-6
[34] European Commission (2004). Actions Against Depression, European Communities, ISBN: 92-894-8251-6
[35] Barth, J., Schumacher, M., & Herrmann-Lingen, C. (2004). Depression as a risk factor for mortality in patients with coronary heart disease: a meta-analysis. Psychosomatic medicine, 66(6), 802-813.
[36] Kumar, R., Anstey, K. J., Cherbuin, N., Wen, W., & Sachdev, P. S. (2008). Association of type 2 diabetes with depression, brain atrophy, and reduced fine motor speed in a 60-to 64-year-old community sample. The American Journal of Geriatric Psychiatry, 16(12), 989-998.
[37] Dickens, C., McGowan, L., Clark-Carter, D., & Creed, F. (2002). Depression in rheumatoid arthritis: a systematic review of the literature with meta-analysis. Psychosomatic Medicine, 64(1), 52-60.

older person negatively affects the outcome of other diseases, such as heart conditions, lupus, or AIDS[39], [40], [41], [42].

Finally, and most importantly, depression is the main cause of suicide in older people in western countries[43]. Depressed persons may require substantial care that may cause distress in caregivers or family members. Partners of depressed people have more difficulties in maintaining social and leisure activities, while the relationship with their partner may suffer as well. Relatives and spouses of depressed patients require attention as they are also dealing with the negative effects of depression[44], [45], [46]. The socio-economic costs of depression in the elderly include the loss of opportunities for social leisure, early hospitalisation and nursing home admission, more frequent (costly) professional help, up to 50% higher healthcare costs, and premature mortality[47], [48], [49].

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[38] Abdel-Kader, K., Unruh, M. L., & Weisbord, S. D. (2009). Symptom burden, depression, and quality of life in chronic and endstage kidney disease.Clinical Journal of the American Society of Nephrology, 4(6), 057-1064.

[39] Lawrence, D., Holman, C. D. A. J., & Jablensky, A. (2001). Preventable physical illness in people with mental illness. Centre for Health Services Research, Department of Public Health, University of Western Australia.

[40] Barth, J., Schumacher, M., & Herrmann-Lingen, C. (2004). Depression as a risk factor for mortality in patients with coronary heart disease: a meta-analysis. Psychosomatic medicine, 66(6), 802-813.

[41] Adams Jr, S. G., Dammers, P. M., Saia, T. L., Brantley, P. J., & Gaydos, G. R. (1994). Stress, depression, and anxiety predict average symptom severity and daily symptom fluctuation in systemic lupus erythematosus. Journal of behavioral medicine, 17(5), 459-477.

[42] Leserman, J., Petitto, J. M., Golden, R. N., Gaynes, B. N., Gu, H., Perkins, D. O., ... & Evans, D. L. (2000). Impact of stressful life events, depression, social support, coping, and cortisol on progression to AIDS. American Journal of Psychiatry, 157(8), 1221-1228.

[43]O'Connell, H., Chin, A., Cunningham, C., & Lawlor, B. A. (2004). Recent developments: Suicide in older people. British Medical Journal, 329, 895-899.

[44] Van Wijngaarden, B., Schene, A. H., & Koeter, M. W. (2004). Family caregiving in depression: impact on caregivers' daily life, distress, and help seeking. Journal of affective disorders, 81(3), 211-222.

[45] Sartorius N. (2001).The economic and social burden of depression. 2001. Journal of Clinical Psychiatry. 62 Suppl 15:8-11.

[46] Magliano, L., McDaid, D., Kirkwood, S., & Berzins, K. (2006). Carers and families of people with mental health problems. Mental Health Policy and Practice across Europe.

[47] European Commission (2004). Actions Against Depression, European Communities, ISBN: 92-894-8251-6

[48] Henderson, J., Henke, N., Kuhn, K., Lavikainen, J., Lehtinen, V., Ozamiz, A., ... & ZENGIGER, K. (2004). Mental health promotion and prevention strategies for coping with anxiety, depression and stress related disorders in Europe: final report 2001-2003. Wirtschaftsverl. NW, Verlag für Neue Wiss.

[49] Katon WJ. et al. 2003. Increased medical costs of a population-based sample of depressed elderly patients. Archives of General Psychiatry, 60(9):897-903.

2.3 Indoor environmental factors for the elderly (*Ana Mendes, Joana Madureira, Lina Seduikyte , Martin Weigl,*)

Indoor environments should safeguard and enhance occupants' health, comfort, and productivity, as people spend around 90% of their lives indoors[50]. There is still limited knowledge regarding the causes of symptoms observed in nonindustrial indoor settings, such as office buildings, recreational facilities, schools, and residences.

Indoor environmental problems are related to bone frailty, and skeletal and muscular structure degeneration. Exposure to indoor air pollution is an important stimulus for the development and exacerbation of respiratory diseases, such as asthma, chronic obstructive pulmonary disease, lung cancer, and cardiovascular disease. This situation is further exacerbated by the increased amount of time older adults spend indoors.

It has been estimated that older persons spend approximately 19–20 h/day indoors, and many spend all their time indoors in elderly care centres. Due to these conditions, older people are more susceptible to the effects of air pollution, therefore, monitoring indoor environmental quality should be a public health priority. Thermal comfort is one of the indoor environmental factors that affect health and human performance. Determined by temperature, humidity and air movement, it has a very significant impact on the general well-being and daily performance of building occupants. Poor thermal environment can also aggravate the impact of air pollutants on occupants' health. The ability to regulate body temperature tends to decrease with age. In general, elderly seem to perceive thermal comfort differently from the young due to a combination of physical aging and individual differences. These are too large to draw an unequivocal conclusion on the requirements of older adults regarding their preferred thermal environment. Nevertheless, self-reported poor health was significantly associated with poor TC. Exposure to cold has often been associated with increased incidence and severity of respiratory tract infections.

Indoor air quality

- The living environment is very important for overall human well-being. Indoor air quality (IAQ) is one of the most important factors influencing indoor microclimate. At the same time, airborne particulate matter (PM) is considered to be one of the key pollutants due to its complexity and adverse health effects. PM, especially its fine fraction, referred to as PM2.5 (particles with aerodynamic diameter lower than 2.5 mm) has been associated with various adverse health effects[51]. A report from WHO stated that on a global scale, 4-8% of premature deaths are related to the exposure to PM in the ambient and indoor environment.

[50] Mendes, Ana, Armanda Teixeira-Gomes, Solange Costa, Blanca Laffon, Joana Madureira, and João Paulo Teixeira. 2018. Indoor environments and elderly health. In Elderly Care Options, Challenges and Trends, edited by Dennis L. Nielsen. New York: Nova Biomedical, Nova Science Publishers Inc. [Available by the author]

[51] Prasauskas, Tadas; Martuzevičius, Dainius; Krugly, Edvinas; Čiužas, Darius; Stasiulaitienė, Inga; Sidaravičiūtė, Rūta; Kaunelienė, Violeta; Šeduikytė, Lina; Jurelionis, Andrius; Haverinen-Shaughnessy, Ulla. Spatial and temporal variations of particulate matter concentrations in multifamily apartment buildings // Building and environment. Oxford : Pergamon-Elsevier Science. ISSN 0360-1323. eISSN 1873-684X. 2014, vol. 76, p. 10-17. DOI: 10.1016/j.buildenv.2014.02.010.

- Major pollution sources in indoor environments include building materials, combustion processes, furniture, various household and personal care products, and plastic utensils. The concentration of an indoor air pollutant depends not only on its indoor emission rate, but also on the rate at which it is being transported from outdoors to indoors (if applicable), and the rates at which it is scavenged by indoor surfaces, consumed by indoor chemistry, and removed by ventilation or air cleaning[52]. Construction practices and indoor sources differ among countries depending on the socio-economic conditions of the occupants.

- Increasing requirements for the building energy efficiency (EE) raise new challenges for IAQ management. The countries within the European Union have assumed commitments to build low energy consumption buildings from 2016 to 2020. This usually means improving EE and air tightness of the building envelope. In the future, EE of existing buildings must also be improved. The main goal of the building refurbishment process is energy saving and improvement of building systems, but the improvement of occupants' wellbeing should also be considered as one of the most important refurbishment goals. From this perspective, IAQ research in low energy/refurbished buildings is of high importance. The modification of building systems, including structures (e.g. insulation of external walls) and heating, ventilation, and air conditioning (HVAC) systems, and new building materials, may have a significant influence on IAQ and subsequently, PM levels[53].

- Results[54] indicated that adequate ventilation must be assured in low energy buildings. While low occupancy of single family buildings may be beneficial to keep most of the pollutants within the recommended values, stronger emitting sources may be difficult to manage, especially immediately after installation. Checking of indoor air quality is recommended before occupancy to avoid exposure to high pollutants concentrations from the interior decoration and furnishing. Moreover, the concept of low energy buildings should be coupled with "healthy sustainable building" concept, aiming to avoid usage of highly emitting building and furniture materials.

