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**"INDEPENDENT LIVING IN AGE-FRIENDLY  
CITIES: STUDY ON DYADS OF ELDERLY  
PEDESTRIANS WALKING DYNAMICS"**

Ph.D. Thesis  
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## INTRODUCTION

The world is ageing and the expected demographic trend will dramatically lead to a substantially higher proportion of older people all over the world. These demographic changes and societal transformation differ among societies in terms of timing, speed and extent, making every country's ageing process different. Industrialising countries start from a relatively young population but the ageing trend is very fast, leading them to become in the next decades "aged societies". Post-industrialised countries such as Italy and Japan already have a high proportion of elderly population, to the extent they can be called "super-aged societies".

Changes in the demographic structure have impacts on different levels. In societal-economical-political spheres, effects of an increasing number of older persons can be seen in the changes of family composition, employment, health care and social participation. At the individual level, the transformations the ageing process produces have direct consequences on personal well-being and quality of life in general. The ageing population is not homogeneous and elderly people cannot be categorised as a uniform group as every person has the own life story. Therefore, a generalisation is hardly possible. Nevertheless, it is undeniable that the more people grow old the more the incidence of facing difficulties and experiencing critical situations increases. In later years, technology moves toward solutions that could provide help in elderly living, particularly Assistive Technology (AT) and Ambient Assistive Technology (AAL). AT might promote autonomous living reducing health and safety risks while, at the same time, it indirectly foster social inclusion and active lifestyle due to the possibility for older persons to continue living at their own place. AAL aim at improving the quality of elderly living as fall detection systems, sensors collecting living parameters, and new communication tools, just to mention a few, allow a growing number of people to age in a safer environment. With the use of assistive technologies, elderly people could be in the conditions to live in the place where they feel protected, preserving their independence, in other words, to age in place.

Since early 2000s, active ageing, supported by the European Union and the World Health Organisation (WHO), has become an important policy goal in many countries. The word "active" *"refers to continuing participating in social, economic, cultural, spiritual and civic affairs, not just the ability to be physically active or to participate in the labour force"*, having as a final and highest goal to *"extend healthy life expectancy and quality of life for all people as they age"* (WHO, 2001). Being physically and mentally involved in the society allows people to play an active role in the community and, at the same time, receive the protection they need, especially in later life. Therefore, the focus is, from one side, to foster ageing in place avoiding insitutionalisation and, from the other side, to build an environment that allows older citizens to continue participating in all kinds of social and economical activities. It is noteworthy that WHO (2008) listed social participation as the most important social

determinant of health due to the role it plays in on one's well-being. Active ageing strategies run parallel to the concept of "age-friendly". An age-friendly environment foster the engagement of people throughout life-course, aiming at preserving health and well-being through the provision of services, infrastructures and places in support to an active and healthy life in older age. The creation of age-friendly environments acknowledges diversity, fights the negative image related to ageism and ensure that everyone has the opportunity to fully participate in societal life.

Under this perspective, cities play an important role in the inclusion of the elderly population in social life as the urbanisation and ageing phenomena are entangled with each other. Today, more than half of the world population lives in urban areas, a trend that, along with ageing, is going to rise. Cities are always more populated and the older segment of the population is going to become the protagonist in metropolis' life. Older people will represent both a resource and a challenge for cities. To make cities age-friendly is one of the most effective instruments the global society has to respond to changes originated by demographic ageing, enabling people to actively live the urban environment, which in turn, will benefit from the involvement and well-being of the citizens. Along the path of elderly inclusion in social activities and urban life, it is of fundamental importance to investigate patterns unique to older adults such as physical, cognitive and perceptual transformation that occur in later life years. In the presented context, the research focused on the way elderly people experience and perceive urban places. In particular, the dynamics of single and dyads of pedestrians moving in a crowd or in a complex environment have been analysed. In the near future the number of elderly people will rise dramatically, several of whom will need to be accompanied outdoor. Therefore, is not only important to study the walking dynamics of an individual pedestrian but the peculiar characteristics of pedestrians proceeding in pair. According to the first statement of the European Charter for Pedestrians' Rights (1988), pedestrians have the right to live in a healthy environment and to enjoy public areas under conditions that safeguard their well-being from both the physical and psychological viewpoint. The Charter continued declaring that elderlies have "*the right to expect town to be places of easy social contact and not places that aggravate their inherent weakness*". Starting from this premise, the present research supports the design of applicative strategies for a safer elderly walking conditions in their daily life activities in urban neighbourhoods.

## **1.1 Contributions**

Thanks to the collaboration with CSAI-Complex Systems and Artificial Intelligence research center this work was aimed at:

- Collecting data about the perception of seniority and elderly living among the general public;
- Examining the walking dynamics of elderly people proceeding alone or in dyad in urban settings;
- Investigating the experience of senior citizens about the perceived safety of walking



in dyad and the walkable conditions of their neighbourhood.

Important concepts in an ageing society such as active ageing, age-friendly cities and independent living are proposed in the first part of the work. Then, the research activity and data analysis of the first study conducted in order to explore the perception of longevity and the adoption of elderly assistive technology is presented. The results of this study and the notion discussed in the first part of the work, constitute the premises for the second part of the thesis, which focuses on pedestrians and, particularly, on dyads of pedestrians. The definition of "dyad of pedestrians" is an original contribution of the present research as well as the study on walking dynamics and walkability perception of elderly pedestrians in urban environments. The work support the consolidated international approach which recognises that walking mobility is related to the maintenance of a healthy, active and engaging lifestyle, key elements for increasing the quality of life in ageing societies.

## 1.2 Thesis Overview

The work is organised mainly in two parts. The first part includes the social framework about ageing society and elderly living, while the second part consists of theoretical framework and empirical studies on pedestrians dynamics. A summary of the contents is provided as follows. Starting from the introduction of the latest demographic trends, the theme of *ageing society* is presented in Chapter 2, where the concept of *independent living*, possibly achieved also by the use of technology, is proposed. Chapter 3 presents the study conducted for data collection and analysis about the perception of seniority and life at old age, carried out in two waves (the first paper-based questionnaire, the second online survey) in the city of Milan. Chapter 4 presents the theme of *age-friendly* and *walkable cities*, important topics to take into consideration in relation to the phenomenon of ageing society.

The second part of the dissertation proposes the definition of "dyad of pedestrian" and an overview of the literature having as objectives pedestrian characteristics in dynamic contexts, in particular: interpersonal distance during locomotion, patterns of small groups in a crowd, elderly pedestrians exposed to environmental complexity (Chapter 5 and Chapter 6). The two following chapters present the results achieved by means of observation and questionnaire administration. Chapter 7 presents an *in vivo* observation focused on single and dyads of pedestrians performed in Galleria Vittorio Emanuele II in Milan for data collection and analysis on elderly pedestrians dynamics in a crowd, while Chapter 8 proposes the activities concerning the administration of a short questionnaire to elderly people walking in Via Padova in Milan. The aim was to acquire the direct experience of senior citizens living in the neighbourhood concerning the perceived safety of walking in pair and the walkability condition of the area. The thesis ends with a section dedicated to the final remarks and future works.



## **CHAPTER 2**

### **Towards an Autonomous Life In Old Age**

#### **2.1 Introduction**

#### **2.2 Population Ageing**

#### **2.3 Independent Living**

#### **2.4 The Role of Technology in Elderly Care**

#### **2.5 Conclusions**

#### **2.1 Introduction**

*The present chapter introduces the theme of independent living and ageing in place analysed inside the ageing society framework. Such important concepts are proposed in the first part, followed by the presentation of different possible solutions coming from the technological field. These sections constitute the background for Chapter 3, where seniority and technology are discussed through the use of a survey data analysis.*

*This chapter also includes extracts and contents of interviews carried out in collaboration with three experts in the field of ageing society, and specifically, in sociological, medical and economic field. Their valuable knowledge contributes with a view from the inside, sharing their personal experience in the discourse of ageing society related issues.*

#### **2.2 Population Ageing**

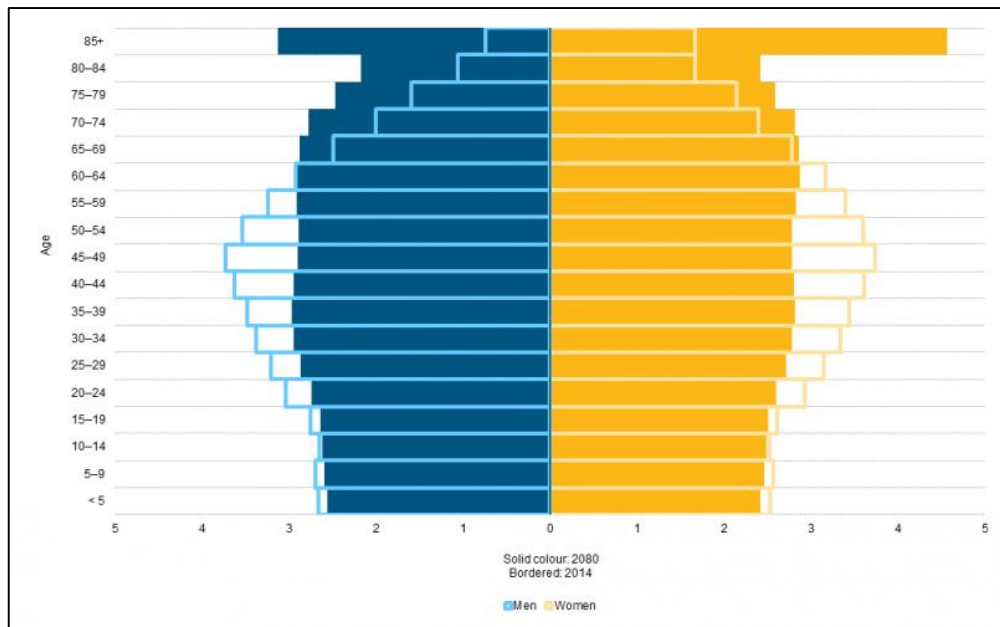
The World population is ageing rapidly and almost all the countries in the world are experiencing demographic ageing. After decades of national populations' growth (even considering an unstable path due to conflicts, epidemics and poor sanitary conditions), today several countries show a tendency of slowing demographic increase. Furthermore, some of them are starting to experience shrinking in population size and ageing society due to low fertility rate and the increase of life expectancy age at birth. This is already a major concern in several post-developed countries where the Total Fertility Rate (TFR) is below the replacement level standardised at 2.1 for developed countries (UN, 2005).

Population ageing is determined by an increase in the population's median age, a decline in the proportion of younger population and a rise in the proportion of the older population. Worldwide, the proportion of people aged 60 and over is growing faster than any other age group, particularly in developed countries where in the next years, the same phenomenon of today's developing countries will occur although the pace will be different. For instance, it took 115 years in France to double from 7% to 14% of older people in the total population while it will take only 27 years to China to register the same increase rate. Hence, the speed of population ageing is different between developed and developing countries: gradual for developed countries,

condensed in few years for the developing ones. This trend is also due to the improvement in the medical field and better general health conditions, roots of another phenomenon nowadays, longevity.

Longevity relates to a life span that is longer than life expectancy age of the population group of reference. Since people are living longer, especially across OECD countries, studies concerning life at old age cannot be neglected. According to UN, life expectancy in developed world regions at present is 78 years old, rising up to 83 years in 2050. Over 65 years old persons constitute 23% of the population in developed regions, 32% in 2050 (UN, 2013). In EU countries 18% of the population is aged 65 or more and life expectancy was estimated at 80.6 years in 2013 (83.3 years for women, 77.8 years for men). The median age in EU countries was 42.2 in 2014 (Eurostat, 2015).

**Figure 2.1: European population pyramids.**



(Source: Eurostat, 2015)

Moreover, since population ageing is the progressive ageing of the older population itself, life expectancy at older age is also a matter of interest. As reported by UN, worldwide, life expectancy at 60 years old was 20 years in 2013 while, in EU countries, 65 years old man could expect to live, on average, 16 years more, 20 years in case of women (Eurostat, 2015).

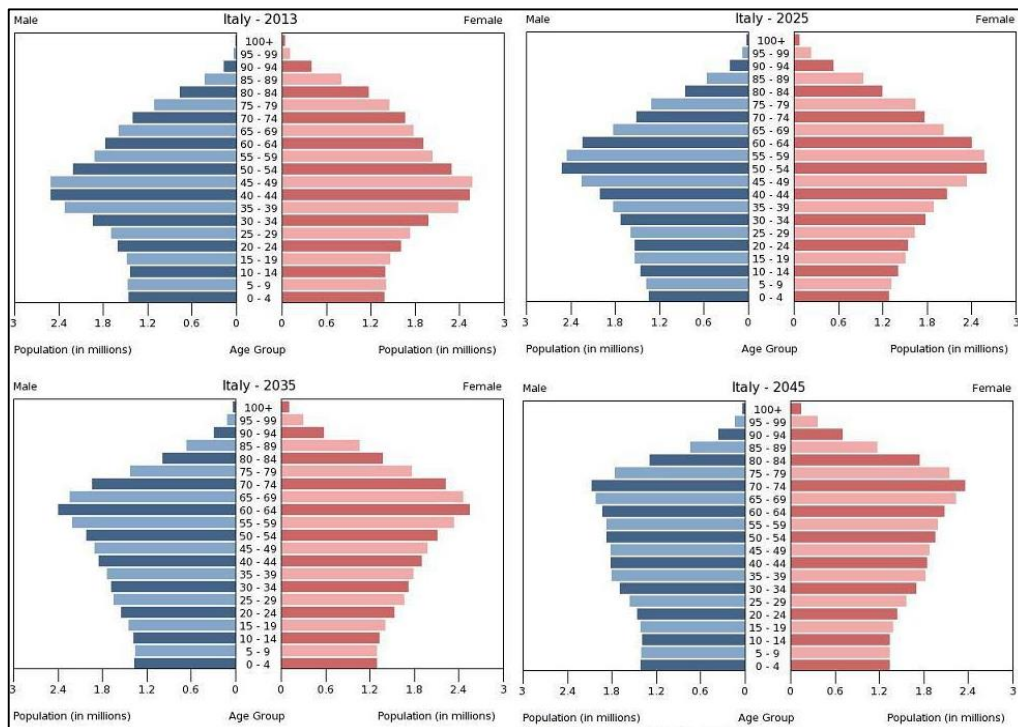
International organisations are actively involved in the development of programmes and projects on ageing since 1990s. In 1995, WHO renamed the "Health of the Elderly" programme to "Ageing and Health", highlighting the effort for the promotion of good health through the development of policies aiming at ensuring the best quality of life for as long as possible. 1999 year was named as the "International Year of Older Persons", representing a turning point in the evolution of WHO's work on ageing and health, and in 2000 the name of the programme changed again in

"Ageing and Life course", indicating the importance of a life-course approach (WHO, 2002). 2012 was nominated the year of "Active Ageing and Solidarity between Generations", with the purpose of convey a more positive image of population ageing also developing new initiatives for the promotion of their active participation in society and economy.

### Italy's Demographic Trend

According to the Italian National Institute of Statistics (ISTAT) both birth rate and mortality show a negative trend; in 2014 less children were born in the country and less people deceased compared to the previous year. For the same year, ISTAT registered 60.808 thousands people regularly residing in the country but from 2004 the number of Italian citizens living in Italy is decreasing. The total population is growing very slowly (+0.4%) even taking into account immigration flows.

**Figure 2.2: Italy's population pyramid, 2013-2045.**



(Source: US Census Bureau, 2014)

Italy's life expectancy is today 83 years old (82 years for men and 85 years for women) and will increase until reaching 87 years in 2050. Life expectancy at 65 years old is 18 years for men and 22 years for women (OECD, 2014a, 2014b). Over 65 years people accounts for around 22% of today's national population, 33% in 2050 (ISTAT, 2015).

Gender difference in life expectancy is reducing, from 5.7 years in 2004 to 4.7 years in 2014. The median age of the Italian population is 44.4 years: 14% of the total population is aged 15 years or less, 64% is between 15 years and 64 years and 22% is

above 65 years. The Total Fertility Rate (TFR, the average number of children born to a woman throughout her life) in Italy was 1.39 in 2013, below the Replacement Level Fertility (RLF, the total fertility rate at which a population replaces itself from generation to generation, not counting migration) that is usually set at 2.1 children in more developed countries and 2.3 in less developed countries (ISTAT, 2015).

### Ageing and Urbanisation

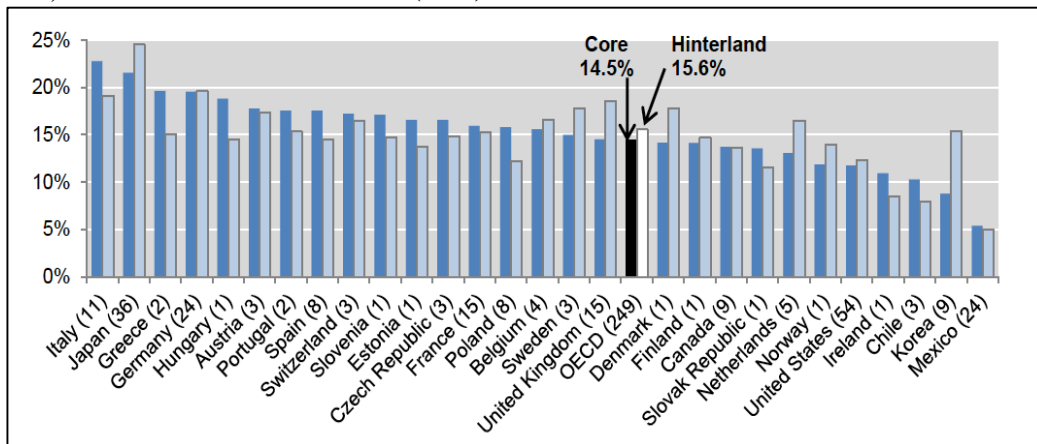
Population ageing is a long-term trend and it produces effects in the labour market, health care sector and in family structure. For instance, a growing number of younger people are migrating to cities in search of jobs, contributing to the urbanisation phenomenon as well as the abandonment of small villages in the countryside.

Today, according to WHO data, 54% of the world population live in urban areas. Moreover, projections say that the majority of the people in less developed countries will also move to urban centres in the next years. In Italy, around 70% of the population live in urban areas (The World Bank, 2015). Living in the city makes it possible to have contacts with other people and access to places more easily compared to the countryside, especially for elderly people. Cities are home to 43% of all people 65 years old and above in the OECD region. During 2001-2011 period, the number of older people increased by 24% in OECD cities and 18% in non-metropolitan areas.

A high percentage of older population is often found in residential suburbs in hinterlands. In OECD countries, 14% of the older population live on average in urban core while the 16% in hinterland. In Italy, around 23% of the total urban core population is composed by over 65 years old, less than 20% in case of residential suburbs in hinterlands. Therefore, in Italy among the elderly people living in metropolitan areas, the percentage of those settled in the city centre is on average higher than those living in wider metropolitan areas (OECD, 2015). Change in the family structure and the social organisation of the community can also be observed, from multigenerational families to smaller households of a single person. Elderly people live as long as possible autonomously to avoid being a burden on children or relatives. If, from one side, this can imply loneliness and difficulties in receiving assistance when needed, at the same time, the maintenance of independence can be a source of motivation to be vital and always reinvent oneself (Scramaglia, 2012).

There are cities that get old more and faster than other, depending on the attractiveness of the city. For instance, universities attract younger people that often remain in the host city. Culturally dynamic urban centres, which offer professional chances, are also able to maintain a city young. However, despite different patterns, cities are growing old, and they have to deal with the needs of an ever more heterogeneous citizenry.

**Figure 2.3: Average older population as percentage of total population in OECD metropolitan areas, for urban core and hinterland (2011).**



(Source: OECD, 2015)

More elderly people are city dwellers, hence, in the future more inhabitants in urban areas will be elderly people. Urbanisation and ageing are entangled with each other: elderly will increasingly utilise urban spaces, becoming the protagonists of metropolitan life. More people are going to live and age at home, the premises for a society where people continue to be as autonomous as possible even in later life. Independent living, discussed throughout the present work, is going to become one of the most impending urban phenomena of the next years.

Elderly people will represent both a resource and a challenge for cities; consequently, it is of fundamental importance to study the unique circumstances to older adults such as the way they move and experience urban places.

### 2.3 Independent Living

Countries all over the world are ageing very fast and in ageing societies the role that older people play becomes more and more crucial. For instance, nowadays and in the future, more elderly people work (paid or voluntary work), contribute to their families (giving support for everyday responsibilities such as caring for the grandchildren), and are a valuable source of experience and knowledge to share in their community. However, the above situations can only be made possible in the presence of two main conditions:

- older persons enjoy good health;
- the society is inclusive in their regards, taking into consideration their aspirations and needs.

According to WHO: "*Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*" (WHO, 1948). From this perspective, to be healthy not only refers to physical condition but it also includes the emotional health that originates from the social context.

In their study, Hirsch et al., (2000), identified two major factors affecting quality of life of an elder individual: independence and engagement. Independence is the capacity to care for oneself making one's own decisions, and is determined in relation to one's level of ability. Engagement is connected to the possibility to communicate, to share experience and friendship. The balance between independence and engagement determines an older person's quality of life. Moreover, the same study highlights the importance that all people around the elder patient play in determining the quality of life of that person. Not only the primary caregivers should be taken into analysis when talking about elderly care but also all those persons that participate in one way or another to the well-being and everyday assistance of the old person, such as family members or friends.

### Social Participation and Active Ageing

As stated by WHO, "*in all countries, and in developing countries in particular, measures to help older people remain healthy and active are a necessity, not a luxury*" (WHO, 2002). From this perspective, social participation can be strongly associated with physical and mental well-being, in older life as during the entire lifetime. Social participation refers to people's interaction and engagement with other people within a society, whether it is a defined association of people or the neighbourhood in a city.

According to Professor Coulmas, international expert for Japanese Studies at the Institute of East Asian Studies at the University of Duisburg-Germany, social participation means "*not only to contribute to the society but also to be engaged in social life.*"<sup>1</sup> If it is true that even simple activities such as meeting friends could be considered as social participation, they do not necessarily mean to be socially committed. Also, the fundamental role communication and interpersonal relations play especially for elderly people, must not be disregarded. In Japan the phenomenon of *Kodokushi* ("lonely death") is sadly known these days, especially as a consequence of the increase in the elderly population and change in the Japanese family system. Social isolation and lack of contacts might be regarded as the main reasons why more and more old people are found dead in their houses without anyone knowing about the person's condition. A 2010 study carried out at NIDI (Netherlands Interdisciplinary Demographic Institute) reveals that, along with the 15-24 years range, it is the 80+ years old who suffer most from loneliness (above 40%), mainly because of the absence of a partner and friends. The percentage of non-institutionalised older adults aged 55-89 who indicated 0 to 3 persons as their social network is up to 20% in case of no partner (7% in case of living with a partner)<sup>2</sup>.

Activities such as working, volunteering, engaging in recreational activities and from a broader viewpoint, living the community with the community, is the heart of social participation. In this way, a sense of belonging and trust to people and places

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<sup>1</sup> From the interview to Professor Coulmas, July 3, 2014, Tokyo-Japan.

<sup>2</sup> From Tineme Fokkema presentation "Loneliness among older adults: theory and empirical evidence". Seminar at the Department of Statistics and Quantitative Methods at the University of Milan-Bicocca, December 12, 2013.



can arise, enforcing social networks or giving origin to new ties as well. This can have positive influences on one's well-being, so noteworthy that WHO lists social participation as the most important social determinants of health (WHO, 2008). During the 1990s and early 2000s, WHO introduced the concept of "Active Ageing", which started to be one of the major topics of discussion in the international arena. At that time, in fact, the awareness inside the international community and national governments concerning ageing population trend grew to the point to take preliminary but decisive actions. The international organisation started thinking about how to face the challenges that lesser births and higher life expectancy would inevitably have produced in a time range of few decades.

The idea of Active Ageing has been originally promoted in occasion of the United Nations' Year of Older People in 1999. Then, in 2002, the WHO made a step forward, creating today's idea about the notion of "active". The word "active" "refers to continuing participating in social, economic, cultural, spiritual and civic affairs, not just the ability to be physically active or to participate in the labour force", having as a final and highest goal to "extend healthy life expectancy and quality of life for all people as they age" (WHO, 2001).

Therefore, Active Ageing refers to the idea that older citizens are put into the conditions of continuing participating in all kinds of social-economical-political activities, e.g., to be involved in the decisions of the community, working full-/part time or being a volunteer, walk in the neighbourhood and have access to its services and infrastructures. Active ageing policies and programmes are necessary to enable older people to continue working and preventing disease that constitute a cost for the individual, families and the health care system (WHO, 2002).

At the family level, interdependence and intergenerational solidarity are as important as living autonomously and healthy, since ageing in a context of friends and family members can provide adequate protection, security and affection. To continue being independent, mobility and accessibility are also key factors in the discourse of active ageing as they presume the capacity to move independently and safely from one place to another.

### Mobility

Mobility, in its narrowest sense can be defined as the ability to travel (Giuliano et al., 2003). More comprehensive definitions refer to mobility as the ability to reach the desired goods, services and activities (Litman, 2003b) and being able to travel where and when a person wants, having the right information concerning the travel and the eventual means to reach the desired place (Suen and Sen, 2004). Metz (2000) further expanded the definition of "mobility", making additional association:

- Mobility as a movement that give physical benefits, improving the overall health condition;

- Mobility as an activity that give psychological benefits such as feelings of independence and self-esteem;
- Mobility as a way of being part of local community life.

Contemporary society is grounded on mobility. To move, walk and travel across the space has not only a functional end but have also meanings according to the contexts.

John Urry in his famous essay of 2002, discussed mobility and travel, particularly concentrating on different ways of travelling and the meaning each of them assumes. He also argued that sociology as a discipline should not only focus on direct social interaction between people but also on the sense of connection built among people that persist even when the presence of the actor is not physical. Hence, all forms of sociality result from the combination of proximity and distance (Urry, 2002). Similarly, geography also concentrates on mobility, but it does not focus on the social bases that travel has in relation to mobility itself. In this context, it is important to match both disciplines through common interests, namely, mobility and social interaction in their widest meaning. Urry continued arguing that physical proximity is particularly important in determined moment or episodes in daily life, sometimes felt as desirable, appropriate or obligatory. For example, it might happen to participate to a job meeting because presence in first person is requested, thus, it is mandatory to travel to the place of the business gathering. Or, travelling to a place people always just hear about, such a city or a historical venue, because they really want to visit it. Therefore, co-presence in case of people gathering and direct experience in case of the visit of a geographical space are two essential features in the discourse of social mobility.

Boden and Molotch (1994) paid much attention to the role of co-presence in social interaction, being skeptical about the possibility of replacing physical mobility with virtual travel through technological devices and communication tools. In particular, co-presence refers to that degree of proximity that concerns eye contacts, body language and all connected feelings producing what Simmel called the "most complete reciprocity" of person-to-person interaction (Simmel et al., 1997: 112).

Co-presence interactions can be divided in face-to-face (e.g., going to meet and talk in person to a friend), face-the-place (e.g., going to visit a natural park and experience in first person the surroundings) and face-the-moment (e.g., going to a live concert and feel the atmosphere of the event) (Urry, 2002). If co-presence is a central element in the construction of sociality, for Urry mobility becomes the means to "gluing social networks together", generating relations where trust and inclusion are the main pillars. Urban spaces and roads are of central importance for people to meet in contemporary cities and the occasions to directly participate in activities and rituals have been increasing, due to the demand for collective gathering (Gottmann, J. & Muscarà, C., 1983).

With regards to road and people mobility, Litman (2003b) claimed that walking is more important than the extent people used to think about it. Everyday the distance covered on foot is 3% only, but if it is considered that 25% of total everyday travelling time is made by walking, the viewpoint changes drastically. Hence, even living in a "auto-mobile" society (Urry, 2002), the importance of walking activities deserves more attention to be treated not only as a means of travelling but as a lifestyle (Colleoni in Calzati and de Salvo, P., 2012).

### Ageing in Place

Today's population is potentially more engaged and lively in older life than before and from latest trends one could presume that more elderly people will be actively moving and living the surrounding environment. Demographic trends produce effects that are going to change the structure of different aspects of life, from job positions to health care and several others. Consequently, the society as a whole will have to adapt to new situations generated by transformations in the population's shape. Not only the government should take action with projects and investments in order to meet the needs of an ageing population but it is also necessary to change the perception and spread a new culture about ageing and life at older age. In their English longitudinal study of ageing in 2002, Doctor Marmot and his colleagues expressed their viewpoint in the following passage:

*"Ask people about ageing in our society, and everyone has a view. Most would think it widely known that older age is a time of declining mental and physical function, worse health, and economic and social dependency. The elderly are a 'problem'. Indeed, a small number of people over the age of 65 fit this stereotype. Most do not. What is striking about the health and social circumstances of older people in society is how variable the picture is, ranging from this rather depressing stereotype to that of vigorous octogenarians, economically and socially independent, with little disability, wide social and cultural interests and much to contribute to society."*

(Marmot et al., 2002)

As we are going to see in the next chapters, the possibility to move independently in the city and have access to places and services is crucial for the well-being and social inclusion of the elder population. Therefore, attention should be increasingly put to mobility and elderly mobility as deeply related to health and quality of life in their widest sense.

With regards to this point in question, but not limited to this, Doctor Toshihiko Hasegawa, Full Professor at the Department of Health Policy Administration of the Nippon Medical School in Japan argued that a change of mind is necessary in order to adapt to next year's major changes.

*"The mind of people should change. Not thinking about elderly people as weak and empty, this is the challenge. This can be made possible by gathering, by cooperating and sharing experience and time."<sup>3</sup>*

Professor Hasegawa also thinks that the word "ageing" will likely fall out of use: *"When the two third of the population will fall into the age brackets of 'aged' it will be nonsense to refer to the society as 'ageing'. Necessarily, how we refer to it will also change. If we think about social capital, intergenerational relationships and knowledge transmission, the word 'ageing society' is no longer a frightening word, isn't it? If good health condition is preserved, the bad meaning one associate to ageing is lost."<sup>4</sup>*

In this discourse elderly people still have strength and knowledge to give to the society. In younger years, economic, familiar and personal aspirations absorbed their energy and time. They dedicated themselves to their job in order to be able to have a good salary, enough for their family and personal interests. At older age, their main objective is no longer to make profit but to continue being part of the system, the social system, but in a different way. This is the moment when older persons, experienced and still able to give their contribution, should have the chance to participate to social life and be active part of it. The motivation to be part of the society is not money-oriented anymore as the primary scope is to be able to give contribution for the creation of a capital, a capital for society use.

As argued by OECD (2013c), independent living is the main trend in later life today. It might implicate personal care services as ageing in place (opposed to hospitalisation or institutionalisation) may increase the demand for care support, being formal (professional caretaker) or informal (relatives or friends).

Independent living refers to the possibility given to older people to continue living at one's private home and/or inside their community, considering the preference of older adults to "ageing in place". In the future, it will be important to support those elderly people who decide to live in their homes providing help through social programmes and technology, particularly living assistive devices. Independence, support and safety will constitute key words in the discourse of ageing in place. But what "ageing in place" actually means (also "age in place")?

Wiles et al. (2011) conducted a literature review of the meaning of "ageing in place" followed by a field study in two communities in New Zealand. From their review emerged a kaleidoscope image where "ageing in place" refers to community life and independence, avoiding institutional care. This is also a preferable option for policy makers, health providers, and by many older people themselves (WHO, 2001), also due to more favourable costs if compared to institutional care.

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<sup>3</sup> From the interview to Professor Hasegawa, June 25, 2014, Tokyo-Japan.

<sup>4</sup> *Ibidem*

In recent years, with further development of new technologies for assisted living, the attention of the researchers and decision makers is also shifting to the quality of life of elderly living in a domestic environment. Living independently at home deals with suitability of the domestic environment, dealing with discourse of inclusive architecture and age-friendly design for example. However, ageing in place do not only refer to home and merely living *at* home but also covers the outdoor environment that is an equal part of ageing in *place*. From this point of view, neighbourhood and the people living in the community are central elements for elderly people to consider their living "in place". Homes are at the centre of a sort of spider web, which is made by social networks (the filaments) and the places (the connections) for every day rituals. From this viewpoint, the old person is inside the web, autonomously moving within the sociocultural context he feels attached to. Therefore, ageing in place also involves a sense of attachment and engagement in life outside home. This is the reason why both housing and the outdoor environment are entangled in the discourse of ageing in place.

As reported by Wiles et al., identity and a sense of belonging derive both from people (neighbours from a micro perspective, community from a macro perspective) and familiar places, which become resources for ageing in place along with their home. Ageing in place is seen as an advantage and a sense of security, remaining connected to one's homes and community. Moreover, it is related to the sense of identity both through independence and autonomy (Wiles et al., 2011).

In this regard, Professor Hasegawa argues:

*"I think that 'ageing in place' as a theory is very good but in reality it is not so easy. For instance, what is 'place' in Japan? Let's take an example. One person was born in Kyushu Island and then goes to Tokyo or Osaka for job. Since rents are too high in the city, he lives in suburban areas. He works long hours, come home at 10 p.m. and just go to bed and sleep. So, he has no relation with the surroundings. In such a vision, what is the real meaning of 'place'. 'Place' is something that has to be built. Social capital is fundamental in this discourse. I have heard that in Italy it is very common for people to meet at the market or talk to friends about own life's episodes. In Japan the society is different, so a formalisation of 'social capital' and occasions for foster social relations are necessary."*

Data presented in the first section give us a general picture of current demographic situation. We are going to live in a society, both at global and national level, where age groups will tend to be more heterogeneous. Compared to today, there will be less younger and more elderly citizens, in particular people in their 70s, 80s and also 90s. Such a demographic change will have important effects on every aspect of people's life, from politics to welfare.

### The pension system and the dependency ratio

The dependency ratio is an age-population proportion of the people that are not in the labor force, the *dependent* part (usually >15<64 years old), and the working age group, the *productive* part (usually 15–64 years old). This ratio helps measuring the pressure on productive population. Old dependency ratio has increased in all OECD countries from 12% in 1950 to 22% in 2010, mainly due to lower fertility rate and high life expectancy (OECD, 2013a). Since the burden on people involved in the economic market is increasing, new policies and strategies will be necessary in order to meet the new needs of the population and the labour market.

In several ageing countries the pension system and the labour market rely on traditional models' grounds that do not fit the contemporary society anymore. Professor Hasegawa argues that Japan is one of these countries, which imported the actual pension system from Europe and it urgently needs to make major changes in order to adapt a society that changes at a very fast pace. However, since there is no country in the international society, which has ever experienced such a situation, no models exist today to search for inspiration. Japan will probably be the first country to face this challenge.

According to Professor Coulmas, to rise the retirement age could be one solution in some countries but not in others. In countries such as Italy, Spain and Greece where the unemployment rate of the younger population is around 40-50% to allow older people to work is the less desirable option.<sup>5</sup>

As an alternative, programmes facilitating the transition from employment to retirement could be developed from the governments. Doctor Kazue Haga, business and economics expert and senior researcher at the German Institute for Japanese Studies in Tokyo, argues that innovation in the economic and business sector is necessary. In her opinion, a possible idea would be thinking of jobs that only the elderly could perform. In this way, younger workers and elderly people would not be competing for the same positions and, at the same time, are working in the same social and economic environment.<sup>6</sup>

*"[For instance, elderly people working] not as employees (it is difficult for a company to let them work until 70 years old) but being involved in other jobs, maybe less remunerative or formalised but regular and according to the person's desires. So, more than increasing the retirement age, the problem concerns the period of time people can work and how. More chances should be created for people to think about their career in older age. Programmes or governmental initiatives should support alternative way of working, especially to be prepared after retirement."*<sup>7</sup>

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<sup>5</sup> From the interview to Professor Coulmas, July 3, 2014, Tokyo-Japan.