- Energy efficiency, thermal comfort, and IAQ should be considered when designing heating, ventilation, and air conditioning (HVAC) systems for low

[52] Kaunelienė, Violeta; Prasauskas, Tadas; Krugly, Edvinas; Stasiulaitienė, Inga; Čiužas, Darius; Šeduikytė, Lina; Martuzevičius, Dainius. Indoor air quality in low energy residential buildings in Lithuania // Building and environment. Oxford : Elsevier. ISSN 0360-1323. eISSN 1873-684X. 2016, vol. 108, p. 63-72. DOI: 10.1016/j.buildenv.2016.08.018.

[53] Prasauskas, Tadas; Martuzevičius, Dainius; Krugly, Edvinas; Čiužas, Darius; Stasiulaitienė, Inga; Sidaravičiūtė, Rūta; Kaunelienė, Violeta; Šeduikytė, Lina; Jurelionis, Andrius; Haverinen-Shaughnessy, Ulla. Spatial and temporal variations of particulate matter concentrations in multifamily apartment buildings // Building and environment. Oxford : Pergamon-Elsevier Science. ISSN 0360-1323. eISSN 1873-684X. 2014, vol. 76, p. 10-17. DOI: 10.1016/j.buildenv.2014.02.010.

[54] Kaunelienė, Violeta; Prasauskas, Tadas; Krugly, Edvinas; Stasiulaitienė, Inga; Čiužas, Darius; Šeduikytė, Lina; Martuzevičius, Dainius. Indoor air quality in low energy residential buildings in Lithuania // Building and environment. Oxford : Elsevier. ISSN 0360-1323. eISSN 1873-684X. 2016, vol. 108, p. 63-72. DOI: 10.1016/j.buildenv.2016.08.018.

energy and other buildings. Energy demand for space heating in such buildings is comparatively low, therefore ventilation systems can be used for heating purposes by introducing warm air even with the low air change rates[55].

- The stratification of air can have effects on the concentration of pollutants in the breathing zone and ventilation effectiveness may be significantly affected by air distribution method and the position of the pollution source. Contaminant stratification is possible at lower flow rates and higher density of contaminants.

- Combined air heating and ventilation systems are often used in low energy buildings. However, running these systems at the heating mode increases vertical air temperature gradient in rooms and can have a negative effect on indoor air quality.

- IAQ and thermal comfort is important for all generations, including elderly people. Sometimes older people need to learn how to use new tools appearing in their living environment or behave in different ways. This includes the regulation of HVAC system and thermal comfort devices in case of mechanical ventilation, or learning about the advantages of opening windows more frequently in insulated buildings where natural ventilation is present.

Examples of achievements and findings from *Holzforschung*, Austria
Indoor Air Quality

Holzforschung Austria has a long tradition of accredited testing, inspection and certification, active standardization, as well as research and development with respect to emissions, especially those coming from wood and timber products. Throughout centuries, formaldehyde has been the main issue of concern. For more than a century issues related to VOC-emissions (volatile organic compounds) have been studied. This report focuses especially on the major research activities within the last century concerning indoor air quality.

1 VOC - emissions from timber and toxicological aspects

The project ran from 2008-2010 and was financially supported by FFG (*Österreichische Forschungsförderungsgesellschaft*, FFG number 818628) - the Austrian research promotion agency, and by the Austrian Association of the wood working industry (*Fachverband der Holzindustrie Österreichs*) and their members.

1.1 Achievement

Step-in-stone for VOC measurement based on thermodesorption gas chromatography coupled with mass spectrometry (TD-GC/MS), substance specific qualitative and quantitative determination of VOCs (calibrated ever since approximately based on 75 typical individual substances) and generation of the

[55] Jurelionis, Andrius; Gagytė, Laura; Šeduikytė, Lina; Prasauskas, Tadas; Čiužas, Darius; Martuzevičius, Dainius. Combined air heating and ventilation increases risk of personal exposure to airborne pollutants released at the floor level // Energy and buildings. Lausanne : Elsevier. ISSN 0378-7788. eISSN 1872-6178. 2016, vol. 116, p. 263-273. DOI: 10.1016/j.enbuild.2016.01.011.

base for accredited testing according to relevant standards.

1.2 Content and Findings
Generation of a wide matrix for typical VOC emissions of building products, furniture products, flooring products, wood species, wood qualities while considering the impact of origin, as well as thermally modified wood. Despite that, a set of typical accompanying non-wood products were evaluated.

Support of Karl Dobianer (independent researcher) within the development of an independent toxicological assessment system (TIAC: tolerable indoor air concentration) based on published and reliable toxicological thresholds, optionally also including odour. Evaluation of the overall toxicological profile based on the hazard index HI, where values up to 1 are safe for all humans, even for young children, elderly people. or persons suffering from specific illnesses (e.g., upper respiratory defects). Values between 1 and 1.5 can be seen as an unspecific border zone whereas with values above, individuals might start showing specific reactions of the contamination. At a range of approximately 4, alterations are usually recommended. The system was since used in a different project, and Karl Dobianer frequently adapts it based on the current state of the art. The TIAC system is also accepted at Austrian cords based on expert opinions.

Most assessed products turned out to be safe with respect to their VOC emissions. Some common substances were identified that might lead to customer complaints. In rare occasions, individual products failed, for example, due to the emission of CMR substances (carcinogenic, mutagenic, or reproduction toxic) such as furfural (e.g., due to specific conditions of thermal treatments).

2 HFA Timber - Indoor Air Quality
The project ran from 2009-2014 and was financially supported by FFG (Österreichische Forschungsförderungsgesellschaft, FFG number 820501) - Austrian research promotion agency, and by a selection of individual industry partners from wood and wood-related industry.

2.1 Achievement
Within this project, the first two 30 m³ model rooms, according to the CEN TC 351 specifications of a theoretical model room (now covered by EN 16516) were constructed as real stand-alone buildings fabricated of conventional building products. One is still in use and can be equipped with any kind of structural components or furnishings, such as floorings, walls, ceilings, or furniture.

2.2 Content and Findings
The project gained the first dynamic profiles of VOC-decline in the built environment under controlled climatic conditions. Different building materials were accessed in labs and selected for the construction of the model rooms. The interior walls were designed in OSB (oriented strand board), plaster board, or a combination of both with or without water vapour barrier in between. As expected, natural building materials such as OSB give higher VOC emissions compared to almost inert materials. However, within reasonable time after construction, these emissions fall under any relevant threshold. By introduction of water vapour

barriers, these emissions can he held back, but typically protrude through after a certain period of time leading to delayed emission peaks.

3 Wood Comet cooperation project with Wood K plus

The project ran from 2012-2014 and was financially supported by FFG (Österreichische Forschungsförderungsgesellschaft) - the Austrian research promotion agency, and by the Austrian Association of the wood working industry (Fachverband der Holzindustrie Österreichs) and their members. Holzforschung Austria was a subcontractor of Wood K plus.

3.1 Achievement

The inter-laboratory comparison between the involved partners clearly demonstrated the problem of applying Toluene-d8-equalents for the characterisation of VOCs in comparison to substance specific evaluation based on calibration. The Td8-resultes deviated almost up to a factor of ten from the reference.

3.2 Content and Findings

Different building products used for the creation of 30 m³ model rooms were assessed under controlled conditions. The VOC concentrations within two different model rooms were measured following each individual finishing stage until final applications. Typical daily activities, such as cooking, smoking, cleaning etc., were performed. These activities most commonly lead to the exceedance of threshold values for specific substances within the indoor air (e.g., limonene when peeling oranges). The construction products and furniture could be seen as only a baseline for indoor VOCs compared to the constant impact of human activity.

4 BIGConAir

The project ran from 2012-2015 and was financially supported by FFG (Österreichische Forschungsförderungsgesellschaft, FFG number 836468) - the Austrian research promotion agency, and by a selection of individual industry partners from wood and wood-related industry. Holzforschung Austria was subcontractor of University of Innsbruck.

4.1 Achievement

Based on the data generated within this project, the first mathematical model for the long-term development of VOC-concentrations in the indoor air was applied. It was possible to fit the model used within EN 717-1 for formaldehyde emissions from a single product under controlled testing conditions for up to 28 days. VOC-measurements (single substances and sum-parameter)derived from real environments and were measured for a much longer time.

4.2 Content and Findings

Long-term indoor air quality was measured in two different office containers made of wood with different constructions. To enable comparison, the same was done in a steel container. Later, the steel container was equipped with loam plastering. All containers were equipped with typical and comparable office furniture and used on daily basis. In order to see the additional contribution from the furniture, the latter was frequently removed and brought back before and after the measurement. While

the steel container showed almost no VOC-emissions, the wooden containers showed a typical decline throughout several months. In all cases, the furniture gave a certain additional contribution. However, in all cases, VOC contamination of indoor air was acceptable or low. In contrast, the subjective sensation was, that the indoor air quality within the steel container was worse compared to the wooden one. Loam plastering improved the subjective sensation of indoor air quality within the steel container.

5 Wood2New

The project ran from 2014-2017 and was financially supported within the WoodWisdom Net+ program (number 101005), and by CEI-Bois - the European Confederation of Woodworking Industries as well as a selection of individual industrial partners from wood and wood-related industry. Holzforschung Austria was partner within a consortium led by Aalto-University.

5.1 Achievement

The development of the ISO 16000-3 method for the measurement of carbonyl substances such as formaldehyde.

First known long-term indoor air quality assessment within a real environment of residential housing.

5.2 Content and Findings

Thirteen building objects got monitored during the phase of building, move in, and operation within the first months. Six objects were timber frame constructions, six were made of solid wood, and one built of concrete served as a reference. In addition to VOCs and VVOCs, other indoor air quality parameters, such as particular mater, airborne microorganisms (mould, yeast), temperature, relative humidity and ventilation rate, were assessed. Furthermore, human health parameters were assessed: blink rate, pulmonary function, pulse and blood pressure, self-assessments of well-being.

Although VOC emissions were high during the building phase and most likely increased at the move in, they showed a specific decline within the first months. In general, good indoor air quality was reached within reasonable time in all objects. However, toxicologically relevant substances could be found in detached occasions, and their origin was found. Controlled ventilation proved to lead towards better indoor air quality compared to manual ventilation. The self-assessment of well-being of residents was generally on a very high level (“excellent”, “outstanding”), even throughout times of elevated emissions.

In addition, also the influence of different wood modification and surface treatment methods on the emission profile, depending on variable climatic conditions from different wood species, was studied. Specific alterations of sorption isotherms could be seen.

6 Brand Wasser Schaden (Fire Water Damage)

The project started in 2016, ending 2019, and is financially supported by FFG (Österreichische Forschungsförderungsgesellschaft, FFG number 850936522) being the Austrian research promotion agency, and by a selection of companies from

building refurbishment industry.

6.1 Achievement
The development of a straight-forward measurement method for odour-relevant VOCs after fire. Assessment of typical odour-relevant VOCs after fire depending on different construction- and interior products.

6.2 Content and Findings
Specimens from selected building and interior products were exposed to smoke under controlled conditions and their typical emission profile was compared to the emission profile after different refurbishment techniques (e.g., ozone or enzyme treatment). Currently, experiments are being performed after a controlled fire in a specifically designed research building.

7 IASca – Indoor Air Scavenger

The project started in 2017, ending 2020, and is financially supported by FFG (Österreichische Forschungsförderungsgesellschaft, FFG number 860587) - the Austrian research promotion agency, and by the Austrian Association of the wood working industry (Fachverband der Holzindustrie Österreichs) and their members.

7.1 Achievement
The development of a novel dynamic measurement method for the evaluation of sorption and desorption of VOC and VVOC on loose materials that may be used for indoor air cleaning.

7.2 Content and Findings
The indoor air quality of existing timber- and mineral based buildings was assessed within the phase of long-term use (for several years). Some of these objects were even assessed within earlier projects, which helped in interpreting newly acquired data. The goal is to understand and model real long-term emission developments within the built environment. This will help with the selection of optimum sorption media in different stages of object use and thus improve indoor air quality.

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3. Environment, design and smart furniture for elderly

3.1 Principles of spatial design for well-being (*Veronika Kotradyová*)

Review of the literature[56] about the built environment, as it impacts the health of older people, introduces health care professionals and researchers to the Our Voice framework for engaging older people as citizen scientists in order to empower them as agents of change in improving their local built environment and ultimately advancing community health.

11 principles of spatial design for well-being are also useful in creating healthy indoor environments. Human behaviour, outlook, general wellbeing and everyday social interactions are directly tied to the natural and built environment. Spaces and their structures influence our everyday lives and may have far-reaching consequences, potentially impacting our long-term mental and physical health. Recent multidisciplinary research of human centred design on platform of BCDlab is summarized into 11 features of supportive environment for contemporary humans – "cultural animals". Lack of a supportive environment contributes to civilisation diseases relevant for public health.

Needs of human beings are changing with time. In the senior age, the formulated 11 principles of spatial design for well-being are even more important.

1.+2. FEELING OF SAFETY; PROSPECT AND REFUGE

First of all it is A feeling of safety, combined with the competence to manage risks and attractions, is connected to other important features - possibility to combine prospect with refuge, which is related to protecting one's back while having an overview of the surroundings. It is clearly reflected in space occupation, especially in public spaces. This need is related to seeing and being seen, where humans need to feel in control.

3. CONTACT WITH OUTDOOR ENVIRONMENT

A 3rd important feature of spatial design for well-being is enabling contact with the outdoors (at least visual) during the day and the possibility to control it – which is still strongly undervalued in many working environments.

4.+5. PERSONAL SPACE and INTIMACY vs SOCIALISATION

Another important issue is the need for personal and intimate space, one's own territory, and competence to occupy and control it. In the old age, controlling own space becomes especially important.

This is related to the need to switch between privacy and socialisation according to one's wishes. It depends on space arrangement supporting or postponing communication, about which a lot of knowledge is found in proxemics and

[56] Tuckett, A. G., A. W. Banchoff, S. J. Winter, and A. C. King. 2018. "The built environment and older adults: A literature review and an applied approach to engaging older adults in built environment improvements for health." Int J Older People Nurs 13 (1). doi: 10.1111/opn.12171. Available: https://onlinelibrary.wiley.com/doi/epdf/10.1111/opn.12171

anthropology. The elderly appreciate if they live in a mixed heterogeneous community in regard to age and social status. . This makes them feel included.

6. APPROPRIATE SCALE

A sixth feature is the appropriate scale and harmonised proportions of buildings and their indoor living and working environment, .where humans spend a lot of time.

7. ATTACHMENT

A seventh important characteristic is the possibility (or competence) to be attached to a place or products, to have the competence to adapt and personalize them to mirror and extend the self into the space, and thus gain a state of self-identification. This is important for both cultural and evolutionary reasons. Attachment is strongly connected with the 8th feature - maintaining the cultural sustainability through giving local identity to the built environment and lifestyle.

8. LOCAL IDENTITY

Securing identity in private and public spaces and preventing loss of local identity due to globalization.

9. BODY CONSCIOUS

It is important to have the possibility to prevent pain and body deformations due to inappropriate products and environmental settings; freedom in choice of body position and using body conscious products are crucial .

10. APPROPRIATE ENVIRONMENTAL STIMULATION

The tenth feature is the selection of adequate sensual stimuli- spaces where people spend a lot of time should not be too stimulating. It is important to provide the elderly the right amount of both stimulating and relaxing special arrangements.

11. MORE NATURAL MATERIALS

Indoor materials should be carefully chosen. Natural materials should have a priority, since they can improve human well-being.

3.2 Smart Furniture in Patent and Literature Databases - current state and results (*Ondrej Krejcar*)

Smart Devices and Smart Furniture as components of a Smart Home have attracted significant interests in the past decades. As a typical example, we can mention recent research for clocks with integrated wireless energy harvesting and sensors (Figure 3. 1,) 57 and Google Home smart speaker.

[57] Song, Chaoyun; Lopez-Yela, Ana; Huang, Yi; Segovia-Vargas, Daniel; Zhuang, Yuan; Wang, Yansong; Zhou, Jiafeng (2018): Novel Quartz Clock with Integrated Wireless Energy Harvesting and Sensing Functions. In IEEE Trans. Ind. Electron., p. 1. DOI: 10.1109/TIE.2018.2844848.

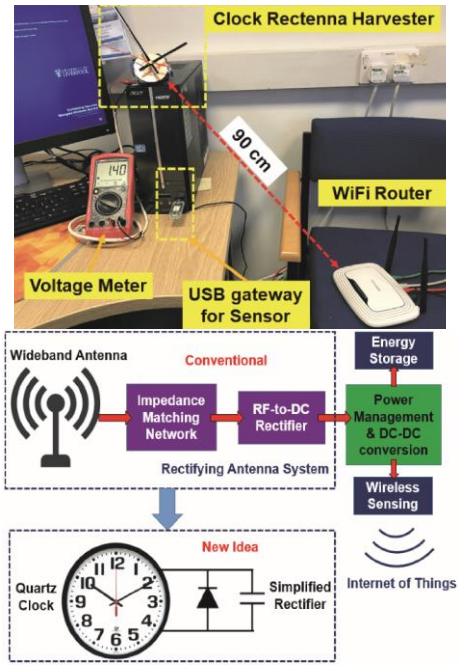

Figure 3.1. Left: Smart Furniture in a real application - clock antenna harvests energy from a typical WiFi router at a distance of 0.9 m [58]. Right: The block diagram for energy-harvesting quartz clock and its application in energy storage and wireless sensing.