<sup>6</sup> From the interview to Doctor Haga, July 3, 2014, Tokyo-Japan.

<sup>7</sup> *Ibidem*

Similarly, Professor Coulmas argues that a "*new social contract is necessary*", meaning that elderly people enjoying pension life and good health should be employed for social services, e.g., taking care of the children in order to allow mothers to go to work. In parallel, younger unemployed people could spend their time and energy caring for elderly people in need for assistance or company.<sup>8</sup>

At EU level, a few governments are developing programmes to encourage older people to continue working. However, as stated by the director of AGE Platform Europe, "*The debate around active ageing should not focus exclusively on prolonging working careers to lighten pressure on public budgets but should aim at making a society where anyone is empowered to participate at all ages*"<sup>9</sup>.

For example, the Senior Intergenerational Social Capital (SISC) project, funded with the support from the European Commission and coordinated by E.Ri.Fo (Ente per la Ricerca e Formazione-Center for Research and Training, Rome-Italy), aimed at transferring knowledge across generations. The project, run from October 2008 to August 2009, identified workers near to the retirement age and supported them in transferring their competencies to younger workers within company, promoting a transitional phase from employment to retirement as well as intergenerational learning (Euro Health Net, 2012). The same report also pointed out that employment makes feel people as valuable members of the society and is also associated to good health, contributing to prevent poor health conditions.

### Health care

The health care sector should also be prepared to supply new and diversified services in response to patients needs, in particular elderly patients. Despite the fact that "elderly" does not necessarily means "ill", it is undeniable that more care assistance is need in older days of life.

Professor Hasegawa theorised what he calls the "Care Cycle". The Care Cycle is illustrated by a spiral, representation of the various care cycles people can experience in their older years. Care assistance of elderly people differs from the one's of younger adult. In younger years, when a person suffers from a disease or is hit by an accident, is assisted for a determined period of time in order to clarify the cause and allow him/her to go back to his/her life. Episodes can repeat in time but they are likely separate and defined. However, in older life, it is more common that episodes become more acute or that health is compromised by different and severe complications.

The cycle starts when, for instance, an acute episode happens at home, such as a severe illness or an accident. The patient then enters a period of rehabilitative care after which he/she recovers and is able to go back to his life. But periodically the elderly fights against some other diseases or complications that force him/her to rely

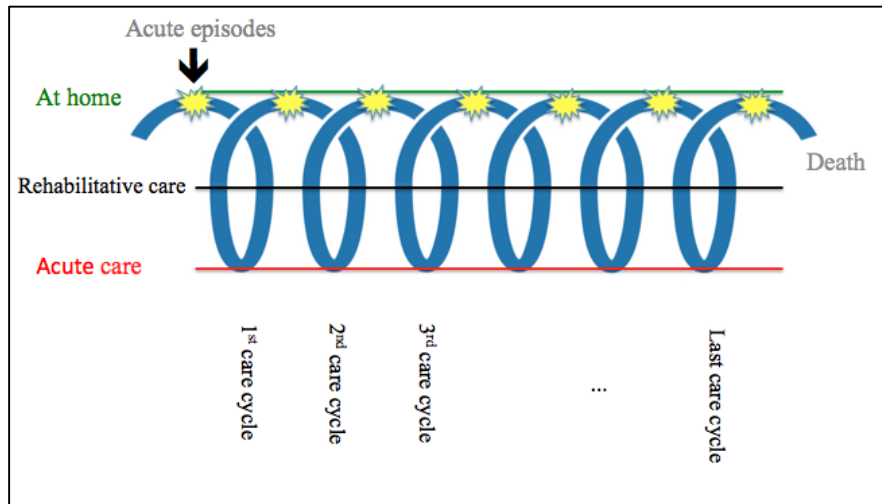
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<sup>8</sup> From the interview to Professor Coulmas, July 3, 2014, Tokyo-Japan.

<sup>9</sup> Statement by Anne-Sophie Parent, Director of the AGE Platform Europe at the 3rd EU Demography Forum in Brussels, November 23, 2010. Extracted from EuroHealthNet report, Brussels, January 2012.

on medical attention again. According to Professor Hasegawa, this kind of cycle can last 3-8 years before death.

**Figure 2.4: Care Cycle according to Professor Hasegawa<sup>10</sup>.**



(Source: Hasegawa, 2014)

Fifty years ago the hospital was in charge of assisting patients during the various phases of recovering, while today several choices are possible such as rehabilitation clinics, caring homes, long-term care institutions etc. These services concentrate on one step of the Care Cycle; nonetheless, they should be integrated in a wider system of collaboration among all the societal spheres such as health, welfare and economic sector. Such a system should be able to provide assistance for the well-being of the person as a whole. Medicine and welfare has as objective the achievement of a good quality of life for the entire society but at the same time, take into account service sustainability.<sup>11</sup>

*"To be healthy means to be able to do what one wants to and to be able to have access to the society in its broader sense. Even in case of illness or disabilities, if the person is included in a societal environment, it is possible for him/her to live in a 'healthy' way."<sup>12</sup>*

Along with a radical transformation of the health caring system, prevention becomes more urgent in order to preserve a good and healthy life style. Ageing well includes also aspects such as a correct nutrition and a moderate physical activity. They can improve the physical and mental wellbeing while promoting social contacts, for example, during every day life physical activities. Starting in young age, a

<sup>10</sup> Hasegawa, T. (2014). *Lessons from Japan to Asia on Health & Social Policies for Ageing Society*. Presented at the Annual Singapore Conference on Ageing 2014, Singapore.

<sup>11</sup> From the interview to Professor Hasegawa, June 25, 2014, Tokyo-Japan.

<sup>12</sup> *Ibidem*



moderate but regular physical activity reduces by about 25% the risks of disorders related to an inactive life style such as heart diseases, stress, depression and loneliness (WHO Europe, 2015). For older adults it is fundamental to continue being physically active. Walking regularly can be the key for them to be engaged in a sufficient level of physical activity. Providing safe and attractive environments to encourage an active life-style among elderly people is very important in order to allow them to maintain a good cognitive capacity while doing prevention of chronic disorders.

## 2.4 The Role of Technology in Elderly Care

Nowadays, new technologies can offer innovative scenarios for elderly housing. Assistive Technologies can promote independent living reducing health and safety risks and, at the same time, fostering social inclusion and active lifestyle. Information Communication Technologies (ICTs) have the potential to improve the quality of housing as well as the organisation of service supply from health professionals.

In this thesis, the main focus is on healthy and active older people. However, it cannot be ignored that there are several situations where the old relative is bedridden or suffer from dementia. In these cases, the help of Assistive Technology (AT) and Ambient Assistive Technology (AAT) can be successfully integrated in everyday life at home.

Assistive Technology is “*an umbrella term for any device or system that allows individuals to perform a task that they would otherwise be unable to do, or increases the ease and safety with which the task can be performed*” (Cowan and Turner-Smith, 1999). Ambient Assisted Living (AAL) technologies relies on Ambient Intelligence (AmI), surrounding people in an "smart" environment where invisible or embedded devices are able to collect information about the state of the inhabitants and adapt to their needs (Vasilakis and Pedrycz, 2006). Monitoring, embedded sensors and ICTs systems are today pervading elements in design and architecture inside the framework of ageing in place.

*"The history of assistive technology for elderly people is long, just to mention one, hearing devices. Technology should go towards the various necessities elderly people have, for example mobility is very important. A technology that is easy to use should be designed, today technology progresses too fast for older people."*<sup>13</sup>

In this regard, the experience of the project "Abitare Sicuri - Sicures Wohnen" carried out in cooperation with the city of Bolzano (Italy), IBM and local partners, is a successful example. In 2011, 30 elderly persons aged 66-80 years who needed health care participated in this pilot study. Their homes have been equipped with wireless sensors and they were able to receive remote care assistance from professionals. The results showed that 80% of them felt safer, 66% improved their mobility thanks to

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<sup>13</sup> From the interview to Professor Coulmas, July 3, 2014, Tokyo-Japan.

physical exercises and 50% learned a new way to communicate with other people through technology (IBM, 2011). This project's aim was to develop a sustainable business for public health assistance and the outcomes were very positive. IBM stated that such embedded systems can generate savings up to 31% while, at the same time, they contribute to improving the quality of life of the older citizens who can continue living at home independently and socially integrated (IBM, 2011).

AAL can add value to elderly living at home and be conceived as a possible way of receiving assistance while being in a familiar environment. Fall detection systems, sensors collecting and analysing living parameters, and new communication tools such as interactive platform are just some example of the available AAT that can allow a growing number of people to age in a safe environment. Smart-homes equipped with sensors, which are invisible to the user but connected to medical specialists who can analyse and monitoring the condition of the elderly at home, can be of help to families taking care of their elderly relatives and, at the same time, give the elderly the conditions to live in a place where they feel protected, preserving their independence. During the next years, technological innovation will be increasingly widespread leading to future generations more used to technological devices and applications.

Japan, the super aged-society with 25% of the population over 65 years old, is at the forefront of technological development and commercialisation of assistive devices and robots; therefore, we can already find a wide set of robots and machines on the market from kitchen robots to artificial pets. Despite a great number of elderly people can still live independently, the portion of those who are in need of assistance is inevitably rising. However, even nowadays, the great majority of long-term care recipients aged 65 or more are assisted at home rather than institutions. In fact, filial piety is still an important value in present-day Japanese families and it has prevented the widespread of nursing homes until recent years, which is mainly due to socio-economic transformations that make more difficult for families to take care of their elderly relatives. Nevertheless, nursing homes are not the preferred choice also because of their high costs and the availability of places, not enough to cover all the requests (OECD, 2013a).

Professor Hasegawa argues that the actual situation is not affordable anymore from the point of view of care assistance and insurance. If, until now, it was possible to economically support elderly people with health problems, the present situation cannot last long. He suggests that one optimal solution is ageing in place while, concerning care assistance, one solution could be:

*"[...] a cooperative of doctors and medical professionals that take care of the elderly population of a determined area, letting them staying in their homes but at the same time to be assisted properly<sup>14</sup>".*

Enforcing independent living at home, properly equipped for elderly use, could also be a preferable option for the government. Nevertheless, health assistance remains a fundamental factor to take into consideration for the success of ageing in place.

*"Life span is prolonged and this could cause severe problems related to services and costs since it might happen that we are not always healthy in our latest years. It is not a question of putting sensors in-house and talk to the children living far through the Internet. Day-services are often necessary for old people living alone, so the point is again human contact and preservation of health"<sup>15</sup>*

Among the latest technological devices, robots can be found in Japan for caring purposes. An example of caring robot is *RIBA II 1/2*, which is able to lift patients from the bed and carry them to the wheelchair.

**Figure 2.5: *RIBA-II 1/2*, a “caregiving” robot able to lift and carry patients up to 80kg of weight.**



(Source: Riken Research Center, 2011)

*HOSPI-Rimo* is another example. It is intended to connect the patient with his doctor also from remote as it can move autonomously inside an environment. Furthermore, the human symbiotic robot *TWENDY-ONE* can understand vocal instructions, is able to manipulate objects and help patients with impairments.

These new robots might be useful for caregivers, supporting them in their daily

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<sup>14</sup> From the interview to Professor Hasegawa, July 3, 2014, Tokyo-Japan.

<sup>15</sup> From the interview to Doctor Haga, July 3, 2014, Tokyo-Japan.

job with the patients. However, it is difficult to imagine robots substituting human care.

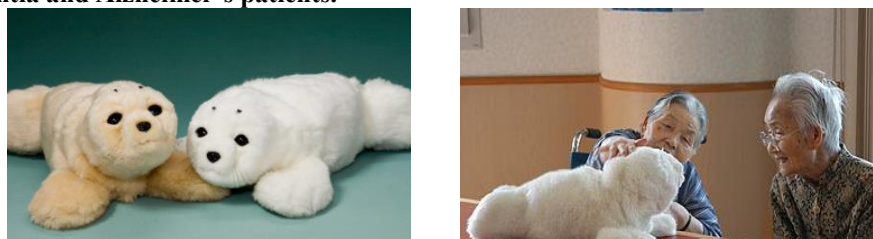
**Figure 2.6:** *HOSPI-Rimo* (left) and *TWENDY-ONE* (right), able to perform complex tasks when instructions are provided.



(Source: Panasonic Corporation; Waseda University Sugano Laboratory, 2011)

The use of robots and the employment of nurses means a double expense for the institution, especially taking into consideration the cost of humanoid nursing robots, sold for millions of yen at the moment. Moreover, at the moment, it is not clear whether robots will be successfully accepted by patients or not, particularly from the emotional perspective. Specialised workers are multitasking compared to robots and human affection is difficult to be replaced (Avento, 2014). *Paro* is one attempt of affective zoomorphic robot. Due to sensors and artificial intelligence, this seal-like robot is able to "interact" with people with facial expressions. Thanks to its interactive and simulating capacities, it is successfully used in therapies for patients suffering from Alzheimer's and other cognitive disorders.

**Figure 2.7:** The robot *Paro* has been found to reduce patient stress and stimulate interaction also in dementia and Alzheimer's patients.



(Source: Paro Therapeutic Robot, 2014)

The tools cited are just few examples of the technological innovation in the field of elderly health care. They can become key elements in assistive care in the future, given the ratio of elderly patients and carers available. Some devices, such as robots, are indeed captivating and also engaging to some extent. Nevertheless, they could be only one alternative among other technological responses to a lack of caregivers or nurses, not the solutions to the international ageing society trend. Alternative

innovation, invisible such as domotics or displayed like walking devices, can also be used effectively for restoring comfort at home, limiting hospitalisation only when strictly necessary. In this way, people can live at home in a familiar environment, helped both by technologies and human care if required, while allowing them to be part of the territory they belong to (Avento, 2014).

Younger generations are everyday users of different kind of technologies; nevertheless, studies claimed that age is not the most influencing factor to the adoption of innovative technologies since level of experience and adequate training have a major impact on the attitude of elderly consumers towards technology (Charness et al., 2001; Oppenauer, 2009). Compared to the past, today's elderly people are more used to the recourse of technological device, from the mobile phone to the Internet. However, as argued in Kuo study (2012), the degeneration of their perceptive abilities and complicated interfaces constitute obstacles, limiting the performance of the device itself. Designers and health care professional should not forget to take into account the level of familiarity the user is supposed to have and the features of the device itself that have to be easily handled by elderly users. Instinctive procedures and simplified interfaces are perceived by senior consumers as more accessible, in consideration to their capacities of working and prospective memory (Kuo, 2012).

Perception of one's own ability and the design of assistive technology is also an important matter in the discussion. The real and perceived capabilities of an old person have a strong influence on the adoption of devices. Functional ability might decrease in a slow way, not easily noticeable in everyday life, which can determine a disparity between actual and perceived ability that in turn influences the confidence and use of devices (Hirsch et al., 2000). Besides, the aesthetic of the devices themselves play a role in acceptance of assisting devices. Older people can be reluctant of relying on devices that they perceive as stigmatizing, feeling ashamed to use it. Hence, a proper inclusive design of elderly technologies is more and more important for the widespread adoption of assistive device. Failing in considering user's perception results in missed opportunities (Hirsch et al., 2000) and discrimination toward older people.

In this regard, the investigation about the possibility that the use of technologies in caregiving and assistance could increase the quality of life of elderly users in an ageing in place scenario was one of the aims of the survey carried out in 2014, presented in the next chapter.

## **2.5 Conclusions**

Chapter 2 introduced the theme of ageing society and independent living in contemporary societies. The development towards an aged society is expected to be around 2030 and, in preparation for that the WHO highlights the importance of the preservation of autonomy and health as the key goal in the policy framework for active ageing. This discourse is of particular interest in urban environment where one's own

independence is also inextricably connected to the territory and its identity.

The chapter also discussed the theme of AAL and its possible application at home. In particular, with the use of AAL:

- People could live longer at home in an autonomous way and in safety;
- Family and friendship relations can be preserved;
- Resorting to medical institutions would be limited to unavoidable cases only;
- Older people could gain self-confidence and be part of the community again (Avento, 2014).

Nevertheless, despite technological advancement, human care and interpersonal relationships remain fundamentally linked to personal well-being and social engagement support in older years.

Concepts discussed throughout the chapter, such as independent living and the perception of senior life, are at the centre of a field research and data analysis presented in the next chapter.

# **CHAPTER 3**

## **Study on the Perception of Elderly Living**

### **3.1 Introduction**

### **3.2 Objectives and Methodology**

### **3.3 Data Analysis and Results**

#### **3.3.1 General Perception about Senior People**

#### **3.3.2 Everyday Life in an Ageing Society**

#### **3.3.3 Services in Support to Elderly Living**

#### **3.3.4 Quality of Life and Technology**

### **3.4 Conclusions**

### **3.1 Introduction**

*This chapter presents the research activity carried out in order to collect data concerning the perception of people about elderly living and possible solutions coming from the technological or social field.*

*The methods used to create and carry out the survey are showed, followed by data analysis and results presentation. For analysis purpose, questions are divided into four main categories: general perception about elderly people; everyday life in an ageing society; services in support to elderly living; quality of life and technology.*

### **3.2 Objectives and Methodology**

After the issues considered in the second chapter, some questions can be arisen: How elderly people are perceived in an ageing society such as Italy? What does the population think about independent living important at older age? According to the population, can the use of technologies increase the quality of life of elderly users in the ageing in place scenario? In order to tackle with these interrogations, field research has been planned and carried out in conjunction with an event called "Longevity", held from April 8th to April 13th, 2014 inside the framework of Milano Design Week, in collaboration with Sarpibridge Project and with the participation of NUST – Nanjing University of Science and Technology and Grey Panthers (an online magazine and communication platform for over 50 years old).

The main reason behind this field research was the lack of data about the perception of seniority and ageing society among the general public. The questionnaire has been designed in order to put the respondents in the position of thinking about their personal viewpoint and experience also in relation to whom they consider to be an old person and the daily life activities of elderly people. The main objective was to understand the perception of the general public about the ageing society they are living in, their awareness about elderly lifestyle and personal opinion concerning technological solution for elderly living.

The survey, entitled "La percezione della longevità" ("The perception of longevity"), contained a set of 17 main questions concerning seniority and technologies, and 7 questions about personal information. Questions aiming at giving insights for research purpose, have been formulated in order to collect opinions, attitudes and experience of the respondents in relation to ageing society issues. The selection of the listed items is the outcome of a first review of institutional and scientific literature on ageing related issues and a second review carried out with the use of the Internet about the main available technology for the senior market.

In order to catch the attention of the respondents, a first engaging question opened the survey, while questions about personal information were collocated at the end of the questionnaire. All the questions, except for the place of residence, were closed-ended including multiple choice, Likert-scale, categorical and numerical questions (the latest two in the personal information section).

The target population was people of all ages living in Italy and the survey was conceived as an explorative research. Also due to the questionnaire distribution channels, the sample population cannot be representative of Italian people's opinion. As shown in the next pages, in fact, the most frequent respondent profile is of highly educated persons, mainly men, with a job position (or retired) and resident in Northern region of the country. Nevertheless, the survey can express a shared attitude, and results offered interesting insights of a population section able to interpret emerging trends.

The survey used a familiar language and it took around 10 minutes to complete it anonymously.

#### First wave:

Visitors were invited by CSAI research center staff to answer a printed version of the questionnaire and 120 copies were collected at the "Longevity" event venue. The collection of data started on the opening day of the event on April, 8th and ended on the last day of "Longevity" on April, 13th 2014. Two questionnaire collected during the event have not been included in the analysis as the respondent indicated a foreign country as place of residence. Therefore, the number of valid responses was 118.

#### Second wave:

For the second wave, the questionnaire has been created using Google Drive, a file storage service created by Google. This service contains Google Form, a function that allows the creation of an online survey, which automatically generates a link connected to the form.

This survey has been performed online thanks to the collaboration of Grey Panthers, online web portal for information concerning life at older age, which posted an alert on its homepage indicating the link to the questionnaire, and Federmanager, association representing the world of business management in Italy, which sent an



invitation e-mail containing the link of the questionnaire. The same link has also been shared through Facebook social network in order to reach the highest number of people as possible.

306 people answered to the online version of the same questionnaire from May, 20th to June, 3rd 2014. Four questionnaires collected online have not been included in the analysis as the respondent indicated a foreign country as place of residence, so the number of valid responses is 302.

**Figure 3.1: First main screen of the online version of the questionnaire (how it appeared to the public)<sup>16</sup>.**

The screenshot shows the first main screen of the online questionnaire. The title is "Questionario. La Percezione della Longevità". Below the title, it says "Università degli Studi di Milano-Bicocca". The text reads: "Grazie per aver accettato di compilare questo questionario. La sua compilazione richiede circa 10 minuti. Le tue risposte verranno trattate in modo anonimo e i dati ottenuti verranno analizzati solo per scopi di ricerca." The first question is: "1. Innanzitutto, secondo il tuo parere, da che età una persona si può 'definire' anziana?". It has seven radio button options: (1) sopra i 40 anni, (2) sopra i 50 anni, (3) sopra i 60 anni, (4) sopra i 65 anni, (5) sopra i 70 anni, (6) sopra i 75 anni, and (7) sopra gli 80 anni. The second question is: "2. Quali di queste condizioni descrivono meglio una persona anziana in buona salute? (massimo cinque risposte)". It has ten checkbox options: (1) serenità, (2) solitudine, (3) tempo libero per le proprie passioni, (4) bisogno di aiuto, (5) socialmente coinvolto e attivo, (6) bisogno di comunicare con gli altri, (7) senza occupazione lavorativa, (8) lavoratore o impegnato nel volontariato, (9) residente in casa, and (10) residente in strutture per anziani.

The total number of valid response was 420. Excel software (14.5.7 version) and Stat Plus Professional Full Version software (5.8.3.10 version) were employed for analysis purpose. In some cases, tables and charts only report data considered relevant to the topic object of discussion (otherwise indicated as ""---").

Four main dimensions are taken into account for analysis purpose and discussed in the next pages: general perception about elderly people; everyday life in an ageing society; services in support to elderly living; quality of life and technology.

<sup>16</sup> For the complete questionnaire see Appendix II for reference.

### 3.3 Data Analysis and Results

Respondents were 262 males (63%) and 155 females (37%). 22% aged between 18 and 29 years old, 26% between 30 and 49 years old, 34% between 50 and 69 years old and 18% aged 70 years or above. Only one respondent was aged less than 18 years old, and it was included in the age category of 18-29 years old.

**Table 3.1: Sample population distribution by gender and age (numeric value).**

	Males	Females
<b>18-29 y.o</b>	44	50
<b>30-49 y.o.</b>	54	54
<b>50-69 y.o.</b>	102	39
<b>70 y.o. and above</b>	62	12
<b>Total</b>	262	155

In regards to education, 42.9% held secondary-high school degree and 57.1% a university degree. Almost half of the sample population held a working position (47.3%), followed by retired (31.6%), student (11.5%) and unemployed (9.6%). 84% of the sample population replied to the questionnaire from the North of Italy and 16% from the Mid-South of Italy.

**Table 3.2: Sample population distribution by education and age (percent value).**

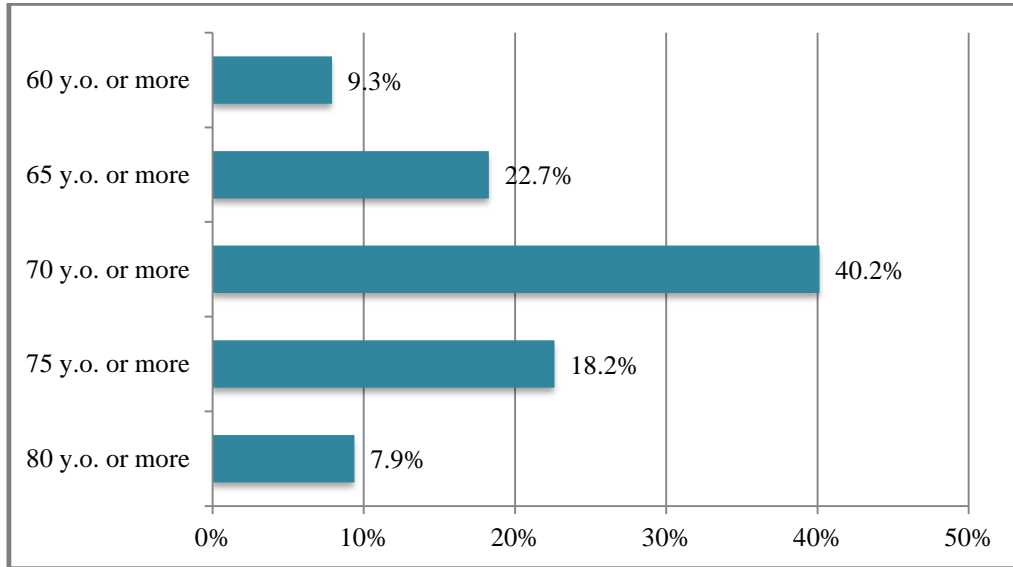
	Up to High School Degree	University Degree
<b>18-29 y.o</b>	14.6	28.3
<b>30-49 y.o.</b>	21.4	29.6
<b>50-69 y.o.</b>	37.6	30.8
<b>70 y.o. and above</b>	26.4	11.3
<b>Total</b>	100% (n.178)	100% (n.240)

#### 3.3.1 General Perception about Senior People

The questionnaire started investigating the perception about old age asking directly: "According to you, at what age a person can be called 'elderly'?".

This age is often conventionally set at 65 years old even if nowadays the boundaries are more flexible (in fact, only seven people indicated ages below 60 years old). 90.4% of respondents chose 65 years old or higher age, specifically, "65 years old or more" 18.2%, "70 years old or more" 40.2%, "75 years old or more" 22.7%, "80 years old or more" 9.3%.

**Figure 3.2: Question N.1, "According to you, at what age a person can be called 'elderly'?".**



Answers to question N.1 have been also analysed according to gender and age. From the table below it can be assumed that, in proportion, more women chose "70 years old or more" (45.8%) while the answer of their male counterpart was more distributed.

**Table 3.3: Question N.1, by gender (percent value).**

	Males	Females
40 y.o. or more	---	---
50 y.o. or more	---	---
60 y.o. or more	9.5%	---
65 y.o. or more	18.6%	27 (17.6%)
70 y.o. or more	<u>36.9%</u>	70 (45.8%)
75 y.o. or more	23.9%	31 (20.3%)
80 y.o. or more	9.1%	15 (9.8%)
<b>Total</b>	100% (n.263)	100% (n.153)

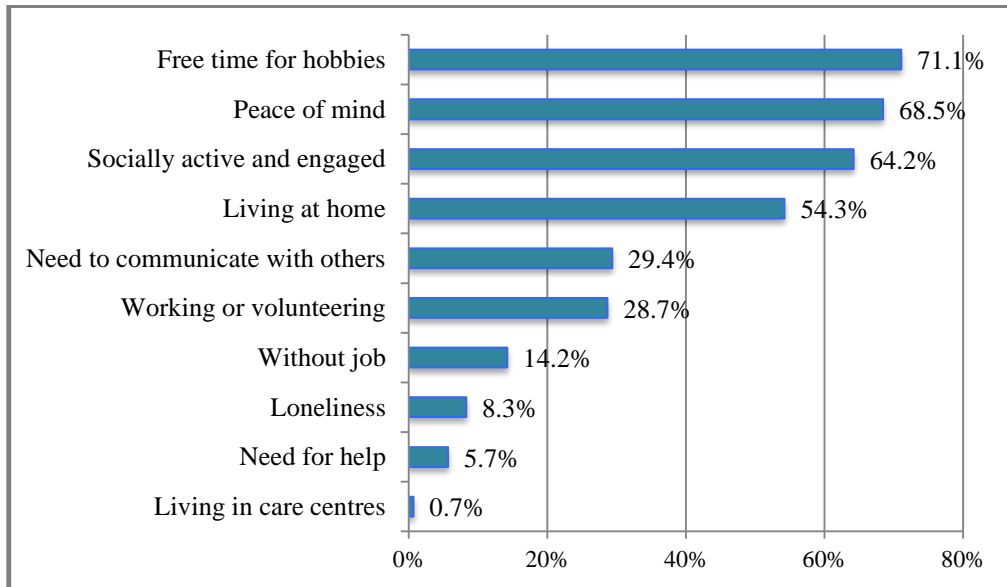
If age is taken into consideration, data showed that the higher the age of the respondent, the higher also the age one can be considered as "elderly" at.

**Table 3.4: Question N.1, by age (percent value).**

	18-29 y.o	30-49 y.o.	50-69 y.o.	70 y.o. and above
40 y.o. or more	---	---	---	---
50 y.o. or more	---	---	---	---
60 y.o. or more	17%	5.6%	6.4%	---
65 y.o. or more	20.2%	20.4%	20%	9.5%
70 y.o. or more	<u>42.5%</u>	<u>42.6%</u>	<u>37.1%</u>	<u>39.2%</u>
75 y.o. or more	13.8%	23.1%	22.9%	29.7%
80 y.o. or more	---	7.4%	9.3%	18.9%
<b>Total</b>	100% (n.94)	100% (n.108)	100% (n.140)	100% (n.74)

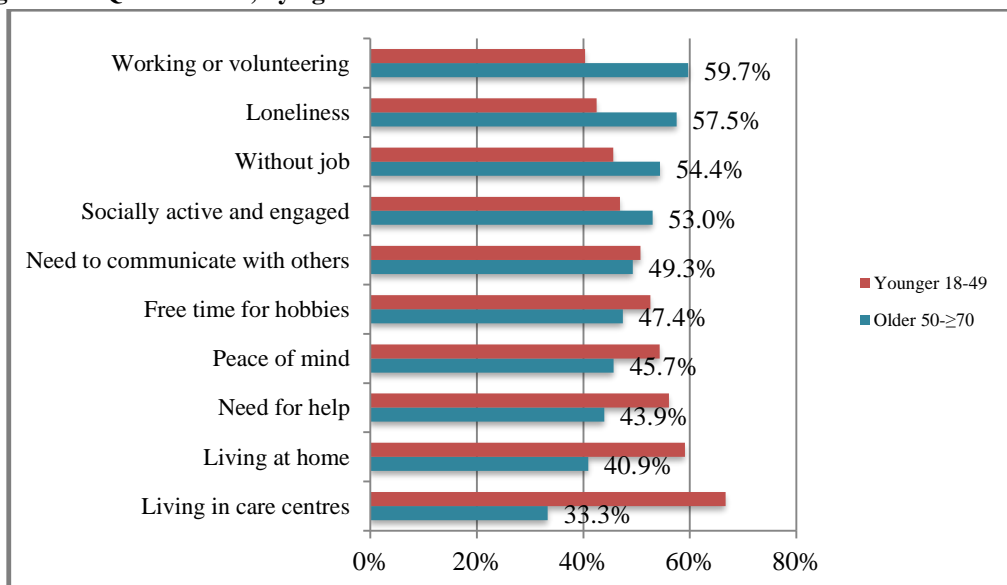
Question N.2, asked the population to choose from a list a maximum of 5 items in the list that best describe an older person in good health according to their personal opinion.

**Figure 3.3: Question N.2, "Which of the following conditions better describe an old person in good health?"**



The emerging profile was based on positive attributes like peacefulness and elderly people in good health are mostly seen as living at home, enjoying free time for hobbies and other social activities. On the contrary, negative attributes such as loneliness, need for help and daily care assistance were below the 10% of choice. However, these perception might change according to the age of the respondents.

**Figure 3.4: Question N.2, by age.**

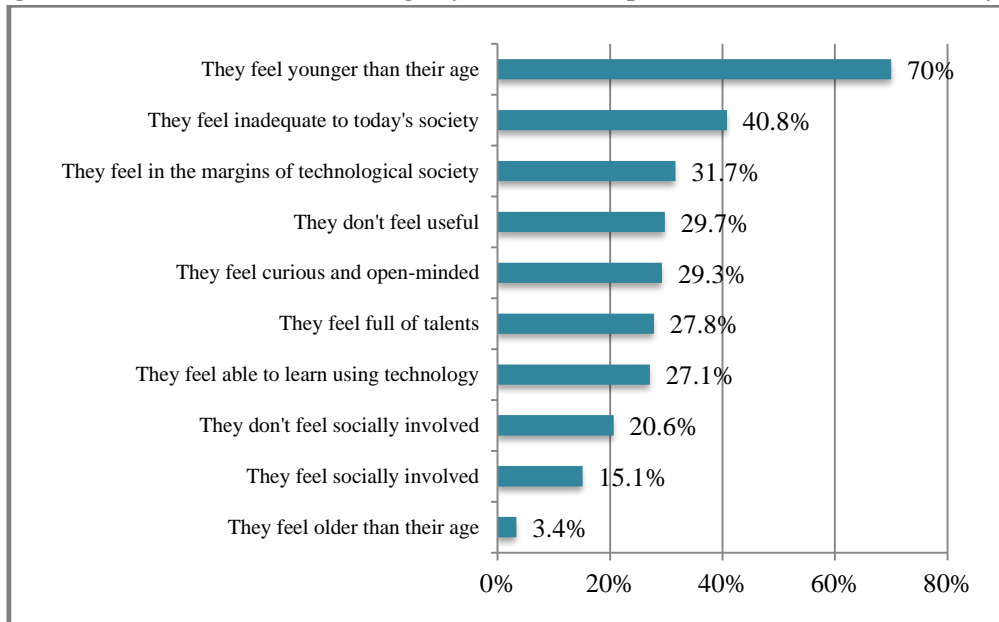


In order to analyse the distribution of the answers among the population by age,

the respondents have been divided into "younger" (18-49 years old) and "older" (50- $\geq$ 70 years old). As shown in the table below, younger respondents thought about healthy elderly people as less involved in working or volunteering activities but living in care centres and in need for help compared to older respondents. Almost 60% of older respondents selected "working or volunteering", perceiving elderly people also as less "in need for help", despite "loneliness" was the second chosen item.

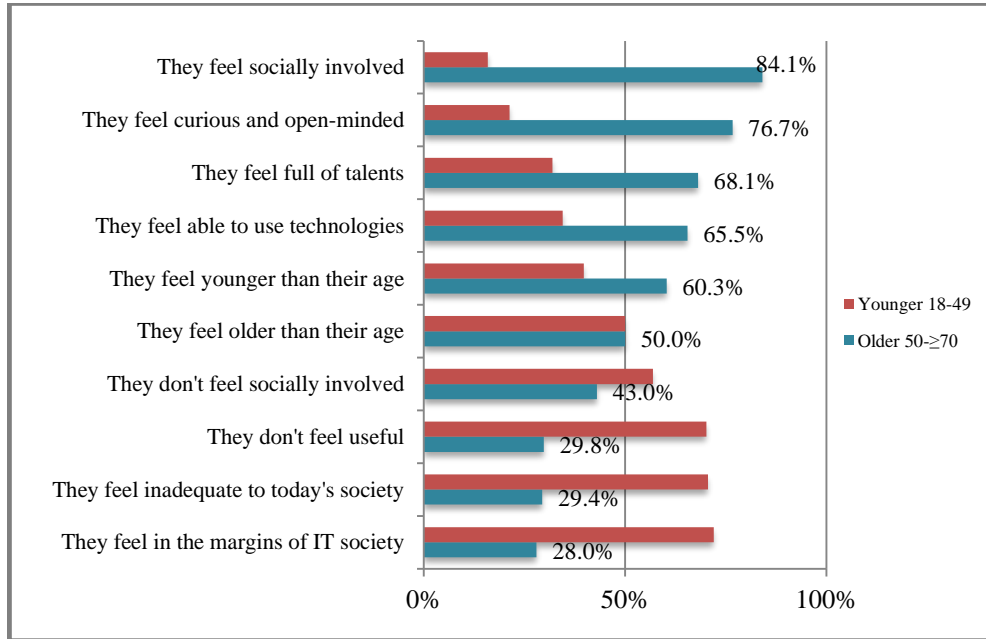
The questionnaire continued asking, in question N.3, an opinion about how the elderly people perceive themselves, choosing a maximum of 5 items from a list. Data showed that 70% thought that older people "feel younger than their age" but, at the same time, they also feel "inadequate to contemporary society" (40.8%) and "in the margins of a technological society" (31.7%), despite the fact that 27.8% of the respondents think that older people still "feel full of talents".