Smart Furniture phrase is unfortunately used in various ways, connections, and meanings; from design of smart furniture to wall mounted electric sockets with internet connection. Here are some examples of existing definitions of smart furniture:

- Ito, Iwaya et al. in 2003 [59] defined: „Smart Furniture is a platform for systems to realize Smart Hot-spot. By simply placing the Smart Furniture, we can turn legacy spaces into Smart Hot-spots. Smart Furniture is needed to be equipped with networked computer, I/O devices and sensors. Coordination with existing network infrastructure or user's devices are also required.".
- Vaida, Gherman et al. in 2014 [60] provide a definition: "Smart Furniture is the furniture which brings added value, functionality, comfort and elegance to fit every personalized requirement issued by the user".

[58] Song, Chaoyun; Lopez-Yela, Ana; Huang, Yi; Segovia-Vargas, Daniel; Zhuang, Yuan; Wang, Yansong; Zhou, Jiafeng (2018): Novel Quartz Clock with Integrated Wireless Energy Harvesting and Sensing Functions. In IEEE Trans. Ind. Electron., p. 1. DOI: 10.1109/TIE.2018.2844848.
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[60] Vaida, C.; Gherman, B.; Dragomir, M.; Iamandi, O.; Banyai, D. (2014): Smart Furniture - Quo Vadis. In International Conference on Production Research - Regional Conference Africa, Europe and

- Braun, Majewski et al. in 2016 [61] defined: Smart Furniture is able to detect the presence, posture or even physiological parameters of its occupants“ (Figure 3. 2.).
- According to Technavio’s smart furniture market research report[62]: “Smart furniture is powered by technological advances such as network connectivity via Bluetooth or Wi-Fi and others, which helps users enhance their furniture beyond its basic analog functions. Smart furniture helps consumers in browsing the Internet for news feeds, weather forecast updates, listen to music. It also offers wireless charging slots for smartphones and has features like distance operation and others”.

Figure 3.2. Potential scenarios for wireless occupancy systems. Bed on top left, office chair on top right, wheelchair on bottom left, and couch on bottom right[63].

Due to the overlap between industry, technology, and people, both basic and applied research needs to address the available literature on the topic as well as topics related to intellectual property (patents). To find results that match the definition of “Smart Furniture”, titles, abstract and keywords will need to be searched. Number of search results according to the year is presented below (Figure 3.3.).

the Middle East (ICPR-AEM) / 3rd International Conference on Quality and Innovation in Engineering and Management (QIEM).

[61] Braun, Andreas; Majewski, Martin; Wichert, Reiner; Kuijper, Arjan (2016): Investigating Low-Cost Wireless Occupancy Sensors for Beds. In N. A. Streitz, P. Markopoulos (Eds.): Distributed, ambient, and pervasive interactions. 4th International Conference, DAPI 2016, held as part of HCI International 2016 Toronto, ON, Canada, July 17-22, 2016, proceedings / Norbert Streitz, Panos Markopoulos (eds.), vol. 9749. Cham?: Springer (LNCS sublibrary: SL3 - Information systems and applications, incl. Internet/Web and HCI, 9749), pp. 26–34.

[62] TechNavio - Infiniti Research Limited (2018): GLOBAL SMART FURNITURE MARKET 2018-2022. Available online at http://samples.technavio.com.

[63] Braun, Andreas; Majewski, Martin; Wichert, Reiner; Kuijper, Arjan (2016): Investigating Low-Cost Wireless Occupancy Sensors for Beds. In N. A. Streitz, P. Markopoulos (Eds.): Distributed, ambient, and pervasive interactions. 4th International Conference, DAPI 2016, held as part of HCI International 2016 Toronto, ON, Canada, July 17-22, 2016, proceedings / Norbert Streitz, Panos Markopoulos (eds.), vol. 9749. Cham?: Springer (LNCS sublibrary: SL3 - Information systems and applications, incl. Internet/Web and HCI, 9749), pp. 26–34.

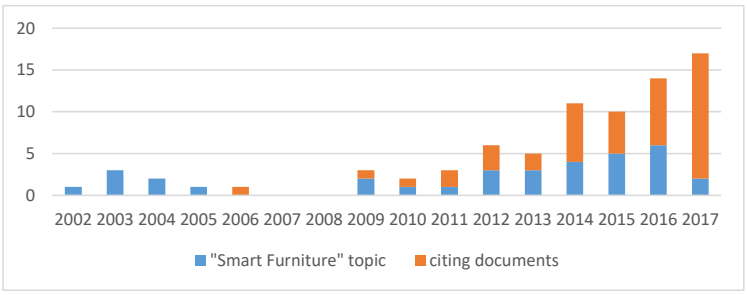

Figure 3.3. Distribution of publications for the term "Smart Furniture" in ISI WOK database (35 – blue color) and citing documents of this set (53 – red color) since 2002.

Trend showed by ISI WOK database (Fig. 3) covered all important journal articles and conference papers dealing with the term "Smart Furniture". Figure also demonstrates the increasing number of citations through the years, since the phrase was first presented and described by a Japanese professor [64].

There is one existing definition of "Smart" in the scientific book from Poslad 2009 [65], where he defined and described Ubiquitous Computing as the umbrella term for three different areas: Smart Devices, Smart Environment, and Smart Interaction. He defined "Smart" as: "Concept smart simply means that the entity is active, digital, networked, can operate to some extent autonomously, is reconfigurable and has local control of the resources it needs such as energy, data storage". His book, with 257 citations at SCOPUS database, is the most cited book in the field of ubiquitous computing.

Patent Databases

Patent database ESPACENET returned 181 results based on the search phrase "Smart Furniture" (as topic search) for years between 1998 and 2017 (there are no results for 2018 yet and older patents are not relevant for our criteria)(Figure 3.4).

[64] Tokuda, Hideyuki (2004): Smart Furniture: A Platform for Creating Context-Aware Ubiquitous Applications Everywhere. In David Hutchison, Takeo Kanade, Josef Kittler, Jon M. Kleinberg, Friedemann Mattern, John C. Mitchell et al. (Eds.): Embedded and Ubiquitous Computing, vol. 3207. Berlin, Heidelberg: Springer Berlin Heidelberg (Lecture Notes in Computer Science), p. 1112.
[65] Poslad, Stefan (2009): Ubiquitous computing: Smart devices, environments and interactions / Stefan Poslad. Chichester: Wiley.

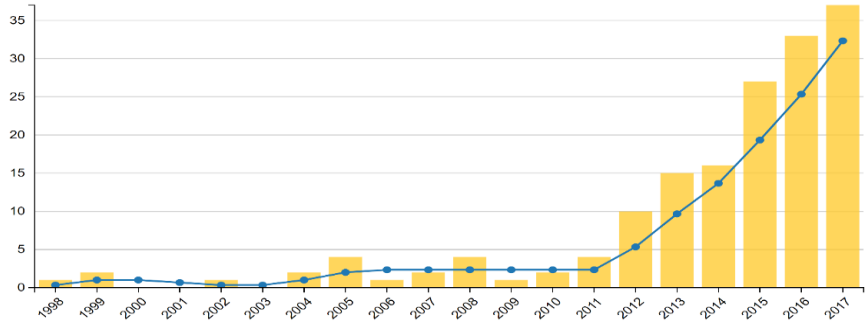

Figure 3.4. Distribution of patents throughout the years for Smart Furniture topic at ESPACENET database (181 publications in total).

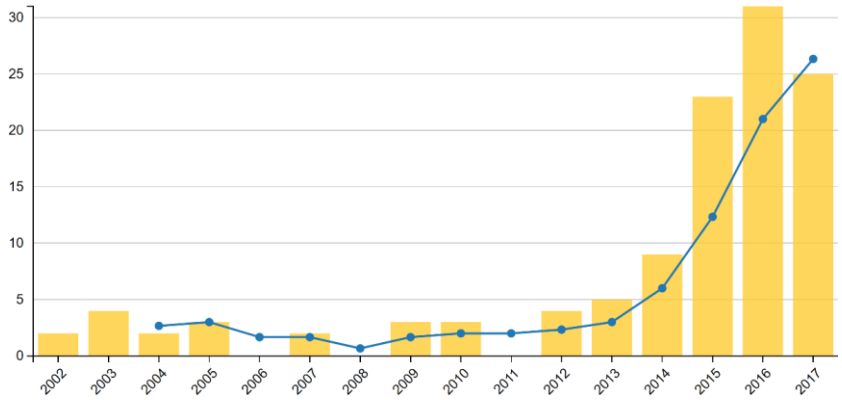

Figure 3.5. Distribution of patents throughout the years for “Smart Furniture” phrase anywhere in the application text in the ESPACENET database ordered by application date (total of 117).

The first relevant patent in the history containing the phrase "Smart Furniture" is probably "RFID smart office chair" by Hagale et al. (Hagale et al. 2004) (Figure 3. 6.) (4x in Abstract, 40x in Claims, 27x in Description). This patent application contains "Smart Furniture" phrase 71 times (4x in Abstract, 40x in Claims, 27x in Description). This patent is also the most cited (cited 71 times by other patents) from all patents covered by this search. Total number of citations is 123.