**Figure 3.5: Question N.3, "According to you, how older persons feel themselves nowadays?".**



Answers to question N.3 were then analysed according to the respondent's age. As shown in the Figure 3.6, younger respondents' opinion was that elderly people "feel in the margins of a technological society" (72%), "feel inadequate to the contemporary society" (70.6%) and "don't feel useful" (70.2%). However, 84.1% of older respondents chose "they feel socially involved", followed by "they feel curious and open-minded" (76.7%) and "they feel full of talents" (68.1%), highlighting a more positive attitude of elderly people.

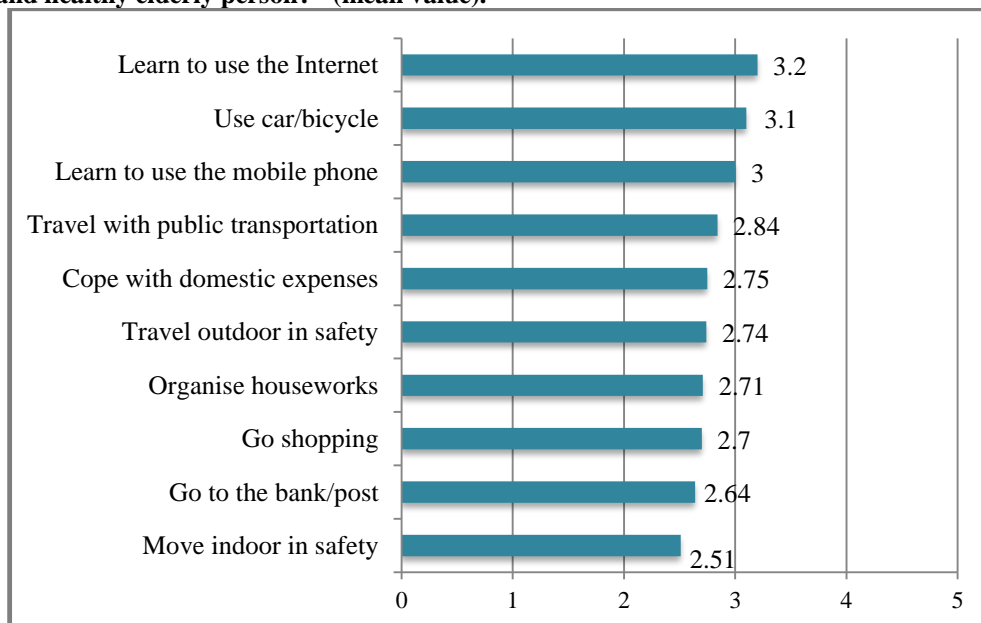
**Figure 3.6: Question N.3, by age.**



### 3.3.2 Everyday Life in an Ageing Society

Question N.4 asked participants to collocate 10 daily activities in a range from 1 to 5, where 1 indicated "not so difficult" and 5 "very difficult" to be performed by an old person enjoying good health. On average, 7 activities out of 10 were considered as "not difficult" or "slightly difficult", so below value 3. Only the use of private transportation means (such as car or bicycle) and electronic or technological devices (such as mobile phones and the Internet) were considered on average as "difficult".

**Figure 3.7: Question N.4, "From 1 to 5, how much difficult are the following activities for an old and healthy elderly person?" (mean value).**

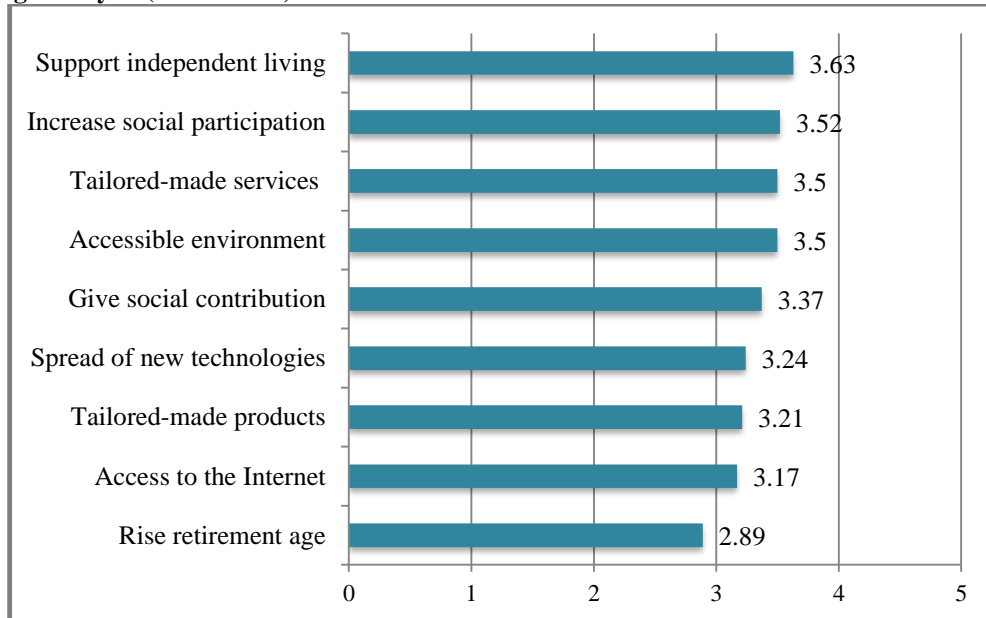


In particular, answers about learning to use the Internet were controversial.

Around 30% replied "not difficult" or "slightly difficult" while around 50% said "quite difficult" or "very difficult".

The following question, N.5, interrogated the sample population about the importance of points of matter inside the framework of an ageing society relying on scale from 1 to 5, where 1 indicated "not so important" and 5 "very important".

**Figure 3.8: Question N.5, "From 1 to 5, how much important are the following issues in an ageing society?" (mean value).**



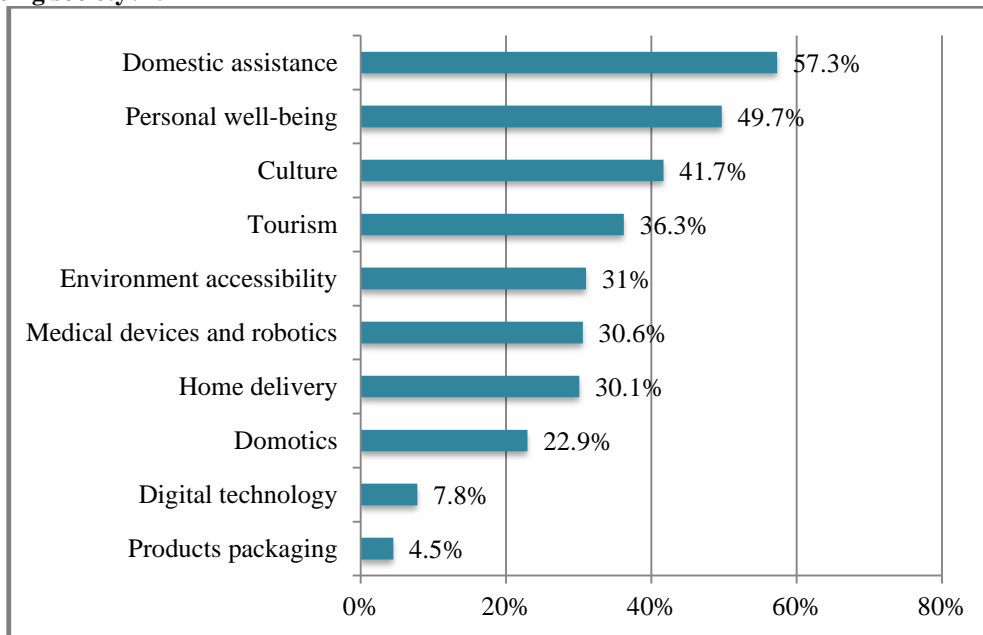
All but one ("rise the retirement age") were on average above value 3. Items concerning self-supporting life, social engagement and the spread of products and services designed for elderly people were considered from more than 50% of the respondents as "quite important" or "very important".

Question N.6 asked which categories of products/services have the potential, according to the public, to create more market possibilities. Multiple choice was possible (maximum 3 items). Home assistance and personal well-being were the most chosen categories with more than 50% of preference, highlighting the importance of services aiming at improving the quality of life and comfort in later life as well. Culture and travel accounted for almost 40% of preference, which emphasise how much important outdoor activities are. To live the surrounding environment and be involved in outdoor experiences have been considered as the categories with the higher potentiality in a society with an increasing number of elderly people. It is also worth to mention that more than 30% of people also selected medical devices and robotics.

However, human relation and piety cannot be omitted in this discussion. Before a prospective technological environment, today families are often giving elderly relatives support and affection, especially if they live near each other. In regard to this, question N.7 asked the respondents to specify the degree of proximity to elderly parents or relatives. 54.4% of respondents answered that they live near their elderly

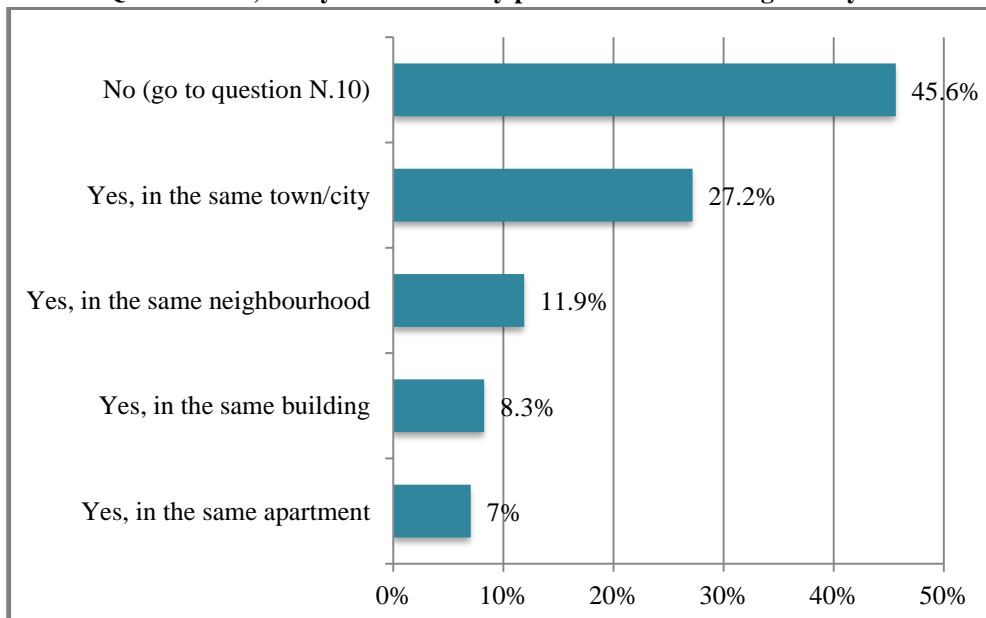
relatives or in the same city while 45.6% live far away.

**Figure 3.9: Question N.6, "Which of these categories could create more business chances in an ageing society?"**



55% of people living close to elderly relatives were asked also to specify the living place of their older family members, (question N.8: "Where do your elderly relatives live?"). In 95% of responses, "at home" was the chosen item, while less than 5% chose caring homes or clinics.

**Figure 3.10: Question N.7, "Do you have elderly parents/relatives living nearby?"**



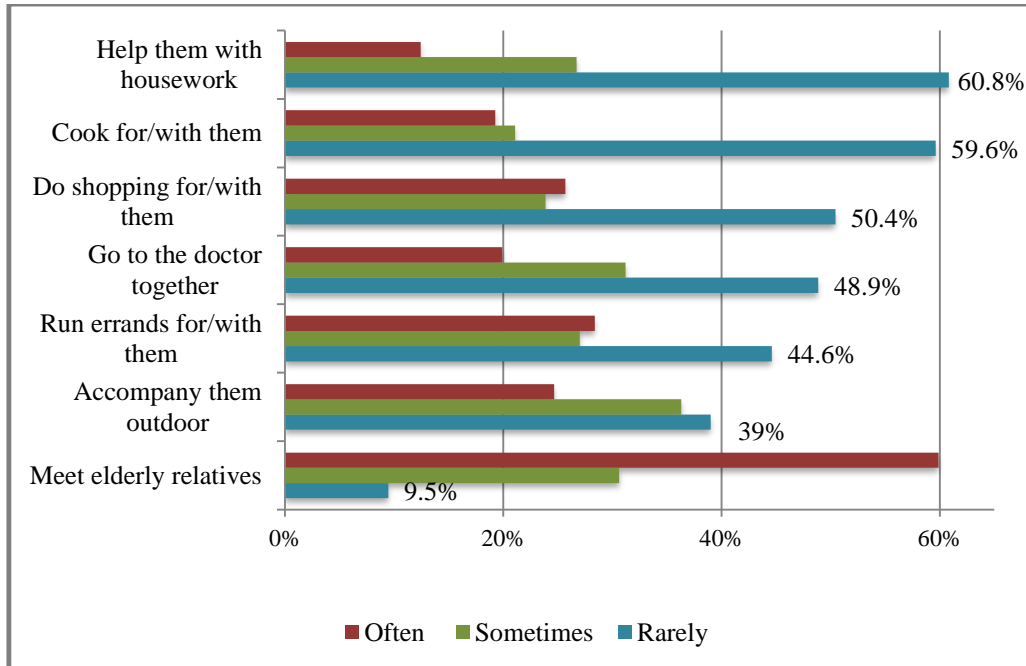
To investigate if living near an old relative was in some way related to the degree of assistance dedicated to him/her, the same group of respondents also filled in question N.9, focused on the frequency in supporting the elderly relatives during their



daily activities.

Almost 60% of people answered that they meet their elderly relatives often but, apart from this item, all the other activities are rarely performed by the respondents. In fact, "rarely" was the most chosen item, which can indicate that the elderly people the respondents are referring to are independent in their daily life activities.

**Figure 3.11: Question N.9, "How many times a week are you involved in the following activities?"**.



### 3.3.3 Services in Support to Elderly Living

Question N.10 asked: "If tailor-made services designed for elderly needs were available, would you rely on them in alternative to you help?". It investigated the position of the sample population about the possibility of turning to services designed specifically for senior citizens to be used in alternative to informal care or informal help. 53% of the respondents' attitude was positive towards services that can relieve them from the burden deriving from elderly assistance activities. However, 32% of people replied that, despite a possible availability of tailored-made services for their elderly relatives, they would continue anyway to be of help to their loved ones. It is also worth to consider the high number of "I don't know" and no answers, a figure indicating that the issue of external caring is delicate and difficult to address.

Question N.10 has been also analysed according to gender and age. More women than men would rely on services designed for elderly citizens in alternative to their help (males: 49.6%; females: 57.6%). This figure probably reflects the role as primary caregiver that women play more often than men.

**Table 3.5: Question N.10, by gender (percent value).**

	<b>Males</b>	<b>Females</b>
<b>They could be used by my elderly relatives in alternative to my help</b>	<u>49.6</u>	<u>57.6</u>
<b>I would give them help anyway</b>	32.4	32.4
<b>I don't know</b>	18	10
<b>Total</b>	100% (n.250)	100% (n.151)

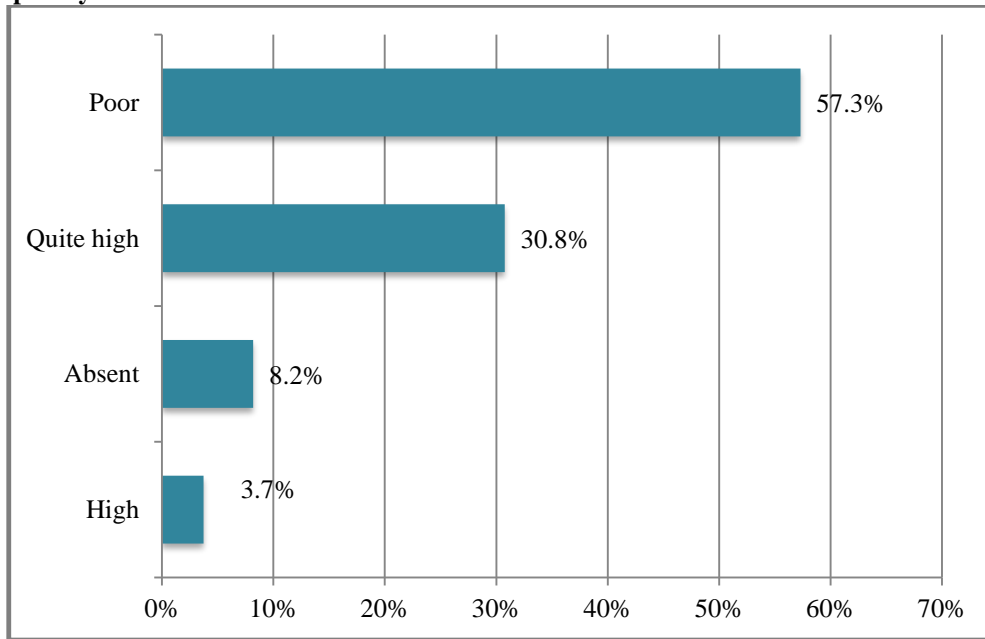
When respondents' age is taken into consideration, data reveals a very different attitude. The majority of younger people (59%) would rely on services specifically designed for their elderly relatives while the answer of older people was heterogeneously distributed among the three options.

**Table 3.6: Question N.10, sample population distribution by age (percent value).**

	<b>18-29 y.o</b>	<b>30-49 y.o.</b>	<b>50-69 y.o.</b>	<b>70 y.o. and above</b>
<b>They could be used by my elderly relatives in alternative to my help</b>	<u>59.1</u>	<u>56.9</u>	<u>51.5</u>	<u>38.1</u>
<b>I would give them help anyway</b>	26.9	32.1	36.8	31.7
<b>I don't know</b>	14	11	11.7	30.2
<b>Total</b>	100% (n.93)	100% (n.109)	100% (n.136)	100% (n.63)

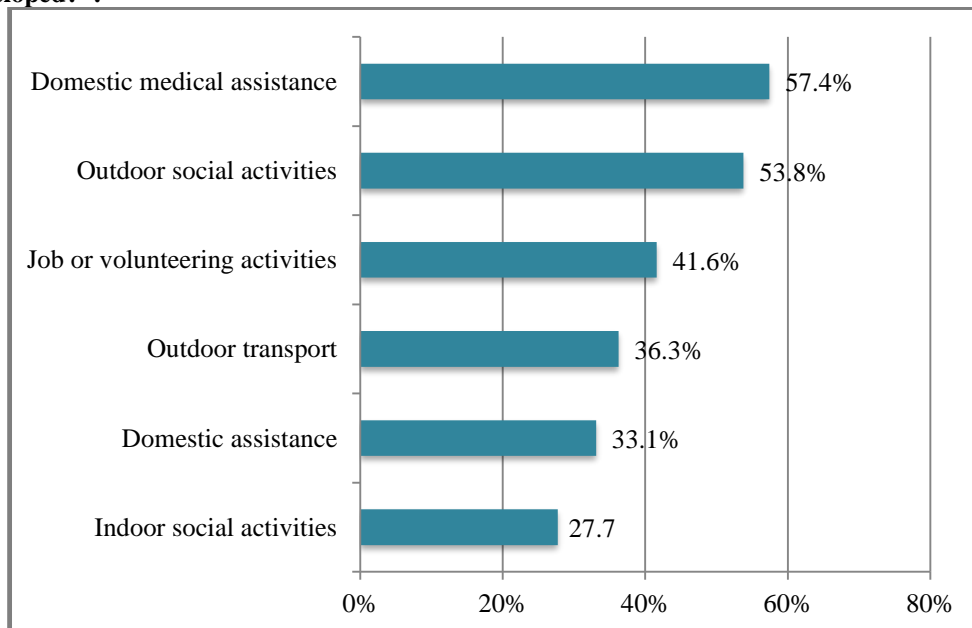
The following question, N.11, interrogated about the quality of the services addressing the older population in the respondent's place of residence. Only 3.7% said that the level of elderly services is high while 8.2%, on the contrary, said they are totally absent. The majority of the population considered the quality of services designed for older inhabitants in their reference environment as "quite high" (30.8%) and "poor" (57.3%).

**Figure 3.12: Question N.11, "How do you evaluate the quality of elderly services offered in the place you live?".**



N.12, asked people to indicate which category of services they would like to be developed more (multiple choice was possible, maximum 3 items). As also expressed in previous answers, people were more oriented to outdoor activities where older persons could gather and build the ground for social relationships as well as services related to health care. The attention was, once again, more focused on the personal well-being, recreational activities and productive ways to live the territory, such as organised work or volunteering.

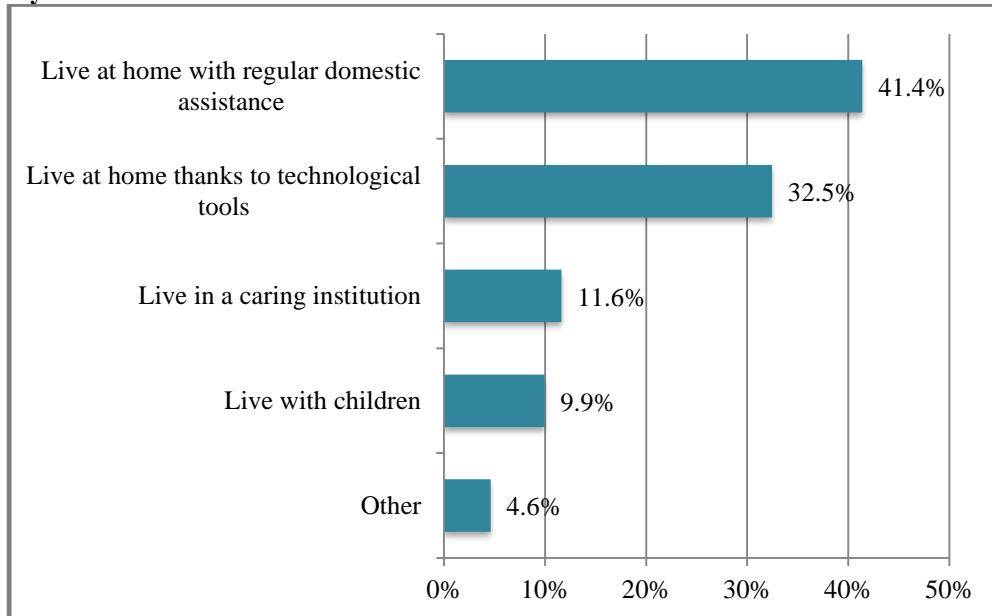
**Figure 3.13: Question N.12, "Which category of services would you like to see more developed?".**



### 3.3.4 Quality of Life and Technology

Last 5 questions were more directly concerning the relation existing between technology and living autonomously. In question N.13 respondents had to express the situation characterised by a higher quality of life, choosing from a list of 5 items.

**Figure 3.14: Question N.13, "Which among the following situation makes you think of a good quality of life?"**



As shown by Figure 3.14, 41.4% of the people thinks that "live at home with regular domestic assistance" was the most preferable context for age enjoying a higher quality of life. Living at home assisted by technological tools rather than professionals accounted for 32.5% of the total answers. Human factor played again a crucial role, being favoured to technological tools. To live with children and in a caring institutions were chosen by around 10% of the population, emphasising the importance and wish of ageing at one's own place independently.

**Table 3.7: Question N.13, by gender (percent value).**

	Males	Females
<b>Live at home with regular domestic assistance</b>	<u>39.1</u>	<u>45.4</u>
<b>Live at home thanks to technological tools</b>	34.5	28.9
<b>Live in a caring institution</b>	10.3	13.8
<b>Live with children</b>	11.9	6.6
<b>Other</b>	4.2	5.3
<b>Total</b>	100% (n.261)	100% (n.152)

Women associated to living at home with regular domestic assistance a better quality of life, probably due to the role of primary caregiving of elderly relatives. Answers analysed according to age, revealed a very interesting attitude toward elderly

living quality of life. Younger respondents were keen on choosing technology (39.8%) while more than 40% of 30-69 years old respondents chose "live at home with regular domestic assistance". Oldest respondents chose almost in same percentage "regular domestic assistance" and "technological tools" related options.

**Table 3.8: Question N.13, by age (percent value).**

	18-29 y.o	30-49 y.o.	50-69 y.o.	70 y.o. and above
Live at home with regular domestic assistance	32.3	<u>41.7</u>	<u>49.3</u>	<u>37.5</u>
Live at home thanks to technological tools	<u>39.8</u>	28.7	2.1	<u>38.9</u>
Live in a caring institution	16.1	13.9	9.3	6.9
Live with children	7.5	9.3	11.4	11.1
Other	---	---	---	---
<b>Total</b>	100% (n.93)	100% (n.108)	100% (n.140)	100% (n.72)

Even if the previous question seemed to reveal a general propensity to human care rather than technological assistance, around 80% of people were nonetheless interested in elderly assistive technologies, around 15% replied they were not much interested (question N.14: "Would you be interested in technologies able to give assistance to elderly people living independently?"). Despite the image of a more traditional way of caring was preponderant, people were nonetheless curious about new solutions coming from the technological field.

**Table 3.9: Question N.14, by gender (percent value).**

	Males	Females
<b>Yes, I'm very interested</b>	<u>78.8</u>	<u>81.8</u>
<b>I'm not much interested</b>	15.3	15.6
<b>No, I'm not interested</b>	5.9	---
<b>Total</b>	100% (n.255)	100% (n.154)

Data did not show major differences between men and women and among age categories.

**Table 3.10: Question N.14, by age (percent value).**

	18-29 y.o	30-49 y.o.	50-69 y.o.	70 y.o. and above
<b>Yes, I'm very interested</b>	<u>79.3</u>	<u>82.4</u>	<u>80.4</u>	<u>76.1</u>
<b>I'm not much interested</b>	17.4	14.8	14.5	15.5
<b>No, I'm not interested</b>	---	---	5.1	8.4
<b>Total</b>	100% (n.92)	100% (n.108)	100% (n.138)	100% (n.71)

People aged 70 years old and above were slightly less interested than their

younger counterparts in medical technologies supporting elderly living. Only five respondents of younger age indicated they are not interested in assistive technologies.

Question N.15 asked: "Could a Smart Home, an intelligent house equipped with advanced automatic technologies remotely controlled, allow a higher number of people to live autonomously at home?". It aimed at investigating the attitude of the respondents towards the idea of advanced systems and automatic technologies. 66% of the respondents chose "yes", 7% "no" and a high percentage, 27%, selected "I don't know".

Despite there was not a considerable difference between the two genders, women were more favourable toward the idea of a smart home in support to elderly independent living.

**Table 3.11: Question N.15, by gender (percent value).**

	<b>Males</b>	<b>Females</b>
<b>Yes</b>	<u>64.9</u>	<u>67.7</u>
<b>No</b>	9.2	---
<b>I don't know</b>	25.9	28.4
<b>Total</b>	100% (n.262)	100% (n.155)

With the increase of the age of the respondents, a lower percentage of "yes" and a higher percentage of "I don't know" could be observed. Compared to other questions, the more specialised nature of this subject could explain a higher uncertainty.

**Table 3.12: Question N.15, by age (percent value).**

	<b>18-29 y.o</b>	<b>30-49 y.o.</b>	<b>50-69 y.o.</b>	<b>70 y.o. and above</b>
<b>Yes</b>	<u>75.3</u>	<u>65.4</u>	<u>63.1</u>	<u>60.3</u>
<b>No</b>	7.5	4.6	9.2	6.8
<b>I don't know</b>	17.2	33 (30%)	27.7	32.9
<b>Total</b>	100% (n.93)	100% (n.110)	100% (n.141)	100% (n.73)

Then, respondents were proposed a crucial topic. Question N.16 posed the direct question: "Who has more chances for social participation?". 46% of respondents answered that "people living autonomously at home" are the ones with more chances to be involved in social life and participate to it. On the other hand, almost one third of the sample selected "people living in elderly residences" associated them to higher chances to social participating while around 24% did not know how to answer.

51.2% of men perceived people living at home as having more chances for social participation. The choice of women was not as clear as men's since the three choices have received a similar number of answers from female respondents.

**Table 3.13: Question N.16, by gender (percent value).**

	<b>Males</b>	<b>Females</b>
<b>People living autonomously at home</b>	<u>51.2</u>	<u>37</u>
<b>People living in elderly residences</b>	29.2	31.8
<b>I don't know</b>	19.6	31.2
<b>Total</b>	100% (n.260)	100% (n.154)

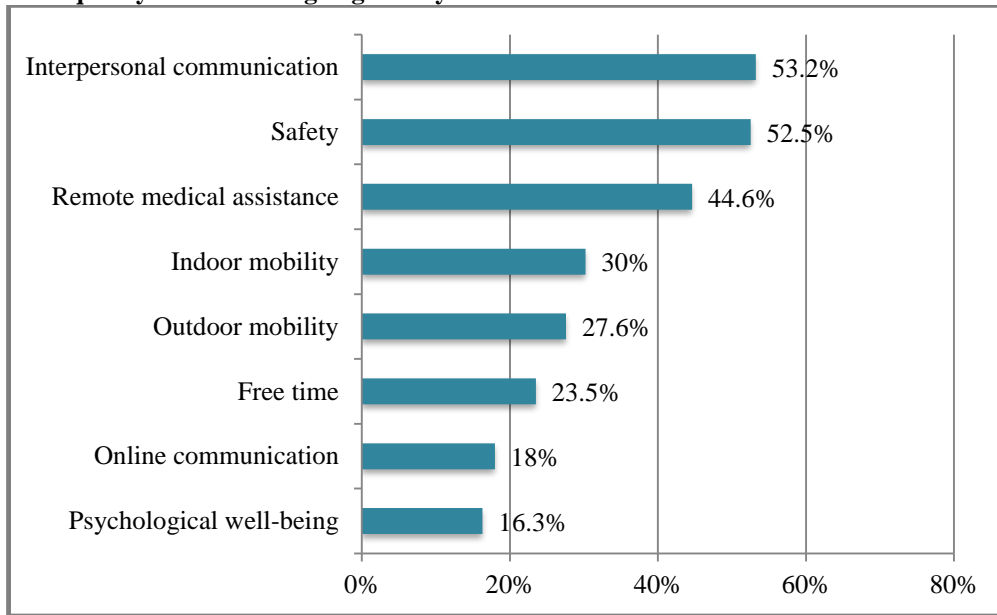
The analysis of question N.16 according to age categories showed very interesting results. 18-29 years old respondents were not sure about the answer or perceived people living in elderly residences as having more chances for social participation. 30-49 years old participants were also not sure about but, in same proportion, also believed that social participation is possible for people living autonomously at home. The majority of people aged 50-70 years and above chose the first item, "people living autonomously at home".

**Table 3.14: Question N.16, by age (percent value).**

	<b>18-29 y.o</b>	<b>30-49 y.o.</b>	<b>50-69 y.o.</b>	<b>70 y.o. and above</b>
<b>People living autonomously at home</b>	26.4	<u>35.5</u>	<u>57.4</u>	<u>63.9</u>
<b>People living in elderly residences</b>	36.3	29	31.2	22.2
<b>I don't know</b>	<u>37.3</u>	<u>35.5</u>	11.4	13.9
<b>Total</b>	100% (n.94)	100% (n.107)	100% (n.141)	100% (n.72)

Finally, the last question, N.17, suggested a list of categories asking the respondents to choose the ones (multiple choice, maximum 3 items) in which they think technology can contribute more in increasing the quality of life in an ageing society. "Interpersonal communication" (53.2%), "safety" (52.5%) and "remote medical assistance" (44.6%) were the most chosen items, while "psychological well-being" and "online communication" accounted for less than 20% of the selections.

**Figure 3.15: Question N.17, "In which of the following categories technology can improve most the quality of life in an ageing society?"**



### 3.4 Conclusions

Chapter 3 dealt with the theme of the perception of seniority from four main viewpoints: general perception about elderly people, everyday life in an ageing society, services in support to elderly living, quality of life and technology.

Through data collection and analysis, it was possible to investigate and confirm the need for ageing in place and independent living lifestyles. What once thought of "seniority" or "old age" does not match to the actual situation. Elderly people saw at themselves as active, full of resources and able to contributing to social life; thus, a cultural change, a change in the way of perceiving older citizens, is necessary in ageing societies.

In general, the sample population of this survey was composed by highly educated people with a regular working condition, mainly males and living in the Northern areas of Italy. The results obtained show a general positive attitude towards elderly living, their possibilities in the contemporary society and the role that technology will play in the near future. Nevertheless, some differences emerged according to the age and gender of the respondents, giving interesting evidence about the perception of life at older age among the population interviewed.

#### General Perception about Senior People

It is notable to observe how much the perception of people about seniority was about 5-10 years higher than the age conventionally set at 65 years. This denotes a lengthening of the younger-adult years, delaying the period of life when one is considered as "old". There were not major differences between male and female respondents. However, a different perception of seniority according to age could be observed: the younger the respondent, the lower the age seniority was associated at.

Results showed how the image of seniority differed according to the age of the



participants. Younger respondents associated the image of the "elderlies" to living in care centres, needing help much more than older people do, while the image deriving from older respondents' choices, is characterised by engaging activities which could also produce more chances to communicate with the others. Moreover, younger people perceive the elderly as potentially able and willing to actively live their older age but that are, at the same time, restrained from objective obstacles, such as technology use and new practices. On the other hand, older respondents perceive elderly persons as full of talents, curious, socially involved and able to learn using technological devices. This data is very interesting to consider when discussing the image of older people, an example of how much different is the perception senior citizens have about themselves and how they are seen from the rest of the population. Older respondents were also aware about the sense of loneliness that can be experienced in later life but, nonetheless, they also considered senior life as more characterised by social engagement and active life style than their younger counterparts did.

#### Everyday Life in an Ageing Society

In Italy one elderly out of four lived in single-person households in 2009, and 38% of over 65 years old women and 15% of men live alone (Health Publishing and Services, 2012). More and more seniors live in their home autonomously, contributing to the growth of the population segment that lives the neighbourhood and use space and services located nearby almost autonomously. Independent living and an increased social participation were seen as very important issues in an ageing society, along with environment and services accessibility and the chance to continue contributing to community life. In this discourse elderly people still have strength and knowledge to give to the society. In younger years, economic, familiar and personal aspirations absorbed their energy and time. At older age, their priority is no longer to make profit but to continue being part of the system, social system, but in a different way. This is the moment where older persons, experienced and still able to give their contribution, should have the chance to participate to social life and be active part of it. In regard to business chances, people considered that service industry related to increasing personal well-being of older people have the highest potential (e.g., domestic assistance, leisure).

More than half of the respondents live near elderly relatives, 95% of whom is living at home. Despite the proximity and the fact that the majority of respondents meet their elderly relatives often, they indicated little involvement in doing shopping or housework, showing that daily life activities were not considered difficult for a healthy old people living autonomously. Due to the difficulty of elderly people in using private transportation means, only to accompany them outdoor was chosen from a high proportion of respondents as an activity where the help of a younger person is needed.

### Services in Support to Elderly Living

When directly asked about the possibility to rely on services specifically designed for elderly people, half of the respondents answered they would use them while one third of the participants replied that they would continue giving their support to elderly relatives anyway. The reason could be represented by working and family activities in younger people's daily life. In proportion, more women than men were favourable to delegate elderly care to external solutions, maybe because women are more often the primary caregivers. Data also revealed uncertainty among over 70 old respondents, possibly because of the awareness of the burden that elderly caregiving imply but, at the same time, the importance for an old person to maintain filial ties. Domestic assistance and outdoor social activities have been indicated as the most preferred services to be developed. Increased well-being at home could allow elderly people to ageing in place and, consequently, have the possibility to continuously be part of the societal life through outdoor activities. In regard to this, a high number of women indicated that living at home with regular domestic assistance is related to a good quality of life, while men chose in similar percentage both living with regular domestic assistance and living with the help of technological tools. Analysis based on age indicated that younger people were more oriented toward technological solutions while domestic assistance was the preferred choice by 30-69 years old respondents. It is very interesting to note that the higher the age of the respondents the lower the number of people choosing "living in caring institutions", confirming previous statement concerning ageing in place lifestyle.

### Quality of Life and Technology

Results showed a favourable position towards technological solutions for elderly care and the new possibilities they can create to let people age at home. However, uncertainty level was very high when asked about Smart Homes, presumably due also to the topic of the question. People not able to express their opinion, might not be familiar with advanced systems and embedded technology so it might have been difficult for them to answer (particularly among older respondents). Nevertheless, data collected through questions addressing to a similar topic with less specialised terms, revealed a positive attitude about relying on solutions in support to independent elderly living. Thanks to domotics and highly advanced medical equipment, it could be easier and safer to continue living at one's place, preferring being assisted at home rather than in medical or caring institutions.

15 years ago, Hirsch et al., (2000) argued that less consideration was given to social, emotional and environmental needs in favour of studies concerning declining motor and cognitive skills. In this regard, attention should be placed on the personal and emotional sphere of the final user in the future. It is important not only to care about the functional side of a solution, of technological origin or not, but also to the acceptability of new technologies. These years, "Digital Divide" is widely discussed inside the scientific community, a term referring to the gap between those who have

the knowledge and ability to access technology and those who don't due to social and economic reasons. Several people aged 65 or more are not regular users of technological tools or services such as computers and the Internet (Niehaves and Plattfaut, 2014). However, nowadays is becoming easier to get connected, through the breaking down of some of the barriers. For instance, internet-enabled devices are easier to use than some years ago. Devices supported by a touchscreen technology, such as smartphones and tablets, can reshape the approach to new technologies and the feeling the older population has towards learning how to use them in daily activities. Internet is no longer attached to the possession of a computer and it is also less expensive due to wider offers from broadband providers. Along with a proper digital education and learning, the "traditional" obstacles that kept seniors from using new technologies can be overcome, bridging the *digital divide* between the older and younger population. In fact, despite the number of elderly users is lower compared to younger ones, results of the present questionnaire showed that older respondents have good expectations about relying on technological solutions for elderly living purpose.

People were also asked about social participation. Around half of the male population considered that people living at home have more chances for social participation while women replied in similar proportion to the three choices offered. Younger respondents showed uncertainty or indicated that people living in elderly residences have more chances for social participation. The experience in first person of older respondents was clearly showed as the higher the age of the participant, the more those thinking that people living autonomously at home have more chances for social participation. Those who could not chose between autonomous or institutionalised elderlies, probably did not have a clear idea of what "social participation" means. As discussed in the previous chapter, social participation not only refers to one person's involvement in a social context but also to be engaged in activities aiming at giving a contribution to the society, made possible also through the establishment of interpersonal relationships. The fact that around one third associated caring institutions to social participation indicates that the word "participation" was interpreted more as "involvement" rather than "engagement" or "commitment". Despite care centres could be perceived as a place where communication and interaction is possible, generally it cannot be said that through nursing homes, elderlies are able to give a contribution to the community, whether it is on a small or bigger scale. Skills and experience of an institutionalised person are not commended as they could if he/she was embedded in a familiar social context. Therefore, more projects should focus on raising awareness on the meaning of social participation and on the potentiality that people ageing in a social context they feel attached to have in contributing to their own well-being and to the social environment as well.

In general, independent living was seen as very important in a scenario where the number of older people increases, and technology can be of help in improving the quality of life of the senior population. More opportunities to familiarise older people

with the use of technology and for social engagement should be fostered in support to elderly's autonomous lifestyle. To experience the surroundings and enjoy outdoor activities were the most chosen categories connected to the improvement of the quality of life in later life. Participating in leisure and cultural activities in the community, and to maintain family supportive relations, allow older people to continue exercising their competence and maintaining autonomy, a key goal in the policy framework for active ageing. However, poor walking conditions can limit outdoor mobility, constituting one element for social exclusion. Under this perspective, environment accessibility and safety are going to become major concerns both for families and institutions. Starting from the results obtained, the next chapters explore the theme of age-friendly cities and elderly walking patterns.

## **CHAPTER 4**

### **Age-Friendly Urban Environments**

#### **4.1 Introduction**

#### **4.2 Towards Age-Friendly Cities**

#### **4.3 The Importance of Developing Walkable Cities**

#### **4.4 Peculiar Characteristics of Elderly Pedestrians**

#### **4.5 Older People Walking in Group**

#### **4.6 Conclusions**

#### **4.1 Introduction**

*The present chapter mainly discusses two prevailing themes in the discourse of ageing society: age-friendly city and walkability. Nowadays, the number of cities with a high presence of senior inhabitants is already considerable and it is predicted to grow very fast in the next years. Urban environments will have to be more "friendly", including all its citizens in city life. As saw in the previous chapters, mobility is one key element of elderly independence and well-being. In the next pages, walking characteristics of elderly pedestrians and outdoor mobility will be presented starting from the concept of "walkability", which is a measure of the overall walking and living conditions in a determined area. The importance of developing strategies protecting citizens' attitude to walk can be appreciated also by reflecting about the various benefits municipalities and citizens can enjoy, namely social-economic-health-environmental benefits.*

*Ultimately, the physical and psychological importance that group walking has at older age anticipates the discussion of Chapter 5 and Chapter 6 about small groups of pedestrians and elderly people.*

#### **4.2 Towards Age-Friendly Cities**

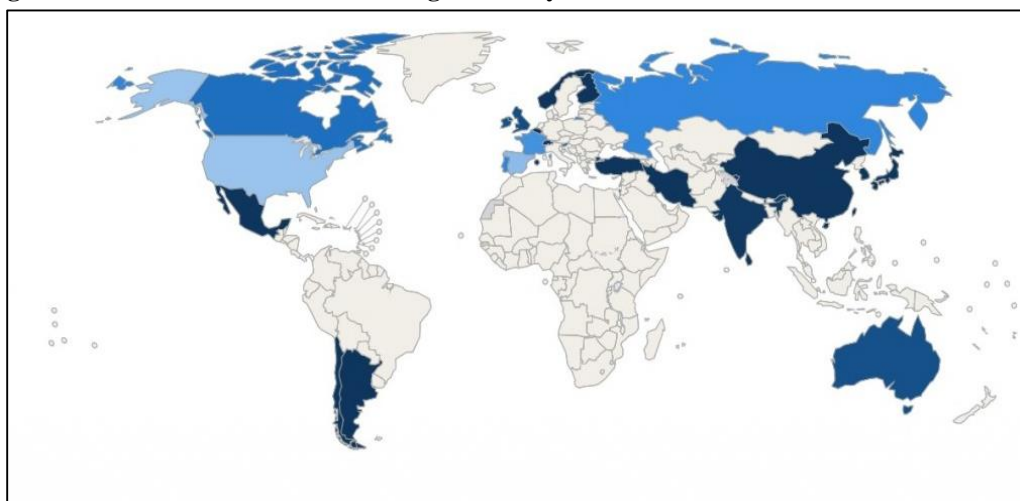
As already mentioned, the world is not only ageing but it is also urbanising. More than 50% of the world population lives in urban centres today and more elderly people are living in cities. By 2050, the 70% of global population will live in urban areas and urban population growth in the next 30 years will occur mainly in developing countries (WHO, 2010).

Nowadays, more attention is put on the inclusiveness of all inhabitants in city life. Particularly, the presence of senior citizens is predicted to grow fast in the next years and municipalities should be prepared to major social changes within urban environments. An age-friendly city is a city that *"encourages active ageing by optimizing opportunities for health, participation and security in order to enhance quality of life as people age. In practical terms, an age-friendly city adapts its structures and services to be accessible to and inclusive of older people with varying*

*needs and capacities.*" (WHO, 2007a). Making cities age-friendly is one of the most effective instruments to respond to demographic ageing, enabling people to actively live the urban environment while the cities themselves will benefit from people involvement and well-being.

The project of developing age-friendly cities arose from several policy initiatives launched by the WHO during the 1990s and early 2000s. During these years, the notion of active ageing, as saw in Chapter 2, have been introduced. Terms such as "active ageing" and "active lifestyle" do not necessarily refer to labour or paid job but, more generally, to participate in several ways to the society. Being active also means to give support to the others, giving contribution from social, cultural, civic and also economic viewpoint. An active lifestyle throughout the life course, enhances the quality of life as people age promoting health, collective participation and independence. Being physically and mentally involved in society allows people to play an active role in the community and, at the same time, receive the protection they need, especially in later life. From the development of policies concerning active ageing, new projects arose. In 2005, the "Global Age-friendly Cities" project was conceived at the opening session of the XVIII World Congress of Gerontology and Geriatrics in Rio de Janeiro, Brazil. The international community reacted with enthusiasm, making possible to implement research and involve several governments and municipalities around the globe. The research protocol was implemented in 33 cities all over the world, where service providers were trained in order to identify factors that make urban environments "age-friendly". Their research activity included focus groups of older people as well as interviews to caregivers. Moreover, data collection and analysis also covered broader areas such as service provision (e.g., health services, transportation), built environment (e.g., housing, outdoor spaces and buildings), and social aspects (e.g., civic and social participation). The results were collected into "Global Age-Friendly Cities: A Guide" (WHO, 2007a) and a "Checklist of Essential Features of Age-Friendly Cities" (WHO, 2007b).

**Figure 4.1: WHO Global Network of Age-Friendly Cities and Communities.**



(Source: WHO, 2013)

As showed by Figure 4.1, until today the majority of cities that have joined the Global Network of Age-Friendly Cities are mainly in the U.S., Australia and Eastern Asia. Few cities can be found in Europe, despite Northern countries and Italy are experiencing dramatic demographic changes, highlighting the long path left to cover. Municipalities should take actions in order to promote the spreading of "age-friendly" in order to foster intergenerational comprehension and integration. It might require time but when concepts such as healthy ageing and inclusiveness will become culturally rooted, age-friendly cities will develop more easily and successfully. An age-friendly city is supposed to be organised in such a way to be able to support and enable people to age actively.

According to the WHO (2007a), polices, services and structures should:

- recognise and make use of capacities and resources among the elderly population;
- anticipate and be flexible in responding to age-related needs;
- respect different lifestyle choices;
- protect those population segments that are most vulnerable;
- promote the inclusion of the elderly and involve them in community life.

**Table 4.1: Essential features of age-friendly cities.**

<p><b>Outdoor Spaces and Buildings</b></p>	<ul style="list-style-type: none"> <li>✓ Green areas are clean and safe</li> <li>✓ Pavements are well-maintained, wide and free of obstructions</li> <li>✓ Pedestrian crossings are safe and sufficient in number</li> <li>✓ Cycle path are separate</li> <li>✓ Good street lighting</li> <li>✓ Buildings are well-equipped for particular needs a</li> </ul>
<p><b>Transportation</b></p>	<ul style="list-style-type: none"> <li>✓ Public transportation network is consistent and reliable</li> <li>✓ Transportation means and stops are accessible, safe and well-equipped</li> <li>✓ Roads are well-maintained</li> <li>✓ Good education: drivers give way to pedestrians</li> <li>✓ Availability of parking</li> </ul>
<p><b>Housing</b></p>	<ul style="list-style-type: none"> <li>✓ Affordable housing near the rest of the community</li> <li>✓ Housing is well-constructed, safe and close to services</li> <li>✓ Housing for frail and older people near to support services</li> </ul>

<b>Social Participation</b>	<ul style="list-style-type: none"> <li>✓ Venues for events and activities are conveniently located and accessible</li> <li>✓ Activities are affordable and can be attended comfortably also by older people</li> </ul>
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(Source: WHO, 2007a)

### Walkability

*“A pedestrian is any person who is travelling by walking for at least part of his or her journey. In addition to the ordinary form of walking, a pedestrian may be using various modifications and aids to walking such as wheelchairs, motorized scooters, walkers, canes, skateboards, and roller blades. The person may carry items of varying quantities, held in hands, strapped on the back, placed on the head, balanced on shoulders, or pushed/pulled along. A person is also considered a pedestrian when running, jogging, hiking, or when sitting or lying down in the roadway”*

(WHO, 2013a).

The excerpt shows several elements characterising a pedestrian. Pedestrians can be alone or in groups, running or slowly enjoying a promenade, autonomous or proceeding with the help of a walking device.

Environmental psychologists and urban planners can be of help of governments and municipalities in order to design and foster age- and pedestrian-friendly spaces. Environmental psychology is the field of psychology that examines the way human beings are affected by the environments as well as the interrelationship that exists between environments and human cognition and behaviour (Dunlap et al., 2002; Gifford, 2007; Stokols and Altman, 1987). The term "environment" in this context is analysed in its broadest sense, encompassing natural, built and social attributes. In fact, "environment" does not only indicate a physical setting (natural or built), but also the social context, which is almost never separable from a physical setting. A few of the common environments surrounding human beings in their daily life are home, workplace, school, shops, parks, cities etc. This means that people experience different kinds of environments in their everyday routine and throughout their life and whether they are aware of it or not, every time they are affected in some way by the living environmental context. Among the theme of interest in environmental psychology, the study of "walkability" and the relationship that exist between pedestrians and the surrounding space can be found. As stated in "Proposed Walkability Strategy" by Stantec Consulting Ltd. (2009): *"Walkability is the measure of the overall walking and living conditions in an area and is defined as the extent to which the built environment is friendly to the presence of people walking, living, shopping, visiting, enjoying, or*



*spending time in an area."*

The attention around the theme of walking in the city grew considerably at the end of the '90s. Designers and urban planners focused on strategies for the development of pedestrian areas and, in general, on promoting walking in urban territories.

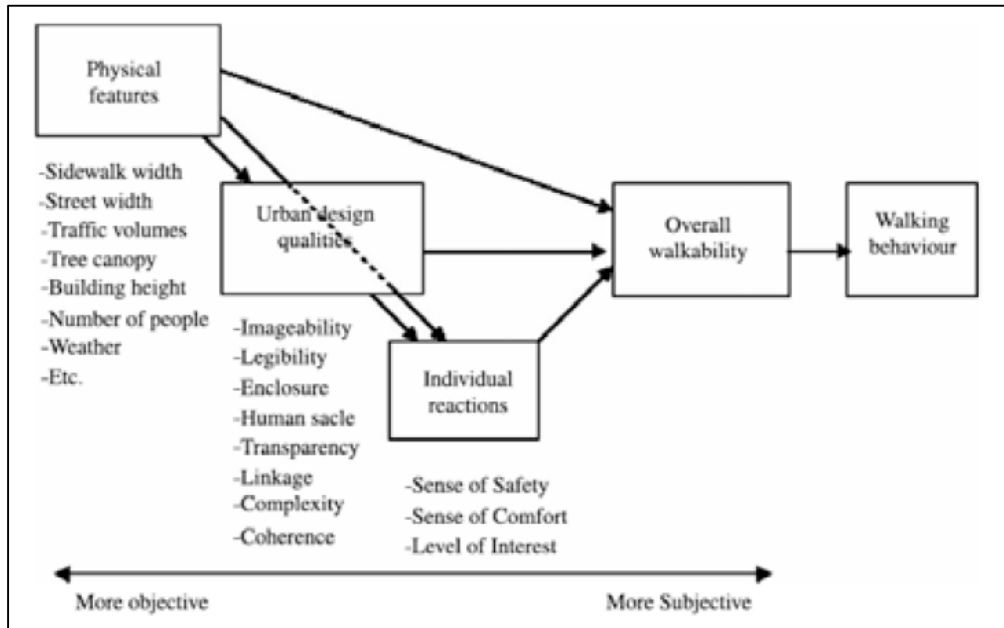
In 1999 the transportation engineer Reid Ewing defined the characteristics for a pedestrian and vehicular flow and he divided them into three categories:

- Essential features. Urban density, mixed use of the territory, relatively small neighborhoods, safe and recurring pedestrian crossing (every 150 meters), continuous sidewalks wide enough for dyads, separate walkaways from vehicles-dedicated lanes.
- Highly desirable features. Proximity to commercial activities and green areas, harmony of big and small buildings in the same area, right proportion of space dedicated to the vehicle traffic and pedestrian flow.
- Nice additional features. Street and public space furniture such as benches, effective signals and urban elements aiming at enriching urban decor and cultural features.

It is not easy to assess whether specific urban elements are directly influencing the way of walking since subjectivity and personal experience are not always attainable and easy to measure. In fact, if it is true that the quality of a pedestrian walk is determined by objective elements such as urban furniture (road signs, parking meters, mail boxes, garbage cans, seating etc.) and walkaways conditions, pedestrian perception of the surrounding space also plays a fundamental role in determining the quality and the recurrence of walking activities of a determined population in a specific area. A territory that considers the human scale, that is, a territory planned putting at the centre the human dimension with its objective and subjective needs, is the one which has the potential of successfully create a vital and mixed-use pedestrian friendly space.

Burton and Mitchell (2006) broadened some of the concepts previously mentioned identifying six components of urban public spaces: familiarity within a space; legibility, or rather to what extent people can find orientation in a specific territory; distinctiveness, the way the urban environment communicates its unique features; accessibility of the space; comfort of the walkaways and its furniture; safety of people walking and crossing streets.

**Figure 4.2: Conceptual framework for a walkable urban design.**



(Source: Ewing, 1999)

A space is pedestrian friendly also if it follows the rule of five "D", according to the designer Julie Campoli (2012). From a more objective point of view, rather than perceptual, density, diversity, design, distance to transit and destination accessibility are all fundamental features that make an environment walkable. Above all, density is the primary condition as it concerns the concentration of the population as well as of services and activities in a determined area. However, even if it is the basic feature, density alone would not be enough in order to make a space pedestrian friendly as all the other characteristics are also very important in the discourse of a walkable, but also, human scale-based environment.

To sum up what discussed until now, the requirements of a walkable environment could be summarised as below<sup>17</sup>.

- **Accessibility and Connection:** the neighbourhood should be connected to other realities and accessible through the demolition of physical and infrastructural barriers. An efficient transportation network that considers vehicular transportation as well as bicycle and pedestrians paths.
- **Density and Mixed Use:** an area where the use of the territory is mixed, offering housing located near businesses without being congested or overbuilt. It is important to avoid specialised neighbourhoods such as residential areas or productive areas only, but to mix activities for the creation of a territory with residences, services, business and shops.

<sup>17</sup> Beverlej, A., & Zambotti, N., (2013). *Towards a walkable city. Per una pedonabilità della città contemporanea. Il caso di Milano*. Retrieved from Politesi digital archive, (archivio digitale delle tesi di laurea e dottorato, Politecnico di Milano).

Walkable neighbourhoods also need to have a centre, a main street or a public space where to gather, a landmark for people to use.

- **Perceived Security:** perceived security not only from crime but also from car traffic. The less the perceived security, the more the incidence of isolation of people in their private sphere, contributing to the decay of public places as a direct effect. Territories that are not perceived as safe are abandoned contributing to their decline; hence urban design for a walkable environment have to carefully enhance security in all its shapes.
- **Pedestrian Design:** plenty of public places to gather and play are necessary, as well as the design of streets for bicyclists, pedestrians, and transit. Open spaces should be planned coherently to human dimension, also respecting all inhabitant's transportation means and necessities. Walkaways are wide enough for two people to proceed side-by-side and preferably well separated from the car lanes. There are frequent and conveniently located street crossings and drivers are encouraged to maintain a low speed.
- **Human Scale and Experience:** a pleasant and pedestrian friendly environment leads people to build experience inside a territory in which they feel comfortable and where they can build a sense of belonging. Public streets, squares and parks increase and enhance social relationships creating a sense of enclosure to the context. The neighbourhood becomes a familiar place, fostering human relationship and promoting the exchange of meaning and experience among the community of people sharing the same territory.

#### 4.3 The Importance of Developing Walkable Cities

Mobility is a key factor for a city that aims at being inclusive. It has been already presented how being able to move around the neighbourhood and the city determines social participation and access to services and infrastructures, contributing in improving the quality of life of all inhabitants and particularly the senior citizens.

Urban settings and services are determinant in supporting senior life, hence, it is important to have in mind the importance the external environments has on the speed of decline in older age. Promoting a healthy and active ageing is one major solution when discussing about quality of life and the reverse of decline speed in old age. Since active ageing is a life long lifestyle, an age-friendly city does not only mean to be "elderly-friendly" but to allow all people in the community to be part of it (WHO, 2007a).

Improving mobility and citizens participation implies barrier-free buildings, streets maintenance, perceived safety and, in general, making secure for children to play, for women to venture outside and for elderly to find place in outdoor activities. The whole community would benefit from an age-friendly environment and, in particular, from the participation of its older members.

An age-friendly city is also a city able to develop a "walkable community", that is, to design a human scale environment where safety is promoted, and people can enjoy walking and gathering in comfort. According to Dan Burden, expert of walkability and cofounder of the Walkable and Livable Communities (WALC) Institute, a walkable community is "*a community that returns rights to people, looks out especially for children, seniors and people with disabilities and takes aggressive action to reduce the negative impacts of sixty-plus years of auto-centric design and uncivil driving practices*" (Victoria Transport Policy Institute, 2014).

In this sense, an age-friendly city has the effect of developing an environment that is pedestrians friendly, characterised by wide sidewalks, safe street crossings, parks and plazas where people can gather, bicycles path etc., anything that allows people walking pleasantly and safely, creating an environment where is desirable to spend time in. A neighbourhood, or broader, a city, has also the interest to extend walkable opportunities as it can take advantage from social, economic, health and environmental benefits.

❖ *Social Benefits*: an age-friendly city is a city able to support life of all generations, sustaining inhabitants to settle a family, raise children and grow old in. At the same time, the same environment enables people to stay active and give their contribution, whether it is economic-social-civic, to the community life and for their neighbourhoods' advantage. Hence, such a city should be barrier-free, removing material obstacles and social inequalities. Cohesion and inclusiveness will foster solidarity among generations, and integration will make older people feel socially accepted and involved. In this way, friendly cities will reach out and include older people at risk of loneliness and social isolation. An environment that is perceived as pleasant, safe and attractive is a key aspect in community livability. People are encouraged to walk instead of using private transportation and interaction is enhanced and a network grows inside the community where people are involved in activities and neighbourhood life. Inclusiveness fosters cooperation and kinship among the members, especially elderly people, who are often in good health and with plenty of time after retiring from work. Crime, car traffic and appropriate streets/sidewalks maintenance are, of course, entangled with the perception of safety. Struggling against street and traffic crimes and implementing strategies for pedestrians' safety are unavoidable prerequisite in order to support walkability and age-friendly cities. In addition, road lighting, condition of sidewalks and street crossing should be taken into account appropriately. Limiting

motor vehicles transport results in overall increase in road safety, as observed in the Netherlands, where the level of non-motorised transport is very high (Pucher and Dijkstra, 2000). The objective is to allow inhabitants to enjoy the surrounding areas by walking in comfort and safety. Public spaces will become more liveable and lively, attracting more people in the community and meeting the needs of the participants.

❖ *Economic Benefits:* a walkable community also provides benefits from an economical point of view. One might think that pedestrian area interdicted to motor vehicles negatively impacts on retail and business activities but studies found out that a commercial area with a good level of walkability actually tends to increase business activity and not only, as housing value also benefits. For instance, the Italian Chamber of Commerce and Milan Municipality announced that the creation in 2009 of a pedestrian area involving one important commercial street in Milan (Via Paolo Sarpi) did not affect negatively the retail business. Walkable areas in the U.S. tend to attract more educated workers and, consequently, register greater economic productivity compared to cities less walk friendly centres and suburbs (Leinberger and Lynch, 2014). Walkability was found to be related also to housing value. Cortright (2009) used data taken from a private company that provides public access to walkability index in the U.S., Canada and Australia ([www.walkscore.com](http://www.walkscore.com)) and 95,000 real estate transactions controlling for house and neighbourhood characteristics. According to Cortright, walkability has a statistically significant positive impact on housing market prices mainly because of the combination of use (residential, commercial and cultural) while also providing accessibility through the creation of pedestrian connections. Similarly, the value of offices and retail venues, increases in relation to fair walkability. In Washington D.C. neighbourhoods, a place with fair walkability registers, on average, \$302 per month more in residential rents and has values of \$82/sq. ft. more for for-sale residential property than in lesser walkable neighbourhoods (Leinberger and Alfonso, 2012). Economic benefits are entangled with economic savings as well (Litman, 2003b), mainly involving:

- **Public Costs.** The use of vehicles imposes various costs related to road maintenance, parking areas, traffic congestion and accidents involving cars. Enhancing non-motorised travel modes, especially for short distances, reduces these costs making municipalities and public institutions save money that can be invested for walkable areas and, in general, in support to the community.
- **Consumers Costs.** Citizens can save money thanks to improved walkability as they can cut expenses coming from the use of private transportation (fuel, parking, insurance).
- **Efficient Land Use.** Asphalt for roads and parking lots subtracts land and damages the environment. Ambient damages provoke high costs for government and, in general, for the human population. Hence, development strategies that are smart and environment-friendly should be fostered.

- **Social Cohesion.** Neighbourhoods are the sites where people interact with their community, whether it is talking with the nearby resident or going to the post office. Attractive, safe and accessible space can increase occasions of connections that can create a network of friends and acquaintances, which plays a fundamental role in terms of personal and collective well-being.
  - **Health.** Economic savings also derive from correct investments in prevention. Promoting a healthy life has positive outcomes both at the societal and individual level since it is more effective to finance strategies in order to prevent diseases rather than to use the same resources to treat them.
- ❖ *Health Benefits:* It is commonly accepted that urban parks and green areas provide comfortable and pleasant living context for citizens but, beside personal preference, there is controversy whether greenery has positive health effects on urban residents (Takano et al., 2002). To demonstrate that living in an area that has walkable green spaces has a positive impact on longevity was the objective of Takano et al. (2002) study. They investigated, through a cohort study of older people, the association between accessible walkable green spaces and the longevity of senior citizens in a densely populated environment (Tokyo area). Their final purpose was to provide facts that constitute key evidence for policy making, facilitating collaboration between the health and urban planning sectors in order to promote health and well-being. In their research, they found that there is a positive association between living in green areas and longevity, independently of age, gender, marital status and socioeconomic status. This means that senior citizens' life can be positively influenced by a green and walkable neighbourhood (Takano et al., 2002). Thus, the presence of green areas and the possibility to walk is linked to an improved health condition of older people, evidence that should be considered by public institutions as basis for any new urban projects. An age-friendly environment can also limit or delay age-related illnesses through the provision of community support and health care services, enabling people to remain healthy and extend life expectancy. Quality of life of all people as they age is improved, including younger generations: the sooner a healthy ageing lifestyle starts, the better for one's health in older age. Nevertheless, it is never too late and appreciable results can be achieved even in later years. For example, people who quit smoking between 60-75 of age can reduce by 50% their risk of premature death (Euro Health Net, 2012). Moreover, increasing physical activity can lead to a reduction of several diseases such as cardiovascular and obesity-related disorders (WHO, 2013a), besides having positive effects also in terms of costs. According to the WHO, a moderate but regular aerobic exercise like walking, provides physical benefits (it can help reducing the risk of chronic illnesses, such as heart disease, type 2 diabetes, asthma and stroke) but also psychological ones, such as happiness. A recent study also associated data from a group of cognitively normal adults who walked regularly instead of leading a sedentary life with a 50% reduction of Alzheimer's risk over 13 years.

❖ *Environment benefits*: the environment also benefits from a decreasing use of motor vehicles. Air pollution causes around 6% of total mortality per year in Europe, about half attributed to traffic-related air pollution, which is a key target for public-health action in Europe and not only (Künzli et al., 2000). The international society is directly involved in climate change and environment protection actions and the Kyoto Protocol is an example. This international agreement was adopted in Kyoto, Japan, on December, 11th 1997 and commits all parties by setting internationally binding emission reduction targets. Developed countries are principally responsible for the current high levels of polluting emissions in the atmosphere as a result of decades of intense industrial activity. Nowadays, developing countries are also contributing to current alarming level of air smog and water poisoning and there is no time to procrastinate anymore if the planet has to be preserved for future generations. One priority is to reduce smog produced by motor vehicles, in favour of more environmentally friendly solutions such as using electrical vehicles, enhancement of public transport or car sharing and the promotion of walking.

#### **4.4 Peculiar Characteristics of Elderly Pedestrians**

Ageing is an irreversible degenerative process of the organism and every person ages in a different way. The ageing process can be influenced by various variables such as genetics, living environment and personal lifestyle. For this reason, people of similar age referred to as "elderly" can be very different to each other. Nevertheless, after the age of 65 it is very likely that people experience some age-related physical and cognitive change (Webb and Weber, 2003). While some of them are part of the natural consequence of the ageing process, like vision and hearing loss, others are the result of serious diseases and accidents such as Alzheimer's disease or a fall.

From the cognitive side, people at old age maintain the capability of performing familiar and simple tasks. In complex situation, where more information and elements might confuse or being of disturb, the task may become more difficult to complete. While walking, the old person has to deal with a number of different situations that might negatively affect the performance and behaviour (Dunbar et al., 2004).

From the physical viewpoint, loss in vision, hearing and mobility have direct effects on walking speed, unstable gait and sense of vulnerability.

- *Vision*. Vision loss is a major health care problem among the elderly. By the age of 65, approximately one person in three experience some form of eye disease that affects vision capacity. Macular degeneration, glaucoma, diabetic retinopathy and cataract are the most common diseases at the basis of vision loss. Particularly, cataract is very common among the elderly. As a consequence, cataract surgery has become a quite popular treatment nowadays, with low risks and several benefits for patients' vision acuity (Quillen, 1999). Cataract removal is recommended when the vision loss interferes with everyday activities such as reading, walking and driving. In fact, diminished vision acuity can affect the ability to detect people and objects,

especially if they are moving. Because of a smaller resting diameter of the pupil (Kline and Scialfa, 1997) elderly are less capable to adapt to lighting levels changes being less able also to distinguish details of people and the environment surrounding them. For the same reason, to look for a person in a crowded situation might be challenging, also because the depth perception is reduced in old persons (Sanders and McCormick, 1993). Poor lighting can make the situation worse because it is more difficult to discern details of the surroundings and, at old age, eyes require more time to adjust to variations in light intensity. In addition, the crystalline gradually becomes yellow causing colours misperception: blue resembles green and purple becomes grey (Hyatt, 1981). Decreasing vision acuity, misperception of depth and colours and a diminished capacity of detail discernment, may have a crucial role for elderly safety. Falls and road accidents involving older people occur frequently at home or in open places causing severe physical and psychological damages to the person involved. A well-lit environment becomes fundamental for the safety and well-being in seniority, both in-house and outdoor.

- *Hearing.* Hearing acuity decrease is widespread among old people, especially among men. Hearing damages can vary from not being able to detect certain sounds to deaf. Hearing loss has repercussion on daily life activities. Understanding people words and talking to the phone can become difficult. Not hearing or understanding what people are saying can make the person feeling embarrassed, ending up withdrawing the conversational situation. Moreover, hearing difficulties may create misunderstandings, making things and human relations more complicated. A decrease in hearing capacity can also affect the identification of people and objects in the environment. This is because of the inability to tune out background noise (Fozard, 1990; Sanders and McCormick, 1993) and a decline capacity in detecting high frequency (Fozard, 1990). Therefore, it becomes difficult to understand a person speaking in a noisy place or perceive a car vehicle approaching putting the old person in a potentially dangerous situation. It has been proven that vision and hearing problems have direct consequences on drivers' safety hence they can presumably have impact on elderly walking and accident involving pedestrians (Dunbar et al., 2004).

Physical change and an overall reduced physical ability are reported to occur in old age. Changes can imply loss of muscle mass and change in posture (Carpman and Grant, 1993), causing a reduced range of motion (Panero and Zelnik, 1979) and reduced strength (Kroemer, 1997). Gait and, consequently, walking speed are directly affected by a decrease in health condition.

- *Gait.* Unstable gait and balance are important risk factors for falls. Since falls are more common in late age and they can lead to serious repercussions, elderly people might proceed slower also to avoid bad consequences caused by a fall. In their study, Vellas et al. (1997) found that falls was associated with female gender, older



age, impair balance and gait abnormalities, poor physical and cognitive health and economic resources. Those who have poor economic resources are more likely to be afraid of falling also because of the financial consequences an injury would determine (this data is particularly related to the setting of the study, the USA, where health insurance is a major concern for the population).

**Figure 4.3: Old woman walking with the help of a roller. In older age, a reduced balance-gait performance might require walking aid in order to move in safety.**



The fear of falling and anxiety after a fall can become a long-last condition that can negatively influence the quality of life of the elderly people. People using walking aids walk more slowly and have poor performance on obstacle course (Imms and Edholm, 1981). In addition, manners of younger pedestrians can make elderly feel uncomfortable with their being more vulnerable. On the other hand, an increased aware of the peril may lead older pedestrians to adopt safer behaviours in order to walk on pavements and cross the road safely. In case of Parkinson's disease, which affects about 1.6% of the population over 65, movements are affected in several ways, including gait. Body balance is unstable and falls occur more frequently, being the physique more rigid (Dunbar et al., 2004). A reduced balance-gait performance is related to cognitive impairments and other functional impairments concerning walking tasks. Consequently, a slower gait affects safety, making the slower person more vulnerable (Baltes and Lindenberger, 1997).

- *Walking Speed.* A slow gait could be the consequence of impairments but also loss of strength, a factor considered normal in aged people. Elderly people experience a decrease in speed of behaviour, hence activity like walking and driving might be compromised (Fozard, 2000). People walking at a slower pace find more

challenges along their way, for example when they have to cross the road in the time afforded by the light signal. Walking speed has also been shown to be associated with survival among older adults and it reflects health and functional status. Higher walking speed may constitute a reliable indicator to measure the vitality of an old person as the body is able to perform a complex task such as walking. On the contrary, slower gait speed can indicate a poor physical health (Studenski et al., 2011). It also seems that gait velocity can constitute a single predictor of adverse events in healthy elderly persons. It might be that walking speed could be enough in detecting people at risk of events that could provoke harmful episodes, which would require hospitalisation, assistance of a caretaker or even death (Montero-Odasso, 2005).

The main physical changes that many people are likely to experience at older age have been presented. A reduced vision, hearing acuity decrease and unstable gait may contribute exacerbating a sense of frailty, that in turn influences interpersonal distance as a mechanism of self-protection. Confidence has effects also on the capacity of elderly to walk in open environment; consequently, they might feel more vulnerable in relation to the surroundings that are often not elderly friendly.