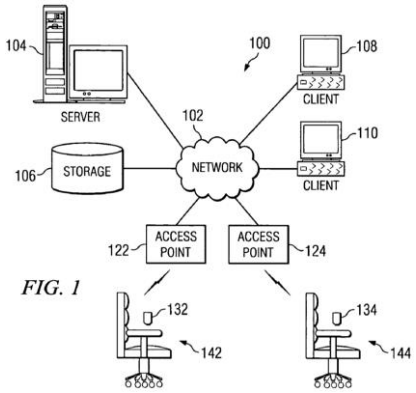

Figure 3.6. Schema of Smart Furniture by Hagale et al. from IBM company in August 2004 [66].

Other patents from search unfortunately do not have any citations related to "Smart Furniture" with the exception of "Novel dining table capable of achieving combined and separate use of mahjong machine and dining table" from Chen Jinchen - China [67] with one cited patent.

One of the most recent (2018) patent applications comes from China and has spread worldwide [68] .It deals with a personalized Smart Furniture which can be controlled with multiple options based on y gesture recognition and emotion recognition. They described three types of inputs that are analysed: electrical, audio, and video signals[69].

[66] Hagale, Anthony Richard; Kelley, Jason Ernest; Rozich, Ryan (2004): RFID smart office chair. Patent no. US6964370 (B1).
[67] Chen, Jinchen (2014): Novel dining table capable of achieving combined and separate use of mahjong machine and dining table. Patent no. CN203914053 (U).
[68] YI XIAOYANG (2018): Furniture Control Method Using Multi-Dimensional Recognition. Patent no. WO2018023512 (A1).
[69] YI XIAOYANG (2018): Furniture Control Method Using Multi-Dimensional Recognition. Patent no. WO2018023512 (A1).

4. Social, economic and technological context[70]

4.1 Social consequences (*Sarmite Mikulioniene*)

Many people around the world can expect to live well into the older age. Increased life expectancy is one of greatest achievement of humanity. Main reasons for this are improved odds of survival of the infants fertility control, and better healthcare throughout life. Older people make productive contributions to their families and communities. Their independence and potential to contribute to the community can be limited by preventable disease and disability and by lack of the appropriate healthcare. Gender is an important determinant of functional capacity and well-being in the older age.

Ageing of individuals can be seen from different vantage points, including family, political, and economic[71]. Ageing is more than an individual journey through time – it is a complex social process that influences other people

Social inclusion from the perspective of older adults in Lithuania[72]

Use of technologies in maintaining autonomy of frail older persons

Although Lithuanian population is ageing, it has one of the shortest expectancies of autonomous life in Europe. An increasing number of the elderly results not only in ageing society, but in increasing morbidity as well. Reality of life is encouraging healthcare systems to consider the needs of older patients and to assess them comprehensively, which is not limited to a physical assessment but includes an evaluation of functional state, cognition, socioeconomic status, home environment, identification of geriatric syndromes and vulnerability factors, and frailty. The term "frailty" is used to describe the status of the elderly person who can usually perform basic daily tasks, but due to the decline in various functions, changes, or disorders cannot quickly restore the strength. Concomitant diseases, disorders, disability, and frailty were considered as synonyms, but the researchers have recently agreed that these terms do not mean the same. The social component of supportive environments is composed of people (family, friends, professional caregivers) who provide help. The physical component includes technologies that make living easier and more autonomous. Gerontechnologies in vulnerable and frail elderly people can compensate for their impaired orientation and memory, widen their communication options, exchange information, and move. With the help of gerontechnologies, safe home environment and health monitoring can be ensured. In this article, algorithm for maintaining autonomy in older persons (created by the authors of this text) is presented[73].

Needs of geriatric patients living at home and meeting them by technical means

Studies show that people with disabilities and older people are reluctant to use services of healthcare institutions. Similarly, families and other informal carers

[70] Julie Byles. Our Ageing World. B.K.R. Nair (ed.), Geriatric Medicine, DOI 10.1007/978-981-10-3253-0_1

[71] Leslie A. Morgan, Suzanne R. Kunkel. Aging, Society, and the Life Course, Fifth Edition. 2016. Springer Publishing Company.

[72] Sarmite Mikulioniene

[73] Damulevičienė Gytė, Lesauskaitė Vita, Knašienė Jurgita, Macijauskienė Jūratė (2010). „Technologijų pritaikymas pagyvenusio amžiaus žmonių savarankiškumui palaikyti". Medicina (Kaunas) 2010; 46 (1 priedas) [Use of technologies in maintaining autonomy of frail older persons]

prefer home care. The purpose of this review is to examine the needs of geriatric patients living at home that can be fulfilled by technical means, and the options of remote care for the elderly. Needs of geriatric patients that can be met by technical means, are mobility, security, communication, recreation, vital functions monitoring, chronic disease control assurance, and assistance in memory. There is a large number of telehomecare technologies that can monitor chronic illnesses and vital functions. The main factors that determine the development of these technologies are an aging society and rational health care policies. The purpose of remote home care is to improve quality of life and promote independence by rationally using the resources and providing services at home. Telemedicine devices make it possible to monitor patients' body temperature, heart rate, respiratory rate, blood pressure, blood glucose, prothrombin time, and oxygen saturation.[74]

Levels and characteristics of the digital divide: a case study of Lithuania

After the sudden growth of popularity of IT and the internet, scholars have noticed emerging differences between usage or non-usage of the internet among different individuals and groups. These differences were defined as the digital divide. At first, more attention was given to the differences of access to IT and the internet, but today, scholars are focusing on another level of the digital divide – one determined by skills, perceived value, and motivation. In this article, we examine the characteristics of the different levels of the digital divide by analszing various statistical indicators. We seek to explain which groups of Lithuanian society feel the social and digital divide the most; in addition, we explain the features and changes of every level of the digital divide.[75]

4.2 Economic consequences of investing in smart habitat (*Petra Marešova*)

The increasing reliance on healthcare and preventive measures results in higher expenses in health and social systems [76], [77], [78] that are intended as help for people in all age groups. From the financial point of view, it is not enough to use individual expense data to decide about the implementation of new interventions. The evaluation needs to be based on the comparison of effectiveness and success rates of a specific intervention, its impact on the quality of patients' lives, as well as on the financial cost.

[74] Lesauskaitė, V. Macijauskienė J., Širvinskienė E. (2009) „Geriatrinių pacientų, gyvenančių namuose, poreikiai ir jų užtikrinimas techninėmis priemonėmis", Gerontologija 2009; 10(3): 176–182 [NEEDS OF GERIATRIC PATIENTS LIVING AT HOME AND THEIR ENSURING BY TECHNICAL MEANS]

[75] Šuminas Andrius, Gudinavičius Arūnas (2018). „Skaitmeninės atskirties požymiai ir lygmenys: Lietuvos atvejo analizė". INFORMACIJOS MOKSLAI, 81 DOI: https://doi.org/10.15388/Im.2018.0.11937 [LEVELS AND CHARACTERISTICS OF THE DIGITAL DIVIDE: A CASE STUDY OF LITHUANIA]

[76] Maresova P., Zahalkova V. The economic burden of the care and treatment for people with Alzheimer's disease: the outlook for the Czech Republic. Neurological sciences. 2016, 37(12), s. 1917-1922. ISSN 1590-1874.

[77] Maresova P., Klimova B., Novotny M., Kuca K. b Alzheimer's and Parkinson's disease: expected economic impact on Europe – a call for a uniform European strategy. Journal of Alzheimer's disease. 2016, 54(3), s. 1123-1133. ISSN 1387-2877.

[78] Maresova P., Mohelska H., Dolejs J., Kuca K. a Socio-economic Aspects of Alzheimer´s Disease. Current Alzheimer research. 2015, 12(9), s. 903-911. ISSN 1567-2050.

The importance of the significant financial burden associated with the care for elderly was recognized by many studies[79] and international strategies (e.g., Innovation for Active & Healthy Ageing, Integrated care: health and social care become one)[80], [81], including the current study that was conducted by the team members. The study was able to show, on an example of people with neurodegenerative illnesses, that the expenses for their care are considerably higher than expected. (Table 4.1.). The need to find the solution to this problem is obvious[82].

Table 4.1.

Financial burden of the treatment and the care for patients with neurodegenerative illnesses

	Mean (billions EUR)			**Range (billions EUR)**		
Year	**2010**	**2030**	**2050**	**2010**	**2030**	**2050**
Alzheimer's disease (AD)	182,880	256,400	342,785	60,616- 316,97	84,985-444,402	113,618-594,130
Parkinson disease (PD)	6,332	8,878	11,869	4,295-8,596	6,022-12,052	8,052-16,113
Total	191,222	267,308	356,705	66,922-325,572	93,037-456,455	123,720-610,243

Source: (Maresova et al.*b*, 2016)[83]

Integrated ICT solutions that would improve healthy and safe aging of elderly play an important role in this area[84],[85]; [86]. The potential of these solutions is also seen in the possible reduction of health and social expenses.