➤ *Vulnerability.* Social-economic resources and mental-physical health have an impact on the general well-being of the people. In particular, a loss, a disease or loneliness often generate psychological distress among the elderly, more than in a younger adult who usually have more resources to solve a critical condition. The ability to leave a determined situation autonomously is the most protective mechanism (Webb and Weber, 2003). In old age, impairments and cognitive deficits rise while, at the same time, the strength of bones and internal organs decreases. These can constitute potential risk factors leading to serious injuries and even death when driving (Braver and Trepel, 2004). To this end, Braver and Trepel (2004) suggest that vulnerability is determining in the number of fatalities in older people involved in crashes. However, it has to be said that in some cases assist to a compensating action can be observed. Older pedestrians, aware of their frailty, might try to act more carefully in performing walking tasks. In this way, they can compensate for functional impairments as they are concentrating at maintaining a safer gait (Dunbar et al., 2004). Personal space works as a protective mechanism from the social context people live in (Hall, 1966; Sommer, 1969), both from physical and psychological point of view. The sense of vision, hearing and mobility are inevitably related to interpersonal space and sense of security. In old age, the interpersonal distance seems to be different if compared to younger years, also as a consequence of the deterioration of the sight and hearing senses as well as a lesser degree of independence. Holland et al. (2004) investigated the effects of self-construal in relation to interpersonal proximity. The results of their studies, showed how interdependence is associated with spatial distance: the more interdependence of participants' self-construal the greater spatial distance during

the interaction. Self-construal automatically regulates interpersonal behaviour meaning that behaviour can be regulated without conscious awareness. An individual's age, gender and moving capability have been found linked to the perception of aggression and physical strength (Webb and Weber, 2003). Furthermore, as the capacity of moving autonomously decrease, or rather, to be able to escape potentially dangerous situations, elderly need to increase interpersonal space. This amount of space can vary also in presence of a third object such as a walking aid device (see Ohno et al., 2012 for reference).

After this discussion, the importance that design plays in contemporary society (e.g., interior design for elderly friendly homes, urban design for age-friendly cities) is clear. The concept of "friendly-city" does not only refer to tangible features such as building new wide sidewalks, green areas and infrastructures for the elderly but also to intangible aspects such as inclusiveness, comfort and safety. An environment that is not inclusive, fails in its aim to be a friendly living context. For this reason, understanding the impact of the built environment on the well-being of all the citizens is the key for further studies on the quality of life of the contemporary and future society.

#### **4.5 Older People Walking in Group**

Some of the positive consequences that a moderate physical activity has on health have been presented, such as reduction of cardiovascular and obesity-related disorders and risk of chronic illnesses, as well as the beneficial effects on mood and psychological well-being. It has been reported that walking in group can have more positive effects on people, particularly on senior persons. A study published on the British Journal of Sports Medicine (Hanson and Jones, 2015) found out that physical (improved blood pressure, heartbeat and cholesterol levels) and psychological (prevention to loneliness, depression, lack of kinship) wellness, are positively associated to walking in group. Doing organised outdoor activity constitutes a habit that can improve the health and mental state of older persons as it fosters relationships while staying fit and avoid sedentary lifestyle. Being in a group, help people to feel part of a small community one can rely on, where to find affection and encouragement to be active.

Because of its beneficial effects, in recent years several initiatives promoting outdoor walking can be counted locally or internationally. For instance, in the United Kingdom the group "The Ramblers" ("The Strollers" in London area) is active, an association of people whose goal is to protect the right of going walking and the places to enjoy a walk. It also develops projects for the preservation and expansion of these places in cooperation with wider coalitions and local communities. Through the preservation of natural and urban areas and walking together, they aim at achieving those benefits that come from enjoying group activity in the nature.

In Italy, a growing number of municipalities are organising walking projects and

group walking events in order to motivate people of all age, but especially in their older years, to enjoy urban areas while remaining healthy and active. These groups are generally called "Gruppo camminatori" ("Group of walkers") or "Camminatori di città" ("City walkers") and initiatives are carried out in bigger cities such as Rome, Milan, Varese and small towns all over the country. The main goal of all these initiatives is to encourage people to remain active, that is not only referred to good health preservation but also to cultivate social ties through socialisation. "Camminiamo insieme" ("Let's walk together"), founded by Coop Liguria, in 1994, is one of the oldest evidence for group walking in Italy that also promotes the valorisation and protection of the natural environment thanks to outdoor activities in the countryside of the region. In fact, members commit themselves to defend the routes they walk through and to educate participants to a sustainable use of the natural resources.

From the technological world, MapMyWalk is an application designed for computers and smartphones for all over the world and developed by MapMyFitness, in Texas. Participants can track a route and make a comment about the activity they carried on and share it with other members who can also join the person in his/her walk by establishing a direct contact to organise the next group walk. The company also developed MapMyRun and MapMyRide for the same scopes of fitness and social cohesion.

Hanson and Jones (2015) carried out a systematic review of 42 studies involving a total of 1843 participant walking in group to investigate whether there is evidence that outdoor walking in group has health benefits and therefore could be recommended by clinicians. 74% of the articles were studies conducted in the past 10 years with no papers prior to 1988. This highlights the recent interest about group walking activities. Studies were located in 14 different countries, mainly in the USA, and the gender of the participants was mixed, and 43% of the studies were on women only (no studies on men only). The analysis showed statistically significant reductions in blood pressure, body fat, total cholesterol and risk of depression in group-walking participants. So, it can be said that group-walking is a potentially effective intervention from physical and psychological health viewpoint. Social cohesion is supported by group activities, fostering motivation and engagement in older people who often lack occasion of outdoor activity with other people. Companionship can help keeping the motivation of carrying on group activity, encouraging an active and emotionally enriched lifestyle. Thus, it is demonstrated that walking in group is origin of a positive feeling, it contributes to stay healthy and facilitates interpersonal relation. Despite these findings, no studies concentrate on smaller group composition like couples, their walking dynamics and the reason behind walking in pairs. However, recent findings reveal that dyads are the most recurrent pattern inside a group of pedestrians.

A study conducted at Csai research center of the University of Milano-Bicocca and presented in Chapter 6 clearly unveils the highest proportion of dyads in flow

composition (Bandini et al., 2014). However, no studies have talked about dyads of pedestrian and no studies concerns directly to older pedestrians walking in pairs. Hence there are the premises to believe in the necessity and scientific relevance to investigate the theme of dyads of pedestrians.

The reasons of walking in pair are mainly companionship, need for assistance or safety: going for a walk, being accompanied to do some commitments, asking for the assistance of a caregiver. To have a supportive partner, emotionally and objectively, can be one important reason of proceeding in pair. In the previous chapter, it was argued that more than 50% of the respondents of the questionnaire about the perception of longevity prefers the idea of outdoor activity for elderly rather than indoor, underlining the importance of achieving a safe and diffuse elderly pedestrian mobility. Sense of security, friendship and comfort are unquestionably related to senior people that still feel independent in their choice and actions but that, at the same time, need support in daily life tasks.

#### **4.6 Conclusions**

The objectives of an age-friendly city and how a city that aims at encouraging active ageing by optimising opportunities for health, participation and security should be, have been discussed throughout the chapter. To adapt structures and services, making them accessible to all people will allow also older citizens to be and feel part of social life.

The sense of vulnerability that arises from a decreased vision and hearing acuity produces an unstable and slower gait, decreasing the moving capacity in senior pedestrians. At older age people increasingly rely on environmental information to balance out fragility, therefore, to make cities age-friendly is one of the most valid ways to respond to demographic ageing and to enable people to actively live the city.

An urban environment that is pedestrian friendly, or walkable, can help all citizens, but particularly elderly, to build ties with other people avoiding sedentary lifestyle. For these reasons, investigation of age-dependent physical and perceptual aspects is crucial and urban planning should adapt the environment of the cities in order to meet elderly pedestrians specific needs and allow them to continue walking in safety for elderly inclusion in the city life.

In conclusion, the chapter highlighted the relevance of taking action and rethinking of living environments through projects and strategies able to support a prolonged life span and an independent living, which is likely to continue well beyond retirement age.



## CHAPTER 5

### What is a Dyad of Pedestrians?

#### 5.1 Introduction

#### 5.2 Defining Dyads of Pedestrians

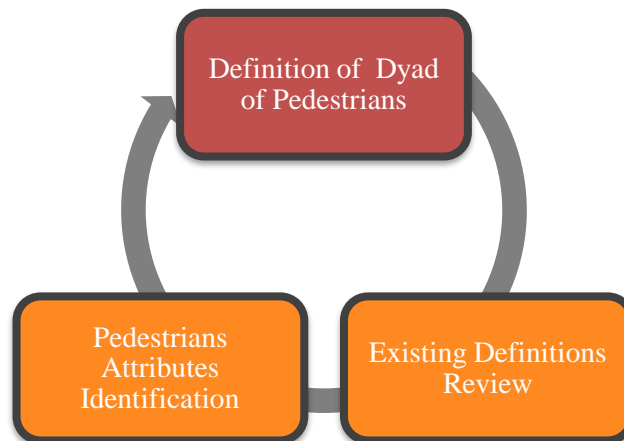
#### 5.3 Conclusions

#### 5.1 Introduction

*The purpose of this chapter is to introduce the concept of "dyad" inside the pedestrians dynamics framework and present the process aimed at defining a "dyad of pedestrians". The words "couple", "pair", "twosome" and "dyad" are often used in everyday life to refer to two people being together. Very often the word "couple" is used to identify two persons involved in a love relationship or to people being very close to each other, for example walking or sitting very close. In the study of pedestrians dynamics and crowd's composition, dyads of pedestrians constitute a major character. Despite their relevance in several related fields, e.g., field of pedestrians behaviour, crowd dynamics and evacuation planning, there are very few studies specifically on dyads of pedestrians and no definition has been given until the moment of writing.*

*In order to tackle the theme directly, a top-down approach was chosen to discuss the notion of "dyad"; therefore, an original definition of "dyads of pedestrians" is presented first followed by a discussion of a few general definitions concerning the meaning of "twosome".*

**Figure 5.1: The top-down approach used to introduce the definition of "Dyad of Pedestrians".**



#### 5.2 Defining Dyads of Pedestrians

At the moment of writing, the scientific world lacks a definition of "dyad of pedestrians". In this study, the word "dyad" is used in case of two persons who have social ties and voluntarily walk together. Despite social outcome of their performance

is also taken into account, the research mainly concentrates on the motion patterns resulting from locomotion. Thus, the definition of a dyad of pedestrians in this context is:

“Two pedestrians can be considered a dyad if, in order to achieve a common goal, they proceed in a cooperative way toward the same direction trying to coordinate with each other to maintain the same velocity and a close proximity.”

First of all, what can be define as a "dyad"?

At the preliminary stage, the consultation of the major dictionaries and encyclopedias helped to define the general framework of the subject. A "dyad" is often defined as "*something that consists of two elements or parts*" (Oxford Online Dictionary, 2014; similarly, Cambridge Online Dictionary, 2014; and Garzanti Online Dictionary, 2014). Also, biology calls "dyads" those chromosomes duplicated as mitosis begins, in phonology a "minimal pair" indicates a couple of words, which differ in only one phonological element.

As more elements were needed for the purpose of defining a dyad of persons, the review continued, shifting to the synonym "couple" in search of more information useful to enrich the understanding of the subject. Some definitions containing interesting attributes have been selected among the others and presented.

For example, according to Hoepli Online Dictionary (2014) a couple can be defined as "*two animated or inanimate beings; two elements of the same species, considered as a unit*".

This first definition is very simple as it takes into account just one attribute, unity. Sabatini-Coletti Online Dictionary (2014) describes a couple as "*two units considered as a single entity; two people bound by a love relationship*".

Oxford Dictionary (2014) considers couples to be "*two people or things of the same sort considered together; two people who are married or otherwise closely associated romantically or sexually*", similarly to Cambridge Dictionary (2014), which states that couples are "*two or a few; two people who are married or having a romantic relationship*".

These last definitions concentrate on the fact that a couple is a unit, indicating that two persons forming a couple have to be seen as a single entity, and that they are bound from only one kind of relationship, love. The term "couple" is commonly used to refer to "loving couples" while for the purpose of the present research, all those twosomes that proceed together intentionally, whether they are bride and groom or friends, are addressed.

Collins Online Dictionary (2014), besides associating two people considered as a pair, also covers the meaning of the verb "to couple" mostly referred to connection:



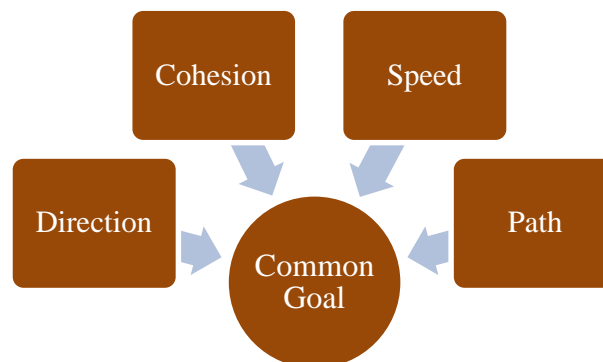
"to connect (two things) together or to connect (one thing) to (another); to associate, put, or connect together".

Garzanti Dictionary (2014) adds the concept of "goal" to its definition, saying that a couple is "two people, two animals or two objects linked by a goal and considered as a consistent unit; two people, usually of different sex, united by marriage or by love relationship".

It is a more comprehensive definition as it mentions entity, gender, relationship and common goal. It could also raise questions on whether "marriage" can be considered as a cooperative way for a common purpose (e.g., family, child rearing, personal fulfilment). The German Sociologist Georg Simmel was a pioneer in the study of couples in the early 19th century. He argued that the dyad is the smallest social group and relies on immediate reciprocity, the smallest the group the more intense the interaction and cooperation is (Simmel et al., 1964). In this sense, marriage can be seen as the most effective example as two persons that are socially recognized by the others, have a relationship and cooperate for the sake of their well-being.

By this time, it can be said that two persons can be identified as a dyad of pedestrians if they are treated as a unit regardless the gender and the existing relationship. Members of this dyad also maintain a certain personal distance to move towards the same target. In this case, the common goal could be represented by reaching a determined place or proceed along the walkway, while both pedestrians negotiate their action coordinating each other's walking behaviours closely. How they proceed and at what speed, represent the goal-driven way a dyad of pedestrians cooperate.

**Figure 5.2: Cooperation of a pedestrians dyad towards a common goal.**



The way groups move toward their goal might be determined by the relationship among the members, in particular a leader. Social ties and the status inside the group can lead to the emergence of a leader who makes decisions and coordinates the actions on behalf of the other members with the aim of crossing the space in the most effective way toward the common goal, the so-called *leader-follower* pattern.

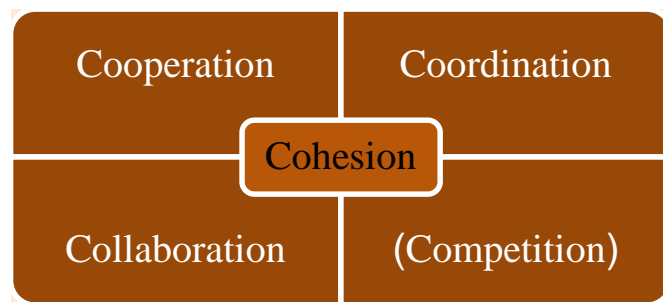
However, a dyad is very different from other pedestrian groups as the involvement of its member is greater, holding a responsibility that cannot be delegated

to others (which can occur in larger groups). This means that the decision one takes has a direct consequence on the other partner as well as on the dyad itself. The two members have to cooperate as the success depends on each other's action: if one fails, the dyad is destroyed (Simmel et al., 1964).

Consequently, joint efforts are necessary to maintain the dyad cohesive and at the same time, successfully reach the goal. Cooperation, coordination and collaboration are necessary in order to avoid competition, which could lead to breaking up and compromise the effectiveness of the dyadic relation.

- *Cooperation*: indicates the situation or the process of working together to the same end, being helpful with each other for common opportunities. The process is not structured and the relationships are informal;
- *Coordination*: refers to the organisation of different elements in order to enable them to work together, that is, to cooperate resulting in an effective relationship. It also implies the ability to manage the elements involved in a harmonious and productive way for the success of a complex activity. Thus, it requires higher level of structure and formal relations than cooperation;
- *Collaboration*: relates to the action of working with someone, one who might not be immediately connected to, to achieve a common goal. In this sense, collaboration is a goal-oriented approach of joint efforts with high level of trust. Therefore, it has the most structured division of roles and dependence;
- *Competition*: is the act or process by two or more parties acting independently, trying to gain or secure something by defeating or establishing superiority over others. Of course, it could not co-exist with cooperation, coordination or collaboration for cohesion aim unless one party cheats.

**Figure 5.3: 4 "Cs" involving Pedestrians' Cohesion: Collaboration, Coordination, Cooperation and Competition.**



A neologism linking together "cooperation" and "competition" is "coopetition". The term "coopetition" was originally coined by Ray Noorda, the founder of Novell Company (an American multinational software and services enterprise), and later introduced in the business and financial worlds as well as in the field of strategic management. It refers to a "cooperative competition" that leads the parties to work together for a common goal (cooperation) but with interaction and struggle

(competition) in order to achieve higher levels of value if compared to the one created without competition (Dagnino and Rocco, 2009).

In case of pedestrians, competition might occur when the leader position is not clear and, in general, cohesion fails when the members are not able to maintain close proximity. For instance, in case of a crowd, it can be difficult for a dyad to always walk next to each other and coordination could be compromised (e.g., members has to slow down and divide because of many people in the same spatial environment). In this case, if they cooperate with each other, they can bring back together to the dyadic formation again (e.g., members of a dyad split because of crowd but with verbal/non-verbal communication they wait for each other to reunite again).

In conclusion, it could be said that members of a dyad coordinate with each other in order to maintain the same speed and a close proximity toward the same direction. In this way, with the help of the other partner, the dyad is able to proceed in a cooperative way until it reaches the target at the same time, preserving cohesion among members.

### **5.3 Conclusions**

Chapter 5 presented an original definition of dyad of pedestrians that constitute the reference point in relation to the contents of the next chapters, particularly the two empirical studies presented at the end of the work.

Trying to merge the attributes discussed above and taking into consideration the scope of the research, two people are considered a dyad of pedestrians if linked by a relationship, walking as much cohesive as possible toward a common target, cooperating with each other and maintaining a similar walking speed.

For future research about pedestrians walking in pair, the definition offered in this chapter could be of help in the preliminary phase of the studies for the determination and detection of the dyads in a situation with different kinds of pedestrians grouping condition.



## CHAPTER 6

### Theoretical Framework of Pedestrians in Dynamic Contexts

#### 6.1 Introduction

#### 6.2 State of the Art of the Present Work

##### 6.2.1 Interpersonal Distance during Locomotion

##### 6.2.2 Patterns of Small Groups in a Crowd

##### 6.2.3 Elderly Pedestrians Exposed to Environmental Complexity

#### 6.3 Conclusions

#### 6.1 Introduction

*This chapter presents the major theoretical framework of studies concerning pedestrian walking patterns. First, a review of recent publications has been carried out, consulting both printed materials and documents from the Internet. Then, in order to concentrate on the main focus of the research, contributions on pedestrians in dynamic context were mainly taken as reference and reported in the next paragraphs. Studies were divided into three groups according to their principal object of study: "interpersonal distance in dynamic context", "patterns of small groups in a crowd" and "elderly pedestrians in dynamic context".*

#### 6.2 State of the Art of the Present Work

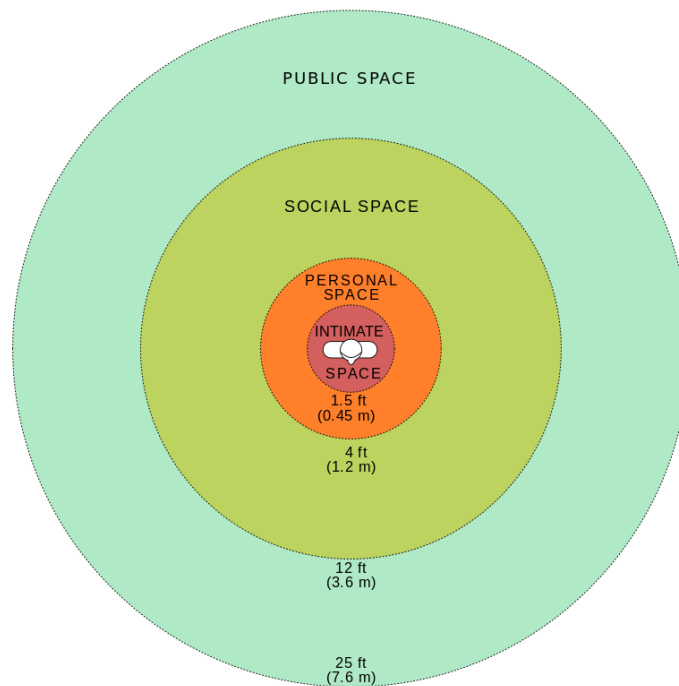
Study on human spatial behaviour and pertaining definition, have origins in the analogy with territorial behaviour in animals (Hediger, 1961). Edward T. Hall (1966) introduced the term "proxemics" in relation to human spatial behaviours and it referred to the nonverbal-communication among human beings that conveys information about the nature of their relationship.

Proxemic behaviour is based on the definition of four interaction zones categories where all social relationships manifestations among human beings fall in (Hall, 1966).

These four zones are:

- *intimate zone* (0 m-0.45 m)
- *personal zone* (0.45 m-1.20 m)
- *social zone* (1.20 m-3.60 m)
- *public zone* (3.60 m-7.60 m)

**Figure 6.1: Four interaction zones according to Hall (1966).**

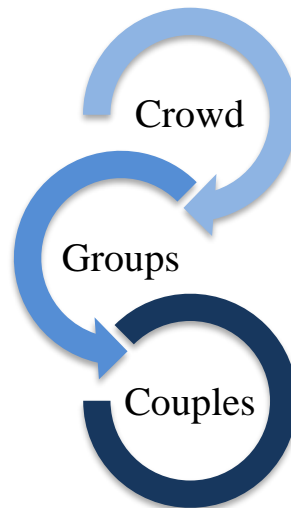


(By WebHamster CC BY-SA 3.0 via Wikimedia Commons, 2011)

As presented in the next paragraphs, few works were specifically dedicated to the groups' behaviour in locomotion, especially small groups, and most of the research has been focusing on proxemics in static rather than dynamic settings. Proxemics constitutes the basis in order to explain and discuss the social and spatial interactions among pedestrians in a crowd and dyads of people during locomotion. In particular, due to the lack of studies on elderly pedestrians, the current work aims at improving the understanding of the behaviours during locomotion of older people, being they in a crowd (unobtrusive observation in Galleria Vittorio Emanuele II, Milan-Italy) or in an urban complex environment (walkability checklist administration in Via Padova, Milan-Italy).

Existing research have studied phenomena typically of crowds (congestions, bottlenecks, stress, evacuation etc.) mostly referring to pedestrians as isolated individuals. Only in recent years research is moving towards the investigation of small groups dynamics (Bandini et al., 2012; Ge et al., 2012; Moussaid et al., 2010; Vizzari et al., 2013; Willis et al., 2004). Pedestrians' behaviour has been recently discussed (Bandini et al., 2012; Costa, 2010; Moussaid et al., 2010; Willis et al., 2004); nonetheless, little has been written about small groups in recent time and, specifically, the theme of "dyad" has not been given the attention it deserves. In addition, despite the number of studies that have elderly pedestrians as subject is increasing recently, none focuses on dyads of elderly pedestrians. There is research about the ability of elderly pedestrians in walking and street crossing (Dommes et al., 2012; Dunbar et al., 2004; Lobjois and Cavallo, 2007, 2009; Oxley et al., 2005; Rantakokko et al., 2009) but they are not specifically concerned about people walking in pairs.

**Figure 6.2: The top-down approach at the basis of the theoretical framework.**



In the next sections, relevant contributions to the study of pedestrians in dynamic context are presented. For the purpose of the current research, groups' behaviours and age constitute the principal objectives. Hence, prominent studies on pedestrians walking dynamics and elderly are reported divided into three categories: "interpersonal distance during locomotion", "patterns of small groups in a crowd" and "elderly pedestrians exposed to environmental complexity" studies.

### **6.2.1 Interpersonal Distance during Locomotion**

Interpersonal distance has been widely discussed under the static context umbrella, less from the dynamic viewpoint. Discussion on eye contact (Argyle and Dean, 1965), intimacy (Patterson, 1976) distance measurement and shape (Hayduk, 1978, 1983), non-verbal behaviour in vertical social relations (Hall, J. A., et al., 2005), gender and sexuality (Uzzell and Horne, 2006), and spatial arrangement during focused interaction (Kendon, 2010) has been carried out from the static point of view: focusing on people standing, sitting or talking but rarely walking. Less observation and studies have been tackled the same behaviours in dynamic situations.

In 1983, Burgess presented a study on walking subjects in the corridors of shopping malls and along sidewalks of small towns. In particular, interpersonal distance has been observed and interpreted according to age differences. Pedestrians have been divided into six age classes and interpersonal distances were measured with the use of a calibrated grid. It was found that all classes showed significant age differences in spacing toward other people.

Particularly concerning age, Webb and Weber's (2003) examined the influence that age, gender and mobility can have in older age in relation to interpersonal distancing. Also, they investigated the association between the perception of physical strength and aggression, and established personal distance. While it was assessed that age, gender and mobility affect the perception of aggression and strength, a weak positive relationship exists between aggression evaluations and interpersonal distance

and between physical strength evaluations and interpersonal distance (Webb and Weber, 2003).

Costa (2010) carried out a study on interpersonal positioning and the association between walking speed and groups (for discussion about groups, see next section). He confirmed what have been proposed by previous studies (Aiello, 1987; Barnard and Bell, 1997; Stier and Hall, 1984) about gender's effects on interpersonal distances. Results from this study showed that male groups walked more "scattered" than female or male-female groups, highlighting a stronger socialisation in females (Costa, 2010). Gender difference has been found to be relevant in small groups (dyads and triads) but not in larger groups. Interpersonal distance among members in larger groups was more homogeneous perhaps because of a lower pressure in demonstrating dominance, status and avoiding intimacy especially among males (Costa, 2010). Moreover, he also found association between interpersonal positioning and height. In dyads where the members shared a similar height, the tendency to walk abreast was higher if compared to people of different height. Previous research on the negotiation of personal space in relation to dissimilarity support this interpretation (Lott and Sommer, 1967; Hartnett et al., 1974; Barrios et al., 1976; Caplan and Goldman, 1981; Aiello, 1987; Kaya and Erkip, 1999).

The interpersonal distance of people in groups of two or more members were analysed in four shopping malls in Turkey and USA under changing conditions of enclosure and density by Ozdemir (2008). People, either walking or standing, were observed in open and closed malls areas through unobtrusive observations and the interaction among group members were recorded using a digital camera. Analysis showed evidence of cultural, age and gender differences in distancing in Turkish and American malls visitors. In particular, adolescents revealed the largest interpersonal distance among groups of their same age and male-female dyads interact more closely than same gender couples (Ozdemir, 2008) probably due to the existence of an intimate relationship.

Along with age, gender and group members' cohesion, the interpersonal distance in dynamic context can also depend on the presence of a third object, suitcase or baby stroller for instance. Ohno et al. (2012) performed 12 experimental situations testing how the presence of wheeled suitcases and baby strollers influence the walking behaviour of approaching pedestrians. In a crowded area in Tokyo, a man was asked to walk in three different directions alternately with a small wheeled suitcase, a big wheeled suitcase, a baby stroller and without any object in particular. The objective was to collect data about the behaviour of other pedestrians in presence of possible moving obstacles and estimating the extra space needed by the person carrying these objects. The results showed that when using a baby stroller the extra space needed (front, back and aside) is at the highest rate, followed by the presence of a big suitcase and a smaller one. Particularly, an approaching person start deviating his/her trajectory on average 1.38m before a baby stroller, 53% more compared to a person carrying no object. In case of a wheeled suitcase behind, the person overtaking needs extra 62% of



space to avoid collision compared to the case of non-objects carrier (Ohno et al., 2012). In high density situation the presence of an object (whether it is pushed or pulled) can alter typical pedestrians flow patterns and become an obstacle that require more space to be avoided. These experiments constitute an interesting point in order to understand more about people's use of the environment when moving along with object. In particular, elderly using walking devices such as rollers or carrying shopping trolleys will constitute a higher proportion of pedestrians in cities and public spaces, making those studies including also walking aids very up-to-date.

### **6.2.2 Patterns of Small Groups in a Crowd**

Hare (1962) was probably the first to focus on small groups of people dynamics. In his handbook, he presented a comprehensive literature review on small group research carried out until publication, giving a start to research on small groups and becoming an important reference for further studies. Among those who talked about dynamic behaviour of groups, Aveni and Knowles were perceptive to consider couples as one of the small groups that form a crowd back in the 1970s. Aveni claimed that crowd is not a collection of individuals. Despite single pedestrians proceed at their own desired speed and direction, it cannot be ignored that most of the time crowds are mainly made up of smaller groups rather than individuals, whether they attend an American football game (Aveni, 1977) or walking in a shopping street (Moussaïd et al., 2010).

Knowles' studies (Knowles, 1973; Knowles et al., 1976; Knowles and Bassett 1976; Knowles and Brickner, 1981) highlighted the importance of social space boundary in order to protect group cohesion from other pedestrian intrusion. The size of the group, the social status of its members, gender and the distance maintained among the members can have influences on group protection. Results performed in a university hallway (Knowles, 1973) revealed that the permeability of boundaries around interacting people was reduced in case of high-status groups and larger groups compared to lower status and smaller groups. Following investigations also indicated that pedestrians walked further away from a group rather than an individual and from an individual rather than an object, in that case a bench (Knowles et al., 1976). The kind of activity that group members perform can also determine boundaries resistance, influencing the distance that other pedestrians establish while passing by (Knowles and Bassett, 1976).

Furthermore, experiments performed by Knowles and Brickner in 1981 indicated that a male subjects protects the group's space more when he shares similar opinions with his confederate rather than in dissimilar situations. For both sexes, sharing a similar opinion strongly affected attraction. However, attraction influenced the protection of the group in case of males but not for females.

Then, in recent years, a few empirical studies have been conducted about small groups, including dyads, and the behaviour of their members also taking into account their age. Moussaïd et el. (2010) argued that, despite most of the pedestrians move in

groups, the majority of the studies existing so far analysed crowds as composed by individuals, moving according to their desired speed and direction. In their study, they demonstrated that up to 70% of the pedestrians in a commercial street were walking in groups, mostly small ones composed by families, friends and loving couples. After the analysis of around 1500 groups in a real environment, they showed how much social interaction is important in shaping group walking patterns that, in turn, influences crowd dynamics. For instance, in high-density level, not only physical constraints caused by the presence of numerous people reduces the flow, but also a V-like walking shape of groups is responsible. V-like shape facilitates communication but, at the same time, has impacts on crowd dynamics.

Among recent works on behaviours of groups, the observation of the spatial organisation of 1020 groups in an ecological setting performed by Costa (2010) can be found. He considered walking speed, gender, age and the shape of the group. Results showed that male groups' walking speed was higher than female groups' and that it was correlated to the alignment among group members while walking. Moreover, depending on the number of members, the shape of the group was also discovered to be different. For instance, male dyads walk abreast more often than female dyads do, while gender mixed dyad proceed abreast more often compared to same-gender dyads. Also, difference in height of the members can cause misalignment inside the group, probably because of a speedier pace of the taller person who often leads the dyad (44.8%).

An innovative and multi-disciplinary approach for the investigation of pedestrian dynamics in high-density situations has been proposed by Bandini et al. (2012). The approach integrates both the socio-psychological perspective of groups of pedestrians and Multi-Agent System simulation technique. First, observation is carried out in order to collect data mainly about spatial arrangement, walking speed, level of density, gender, group size and shape. Secondly, simulations are performed to investigate those scenarios, which are difficult to study empirically. The outcome of these simulations is the design of what-if situations that can be useful to design strategies for an effective management of pedestrians' circulation. The adopted multi-disciplinary approach and methodology provide a successful example of integrating methodology for the study of pedestrians' walking patterns and first results of this study are going to be presented in Chapter 7.

Willis et al. (2004) chose a video-based observation to explore human behaviour, walking speed and distance in urban spaces. In their study, the authors investigated spacing behaviours of pedestrians in urban environments. Particularly, they focused on individuals' movement preferences (walking speed, position preferences and interpersonal distance) and the influence context can have on these variables. Results show that age, gender, level of mobility, group size, time of day and location have significant effects on the movement preferences. Also, a significant association exists between faster walking speed and single pedestrians, males, adults and people walking with no great impediment. On the contrary, a slower walking

speed was associated to groups, females, children, elderly and people carrying bags or using walking aids (Willis et al., 2004). Interpersonal distance was mainly affected by size of the group (higher in case of triads, lower in case of dyads because of greater intimacy) and the location (depending on the pavement width). In relation to ageing, the higher the age the shorter the distance between the group members and the slower the walking speed.

The observation of pedestrian walking behaviour not only concerns urban area but other environments not necessarily open-air. For instance, Schultz et al. (2008), collected field data of travelling people inside the passengers terminal of Dresden International Airport. First, an important distinction has been made for statistical purposes between the behaviour of business-driven and leisure-driven passengers. Generally, frequent flyers already know the environment and the tasks to perform before boarding while the same thing cannot be said for leisure travellers who have to collect information to find their ways. Walking speed and direction are influenced from the behaviour of the different categories of passengers, also because the last ones often travel in groups. The walking speed of business travellers was higher than tourists and the association between groups and slower speed was found to be significant even if larger groups tended to split into smaller groups of 2-3 members. Moreover, it should be taken into account that around 50% of passengers observed in the study walked in groups. On the other hand, the presence of luggage had a small influence on the walking speed of passengers while the size of groups did. Despite the effects of groups size on walking speed were expected prior data recording, the effects of decreasing speed were higher than expected (Schultz et al., 2008). This research can add valuable data useful to determine passengers flow and allow the aviation sector to be aware of the discomfort that unexpected flow of travellers can produce inside an airport.

Research and simulation of pedestrians circulation dynamics can also give important contributions in case of sudden evacuation from buildings as a consequence of an emergency. With reference to the existing literature, Zheng et al. (2009), identified seven methodological approaches concerning crowd evacuation of a building, discussing the advantages and limitations of each approach. In this context, the psychological aspect should also be taken into consideration when dealing with evacuation models. To this end, Mawson's studies on social ties (2005, 2012) highlighted the crucial role emotional bonds play in emergency situations' management. According to Mawson, people move towards familiar persons trying to remain in groups during evacuation, preserving the existing social ties. Therefore, studies on groups' dynamics are fundamental evacuation plans design in case of emergency, in particular in urban areas where people have more occasions to gather in crowded places and multi-storey buildings.

### **6.2.3 Elderly Pedestrians Exposed to Environmental Complexity**

From a cognitive and behavioural approach, Kirasic (2000) carried out a broad literature review on spatial behaviour in elderly people. In his study, he also discussed of older adults spatial ability, such as orientation, perception and visualisation, according to different spatial tasks. Age related changes in way-finding and orientation behaviour represent a major concern in old age as elderly might not recognise spatial markers once familiar to them and lose their way home, whether they are pedestrians or drivers. In such a condition, spatial learning ability, way finding ability, memory and orientation play an important role from the perspective of a safe and independent life in old age.

People will live longer and the number of elderly pedestrians is expected to rise. Hence, pedestrian flows are going to be more complex. Some studies have concerned about the homogeneity of pedestrian stream and the presence of elderly people. Despite some attempts, a specific border between the homogeneous and non-homogeneous traffic of pedestrians on sidewalks have not been determined yet. Some studies put this border limit at 20% for the elderly (US National Research Council, 2000) while others at 30 % (Pheasant et al., 2006). However there is not a unique criterion yet to assess the percentage of elderly people that can determine the difference between and homogeneous to a non-homogeneous traffic flow.

Elderly pedestrians face more difficulties in walking mainly because of physical impairments and, sometimes, cognitive impairments as well. Outdoor physical activity, such as walking, is a key element in elderly health, allowing them also to maintain their independence in every day life tasks performance. A loss in the ability to walk outdoor may threaten independent living and social participation in the neighbourhood. Particularly, the kind of environment (natural geographical features, street and traffic conditions), musculoskeletal diseases, slow walking speed and poor socioeconomic status were correlated to a sense of insecurity when walking outside (Rantakokko et al., 2009).

Experiments on time estimation, time constraint for street crossing and vehicle speed involving elderly participants were performed using a street-crossing simulation device and reported by Lobjois and Cavallo (2007, 2009) and Dommes et al. (2012). Time constraint revealed to affect participants of all ages in crossing decisions, particularly the older category, which registered a higher mean time gap (Lobjois and Cavallo, 2007). When vehicle speed was also taking into consideration, the decision of younger pedestrians was not affected while in case of elderly, speed influenced their decision to cross the street both in presence of a time constraint and when there was not. With the increase of vehicle speed, older participants accepted shorter and shorter time gaps, putting themselves at risk of a potential injury. Thus, older adults are exposed to higher chances of making unsafe crossing decisions in case of vehicles approaching at a high speed because of an inadequate estimation of crossing time with safety margins (Lobjois and Cavallo, 2009). In the light of these findings, a later study was performed in order to test the effectiveness of a behavioural and educational

training method for elderly pedestrians in order to understand whether unsafe street-crossing decisions would be reduced or not. Training was found to produce some short- and long-term benefits from the behavioural point of view (such as higher safety margins). Nevertheless, the higher the vehicle's speed, the more unsafe decisions were recorded. Dommès et al. (2012) argued that a training program is not effective for age related perceptual and cognitive difficulties in taking street-crossing decisions. Some other measures should be applied to induce drivers slow down and reduce the number of car accidents involving elderly pedestrians.

### **6.3 Conclusions**

Chapter 6 aimed at offering an overview of the main contributions to the study of pedestrians walking dynamics, in particular to the study of small groups and elderly subjects. Discussion and relevant studies were organised in three sections:

- Interpersonal distance during locomotion
- Patterns of small groups in a crowd
- Elderly pedestrians exposed to environmental complexity

The literature framework showed that, despite research on elderly and groups of pedestrians exist, only relatively little studies addressed directly to elderly pedestrians walking dynamics. Some of them took into account small groups in relation to gender (Costa, 2010; Knowles, 1973; Knowles et al., 1976; Knowles and Bassett 1976; Knowles and Brickner, 1981; Willis et al., 2004) or age (Costa, 2010; Knowles, 1973; Knowles and Bassett 1976; Knowles and Brickner, 1981) but none was specifically focused on older dyads.

In conclusion, although studies concerning elderly walking ability and group dynamics exist, no studies have been focusing specifically on dyads of elderly pedestrians. Since official projections warn us on the future trends of the population, more studies should be characterised by a strong commitment to elderly walking dynamics in their complexity.



## CHAPTER 7

### *In Vivo* Observation and Analysis of Pedestrians Dynamics in Galleria Vittorio Emanuele II (Milan-Italy)

#### 7.1 Introduction

#### 7.2 Objectives

#### 7.3 Observational Setting and Methodology

#### 7.4 Qualitative Analysis

#### 7.5 Data Analysis and Results

#### 7.6 Conclusions

#### 7.1 Introduction

*This chapter presents field research for the collection of empirical data through unobtrusive observation of pedestrian circulation dynamics in crowded scenario.*

*This study is based on research carried out by the CSAI research center of the University of Milano-Bicocca. Previous findings are further analysed in regard to the present research framework and in order to investigate the presence of elderly dyads in a crowded setting.*

*First, the observational setting and methodology of the study are introduced. Then, observation activities performed with the use of a video recording in Galleria Vittorio Emanuele II in Milan (Italy). Finally, data analysis and the results obtained throughout the research conclude the chapter.*

#### 7.2 Objectives

As mentioned before, very few studies concerned elderly pedestrians and their walking behaviours. Elderly pedestrians present specific characteristics compared to younger people and it is a major priority to study their behaviour since their presence is increasing dramatically. In ageing societies, the understanding of behavioural differences between younger and older pedestrians, both in single and dyadic situations, is one of the keys for a successful management of space and environment. For these purposes, the present study aimed at collecting walking time, path length and speed data about singles and dyads of pedestrians taking into consideration gender and age.

#### Objectives of Galleria Vittorio Emanuele II Study Case

- **Pedestrians Behaviour Observation and Identification**
- **Groups Presence Estimation**
- **Single-Dyads/Adult-Elderly Pedestrians Behaviour in Locomotion**

Data collection was achieved by means of unobtrusive observation of pedestrian circulation dynamics. Observation is considered as the most important technique to collect behavioural and non-verbal data (Corbetta, 1999) and, from the social science perspective, *in vivo* observation (i.e. on the field) is an effective mean in order to obtain data about human behaviour also considering them through the environment and the social context they are observed in. This observational method allows collecting empirical data without exerting control over the place of the study. For these reasons, technologies such as video recording can be useful tools for direct observation as, for instance, the phenomenon can be videotaped to analyse the collected data at a later stage. Observation can be *obtrusive* (subjects are aware of being studied) or *unobtrusive* (subjects are unaware of being studied) (Babbie, 1995). Taking into consideration the objectives of the present study, unobtrusive observation method was adopted, constituting the observational method of reference throughout the present chapter.

### **7.3 Observational Setting and Methodology**

A previous study carried out at the CSAI research center of the University of Milano-Bicocca analysed the crowd composition of a sample population selected from a video recording performed in Galleria Vittorio Emanuele II in Milan-Italy.

Galleria Vittorio Emanuele II is a very popular walkway in the city centre of Milan, which connects La Scala Square to Duomo Square. It is both an attraction for tourists, who go there to shopping and visit the beautiful arcade of the Galleria and, in general, a pleasant passageway for strollers that chose the area surrounding the Duomo for a walk. The Galleria is also well-known as the city "drawing room" ("il salotto di Milano") due to the numerous shops and cafeterias that has become one of the most prestigious meeting place in the city. Because of its fame, Galleria Vittorio Emanuele II can be very crowded, in particular during the weekend when *milanese* citizens mix up with international tourists. Nevertheless, even in weekdays, the place is visited by a high number of tourists or people doing shopping; commuters also use the passageway in rush hours. For these reasons, Galleria Vittorio Emanuele II has some favourable characteristics for the observational purpose of pedestrians. In fact, the area is a pedestrian zone, located in the city centre of Milan and an important connection point for urban transportation. Moreover, Galleria is entirely covered by a glass-vaulted arcade. For study purpose, this ceiling prevented that, in case of rain, umbrellas hid pedestrians and occluded portions of the pavements, compromising the success of data collection activities. The shape of the passage is octagonal and buildings and paving are decorated with mosaics. The geometrical decorations on the pavement were helpful to establish spatial reference points later discussed.

First of all the research team, composed of 4 members, performed few inspections to check the topographical features of the Galleria in order to determine the more suitable place for the observation. The walkway is housed within a four-story double arcade and one balcony just at the top of the entrance from La Scala Square,

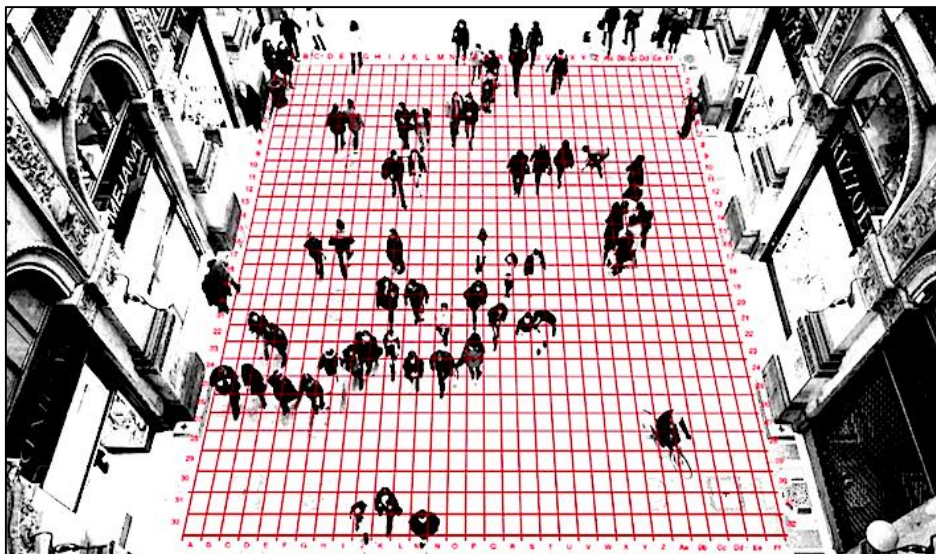


about 19 metres high, was chosen as the best position for video footages. The equipment for video footages has been placed in a location partly hidden from the balcony railing and positioned at a quasi-zenith point of view in order to avoid images distortion and trajectories occlusion. In this way, pedestrians were not aware of being recorded.

The official authorisation of the Municipality of Milan was asked before observation activities started and the existing privacy legislations were consulted beforehand to avoid ethical issues concerning people record-keeping. After obtaining the necessary authorisation by the Municipality for recording, the setting was ready for the study. Observation was carried out on 24th of November 2012 from about 2:50 to 4:10 pm, using two professional full HD video cameras with tripods for recording.

Two versions of the videos were used for this study, one coloured and one black and white. The black and white version of the video was created using *iMovie 2011* (9.0). A squared portion, 12.8x12.8m (163.84 m<sup>2</sup>) of the walkway was considered. A grid was designed using *Photoshop CS5* and superimposed to the black and white version of the video, reproduced using *VLC Media Player*. Every cell is 0.4x0.4 m<sup>2</sup> for a total of 1024 squared cells. In order to facilitate the detection and analysis of the pedestrians, an alphanumeric code was added on the sides of the grid (from 1 to 32 on right-left sides, from A to Ff on top-bottom sides).

**Figure 7.1: Snapshot of the grid superimposed on black and white video images.**



Bidirectional pedestrian flows, from North to South and vice versa, were manually counted and a total of 7773 persons walked through the selected portion during the recording time. Pedestrians who stopped to take pictures or who walked out of the video portion covered by the grid, for example to enter a shop, were not taken into account. Only those pedestrians who walked for the entire length of the portion of walkway covered by the grid were analysed.

The analysis started when a pedestrian was at the centre of the cell and stopped when he/she went out the last cell of the grid. For path measurement, straight steps

from the centre of a cell to the centre of the one ahead were measured as 0.4 metre long path. Oblique steps cell by cell were measured as diagonals between the two cells, 0.56 metre long path.

The level of density and the level of service (LOS) were first observed and calculated. The level of density refers to the relationship between the number of people in a given position and the physical area they occupy while the level of service (LOS) refers to a set of standardised values that describe the density of a pedestrian flow into a specific context (Fruin, 1971). The lower the density, the better walking conditions. On the contrary, level F indicates that the walking situation is very critical due to high density of pedestrians, which make it impossible to move freely.

**Figure 7.2: Level of Service (LOS) criteria (Fruin, 1971).**

Level of Service	Flow Rate (pedestrian/minute/meter)	Density (pedestrian per squared meter)
A	≤ 7	≤ 0.08
B	7 - 23	0.08 - 0.27
C	23 - 33	0.27 - 0.45
D	33 - 49	0.45 - 0.69
E	49 - 82	0.69 - 1.66
F	≥ 82	≥ 1.66

On average, the level of density was low (0.22 people per m<sup>2</sup>) and the level of service belonged to B Level (7.78 pedestrians per minute per m). In general, an irregular flow in low-medium density condition was observed. For research purpose, it was decided to take into consideration minutes that fell within LOS B only.

A subset of 15 minutes was extracted by sampling the recorded videotape one minute every five. 1645 pedestrians were manually counted, the 21% of the total pedestrian flow (7773 people). Among this sample, the majority of people walked in groups, 84%, while a smaller portion was detected as single pedestrian, 16%. Of the 84%, 44% were dyads, 22% groups formed by 4 or more persons, 18% triads and 16% singles. (Bandini et al., 2014; Gorrini et al., 2015). Thus, the importance and the need to study the walking behaviours of pedestrians in pairs are demonstrated.

### Manual Detection

For pedestrians detection purposes, the coloured version of the video was employed, reproduced using *VLC Media Player*. The identification of elderly pedestrians and dyads was assessed on the basis of typical locomotion, physical and verbal behaviours (see Table 1 and Table 2 for reference). The coloured version of the video simplified the detection of the subjects of this study and zoom function available in *VLC Media Player* was valuable to this aim.

For manual analysis, the black and white version of the video was used. The playback of the images in slow motion was possible, taking advantage of the option "frame by frame" to better detect the pedestrians' walking patterns and to determine their path. The extension time format that include hundredths of a second was used to precisely evaluate walking time.

#### **7.4 Qualitative Analysis**

In order to produce results as accurate and reliable as possible, two coders were in charge of the manual analysis following the instructions given by a supervisor beforehand. Data analysis and results were compared and shared for the definition of the observed phenomena.

The study focused on walking people observation, with particular attention to dyads and elderly pedestrians. If it is considered that the observation took place in autumn and in a place that can be crowded on a Saturday afternoon, the number of elderly pedestrians was substantial. It has been observed that the walking flow was heterogeneous in its composition. It was not difficult to identify large groups of tourists, loving couples or families with children indeed.

First, the coloured version of the video has been examined to determine the composition of the crowd and the characteristics of groups. In order to correctly detect members of the same dyad or individuals, video images were carefully analysed trying to avoid interruptions. Particular attention was given when dyads split (to avoid collision or because one member was attracted by a shop). Slow motion and playback images features were often used in order to assess the belonging to the a dyad and to correctly follow the path of the pedestrians. When a potential couple approached the upper or lower side of the grid, coders carefully analysed the behaviours of each member, trying first to assess whether the two people were intentionally walking together or were close to each other by chance. Due to crowded excerpts, the detection of dyads was more complicated than expected. To this end, a checklist was designed based on typical locomotion, physical and verbal behaviours. In quiet moments, the detection of dyads mainly started from evaluating high spatial cohesion and movements coordination, the synchronisation of pace toward the same direction, physical contact (for example hand in hand in case of loving couples) and verbal behaviours such as talking and looking at each other while talking. In case of crowded situation or separation, leader/follower dynamics were very important to determine the existence of a relation between pedestrians. In addition, turning the head or the torso to search for each other and waiting dynamics were also considered in circumstances of high density.

**Table 7.1: Checklist to support coders in detecting dyads in pedestrian stream.**

- walking in the same direction
- high spatial cohesion among members while walking
- high coordination in turning manoeuvres
- physical contact (e.g., arm in arm, hand in hand, hugs)
- high synchronisation of walking pace
- leader/follower dynamics in sudden change of direction
- turning head or torso in case of separation
- waiting dynamics in case of separation
- talking while walking
- gesticulation while talking
- stop walking to emphasise the discussion
- looking at each other
- looking for each other in case of separation
- looking at the same direction

Due to the difficulty of detecting people aged approximately 65 years old or over relying on video images only, a checklist was designed and provided to coders before the start of the detection process. The checklist mainly included typical locomotion behaviours and visible physical indicators easily recognizable even through video images. When a potential elderly person approached the upper or lower side of the grid, coders carefully analysed the physical and walking behaviours first, in order to assess whether the person could be considered an elderly pedestrian aged approximately 65 years or above. Visible attributes related to physical conditions such as unsteady gait, posture (e.g., walking with the hands behind the back) and the use of aid devices (e.g., stick) were considered at a first stage. Then, clothing (e.g., style, colours, hat) and look (e.g., white hair/baldness) were also taken into account.

**Table 7.2: Checklist designed based on typical locomotion and visible physical indicators.**

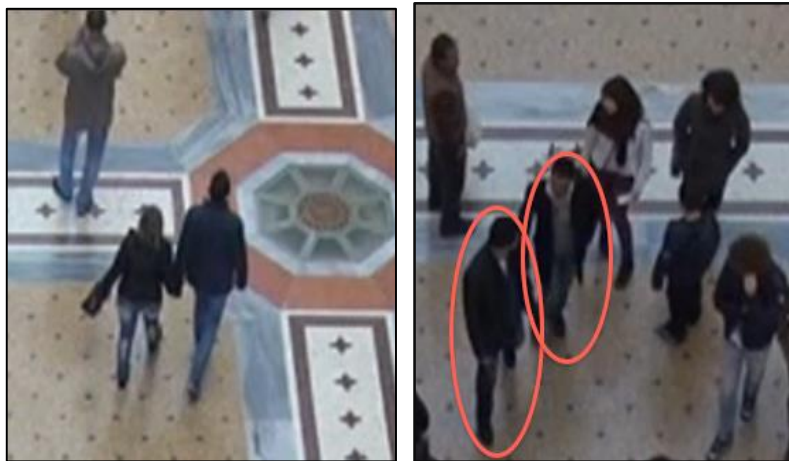
- relatively slow walking speed
- unsteady gait
- use of artifacts (e.g., stick)
- lame posture (e.g., hunch, hands behind the back)
- white hair/baldness
- clothing (e.g., style, colours, hat)

No particular difficulty was faced in order to assess whether a pedestrian was very old (around 75 years and above), while it was not easy to determine the age of people who fall approximately between 60-70 years. At the last stage of the observation, among the pedestrians detected, those who apparently looked very old were selected also considering gender balance.

A relatively large amount of time was necessary to detect and analyse the pedestrians suitable for the present research aims, particularly old dyads. Approximate total time for detection and manual analysis of adult single pedestrians accounted for

20 minutes, while around 35 minutes were necessary for old single pedestrians. On average, it took around 20 minutes to detect and select one dyad of normal age pedestrians and 35 minutes to manually analyse it. Additional time was necessary in case of elderly dyads: around 30 minutes to detect and select one dyad of old pedestrians and 45 minutes to manually analyse it.

**Figure 7.3: Two of the adult dyads analysed. Physical contact such as hand in hand and leader follower dynamics in case of separation were among the characteristics taken into consideration in detecting a dyad.**



#### Adult and Elderly Pedestrians

As a general observation, the two observers counted more elderly men walking alone than elderly women. Women appeared to be more likely to walk in pair, triple or quadruple. Old pedestrians tended to stay close to each other; elderly women might have physical contact (arm in arm, hand in hand) while men, instead, often had both hands behind their back while walking.

At a first level of analysis, the path of the elderlies tended to be easier to follow than adult pedestrians', mainly because of the reduced walking speed and regular path. In fact, old pedestrians seemed to preserve the original path even when they have to modify it to avoid an obstacle. After eluding the obstacle, they tried to go back to their first route keeping the desired direction. Furthermore, elderly pedestrians often walked along the walls where they might feel safer and where the pedestrian flow is less intense.

Adult single pedestrians usually walked at a higher pace and in a more irregular way. They probably feel more confident of their walking ability compared to elderly pedestrians and try to avoid obstacles on their path in order to proceed at their desired velocity. When facing an obstacle, adult people deviated at the very last moment while elderly people needed to "prepare" to change direction. They were attentive in anticipating oncoming obstacles, even in case the obstacle was still quite far from them. The reasons could lay in a different perception of distance and danger, being also interpreted as feeling insecure and conscious of not being able to move as responsive as the others, confirming previous studies (Webb and Weber 2003; Ohno et al., 2012).

### Singles and Dyad Members

Since members of a dyad are engaged in a tacit negotiation, walking pace was often highly synchronised and the path maintained stable with the aim of achieving a particular goal together. Nevertheless, it was noticed that in general adult dyads of pedestrians walked at a faster pace and had a more irregular path compared to elderly dyads, which tended to maintain their original path and slow pace. Because of a high spatial cohesion and movement coordination, elderly dyads avoided sudden change of direction or splitting, trying to be regular in their walking path.

**Figure 7.4: A family of adult pedestrians split to let a dyad of old women proceed without changing path or splitting.**



To this regard, it has been also observed that adult pedestrians tried not to pass between members of a dyad, particularly if the couple was of elderly people. Depending on the characteristics of the dyad, relationship in particular, the members had a certain degree of distance between them and might split in case of need (obstacle on the ground, standing person, other people approaching).

**Figure 7.5. Waiting dynamics in an elderly dyad.**



Partners tended to remain together, especially elderly ones. If they split, adult couples were quicker in getting back together so often they did not need to stop or wait for each other as the person behind hurried up to catch up with the partner. In case of elderly persons, sometimes the first pedestrian had to stop and wait for the second one.

## 7.5 Data Analysis and Results

Data analysis relied on a sample of 62 pedestrians: 15 adult single pedestrians, 16 adult dyad members, 15 elderly single pedestrians and 16 elderly dyad members.

This section presents the results of the observation and the analysis discussed in previous paragraphs. Excel software (14.5.7 version) and Stat Plus Professional Full Version software (5.8.3.10 version) were employed for analysis purpose.

Statistical analysis was performed in order to explore and present data to discover if age, gender and grouping had effects on pedestrians walking path and speed. In particular, to explain the relation of the data to the sample population, independent samples t-test analysis (i.e. two tailed t-test), one sample t-test analysis (i.e. one tailed t-test) and the analysis of variance (i.e. ANOVA) techniques were used. For this study the significance level of the tests has been set at 5%.

Data resulting from the studies previously carried out by the CSAI research center and introduced at the beginning of the current chapter, clearly indicates that dyads accounted for the highest proportion of flow composition. Due to the fact that Galleria is a touristic spot and leisure place, it is not surprising that the number of groups was very high.

### Walking Path and Speed

As expected, on average adult pedestrians used less time to cover the distance (13.07 s,  $\pm 2.35$ ) than elderly pedestrians (21.83 s,  $\pm 5.57$ ) despite adults walked longer path (13.59 s,  $\pm 0.75$ ) than elderlies (13.32 s,  $\pm 0.49$ ). Adult pedestrians walking speed (1.07 m/s,  $\pm 0.22$ ) was higher than the speed of elderly pedestrians (0.65 m/s,  $\pm 0.16$ ).

**Table 7.3: Average walking time/path/speed according to age and grouping.**

	Time		Path		Speed	
	Average	SD	Average	SD	Average	SD
All Adult Pedestrians	13.07 s	2.35	13.59 m	0.75	1.07 m/s	0.22
All Elderly Pedestrians	21.83 s	5.57	13.32 m	0.49	0.65 m/s	0.16
Adult Single Pedestrians	11.46 s	2.08	13.86 m	0.91	1.24 m/s	0.19
Elderly Single Pedestrians	20.42 s	5.29	13.26 m	0.47	0.69 m/s	0.19
Adult Dyads	14.58 s	1.41	13.35 m	0.46	0.91 m/s	0.08
Elderly Dyads	23.16 s	5.67	13.37 m	0.51	0.61 m/s	0.12

On average, men required less time than women to cover the distance (men 17.19 s,  $\pm 6.12$ ; women 17.78 s,  $\pm 6.22$ ) and walked a shorter path (men 13.31 m,  $\pm 0.54$ ; women 13.63 m,  $\pm 0.71$ ). Male pedestrians walked faster than females (men 0.87 m/s,  $\pm 0.29$ ; women 0.85 m/s,  $\pm 0.29$ .)

**Table 7.4: Average walking time/path/speed according to age and gender.**

	Time		Path		Speed	
	Average	SD	Average	SD	Average	SD
All Men	17.19 s	6.12	13.31 m	0.54	0.87 m/s	0.29
All Women	17.78 s	6.22	13.63 m	0.71	0.85 m/s	0.29
Adult Men	11.80 s	1.64	13.43 m	0.62	1.16 m/s	0.19
Elderly Men	20.80 s	4.16	13.20 m	0.52	0.70 m/s	0.15
Adult Women	12.85 s	2.63	13.96 m	0.99	1.11 m/s	0.25
Elderly Women	20.82 s	4.64	13.45 m	0.43	0.68 m/s	0.19

On average, single pedestrians covered the distance in a shorter time compared to dyad member (singles 15.94 s,  $\pm 6.03$ ; dyad members 18.87 s,  $\pm 5.96$ ) but the walking path was longer (13.56 m/s,  $\pm 0.78$ ) than of dyad members (13.36 m/s,  $\pm 0.47$ ). Single pedestrians' walking speed (0.97 m/s,  $\pm 0.34$ ) was higher than the speed of dyad members (0.76 m/s,  $\pm 0.19$ ).

**Table 7.5: Average walking time/path/speed according to dyad-formation.**

	Time		Path		Speed	
	Average	SD	Average	SD	Average	SD
All Singles	15.94 s	6.03	13.56 m	0.78	0.97 m/s	0.34
All Dyad Members	18.87 s	5.96	13.36 m	0.47	0.76 m/s	0.19

### Walking Path

During qualitative observation, coders noticed that adult pedestrians walked irregularly in the crowd more often than their elderly counterparts, avoiding obstacles and lengthening the path in order to reach their goal quicker. Statistically analysis was performed to investigate the effect of age, gender and grouping on path length.

An independent samples t-test (at the  $p < .05$  level) was conducted to investigate the effect that grouping had on path length. Results did not show a significant difference between the walking path of all single pedestrians and all dyad members pedestrians [ $F(1,60)=2.0$ ,  $p=0.21$ ].

A two-factor analysis of variance (at the  $p < .05$  level) was conducted to compare the walking path of adult singles (13.86 m,  $\pm 0.91$  SD), adult dyad members (13.35 m,  $\pm 0.46$  SD), elderly singles (13.26 m,  $\pm 0.47$  SD) and elderly dyad members (13.37 m,



$\pm 0.51$  SD). The analysis showed that there is a tendency to a significant interaction between the effects of age and grouping on path [ $F(1,58)=3.86$ ,  $p=0.05$ ]. Results did not show a significant effect for the age factor [ $F(1,58)=3.14$ ,  $p=0.08$ ] and for the grouping factor [ $F(1,58)=1.73$ ,  $p=0.19$ ]. Therefore the difference among the length of path of adult singles, adult dyad members, elderly singles and elderly dyad members was statistically significant. To investigate the results obtained from the ANOVA test, one sample t-test analysis (at the  $p<0.05$  level) was conducted afterwards. Results showed significant difference between the walking path of adult single and adult dyad pedestrians  $t(29)=1.7$ ,  $p=0.03$ ; adult single and elderly dyad pedestrians  $t(29)=1.7$ ,  $p=0.04$ . Results did not show a significant difference between the walking path of adult single and elderly single  $t(28)=1.7$ ,  $p=0.5$ ; adult dyad and elderly single  $t(29)=1.7$ ,  $p=0.32$ ; adult dyad and elderly dyad  $t(30)=1.7$ ,  $p=0.5$ ; elderly single and elderly dyad  $t(29)=1.7$ ,  $p=0.29$ . The statistical analysis showed that adult single pedestrians walked a longer path compared to adult and elderly dyad members.

As shown in Table 4, on average, male pedestrians walking path was shorter than of female pedestrians. An independent samples t-test was conducted to compare the path of male and female pedestrians. Results showed a tendency to significance  $t(60)=2.0$ ,  $p=0.05$ . A one-factor analysis of variance was conducted to compare the walking path of male-male dyads (13.21 m,  $\pm 0.57$  SD), female-female dyads (13.43 m,  $\pm 0.44$  SD), male-female dyads (13.34 m,  $\pm 0.47$  SD). The analysis showed that there was not a significant difference among dyads of different gender composition [ $F(2,29)=0.46$ ,  $p=0.64$ ]. Therefore the path of female pedestrians in dyads was not statistically longer than of their male counterparts.

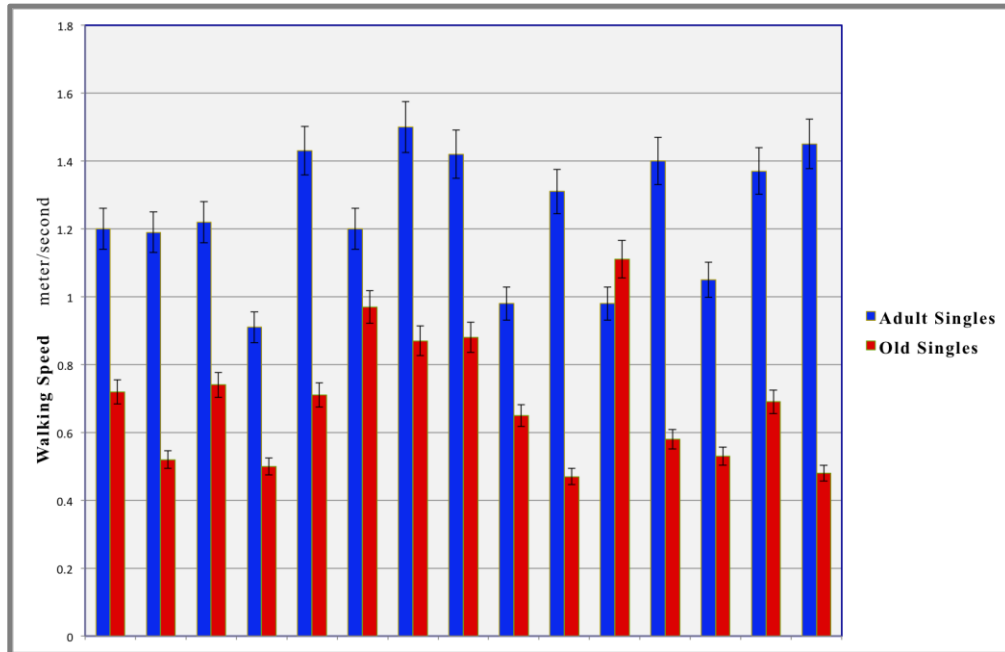
### Walking Speed

Statistically analysis was performed to investigate the effect of age, gender and grouping on walking speed. An independent samples t-test analysis was conducted to investigate the effect that grouping had on walking speed. A significant difference has been found between the walking speed of all single pedestrians and all dyad member pedestrians  $t(60)=2.0$ ,  $p<0.0001$ ).

A two-factor analysis of variance was conducted to compare the walking speed of adult singles (1.24m/s,  $\pm 0.19$  SD), adult dyad members (0.91 m/s,  $\pm 0.08$  SD), elderly singles (0.69 m/s,  $\pm 0.19$  SD) and elderly dyad members (0.61 m/s,  $\pm 0.12$  SD). The analysis showed that there is a significant interaction between the effects of age and grouping on speed [ $F(1,58)=9.52$   $p<0.0001$ ]. Results showed a significant effect for the age factor [ $F(1,58)=119.01$ ,  $p<0.0001$ ] and for the grouping factor [ $F(1,58)=28.8$ ,  $p<0.0001$ ]. Therefore, the difference among the speed of adult singles, adult dyad members, elderly singles and elderly dyad members was statistically different. To investigate the results obtained from the ANOVA test, one sample t-test analysis was conducted afterwards. Results showed a significant difference between the walking speed of adult single and elderly single pedestrians  $t(28)=1.7$ ,  $p<0.0001$ ; adult single and elderly dyad pedestrians  $t(29)=1.7$ ,  $p<0.0001$ ; adult single and adult

dyad pedestrians  $t(29)=1.7$ ,  $p<0.0001$ ; adult dyad and elderly single pedestrians  $t(29)=1.7$ ,  $p<0.0001$ ; adult dyad and elderly dyad pedestrians  $t(30)=1.7$ ,  $p<0.0001$ . The difference was not significant between the walking speed of elderly single and elderly dyad pedestrians  $t(29)=1.7$ ,  $p=0.07$ . The statistical analysis showed that adult single pedestrians walked faster than their old counterparts, both as single or dyad members.

**Figure 7.6: Difference in walking speed of adult singles and elderly singles pedestrians.**



An independent samples t-test was conducted to compare the speed of male and female pedestrians. Results did not show a significant effect  $t(60)=2.0$ ,  $p=0.81$ . A one-factor analysis of variance was conducted to compare the speed of male-male dyads (0.83 m/s,  $\pm 0.21$ ), female-female (0.75 m/s,  $\pm 0.16$ ) and male-female dyads (0.74 m/s,  $\pm 0.02$ ). Results did now show a significant effect of gender on walking speed [ $F(2,29)=0.71$ ,  $p=0.5$ ].

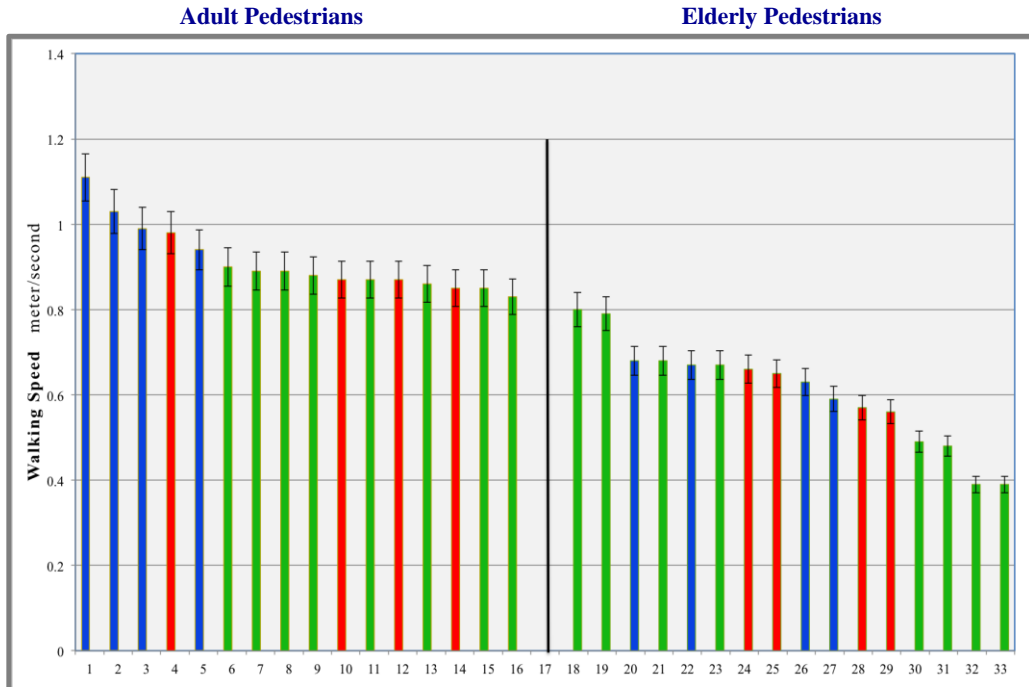
In conclusion, results showed that the average speed of elderly pedestrians was 40% lower than the one of adults. Dyads walked 22% slower compared to single pedestrians due to the preservation of members cohesion and negotiation of walking pace; particularly, adult singles walked 44% faster than elderly pedestrians proceeding alone and 51% faster than elderlies in pairs.

According to the findings of the statistical analysis it can be argued that:

- age and grouping had effect on the walking path of adult single pedestrians, who walked a longer path compared to adult and elderly dyad members. Gender had effects only on single pedestrians but not on dyads, hence the path of women singles was longer than of men singles.
- age and grouping had effect on walking speed while gender had no effect. Adult

single pedestrians walked faster than their old counterparts, both as single or dyad members.