[79] Dodel R., Belger M., Reed C., Wimo A., Jones R.W., Happich M., Argimon J.M., Bruno G., Vellas B., Haro J.M. (2015). Determinants of societal costs in Alzheimer's disease: GERAS study baseline results. Alzheimers Dement. 11(8):933-45. doi: 10.1016/j.jalz.2015.02.005

[80] European Comission, 2017A https://ec.europa.eu/research/innovation-union/pdf/active-healthy-ageing/ageing_summit_report.pdf

[81] European Comission, 2017B https://ec.europa.eu/digital-single-market/en/integrated-care-health-and-social-care-become-one

[82] Maresova P., Klimova B., Novotny M., Kuca K. b Alzheimer's and Parkinson's disease: expected economic impact on Europe – a call for a uniform European strategy. Journal of Alzheimer's disease. 2016, 54(3), s. 1123-1133. ISSN 1387-2877.

[83] Maresova P., Klimova B., Novotny M., Kuca K. b Alzheimer's and Parkinson's disease: expected economic impact on Europe – a call for a uniform European strategy. Journal of Alzheimer's disease. 2016, 54(3), s. 1123-1133. ISSN 1387-2877.

[84] Maresova P., Klimova B., Novotny M., Kuca K. b Alzheimer's and Parkinson's disease: expected economic impact on Europe – a call for a uniform European strategy. Journal of Alzheimer's disease. 2016, 54(3), s. 1123-1133. ISSN 1387-2877.

An ongoing study compares five different population scenarios of people with Alzheimer's disease –it involves the administration of different kinds of medication compared with a scenario with no change in treatment up to the year 2080. The research uses computer simulations to formulate predictions. Changes in economic impacts are expected starting from the year 2023, when new medication is anticipated on the market. The results clearly illustrate that any intervention aimed to keep the patient in any stage of the disease for a longer period of time means the rise of treatment and care costs as well as the growth of the number of Alzheimer's disease patients. Prolonging the life of Alzheimer's disease patients is meaningful in terms of their quality of life, so when new medication is introduced, the society must be ready to bear the increased economic burden.

This model is a base for other future variants based on the improvement of environmental conditions (smart habitat) and their impact on savings in care.

To calculate savings it is important to consider:

- BIA (budget impact analysis) method that suggests a process (model) for the formulation of the impact of expenses connected to the aging population on the public expenses, mainly in healthcare and social care
- use the the access to other professionals (due to the membership in European Cooperation) that consider ICT solutions for elderly people to suggest a model which formulates the potential savings (when supported by evidence) using the specific ICT solutions in health- and social care while considering future changes of the elderly population.
- the creation of other types of expense models for specific disabilities of elderly people, which ICT should find solutions to – and the impact on health- and social care.

4.3 Quality of life in context of smart ageing (*Baraković Sabina and Baraković Husić Jasmina*)

In the following years all life spheres will be flooded with smart things and systems. These systems will completely change everyday activities by creating opportunities for development and innovation, which in turn will bring in countless benefits. Smart systems will connect homes, cars, governments, health, etc. This concept will also change the way people interact with the society and things around them and try to simplify our lives. Generally, the ultimate goal of smart concepts should be to improve our Quality of Life (QoL).

[85] Maresova P., Klimova B., Krejcar O., Kuca K. c Legislative aspects of the development of medical devices. Česká a slovenská farmacie. 2015, 64(4), s. 133-138. ISSN 1210-7816

[86] Maresova P., Klimova B., Kuca K. d Alzheimer´s disease: Cost cuts call for novel drugs development and national strategy. Česká a slovenská farmacie. 2015, 64(červen), s. 25-30. ISSN 1210-7816.

QoL definition and meaning varies for people of different gender and age groups and their cultural, economic, and educational background. To simplify, QoL is related to an overall enjoyment of life. However, some authors use a term "satisfaction" to define QoL, some use "well-being", while others use "apperception" in defining it. The example of the first type is: "*QoL is the degree of need and satisfaction within the physical, psychological, social, activity, material, and structural area*". Second type defines QoL as "*a state of well-being which is a composite of two components: 1) the ability to perform everyday activities which reflect physical psychological and social well-being, and 2) patient satisfaction with levels of functioning and the control of disease and/or treatment related symptoms*". The third is used by the World Health Organization (WHO) and World Health Organization Quality of Life (WHOQOL) Group. They define QoL as "*apperception of one's position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns*". To sum, QoL is a multidimensional concept which emphasizes the self-perceptions of an individual's current state of mind affected in a complex way by the person's physical health, psychological state, personal beliefs, social relationships, and their relationship to salient features of their environment.

Simplification and facilitation of everyday activities and improvement of QoL is especially important for the elderly since their number is significantly increasing according to available statistics. The number of people aged 60 years or older will rise from 900 million to 2 billion by 2050, and the population ages even quicker than in the past. The World Population Aging Report indicates that the growth rate of the older population is more rapid in developing countries than in developed countries.

With this in mind, it is clear that smart things and systems should be largely devoted to to improving QoL of elderly, given that they will represent 22% of the entire world population. This concept is named smart ageing. Smart ageing is defined as technology and innovation usage in both the public and private sectors to create products, services, solutions, and systems to improve QoL of people aged 50 and over. Healthy ageing is another term used to describe the concept of enabling older people to enjoy a high QoL. Term mentioned in WHO is active ageing and is defined as the process of optimizing opportunities for health, participation, and security in order to enhance QoL as people age.

Smart Ageing Ecosystem

Smart ageing ecosystem[87] includes key determinants of healthy ageing as described in EuroHealthNet, and covers economic, social, and environment dimensions in objective and subjective conditions, and all aspects of human QoL (see Fig.1). On the other hand, QoL has eight dimensions as suggested by Eurostat: material living conditions, health, education, productive and valued activities, governance and basic

[87] Baraković Husić, J., Baraković, S., Cero, E., 2019. Smart Ageing: Are we succeeding? International Conference on Medical and Biological Engineering, CMBEBIH 2019. Sarajevo, Bosnia and Herzegovina.

rights, leisure and social interactions, natural and living environment, and economic and physical safety.

Each smart ageing determinant should be contained at least in one QoL dimension (see Fig. 2). For example, New Technologies (determinant) contributes to Leisure and Social Interactions (dimension) of elderly given that it provides new ways of entertainment and communication. However, it contributes negatively to Personal insecurity given that usually people over 50 are insecure when using new devices, applications, etc., resulting in the withdrawal and abstinence from new technology products. Using New Technologies allows elderly to increase their incomes by having jobs, which consequently affects their Material Living Conditions. New Technologies also have an impact on 1) Education, by expanding the options of older adults to gain knowledge and stay competitive, 2) Productive and Valued Activities, since they can perform contemporary tasks that are useful to themselves and the community, and 3) Health, by, at a minimum, better monitoring of their health conditions.

This mapping provides a connection between smart ageing determinants and QoL dimensions, and results in QoL indicators for elderly. Knowing which features of smart ageing products and services affect which QoL dimension of elderly enables better targeting and effectively achieving the ultimate goal –improved QoL of elderly. Research and industry communities should consider this when developing their products and services.

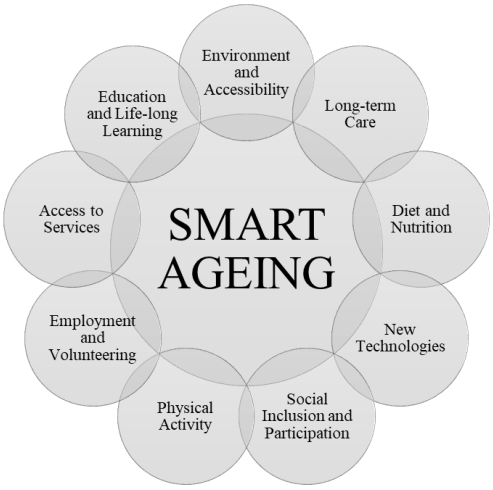

Figure 4.1. Smart ageing determinants**.**

Research findings on smart ageing and QoL

Today we are witnessing multiple smart ageing solutions being developed and produced, with many more in the announcement, but the QoL of elderly is not

noticeably improved yet. Motivated by this, authors[88] seek to give an answer to the following question: are the existing smart ageing solutions succeeding in direct improvement of QoL of elderly?

The results of the conducted survey[89] give a clear answer to it – they are not. The authors could not conclude that the existing smart ageing solutions necessarily directly contribute to QoL of elderly due to several reasons. Firstly, the existing approaches have not addressed various dimensions of QoL of elderly, nor have they included different smart ageing determinants, meaning that they are not multidimensional and comprehensive, i.e., not in line with QoL nature. Furthermore, the majority of solutions have not been developed/produced for direct usage by elderly but for people around them. Last and most important, most solutions were never properly verified by the elderly so one cannot say that they have been beneficial to them.