**Figure 7.7: Difference of walking speed between adult dyad members and elderly dyad members (Blue: Male-Male; Red: Female-Female; Green: Male-Female).**



From a more qualitative observation perspective it was noticed that male-female dyads proceeded very close (very often also because they were holding hands or walk arm in arm) and can be perceived as intimate, indivisible. It was also observed that female-female dyads, especially if elderly, often walked very close or have physical contact, while male-male dyads tended to have a greater interpersonal distance resulting in a dyad that split with more frequency. In addition, the present study also highlighted that dyads tried to preserve the cohesion, in particular elderly people. According to the present study, it can also be argued that cohesion not only depended on communication but also on safety and non-verbal interaction. The observation suggested that self-confidence and sense of protection were fundamental aspects in elderly dyads, whose members walked in close proximity even without talking.

## 7.6 Conclusions

This chapter described and discussed the observation performed in Galleria Vittorio Emanuele II in Milan. Since the dyadic formation is the most common pattern among pedestrians in a crowd, analysis of pedestrians walking in pairs has been carried out taking into consideration the age, gender and grouping factors. The findings support the hypothesis that elderly people's walking behaviours differ from that of adult pedestrians. In particular, age has effect on the walking speed, which is on average lower for elderly pedestrians (both single and dyad) than their younger

counterparts, as well as on the walking path length. In addition, qualitative observation and data analysis contributed to give a more complete image about elderly walking, whether they are alone or in pairs, males or females.

The study on elderly pedestrians and elderly dyads constitutes a valuable contribution towards the definition of parameters for characterising pedestrians' locomotion, exploitable in different fields such as the development of urban pedestrians management models and improvement of existing infrastructure. In particular, they can find application in the development of emergency strategies (escaping from a building or from an area hit by a natural disaster) and congestion avoidance in critical place or on occasion of events. Being aware of elderly pedestrians walking patterns and behaviours can help policy makers and decision strategists to develop solutions that are effective and inclusive but, at the same time, that also promote the culture of intergenerational coexistence.

#### **ACKNOWLEDGMENT**

This work has been performed thanks to the authorisation of the Municipality of Milan. The existing Italian legislation about privacy (d.lgs. 196/2003) was consulted and complied in order not to exceed ethical issues about the privacy and anonymity of the people recorded within the pedestrian flows.

## CHAPTER 8

### Study on Walkability Perception in Via Padova (Milan-Italy)

#### 8.1 Introduction

#### 8.2 Objectives

#### 8.3 Identification of the Setting

#### 8.4 Methodology

#### 8.5 Qualitative Observation

#### 8.6 Data Analysis and Results

#### 8.7 Conclusions

#### 8.1 Introduction

*The ability to walk and cross the road safely is very important for the health of people in their older age. Walking around the neighbourhood is not only a pleasant physical activity but it is also related to the accessibility to services, places of attraction and, from a broader point of view, social inclusiveness. Consequently, for cities where a high number of elderly people live nowadays, such as Milan, the awareness of elderly pedestrians characteristics and difficulties is crucial not only for the municipal road administration but for urban life at the neighbourhood level as well.*

*First, the chapter presents the reasons behind the choice of Via Padova as data collection setting aiming also at presenting the demographic situation of the city of Milan. In this regard, special acknowledgement to Dr. Borrelli for this preliminary analysis, carried out in 2013 at the CSAI-Complex Systems and Artificial Intelligence research center at the University of Milano-Bicocca. Then the tool for data collection are introduced and results are presented in details. Finally, the chapter closes with the findings and the contributions of this study.*

#### 8.2 Objectives

The main objective of this research was to investigate the perception of older citizens about the walkability of the neighbourhood they live in. As discussed in Chapter 4, walkability can be thought as a measurement of how much a neighbourhood or, in general, an environment is pedestrian friendly or not. In particular, safety and mobility of older pedestrians in urban environment has become a topic of urgent nature. Since the number of older citizens is expected to rise dramatically, cities and urban areas should be prepared in order to adapt existing infrastructures and plan new ones being aware of the different needs of a heterogeneous population. Asking citizens about their personal experience represents the most direct way to collect valuable and original information of daily practice, in this case, in a determined setting. In fact, one way of assessing pedestrian's access to

an environment is to involve the walking community.

Elderly pedestrian's opinions on walkability and crossing condition have been collected in Via Padova, a long street that connects central areas to the more suburban territories of Milan. Via Padova has been chosen as a densely populated neighbourhood and to be one of the urban streets registering the highest number of accidents involving elderly people in the city of Milan.

The present study constitutes an important step towards an in-depth analysis of elderly pedestrians habits and practice. In particular, the research focused on dyadic composition, investigating the reasons for walking in pair in older age.

Italy's population is the "eldest" in the world after Japan and nowadays there is a high number of domestic carer who give assistance to elderly people. In the past, spouses, daughters and daughters-in-law were the ones caring for the relatives in their old age. Today, the informal support coming from family members is decreasing due to the changing of family structure and lifestyle: more elderlies are living in their home and less young relatives live together or can take care of them. The figure of *badante*, a paid domestic elderly carer, is very common in the Italian context. Data collected by the Italian National Statistic Institute indicate that today, there are around 1,500,000 *badanti* in Italy. 89% of them are women, providing either 24-hours in-home care or part-time assistance, going back to their homes after working hours (Da Roit, 2007).

The concept of "care" do not only limit in assisting people to make sure that they can get better and not injure him-herself. Eldercare, in particular, also aims at maintaining the quality of life as high as possible through the human interaction established with the caregivers. This aspect also includes going out together, walking in the neighbourhood and access spaces and services the city offers. In the future, more dyads of pedestrians composed by an old person and a carer will be observed, particularly female dyads. Therefore, the increasing number of older people living and moving in urban spaces, alone but particularly together with another person, is worth consideration.

To collect the necessary information, the questionnaire "Walkability Checklist. How walkable is your community?" (US Department of Transportation, United States Environmental Protection Agency, National Center for Safe Routes to School and Pedestrian and Bicycle Information Center) has been chosen and adapted to the context and target of the research (further details in paragraph 8.4).

Objectives of Via Padova Study Case
- <b>Walkability Assessment</b>
- <b>Investigation about the relation between the perceived safety and dyadic formation</b>
- <b>Bottom-up Proposals Definition</b>

The final goal was to figure out whether Via Padova area "(...) *is friendly to the presence of people living, shopping, visiting, enjoying or spending time in an area*" (Abley, 2005), in other words, to have a picture of the walkability of the neighbourhood.

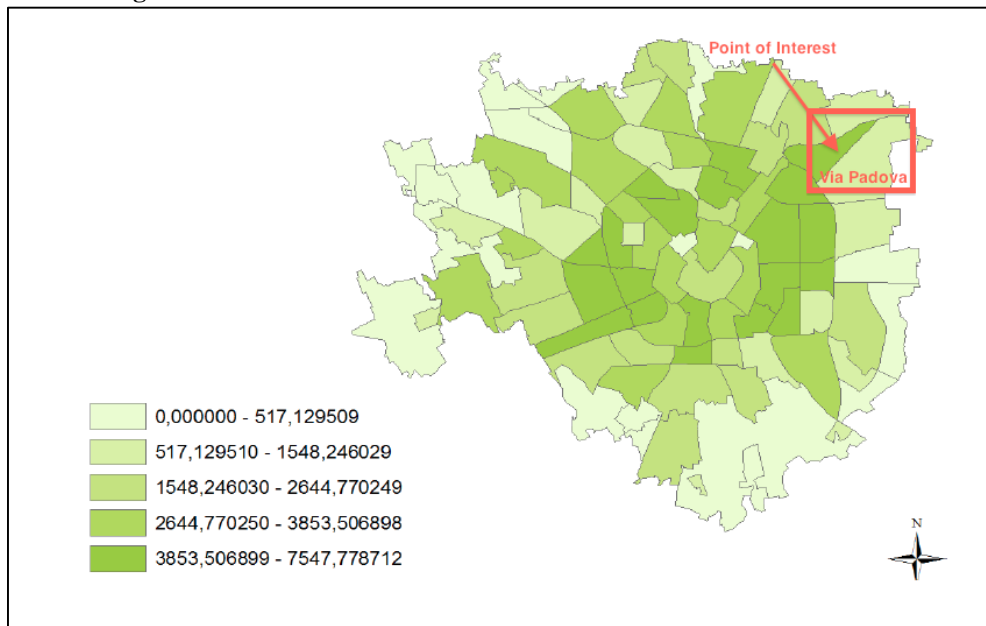
### **8.3 Identification of the Setting**

Research activity carried out at the CSAI research center first aimed at investigated the situation of neighbourhoods in the municipality of Milan, trying to define whether some neighbourhoods accounted for a higher number of elderly residents. Then, data concerning road accidents in Milan involving elderly people has been matched, obtaining an interesting picture of a few areas of the city.

Socio demographic data of the city of Milan were collected from the municipality and official statistic centres. Moreover, data concerning road accidents and fatalities have been also taken into account. Despite road accidents mainly involve pedestrians under 60 years of age in Milan, the highest percentage of fatalities (60%) occurs among over 60 years old pedestrians. This data confirmed previous studies arguing that when elderly people are involved in road accidents have the highest percentage to die compared to younger people.

The study continued with the localisation of the areas where road accidents involving elderlies concentrates most in the wider area of Milan, including suburban roads. First, the city of Milan was preliminary divided into neighbourhoods. After, for each neighbourhood the number of elderly residents has been identified. Figure 8.1 shows different colours according to the density: the deeper the green, the higher the elderly residents in that area. For this analysis, Geographical Information System (GIS) was used. GIS includes technologies and methods that can be applied to several fields such as engineering, transportation, telecommunications etc. The computer system allows the acquisition, storing and management of data related to positions on Earth's surface, which can be edited in maps and presented. The user can analyse different kinds of spatial information even in the same map, enabling people to easily understand the information resulting from the operations. Finally, data about road traffic accidents collected from the Police Office and Civil Protection were examined and crossed with the socio-demographic results.

**Figure 8.1: The city of Milan and the distribution of elderly residents population density for km<sup>2</sup> for each neighbourhood.**



(Source: Borrelli, Csai center report)

The analysis showed that the 98% of accidents involving older people were registered in urban roads, the remaining 2% in suburban areas. The research was carried out focusing on urban streets. Data from 2006 to 2010 revealed that three streets have registered the highest percentage of accidents involving elderly people: Via Padova, Viale Monza and Via Lorenteggio. All three are very long and traffic congested roads in Milan as they connect suburban areas to the city centre and they are major roads connected to highways. At the end, taking into consideration also data concerning accidents involving both older pedestrians and older drivers, Via Padova proved to be the street with most accidents involving elderly people in Milan.

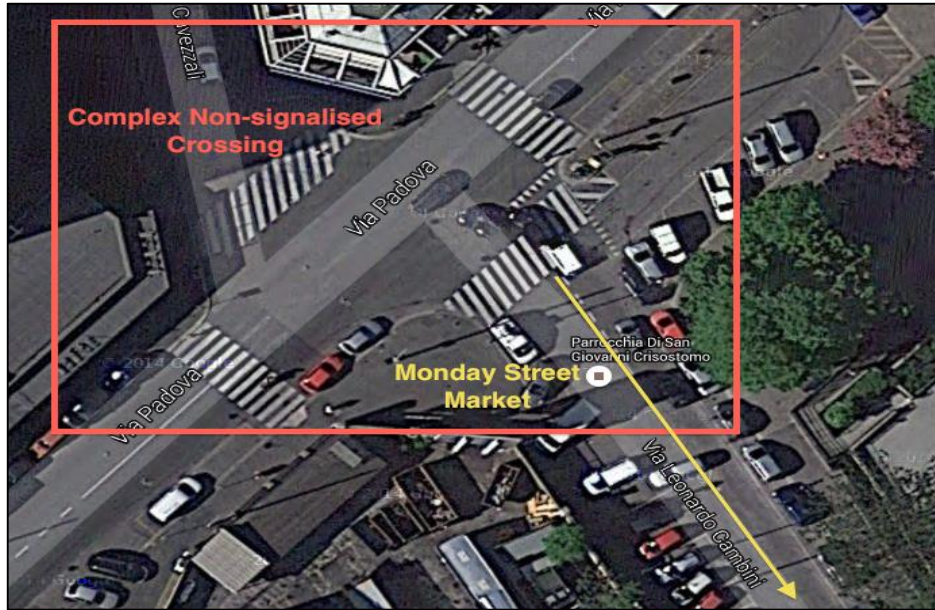
#### **8.4 Methodology**

In order to exactly determine the point of observation and data collection, preliminary inspections were necessary. Researchers went three times in different days, so to notice differences during daytime according to the day of the week and weather. Researchers also carefully checked crossing, road and pavements condition, traffic lights and signals etc. in order to identify any possible dangerous situation, particularly for pedestrians, taking also into account the attractiveness of that area for elderly people. Pedestrian crossing and intersections in proximity of supermarkets, churches, pharmacies, parks etc. were localised and observed. Inspections also considered the presence of elderly population.

Finally, among all the possibilities, the setting for the observation and data collection was localised at the intersection of three roads: Via Padova, Via Cavezzali, Via Cambini. The area is characterised by a dangerous and complex non-signalised crossroad.

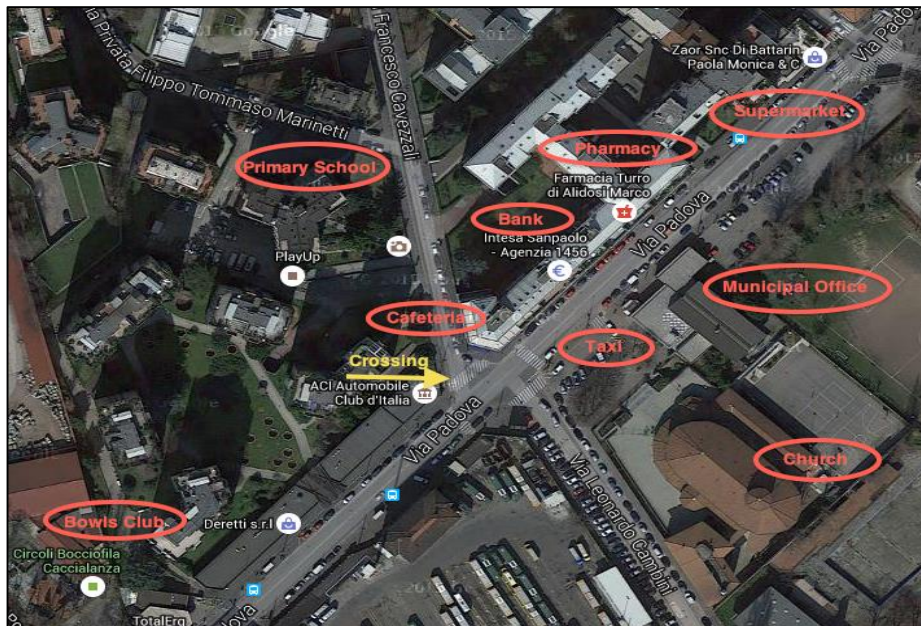


**Figure 8.2: Complex non-signalised crossing, Via Padova-Via Cavezzali-Via Cambini, Milan.**



Via Padova and Via Cambini are two-lane roads while Via Cavezzali is a one-way road so it is possible to turn in from Via Padova. Between Via Padova and Via Cambini there is a lay-by used as Taxi station just in front of a church and a municipal office. Around this crossroad there are many elements of attraction for elderly people such as a church, a municipal office, a bowls club, a supermarket, cafeterias and a pharmacy. Moreover, every Monday morning an open-air market takes place in Via Cambini.

**Figure 8.3: Attractions in proximity to the non-signalised crossing of Via Padova, Milan.**



In addition, a primary school is three minutes walk from the crossing and it is not rare that grandparents go and pick up their grandchildren on their parents behalf.

Moreover, in five minutes walk from the crossing, there is a branch of the San Raffaele Hospital, one of the biggest and most important hospitals in Italy.

**Table 8.1: List of main attractions points in the setting area.**

Attraction	Street
<b>San Giovanni Crisostomo Church</b>	Via Cambini/Via Padova corner
<b>Street Market</b>	Via Cambini (Monday morning only)
<b>Bank</b>	Via Padova, 107
<b>Cafeteria</b>	Via Padova/Via Cavezzali corner
<b>Municipal Office</b>	Via Padova, 118
<b>Bowls Club</b>	Via Padova, 91
<b>Supermarket</b>	Via Padova 117
<b>Pharmacy</b>	Via Padova, 121

During the inspections, researchers noticed that the area surrounding the crossroad is lively during day-time because of its vicinity to several points of attractions, is congested especially in the morning and when the open market takes place, and that a high number of pedestrians are elderly. For all these reasons, the crossroad Via Padova-Via Cavezzali-Via Cambini was chosen for the purpose of the current study.

After the first inspections performed to evaluate the general situations and to determine the setting of data collection, the criterion to collect data about elderly pedestrians and their experience has been discussed. In particular, it was important to give the elderly the opportunity to express themselves about the walking conditions and to measure the walkability level of the chosen area of investigation.

A review of the main walking survey tool has been carried out to find the best one that could fit the identified setting and aims. It was found that tools are mainly self-administered online questionnaire or paper based checklist. "RateMyStreet" and "Walkonomics" are among the most popular online tools for walkability measurement. "RateMyStreet" is a website dedicated on rating streets' walkability. Utilising Google maps and Google Streetview, people around the world are enabled to rate their street using a five star rating system. "Walkonomics" is an app for iPhone and Android that not only enables urban pedestrians to find the fastest walking route to any destination, but also the most enjoyable one. Walkonomics relies on Open Data from government and also OpenStreetMap (an online project which aims at collecting geographical world data for the creation of maps). Collected data is used to rate and map the walkability of over 700,000 streets and footpaths, mainly concentrated in North-South America and Europe.

A widely used paper based walkability measure is the Irvine Minnesota Inventory developed between 2003 and 2004 at the University of California, Irvine (UCI), and refined and tested at UCI and at the University of Minnesota. The Irvine Minnesota Inventory measures several characteristics concerning built environment. Its 160 items cover four areas: accessibility (62 items), pleasurability (56 items),

perceived safety and traffic (31 items), and perceived safety and crime (15 items) (Day et al., 2006). Despite it is an established walking audit tool, it was not appropriate to the current study mainly because of its length.

The review highlighted the need for a questionnaire that was shorter and that could be administered from a researcher directly to the interviewee. In this way, the number of complete questionnaires would have been higher and, most importantly, the direct contact with the people interviewed would not have been lost. Since it was important for the study to collect personal experience of the people living in the neighbourhood, a short but effective checklist was needed in order not to bother the people and at the same time, give space to their thoughts. Thus, another checklist has been preferred, the "Walkability Checklist. How walkable is your community?" resulted from the contributions of US Department of Transportation, United States Environmental Protection Agency, National Center for Safe Routes to School and Pedestrian and Bicycle Information Center ([www.pedbikeinfo.org](http://www.pedbikeinfo.org)). It is very short and it consists of five multiple-choice questions. For each question the interviewee is also asked to give a rate from 1 to 6.

First, the checklist has been translated into Italian language. Then, it has been modified according to the setting and the target audience. It contained eleven questions, the first four aiming at both give a rating and point out eventual critical aspects and six concerning the perception of safety related to the presence of an accompanying person. At the beginning, the questionnaire provided a section to fill in with personal information of the respondents (e.g., gender, age, presence of walking aids).

From question N.1 to question N.4 the perception about pleasantness, comfort and safety of walking in the neighbourhood are mainly investigated. This first part of the questionnaire have been adapted according to the setting (a complex non-signalised crossroad) and the audience (elderly people) so, items that originally included elements such as traffic lights, were replaced or modified.

The second part was changed particularly according to the subjects of the present research, elderly pedestrians and dyads of elderly people. For this reason, a key question (N.5) has been introduced. Question N.5 cited: "Would you feel safer if accompanied by somebody?". The interviewees had to reply "yes" or "no" and then answer to question N.6 concerning the reason why they would or would not feel safer if accompanied, providing an assessment as well. Following questions from N.7 to N.10 were administered only to people who gave a rate from 6 to 10 to question N.5, as they focused on the preferred person and way to be accompanied by another person. The final question, addressed to all interviewees, suggested a list of possible solutions in order to improve the crossing conditions but it also offered the respondent to possibility to make additional proposals.

For each question multiple answers was possible and space was given to open answers as well. The rating scale was also modified from the original checklist, from 1 to 6 to 1 to 10. The reason behind this choice is the familiarity Italian people have with

this rating scale rather than 1 to 6. The 1 to 10 rating not only is used in the schooling system for grade assessment but it is also widespread in daily life as evaluating tool in general. From five to ten minutes were necessary in order to fill in one questionnaire.

**Table 8.2: Questions contained in the walkability checklist administered in Via Padova.<sup>18</sup>**

1. How much pleasant is to walk in this area of the neighbourhood?
2. Is there enough space to walk on the pavements?
3. Is it easy to cross the street?
4. How much do you think drivers behave well toward pedestrians?
5. Would you feel safer if accompanied when walking/crossing the street?
6. How much, from 1 to 10, and why?
7. How would you like to be accompanied? (hand in hand, by arm)
8. By who would you like to be accompanied? (young, adult, same age person)
9. By who would you like to be accompanied? (male, female)
10. By who would you like to be accompanied? (carer, spouse, relative, friend)
11. Which of the following solutions could be effective in crossing the road more safely?

Two interviewers went to the crossing area six times in a month (May) on Monday and Friday, from around 9:00 a.m. to around 12:00 a.m. Monday was chosen as the local open market is held attracting a high number of elderlies and Friday as a weekday with no particular complex conditions for people walking in the neighbourhood to shopping and other commitments aside. On Monday, one of the crossing road, Via Cambini, is close to the traffic due to the open market becoming a pedestrian area. Nevertheless, the near streets and the crossing area are very crowded because of many cars passing by and some that stops near the market for get off-get in of passengers going shopping.

The target of the survey were people walking near the crossing aged 65 years or above, of both genders, walking alone or with a partner and with or without walking aids. The checklist used was prepared beforehand in several copies and it was filled in directly by the researchers interviewing elderly pedestrians.

### **8.5 Qualitative Observation**

During the inspections, it was noticed that the number of the elderly people walking in the neighbourhood was very high, in the morning more than during the afternoon and evening. In general, the traffic was congested in the early morning and in the late afternoon during rush hour while during daytime traffic flow was normal. As mentioned before, the proximity with a primary school, public offices and hospitals makes the chosen crossroad very congested. Moreover, since the crossroad lacked a traffic light, pedestrians had to be very careful in this specific point of the road. Elderly pedestrians in general, but those who walk accompanied or with the use of aids in particular, had more difficulties in crossing the road in safety, being their walking

<sup>18</sup> For the complete questionnaire see Appendix III for reference.

pace slower and their gait less stable. Very often they had to wait for a long time; they were able to cross the streets when a driver stopped and let them pass or if a younger person started crossing the streets making the incoming cars stop and wait also for the other pedestrians to cross.

It was noticed that several elderly people mainly walked alone or with a person of around the same age. Some of them walked besides a younger person, presumably a caregiver or a relative, and others with the assistance of some aids (sticks, crutch, rollers). In general, they were walking slowly, for pleasure or proceeding toward a "target" (e.g., the bank or the supermarket). On Monday morning, the majority of the people walking near the crossing went to the open market to do some shopping or was coming back home after it. In this case, people carried shopping bags or shopping trolley and generally walked at a slower pace.

**Figure 8.4: Elderly pedestrians in Via Padova neighbourhood on street market day.**



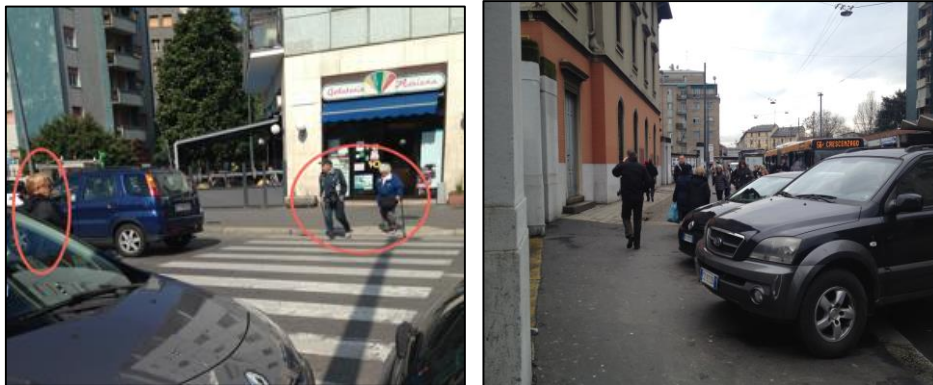
Since Via Padova connects the city with suburban areas, the road is also used for heavy transport so it was not rare to see trucks and vans passing. In addition, a double-length bus is in service in Via Padova. The crossroad is not only near two of this bus stops but it is also very near to one of the bus deposit of the local public transportation company. Hence, traffic of private cars, trucks and public transports made the situation in the neighbourhood very critical. During rush hours, the number of vehicles made the streets congested and it also happened that cars and delivery vans were temporary double-parked. The problem of double parking is widespread all over Italy but in urban centres, where the number of parking places is scarce and the streets are narrow, it is more critical.

**Figure 8.5: Irregular parking in Via Padova causes traffic congestion and worsen pedestrians' safety.**



Near the crossing object of study there are many shops, offices and attractions and cars were frequently parked irregularly, making crossing the street more dangerous for the pedestrians. For instance, cars were also parked in front of ramps or on crosswalks and pedestrians were not able to see the lane unless they move some steps forward.

**Figure 8.6: Cars parked on the crosswalks or occupying portions of sidewalks become obstacles for pedestrians. At the crossing, pedestrians are forced to move forward in order to evaluate the crossing condition, putting themselves in a dangerous situation.**



Last, there is a taxi stand in front of the public office and the church in Via Padova, which also contributes to a lack of parking and traffic congestion.

To sum up, from the point of view of pedestrians safety, the area presents the following difficulties:

- |  |
|--|
| ➤ <b>Poor street crossing safety</b>     |
| ➤ <b>Heavy traffic</b>                   |
| ➤ <b>Double parking</b>                  |
| ➤ <b>Vehicles parked on the pavement</b> |

## 8.6 Data Analysis and Results

This section presents the results of the observation and the analysis of data collected in the setting discussed in the previous paragraphs. First, general information about the sample is introduced. Next, each question results and analysis are presented. Excel software (14.5.7 version) and Stat Plus Professional Full Version software (5.8.3.10 version) were employed for analysis purpose. Most recurrent answers under the entry "other" are shown in the charts as independent items despite they were not originally listed in the paper questionnaire. Statistical analysis was performed in order to explore and present data to discover the existence of patterns and identify trends. In particular, to explain the relation of the data to the sample population, independent samples t-test analysis (i.e. two tailed t-test), the analysis of variance (i.e. ANOVA) and regression analysis techniques were used. For this study the significance level of the tests has been set at 5%.

### Sample general overview

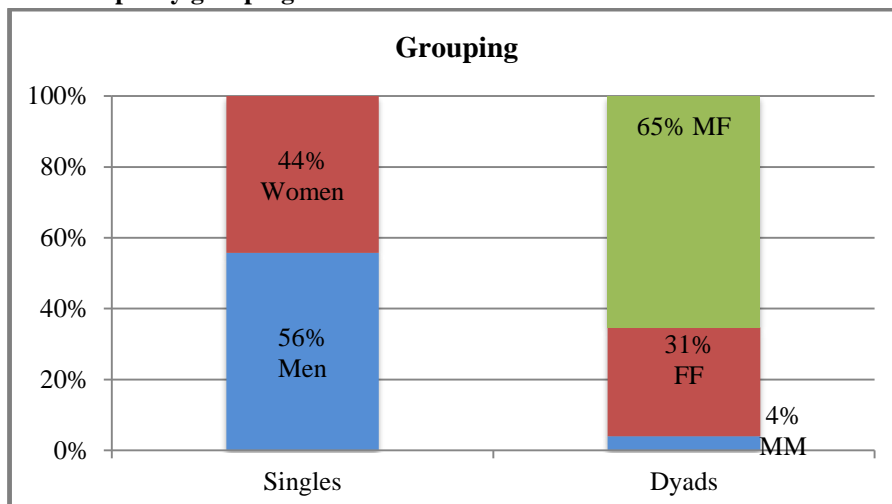
122 pedestrians aged 65 years or above were interviewed. The sample was divided according to age (five categories), gender (males and females) and grouping (singles and dyad members).

**Table 8.3: Sample by age.**

	Age Range					Gender		Composition	
	65-70 y.o.	71-75 y.o.	76-80 y.o.	81-85 y.o.	86 y.o. and above	Males	Females	Singles	Dyad Members
N.	26	25	30	31	10	59	63	70	52
%	21%	21%	25%	25%	8%	48%	52%	57%	43%

For both men and women the mean age was 77 ( $\pm 6.4$  SD), for singles 78 ( $\pm 5.8$  SD) and for dyad members 76 ( $\pm 6.9$  SD). Single pedestrians were 39 males and 31 females; pedestrians walking in dyad were 20 males and 32 females.

**Figure 8.7: Sample by grouping.**



Dyadic formation fell into three different categories according to members' gender: male-male (n.2 pedestrians, 4%), female-female (n.16 pedestrians, 31%) and male-female (n.34 pedestrians, 65%).

People in pair were mainly walking with the spouse (58%) followed by an acquaintance (23%), a caregiver (11%) and a family member (8%).

**Table 8.4: Dyad sample by walking partner.**

	Dyad, accompanied by:	
	N.	Tot. Dyads
<b>Spouse</b>	30	58%
<b>Acquaintance</b>	12	23%
<b>Caregiver</b>	6	11%
<b>Family member</b>	4	8%

36% of the respondents said that they sometimes walk accompanied, 30% indicated "rarely", 17% "often", 12% "never" and 5% "always".

**Table 8.5: Sample by frequency of walking accompanied by another person and the use of walking aid.**

Frequency			Walking aid		
	N.	%		N.	%
<b>Never</b>	15	12%	<b>None</b>	87	71%
<b>Rarely</b>	36	30%	<b>Stick</b>	30	25%
<b>Sometimes</b>	44	36%	<b>Tripod</b>	0	0%
<b>Often</b>	21	17%	<b>Crutch</b>	4	3%
<b>Always</b>	6	5%	<b>Roller</b>	1	1%

The majority of the people did not use a walking aid (71%), 25% used a stick, 3% a crutch and only one person a roller.

People living nearby accounted for the 96% of the sample while people not living in the neighbourhood were only 4%.

Question N.1: Pleasantness

The first question interrogated people about the pleasantness of walking in the area of research interest. The average evaluation score was 5 out of 10. The most chosen answers were related to danger (38%), dirt (28%) and scarce greenery (26%).

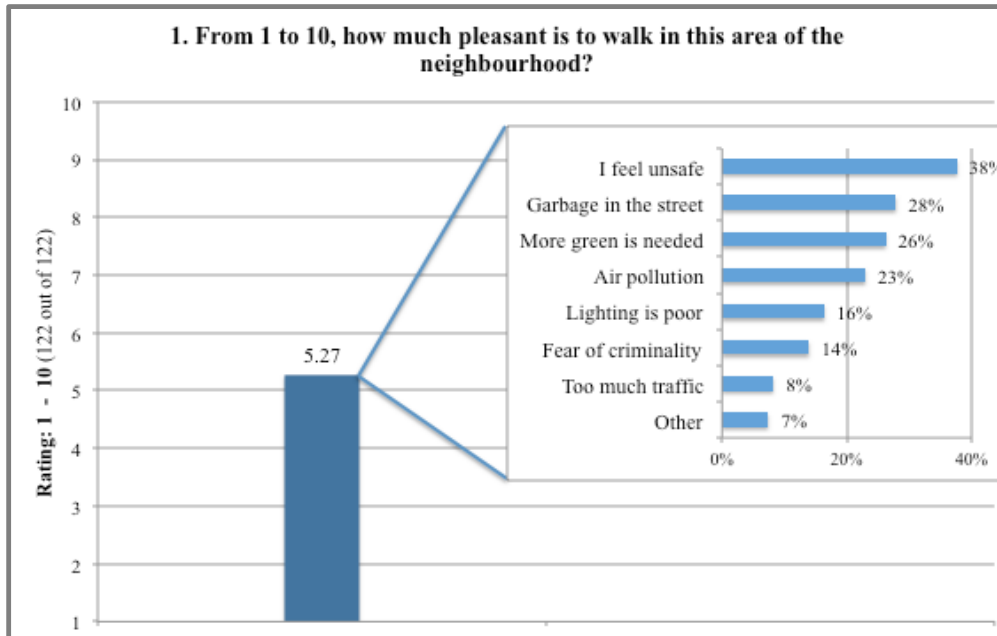
A one-factor analysis of variance (at the  $p < .05$  level) was conducted to compare the effect of age on the general rating of question N.1 among 65-70 years old (5.85,  $\pm 0.94$  SD), 71-75 years old (5.04,  $\pm 3.04$  SD), 76-80 years old (5.53,  $\pm 1.98$  SD), 81-85 years old (5.16,  $\pm 2.54$  SD), 86 years old and above (3.9,  $\pm 3.21$  SD). There was a significant difference in the rating of question N.1 for these five conditions [ $F(4,117)=3.52$ ,  $p=0.01$ ]. Results suggested that age had an effect on the general rating of the pleasantness of walking in the neighbourhood of reference.



An independent samples t-test (at the  $p < .05$  level) was conducted to compare the effect of gender on the general rating of question N.1 between males (5.26,  $\pm 2.41$  SD) and females (5.26,  $\pm 2.46$  SD). There was not a significant difference in the rating of question N.1 for these two conditions  $t(120) = 1.98$ ,  $p = 1$ . Results suggested that gender did not have an effect on the general rating of the pleasantness of walking in the neighbourhood of reference.

An independent samples t-test (at the  $p < .05$  level) was conducted to compare the effect of grouping on the general rating of question N.1 between singles (5.22,  $\pm 2.58$  SD) and dyad members (5.33,  $\pm 2.27$  SD). There was not a significant difference in the rating of question N.1 for these two conditions  $t(120) = 1.98$ ,  $p = 0.69$ . Results suggested that grouping did not have an effect on the general rating of the pleasantness of walking in the neighbourhood of reference.

**Figure 8.8: Question N.1: average rating and answer choices.**

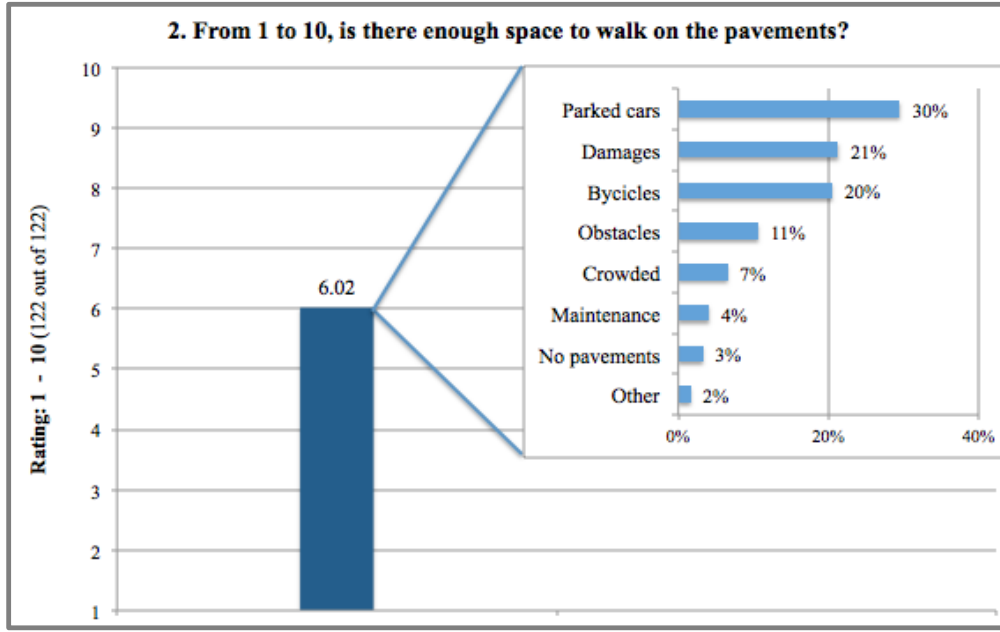


### Question N.2: Comfort

The second question asked about the comfort of walking in the area of research interest. The average evaluation score was 6 out of 10. The most chosen answers were related to irregular parking (30%), bad pavements conditions (21%) and cycling on the pavements (20%).