This conclusion opens a wide area of research issues to be addressed and corrections to be applied in the future. However, in order to succeed in improving QoL of elderly, research and industry communities are recommended to develop smart ageing solutions that cover all elderly QoL dimensions and utilize smart ageing features to do so. An important recommendation is to ask the elderly what would help them and increase their QoL in a certain context, produce solutions directly for that population, and afterwards verify their products and services with them.

[88] Baraković Husić, J., Baraković, S., Cero, E., 2019. Smart Ageing: Are we succeeding? International Conference on Medical and Biological Engineering, CMBEBIH 2019. Sarajevo, Bosnia and Herzegovina.

[89] Baraković Husić, J., Baraković, S., Cero, E., 2019. Smart Ageing: Are we succeeding? International Conference on Medical and Biological Engineering, CMBEBIH 2019. Sarajevo, Bosnia and Herzegovina.

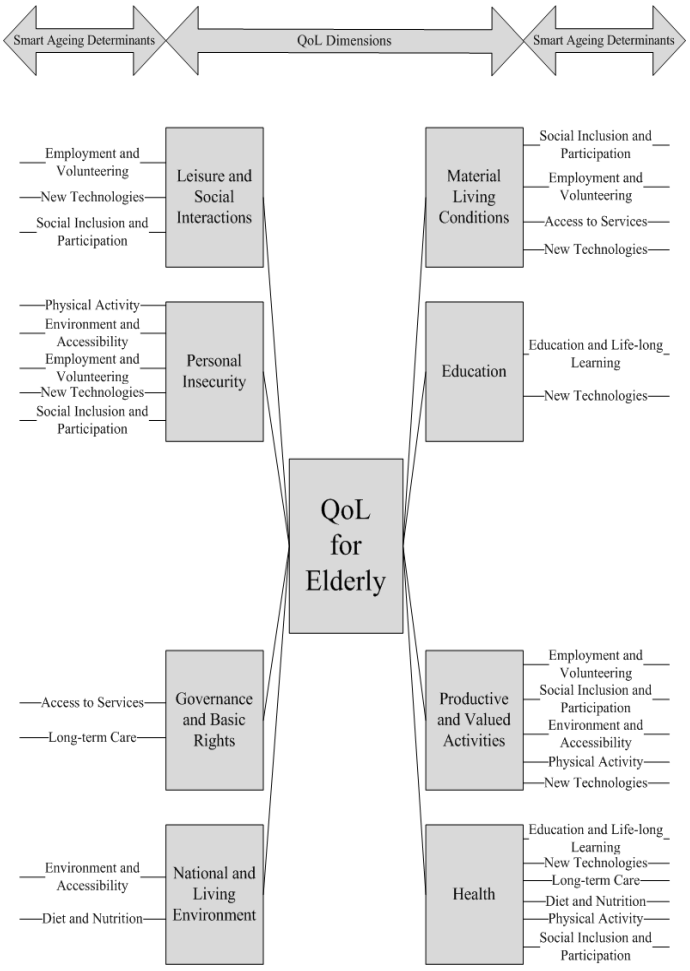

Fig.4. 2. Mapping between QoL dimensions and smart ageing determinants.

5. Policy and practices (*Jonathan Gomez-Raja*)

The 2018 Ageing Report: Economic and Budgetary Projections for the EU Member States (2016-2070)[90] looks at the long-run economic and fiscal implications of Europe's ageing population.

Strategy and action plan for healthy ageing in Europe, 2012–2020[91] outlines synergies and complementarities in cooperation with partners and with European Commission initiatives. In implementing this strategy and action plan, the Regional Office will ensure that all countries in the WHO European Region are adequately covered, as population ageing is spreading fast in the Region, making the need to prepare health and social care systems for ageing populations particularly urgent.

European Scaling-up Strategy in Active and Healthy Ageing [92] states that health and care services in Europe are undergoing changes to adapt systems to a growing demand caused by ageing and the expansion of chronic diseases. This restructuring, which combines health and social care resources, involves developing and testing innovative solutions and eventually the large-scale implementation of the most successful practices. The multitude of good examples developed throughout the EU has led to a realization that a comprehensive scaling-up strategy is needed at European level. The European Innovation Partnership on Active and Healthy Ageing (EIP AHA or Partnership), which brings together key stakeholders in this policy area and supports the good practices and References Sites developed by its partners, can act as a catalyst to foster scaling-up across regions and countries.

Artificial Intelligence for Health and Health Care[93] study centres on how computer-based decision procedures, under the broad umbrella of artificial intelligence (AI), can assist in improving health and health care. Although advanced statistics and machine learning provide the foundation for AI, there are currently revolutionary advances underway in the sub-field of neural networks. This has created tremendous excitement in many fields of science, including medicine and public health. First demonstrations have already emerged, showing that deep neural networks can perform as well as the best human clinicians in well-defined diagnostic tasks. In addition, AI-based tools are

[90] The 2018 Ageing Report: Economic and Budgetary Projections for the EU Member States (2016-2070).
https://ec.europa.eu/info/publications/economy-finance/2018-ageing-report-economic-and-budgetaryprojections-
eu-member-states-2016-2070_en
[91] Strategy and action plan for healthy ageing in Europe, 2012–2020. Available:
http://www.euro.who.int/__data/assets/pdf_file/0008/175544/RC62wd10Rev1-Eng.pdf?ua=1
[92] European Scaling-up Strategy in Active and Healthy Ageing. Available:
https://ec.europa.eu/research/innovation-union/pdf/active-healthy-ageing/scaling_up_strategy.pdf
[93] U.S. Department of Health and Human Services (HHS). Artificial Intelligence for Health and Health Care. December 2017. Available: https://www.healthit.gov/sites/default/files/jsr-17-task-002_aiforhealthandhealthcare12122017.pdf

already appearing in health oriented apps that can be employed on handheld networked devices such as smart phones.

Smart cities: digital solutions for a more liveable future[94] state that after a decade of experimentation, smart cities are entering a new phase. Although they are only one part of the full tool kit for making a city great, digital solutions are the most powerful and cost-effective recent additions to that tool kit. This report analyses dozens of current applications and finds that cities could use them to improve some quality-of-life indicators by 10–30 percent. It also finds that even the most cutting-edge smart cities on the planet are still at the beginning of their journey.

- Smart cities add digital intelligence to existing urban systems, making it possible to do more with less. Connected applications put real-time, transparent information into the hands of users to help them make better choices. These tools can save lives, prevent crime, and reduce the disease burden. They can save time, reduce waste, and even help boost social connectedness. When cities function more efficiently, they also become more productive places to do business.
- MGI assessed how dozens of current smart city applications could perform in three sample cities with varying legacy infrastructure systems and baseline starting points. We found that these tools could reduce fatalities by 8–10 percent, accelerate emergency response times by 20–35 percent, shave the average commute by 15–20 percent, lower the disease burden by 8–15 percent, and cut greenhouse gas emissions by 10–15 percent, among other positive outcomes.
- Our snapshot of deployment in 50 cities around the world shows that wealthier urban areas are generally transforming faster, although many have low public awareness and usage of the applications they have implemented. Asian megacities, with their young populations of digital natives and big urban problems to solve, are achieving exceptionally high adoption. Measured against what is possible today, even the global leaders have more work to do in building the technology base, rolling out the full range of possible applications, and boosting adoption and user satisfaction. Many cities have not yet implemented some of the applications that could have the biggest potential impact. Since technology never stands still, the bar will only get higher.
- The public sector would be the natural owner of 70 percent of the applications we examined. But 60 percent of the initial investment required to implement the full range of applications could come from private actors. Furthermore, more than half of the initial investment made by the public sector could

[94] McKinsey Global Institute (MGI). SMART CITIES: DIGITAL SOLUTIONS FOR A MORE LIVABLE
FUTURE. June 2018. Available:
https://www.mckinsey.com/~/media/mckinsey/industries/capital%20projects%20and%20infrastructure/our%20insights/smart%20cities%20digital%20solutions%20for%20a%20more%20livable%20future/mgi-smartcities-full-report.ashx

generate a positive return, whether in direct savings or opportunities to produce revenue.

- The technologies analysed in this report can help cities make moderate or significant progress toward 70 percent of the Sustainable Development Goals. Yet becoming a smart city is less effective as an economic development strategy for job creation.
- Smart cities may disrupt some industries even as they present substantial market opportunities. Customer needs will force a reevaluation of current products and services to meet higher expectations of quality, cost, and efficiency in everything from mobility to healthcare. Smart city solutions will shift value across the landscape of cities and throughout value chains. Companies looking to enter smart city markets will need different skill sets, creative financing models, and a sharper focus on civic engagement. Becoming a smart city is not a goal but a means to an end. The entire point is to respond more effectively and dynamically to the needs and desires of residents. Technology is simply a tool to optimize the infrastructure, resources, and spaces they share. Few cities want to lag behind, but it is critical not to get caught up in technology for its own sake. Smart cities need to focus on improving outcomes for residents and enlisting their active participation in shaping the places they call home.

Smart Homes for Elderly Healthcare—Recent Advances and Research Challenges[95] states that advancements in medical science and technology, medicine and public health coupled with increased consciousness about nutrition and environmental and personal hygiene have paved the way for the dramatic increase in life expectancy globally in the past several decades. However, increased life expectancy has given rise to an increasing aging population, thus jeopardizing the socio-economic structure of many countries in terms of costs associated with elderly healthcare and wellbeing. In order to cope with the growing need for elderly healthcare services, it is essential to develop affordable, unobtrusive and easy-to-use healthcare solutions. Smart homes, which incorporate environmental and wearable medical sensors, actuators, and modern communication and information technologies, can enable continuous and remote monitoring of elderly health and wellbeing at a low cost. Smart homes may allow the elderly to stay in their comfortable home environments instead of expensive and limited healthcare facilities. Healthcare personnel can also keep track of the overall health condition of the elderly in real-time and provide feedback and support from distant facilities. In this article, we have presented a comprehensive review on the state-of-the-art research and development in smart home-based remote healthcare technologies.

[95] Sumit Majumder, Emad Aghayi, Moein Noferesti, Hamidreza Memarzadeh-Tehran, Tapas Mondal, Zhibo Pang and M. Jamal Deen. 2017. Smart Homes for Elderly Healthcare—Recent Advances and Research Challenges. MDPI – Sensors. Available: www.mdpi.com/1424-8220/17/11/2496/pdf

Age friendly cities of WHO[96] is a network the encouraging the development of age-friendly cities, to tap the potential that older people represent for humanity. It outlines the challenge facing cities, and summarizes the research process that led to identifying the core features of an age-friendly city.

A European Innovation Partnership on Active and Healthy Aging (EIPAHA)[97] platform is a communication and information hub for all actors involved in Active and Healthy Ageing throughout Europe. It contains an action group about "Age Friendly environments" whose main objective on "Innovation for age friendly buildings, cities, and environments" is to bring together partners from all over Europe who are committed to implementing strategies for the creation of age-friendly environments which support active and healthy ageing of the European population.

Universal Guide for addressing accessibility in standards[98] The purpose of this Guide is to assist developers of standards (e.g., technical committees or working groups) to address accessibility in standards that focus, whether directly or indirectly, on any type of system that people use. It provides guidance for developing and writing appropriate accessibility requirements and recommendations in standards.

Examples of existing policies on accessibility in Spain

Criterios Dalco

Accessibility refers to the different dimensions of human activity: moving, communicating, reaching, understanding, using, and manipulating are some of the basic forms of human activity. Ensuring accessibility means ensuring that these activities can be accomplished by any user without encountering any type of barrier. These activities are summarized in four major groups: Ambulation, Apprehension, Localization, and Communication (DALCO).
normas@aenor.com
http://www.aenor.es/aenor/normas/normas/fichanorma.asp?tipo=N&codigo=N0040254#.Ww5Ov_ZuLIUA

Estudio de la Fundación Vodafone

The study of the Vodafone Foundation "The elderly before the Tic" explains why the reduction of the digital gap has to be a social priority , especially in the older adults where the digital gap creates greater impact, due to the problems of the elderly related to communication loneliness and care, among others.

http://enfermeriacomunitaria.org/web/attachments/article/156/LosMayoresAnteLasTIC.pro_ucm_mgmt_010759.pdf

[96]https://books.google.es/books?hl=es&lr=&id=4uWtQy6rGywC&oi=fnd&pg=PP6&dq=Age+friendly+economy&ots=XXEZ-9poOF&sig=34emAIudoe4ROTnLj-vWJDH7Y3Y#v=onepage&q=Age%20friendly%20economy&f=false
http://ec.europa.eu/research/innovation-union/images/silvereco.png
[97] https://ec.europa.eu/eip/ageing/home
[98]https://isotc.iso.org/livelink/livelink/fetch/2000/2122/4230450/8389141/ISO_IEC_Guide_71_2014%28E%29_Guide_for_addressing_accessibility_in_standards.pdf?nodeid=8387461&vernum=-2

Sistema de la dependencia en España y Tecnologias Implementadas

The system of dependency is the set of services and economic resources intended to promote personal autonomy as well as care and protection of the dependant people, through accredited public and private services , and contributes to the improvement of the living conditions of the citizens. System is supported by the most important Law 39/2006, of December 14, on the Promotion of Personal Autonomy and Care for people in situations of dependency.

http://www.dependencia.imserso.es/dependencia_01/saad/index.htm
http://www.dependencia.imserso.es/dependencia_01/saad/ley/index.htm

The only successful technological service implemented in Spain is The Andalusian Tele-Assistance Service (SAT) of the Ministry of Health and Social Welfare of the Andalusian

The Andalusian Telecare Service manages more than 17,100 calls per day. This service has served more than 35 million claims since its creation in 2002. The Andalusian Tele-Assistance Service (SAT) of the Ministry of Health and Social Welfare of the Andalusian Government has attended more than 17,100 calls per day in the first half of 2013, which translates into a total of 3,101,914 calls since January to June, which has involved more than 104,000 hours of conversation. Since the start of this service in 2002, more than 35 million calls have been answered.

In addition to the management of the calls from the SAT, in the first semester of 2013 more than 4,700 home monitoring visits were carried out in order to increase the effectiveness of the service and the perception of safety in the users. Initially collected data and the usage of teleassistance devices were reviewed, and new useful information in managing the service was obtained. **https://www.juntadeandalucia.es/agenciadeserviciossocialesydependencia/es/noticias/not_130713/wfnews_view_pub**

LIVING LAB-participation of end users

Living lab has up-to-date didactic methods which are used for research in everyday environment. The lab offers a comprehensive and direct service providing customized solutions for research projects and in the development and innovation of products and services related to the Ageing challenge.
Living Lab is a tool enabling the end user to be actively involved, from their own everyday environment, in the design process, redesign of projects, products and services, as well as in the pilot stage.
https://enoll.org/network/living-labs/?livinglab=living-lab-social-real-environments-ageing-lab

Some examples could be found in the following links:
https://enoll.org/network/living-labs/?livinglab=autonom-lab#description

https://enoll.org/network/living-labs/?livinglab=doll-danish-outdoor-lighting-lab#description
http://livinglabsocial.com/en/index-en.html whose objectives are:

- Testing, validating, and manufacturing prototypes and refining complex solutions in real life - constantly evolving environments where multiple unknown factors in traditional research interfere.
- Allowing the customization of products and services to the real needs of the end user.
- Studying the older people in their real-life environment, with a frequent observation.

This methodology is endorsed by the European Network of Living Lab.

6. Conclusion and future work

Due to the aging of the population, technological solutions may provide substantial value to the elderly The existing smart ageing approaches have not addressed various dimensions of QoL of elderly, nor have they included different smart ageing determinants. In other words, they are not multidimensional and comprehensive, i.e., not in line with QoL nature. The majority of solutions have not been developed for direct usage by the elderly but for people around them. Most solutions were never properly tested and validated by the elderly, so one cannot say that they have been beneficial to them. Although, on the one hand, the amount of technological solutions is growing rapidly among elderly and their caregivers, who are enthusiastic about using technologies to improve the independence, cognition, mood, and social functioning of the older adults. On the other hand, the increased availability and use of the technology is hindered by legislative aspects and greatly challenged by the diversity of governmental approaches in individual countries. The use of wireless devices and storage of information on the internet also leads to potential security concerns. It is therefore recommended that practitioners, policy makers, care insurers, and care providers work together with technology developers and researchers to prepare strategies for the implementation of assisting technologies in different care settings. This may help future generations of persons with dementia to use available and affordable technologies and, ultimately, to benefit from them[99].

In the first year of the COST Action, the overview of the technologies for the elderly with Alzheimer's Disease (Attachment 1), definition of smart furniture (currently – paper under review), current practices from different countries (WG3 report and Attachment 2), and examples of projects (WG3 report and Attachment 3) was mapped out.

In the future work the theoretical background will be combined with specific IT solutions of other working groups to analyse and describe new solutions and their market potential as well as legislative and social impacts.

[99] Maresova p.,*, Tomsone S., Lameski P., Madureira J., Mendes A., Zdravevskic E., Chorbevc I., Trajkovikc V., Ellene M., Rodil K. Technological Solutions for Older People with Alzheimer's Disease: Review. Curr Alzheimer Res. 2018;15(10):975-983. doi: 10.2174/1567205015666180427124454

Attachments

Attachment 1 - Research paper “Technological Solutions for Older People with Alzheimer’s Disease: Review”

Attachment 2- Existing practices regarding health care in relation to smart living spaces for older persons

Attachment 3- List of identified projects on national and European level