A one-factor analysis of variance was conducted to compare the effect of age on the general rating of question N.2 among 65-70 years old (6.31,  $\pm 2.06$  SD), 71-75 years old (6.04,  $\pm 1.29$  SD), 76-80 years old (5.93,  $\pm 1.17$  SD), 81-85 years old (6.29,  $\pm 1.21$  SD), 86 years old and above (5.0,  $\pm 3.33$  SD). There was a tendency to significance in the rating of question N.2 for these five conditions  $[F(4,117) = 2.39$ ,  $p = 0.05]$ . Results suggested that age had an effect on the general rating of the comfort of walking in the neighbourhood of reference.

**Figure 8.9: Question N.2: average rating and answer choices.**



An independent samples t-test was conducted to compare the effect of gender on the general rating of question N.2 between males (6.02,  $\pm 1.77$  SD) and females (6.06,  $\pm 1.57$  SD). There was not a significant difference in the rating of question N.2 for these two conditions:  $t(120)=1.98$ ,  $p=0.84$ . Results suggested that gender did not have an effect on the general rating of the comfort of walking in the neighbourhood of reference.

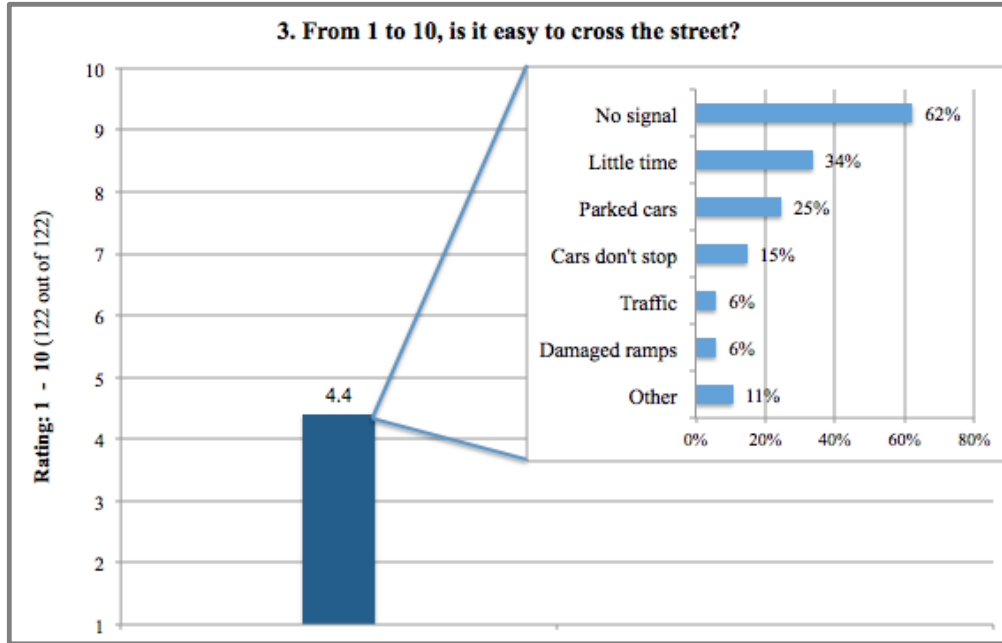
An independent samples t-test was conducted to compare the effect of grouping on the general rating of question N.2 between singles (6.13,  $\pm 1.26$  SD) and dyad members (5.94,  $\pm 2.22$  SD). There was not a significant difference in the rating of question N.2 for these two conditions  $t(120)=1.98$ ,  $p=0.43$ . Results suggested that grouping did not have an effect on the general rating of the comfort of walking in the neighbourhood of reference.

### Question N.3: Crossing

The third question interrogated people about the crossing condition in the area of research interest. The average evaluation score was 4 out of 10. The most chosen answers were related to the absence of a traffic light (62%), insufficient time to cross the road (34%) and parked cars obstructing pedestrians' view (25%).

A one-factor analysis of variance was conducted to compare the effect of age on the general rating of question N.3 among 65-70 years old (5.0,  $\pm 1.52$  SD), 71-75 years old (4.48,  $\pm 1.76$  SD), 76-80 years old (4.03,  $\pm 3.0$  SD), 81-85 years old (4.39,  $\pm 3.31$  SD), 86 years old and above (3.4,  $\pm 1.82$  SD). There was a tendency to significance in the rating of question N.3 for these five conditions [ $F(4,117)=2.42$ ,  $p=0.05$ ]. Results suggested that age had an effect on the general rating of the crossing condition in the neighbourhood of reference.

**Figure 8.10: Question N.3: average rating and answer choices.**



An independent samples t-test was conducted to compare the effect of gender on the general rating of question N.3 between males (4.43,  $\pm 2.50$  SD) and females (4.37,  $\pm 2.57$  SD). There was not a significant difference in the rating of question N.3 for these two conditions:  $t(120)=1.98$ ,  $p=0.84$ . Results suggested that gender did not have an effect on the general rating of the crossing condition in the neighbourhood of reference.

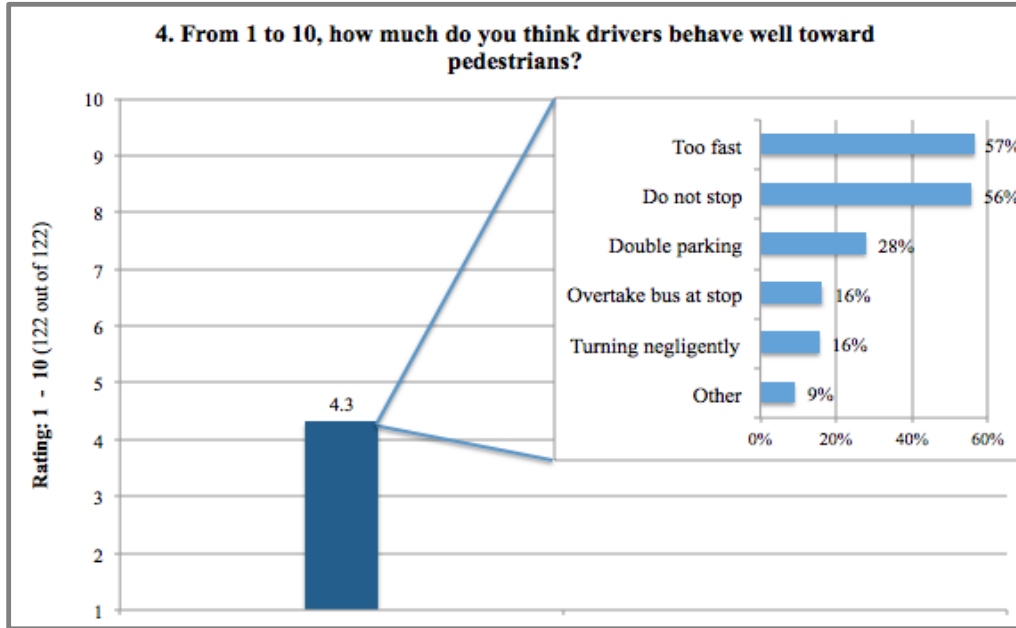
An independent samples t-test was conducted to compare the effect of grouping on the general rating of question N.3 between singles (4.35,  $\pm 2.32$  SD) and dyad members (4.41,  $\pm 2.81$  SD). There was not a significant difference in the rating of question N.3 for these two conditions  $t(120)=1.98$ ,  $p=0.83$ . Results suggested that grouping did not have an effect on the general rating of the crossing condition in the neighbourhood of reference.

#### Question N.4: Respect

The fourth question asked about the respect of drivers in relation to the people walking in the area of research interest. The average evaluation score was 4 out of 10. The most chosen answers were related to driving speed (57%), drivers not stopping near zebra crossing (56%) and double-parking habit (28%).

A one-factor analysis of variance was conducted to compare the effect of age on the general rating of question N.4 among 65-70 years old (4.88,  $\pm 1.71$  SD), 71-75 years old (4.08,  $\pm 2.66$  SD), 76-80 years old (3.77,  $\pm 2.74$  SD), 81-85 years old (4.68,  $\pm 2.36$  SD), 86 years old and above (3.8,  $\pm 2.18$  SD). There was a significant difference in the rating of question N.4 for these five conditions [ $F(4,117)=2.70$ ,  $p=0.03$ ]. Results suggested that age had an effect on the general rating of the respect of drivers in relation to the people walking in the neighbourhood of reference.

Figure 8.11: Question N.4: average rating and answer choices.



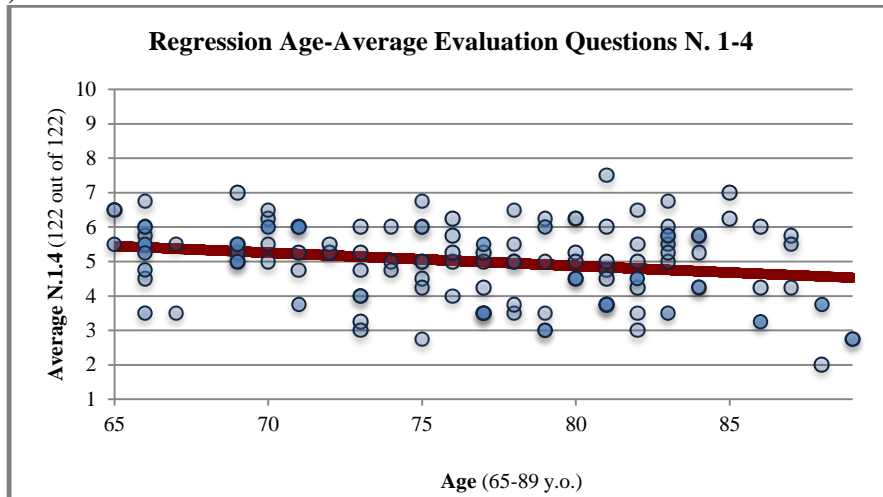
An independent samples t-test was conducted to compare the effect of gender on the general rating of question N.4 between males (4.48,  $\pm 2.51$  SD) and females (4.21,  $\pm 2.73$  SD). There was not a significant difference in the rating of question N.4 these two conditions:  $t(120)=1.98$ ,  $p=0.34$ . Results suggested that gender did not have an effect on the general rating of the respect of drivers in relation to the people walking in the neighbourhood of reference.

An independent samples t-test was conducted to compare the effect of grouping on the general rating of question N.4 between singles (4.33,  $\pm 2.49$  SD) and dyad members (4.31,  $\pm 2.42$  SD). There was not a significant difference in the rating of question N.4 for these two conditions  $t(120)=1.98$ ,  $p=0.95$ . Results suggested that grouping did not have an effect on the general rating of the respect of drivers in relation to the people walking in the neighbourhood of reference.

#### General Walkability Rating

A simple linear regression was calculated to predict the average rating from question N.1 to question N.4 based on age. The hypothesis was that older respondents rated the questions with lower scores. A significant regression equation was found [ $F(1,121)=6.17$ ,  $p=0.01$ ], with an R square of .05. Results suggested that age had an effect on the general walkability rating condition in the neighbourhood of reference.

**Figure 8.12: Regression scatterplot question N.1-4 (darker marks represent multiple data points).**



Dyads and Perceived Safety

Question N.5 interrogated the respondents about if they feel safer or not when walking and crossing the street if accompanied by another person. Question N.6 asked to rate the perceived sense of safety in walking and crossing if accompanied and also includes the possibility to justify the score. Question from N.7 to N.10 gave further details about the perceived safety of respondents giving a score of 6 or above.

65 persons replied "yes" (I would feel safer) and 57 persons "no" (I wouldn't feel safer). The average evaluation score was 5 out of 10 for males and 6 for females.

**Table 8.6: Average of safety perception if accompanied, rating by gender.**

	Men	Women
<b>Mean</b>	5	6
<b>SD</b>	2.21	2.33

The most recurrent reasons for people giving a lower score (1-5 on the rating scale) were related to indifference in proceeding in pair (49%) and autonomy (33%).

The most recurrent reasons for people giving a higher score (6-10 on the rating scale) were related to fragility (30%), fear of falling and robbery (33%) and the pleasantness deriving from walking in company (19%).

Figure 8.13: Average rating question N.5 (scores from 1 to 5).

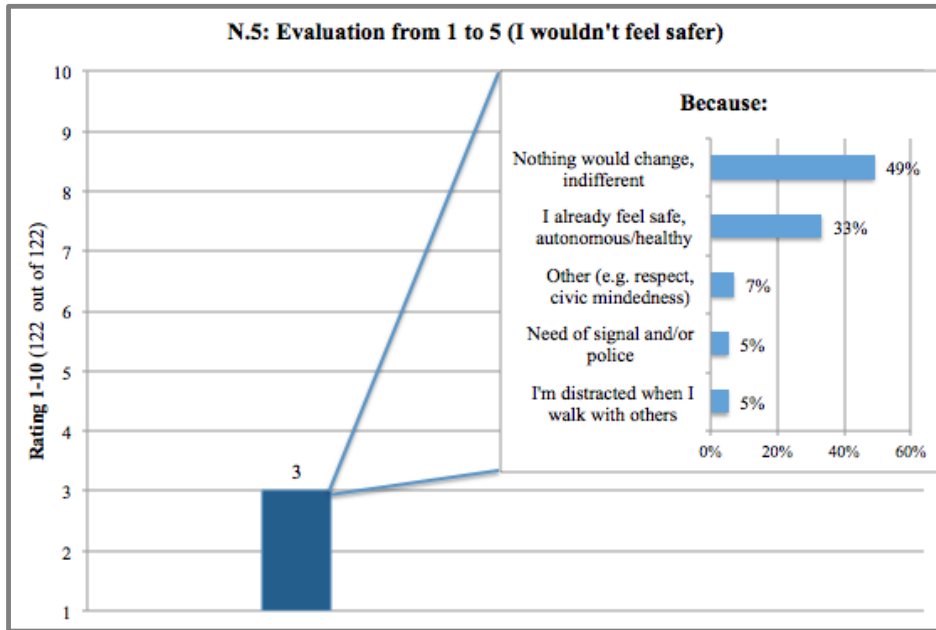
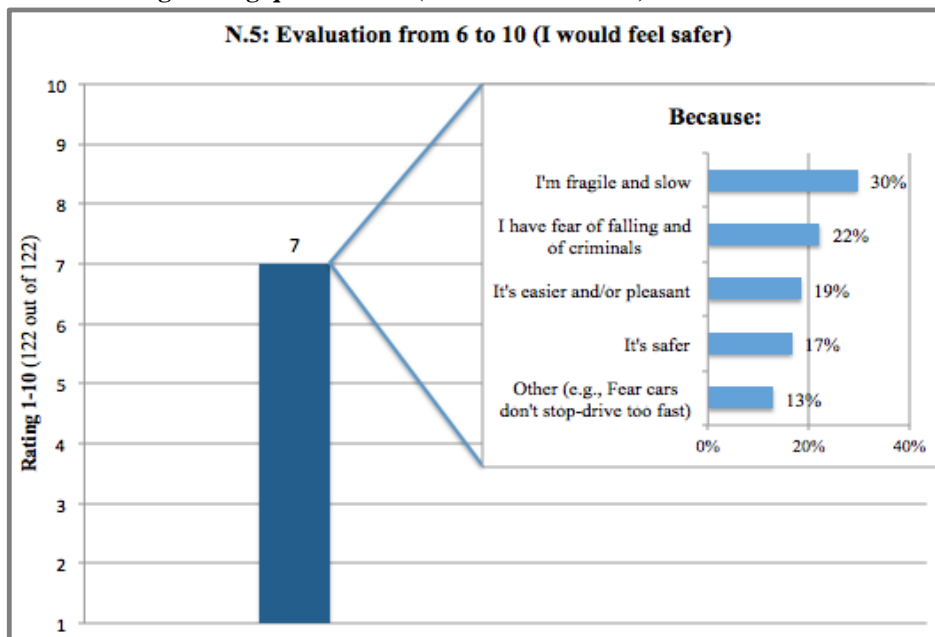
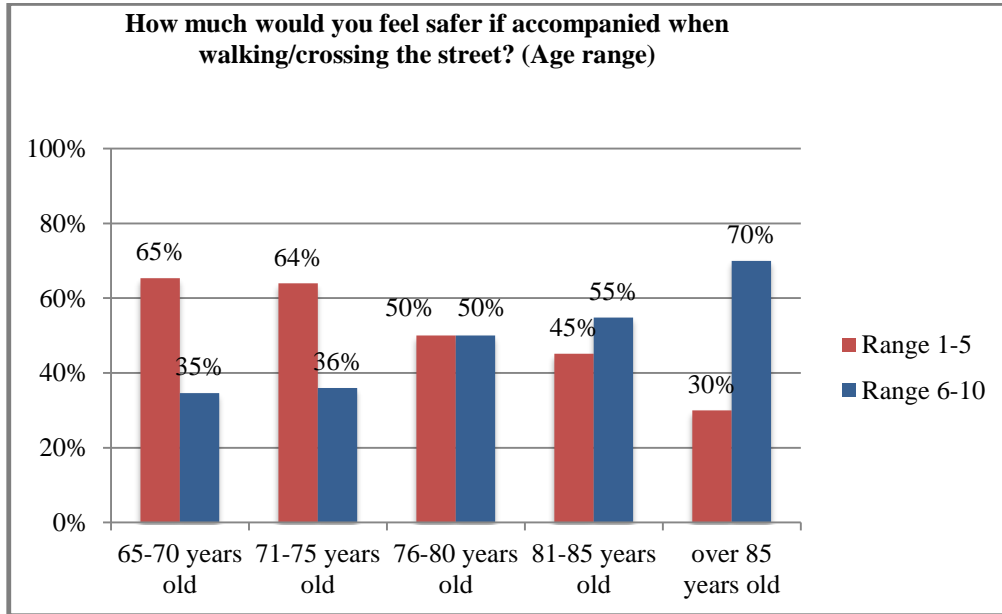


Figure 8.14: Average rating question N.5 (scores from 6 to 10).



As shown by the Figure 8.15, age appeared to be related to the evaluation scores. The higher the age, the higher the score given to the sense of safety perceived when walking in pair.

**Figure 8.15: Question N.6 by mean rating and age.**

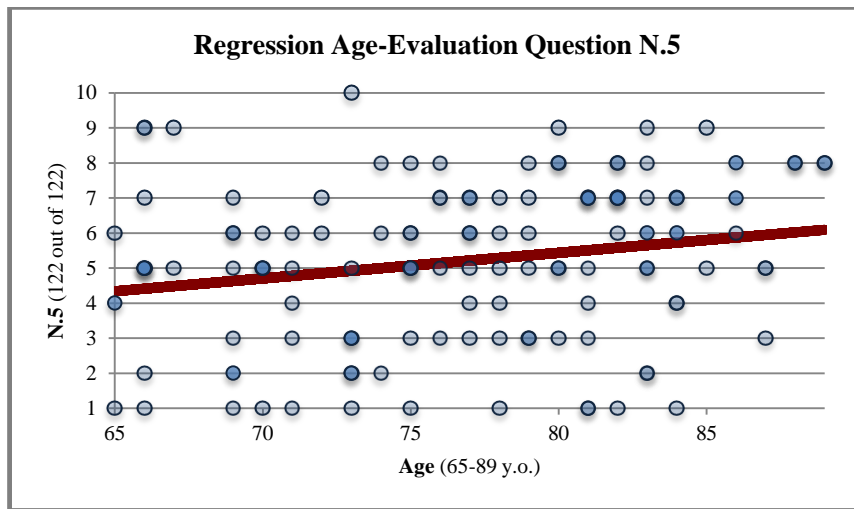


An independent samples t-test was conducted to compare the effect of gender on the rating of question N.6 between males (4.62,  $\pm$ 5.05 SD) and females (5.71,  $\pm$ 5.29 SD). There was a significant difference in the rating of question N.6 for these two conditions:  $t(120)=1.98$ ,  $p=0.01$ . Results suggested that gender had an effect on the rating of the sense of safety perceived if walking in pair in the neighbourhood of reference.

An independent samples t-test was conducted to compare the effect of grouping on the general rating of question N.6 between singles (4.54,  $\pm$  5.22 SD) and dyad members (6.0,  $\pm$  4.4 SD). There was a significant difference in the rating of question N.6 for these two conditions  $t(120)=1.98$ ,  $p=0.0001$ . Results suggested that grouping had an effect on the rating of the sense of safety perceived if walking in pair in the neighbourhood of reference.

A simple linear regression was calculated to predict the average rating of question N.6 based on age. The hypothesis was that older respondents rated the questions with higher scores. A significant regression equation was found [ $F(1,121)=5.10$ ,  $p=0.003$ ] with an R square of .04. Results suggested that age had an effect on the general sense of safety perceived if walking in pair in the neighbourhood of reference.

**Figure 8.16: Regression scatterplot question N.5 (darker marks represent multiple data points).**



Moreover, as shown by Table 8.7 and Table 8.8, the majority of respondents who gave a rating score of 6 or above would prefer being accompanied by an adult male family member proceeding beside them.

**Table 8.7: Question N.7 (left) and N.8 (right).**

N.7-8. When you are accompanied, you feel safer if accompanied (by): (multiple choice possible):					
	Beside	Hand in hand	Adult	Young	Same age
N.	43	26	45	29	24
%	66%	40%	69%	45%	37%

**Table 8.8. Question N.9 (left) and N.10 (right).**

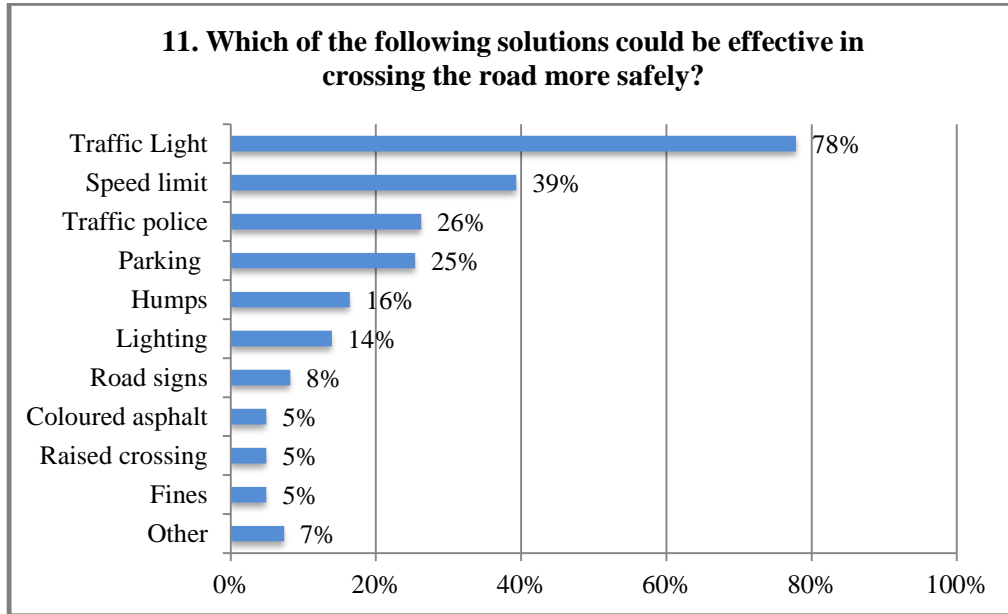
N.9-10. When you are accompanied, you feel safer if accompanied by: (multiple choice possible)						
	Man	Woman	Family member	Acquaintance	Spouse	Caregiver
N.	46	42	42	33	26	10
%	71%	65%	65%	51%	40%	15%

Question N.11: Possible Solutions

The last question asked about possible solutions in order to cross the street in a safer way. A list of items was prepared but interesting alternatives have been proposed directly by the respondents. Placing a traffic light was chosen by 78% of the interviewees, followed by lowering the speed limit in the area (39%). The presence of traffic police was suggested by the 26% of the people.



**Figure 8.17: Question N.11: possible solutions choices.**



### 8.7 Conclusions

Chapter 8 presented the objective, methodology and results of the study carried out in Via Padova neighbourhood in Milan, particularly near a complex non-signalised intersection. This research also aimed at collecting insights directly from the citizens as well as suggestions in order to make the area safer and more enjoyable. In general, older pedestrians would feel safer if accompanied by another person, especially women, as with the age environment complex conditions are perceived as more critical.

The sample was composed of elderly people, the almost totality living in the neighbourhood, walking without aids and proceeding alone (n.70) or accompanied (n.52), mainly by the spouse or an acquaintance.

Questions from N.1 to N.4 represented the walkability scale for Via Padova neighbourhood. It gave information and rating scores about pleasantness, comfort, crossing condition and driver's behaviour and respect towards the older pedestrians. Questions from N.5 to N.10 represented the scale of the relation between safety perception and dyad composition. The last question, N.11, indicated a possible set of solutions in order to put a remedy to the critical crossing situation.

Results showed that the area of interest is not yet an age friendly environment having collected a low level of walkability in the neighbourhood. In general, the average rating to question N.5, concerning the increase in safety perception if accompanied, was 5 out of 10. Despite, at a first look the average score of 5 could indicate that respondents would not feel safer walking in pair, more people (n.65) replied that they would feel safer if accompanied compared to those that would not feel safer in pair (n.57). This can be explained by the fact that who said "no" gave on average a very low score (3 out of 10) contributing to bring the average score below 6.

In addition, statistical analysis gave interesting results about the effect that age,

gender and grouping has of the safety perception.

According to the findings, it can be argued that in the neighbourhood of reference:

- the higher the age, the lower the rating score in the walkability scale. Hence, pleasantness, comfort, crossing and respect towards the pedestrians accounted for a lower rating, meaning that older pedestrians were more sensitive to the critical situations of the area of interest;
- gender factor had no effect in relation to walkability condition;
- grouping factor had no effect in relation to walkability condition.

Moreover, in relation to the safety perception of walking in dyad in the neighbourhood of reference, it can be argued that:

- age factor had effect on safety perception in dyadic composition as the older the pedestrians, the safer they would feel if accompanied by another person;
- gender factor had effect on safety perception in dyadic composition as women would feel safer if accompanied by another person compared to men;
- grouping factor had effect on safety perception in dyadic composition as dyad members would feel safer in walking and crossing the street compared to single pedestrians interviewed.

The experience of the inhabitants helped us to give insights about the real walkable condition of the area, providing an important added value to the research. For instance, interviewees indicated situations that were not forecasted when the questionnaire has been designed. Fear of criminals, the problem of cycling on the pavements and the difficulty of crossing the road because drivers do not stop at the walkway have been suggested by the respondents as critical issues. In addition, several people indicated traffic police as a solution to ameliorate the walking condition in the area close to the crossing. In fact, people noticed that with their presence, on Mondays when the open market is held, both the crossing situation and the perceived safety related to public order are improved.

The present study constituted an important statement for the city of Milan, as well as for other cities in need of improving elderly pedestrians' comfort and safety and, in general, to improve the walkable condition in a residential neighbourhood. It showed that, despite elderly citizens are generally independent and autonomous when moving in urban spaces, it is easier, safer and more pleasant for them to walk in pairs. The findings of this research constitute the basis for the motivations in support to urban environments inclusiveness and social engagement for an increase in the quality of life of elderly persons discussed throughout this thesis.

## FINAL REMARKS AND FUTURE WORKS

The current work aimed at investigating the walking dynamics and conditions of elderly people as well as collecting data about the perception of seniority and elderly living in a historical period where the beliefs associated to the notion of "old" are changing due to demographic trend and the consequent social transformations. The three studies presented investigated the theme of elderly living and walking patterns starting from three different dimensions: perception (longevity questionnaire), behaviour (Galleria Vittorio Emanuele II-Milan unobtrusive observation) and user experience (Via Padova-Milan walkability checklist).

An overview of the latest demographic trend and social-driven phenomena, such as active ageing, age-friendly cities and independent living, have been proposed in the first part of the thesis. These transformations, which involve the society on several levels, have been discussed throughout the first chapters. From a macro-level viewpoint, welfare, economy and politics are affected by the increasing number of older persons while, from a micro-level perspective, personal well-being and quality of life of elderly people and their families are exposed to the consequences of the ageing process.

The research activity carried out to explore the perception of elderly living and the adoption of assistive technology for senior persons was presented afterward. The study indicated that the conventional age seniority is set at and the perception of the people living in an ageing society is slightly different. This difference is mainly determined by the ideas associated to elderly living and the autonomous life-style conducted by a high number of older people nowadays. Social engagement, the maintenance of an active way of living and technologies able to support ageing in place, resulted in playing an important role in elderly living according to the participants of the survey. These results constituted the premises for the second part of the thesis, which focused on the experience of the elderly people in outdoor environments. Elderly pedestrians and, specifically, dyads of elderly pedestrians were the subjects of the unobtrusive observation performed in Galleria Vittorio Emanuele II-Milan (Italy) and the questionnaire administration activity carried out in Via Padova-Milan (Italy). The observational study mainly concentrated on the effect of age, gender and cohesion on distance covered time, path and speed. The results achieved through the observation offer important information about the composition of a crowd, where dyads account for the highest proportion. Data analysis indicated that elderly pedestrians walk at a slower speed compared to their younger counterparts, both as single and in dyadic composition, taking also longer time to cover the distance set while maintaining a more stable path. The survey carried out in a densely populated neighbourhood in Milan allowed to collect interesting insights about elderly people's experience and perception in relation to the walkable condition of the study setting. This original study revealed that older pedestrians, especially females, feel safer if accompanied by another person in a complex urban setting.

To be physically and mentally active allows people to be involved in societal life which, in turn, should give them protection and comfort. An age-friendly surrounding is an environment that supports the engagement of people from younger to older age, providing services and possibilities for the preservation of health and well-being. Through the creation of age-friendly cities, the impact of ageism at the social level would be connoted by more positive attributes rather than negative ones, giving to all people the chance to contribute according to their possibilities and abilities.

Older persons represent both a resource and a challenge for cities, therefore the development of age-friendly cities is a priority for the international community, which is asked to find solutions to ageing and urbanisation phenomena. As stated in the European Charter for Pedestrians' Rights (1988), pedestrians, especially elderly ones, should be guaranteed a healthy and lively environment where social contact is fostered with the final aim of ensure them a good quality of life in urban neighbourhoods. Hence, it is fundamental to take into consideration the way elderly people live and travel within urban spaces.

The research contributed in individuating and describing some of the characteristics related to elderly mobility that are useful for the development and management of good walkability conditions and age-friendly cities in general. Central and local governments are usually responsible for identifying walkability problems and prioritise projects aiming at improving pedestrians' walking conditions. Roads should be seen not only from the transportation functional perspective but also as place that serve diverse purposes, socialisation and recreational ones above all. The availability of benches and gathering places, larger and well-maintained pavements, regulated crossing and safer public order have to be put into practice for the comfort of the whole population. An "attractive city" is a city that succeeds in bringing and engaging people thanks to the transformation of public spaces, which becomes the stage for social involvement and interpersonal communication able to restore and develop an urban territory that includes the community living in (Colleoni and Guerisoli, 2014).

Ongoing experimental studies have been already designed at the CSAI research center to further investigate elderly walking dynamics in urban settings. In particular, future works include:

- unobtrusive observation of a larger sample population of elderly pedestrians and in consideration of more variables in a crowded setting;
- use of different data analysis techniques, such as computer-based simulations, in order to develop reliable simulations of pedestrians' dynamics;
- investigation about elderly locomotion in an urban complex environment also thanks to video-recording already performed.

In conclusion, the present work discussed about the perception of life at older age, elderly people dynamics during locomotion and their walking experience in dyadic composition, giving contributions for the development of future research aiming at

acquiring further understanding about elderly pedestrians, who will play an central role in super-aged societies such as Italy. The findings of the studies also support the consolidated international approach, which identify in outdoor activities and community life engagement the principles for a healthy and active lifestyle, in other words, the key elements for increasing the quality of life in ageing societies.



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## **APPENDICES**

**I. Literature Review Table**

**II. Questionnaire "The Perception of Longevity"**

**III. Walkability Checklist**



## Appendix I Literature Review Table

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
<b>Proxemic Theory Review - Proxemics can be defined as "the interrelated observations and theories of man's use of space as a specialized elaboration of culture"(1966)</b>											
Aiello, J. R., (1987). <i>Human spatial behavior</i> . In Handbook of environmental psychology (Vol. 1). Krieger Florida. 389-505.	x		x	x	x	x	x	x	x	Review	Extensive and comprehensive literature review of existing studies about human spatial behaviour.
Antonini, G., Bierlaire, M., & Weber, M. (2006). Discrete choice models of pedestrian walking behavior. <i>Transportation Research Part B: Methodological</i> , 40(8), 667–687.		x	x							In silicon	Model predicting the place of the next step of a walking pedestrian in an agent based simulation.
Aveni, A. F. (1977). The not-so-lonely crowd: Friendship groups in collective behavior. <i>Sociometry</i> , 96–99.		x	x	x	x	x				In vivo	Empirical study focusing the group-level phenomenon rather than approaching to crowd on the individual level.
Ballerini, M., Cabibbo, N., Candelier, R., Cavagna, A., Cisbani, E., Giardina, I., ... Procaccini, A. (2008). Interaction ruling animal collective behavior depends on topological rather than metric distance: Evidence from a field study. <i>Proceedings of the National Academy of Sciences</i> , 105(4), 1232–1237.		x	x							In vivo	Study demonstrating that the interaction among birds in a flock does not depend on the metric distance but on the topological distance.

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Bandini, S., Gorrini, A., Manenti, L., Vizzari, G. (2012). Crowd and Pedestrian Dynamics: Empirical Investigation and Simulation. 8th Conference on Methods and techniques in Behavioural Research. <i>Proceedings of Measuring Behaviour 2012</i> , Utrecht, Netherlands, 308-311.		x	x	x	x	x				In vivo, In vitro, In silicon	An innovative and multi-disciplinary approach for the investigation of pedestrian dynamics in high-density situations is proposed to design strategies for an effective management of pedestrians' circulation.
Burgess, J. W. (1983). Developmental trends in proxemic spacing behavior between surrounding companions and strangers in casual groups. <i>Journal of Nonverbal Behavior</i> , 7(3), 158–169.		x				x		x		In vivo	Observation on walking subjects in the corridors of shopping malls and along sidewalks of small towns. Proxemic behaviours according to age differences have been widely observed and interpreted.
Burgess, J. W. (1989). The social biology of human populations: Spontaneous group formation conforms to evolutionary predictions of adaptive aggregation patterns. <i>Ethology and Sociobiology</i> , 10(5), 343–359.	x		x				x	x	x	In vivo	Tests to show how age, gender and socio-cultural differences can shape the spontaneous formation of group, mainly related to reproductive behaviour.

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Camperio, C. A., & Malaman, M. (2002). Where to sit in a waiting room: density, age and gender effects on proxemic choices. <i>Human evolution</i> , 17(3-4), 175–185.	x		x				x	x		In vivo	Study on proxemic behaviour in a hospital waiting room, distinguishing gender and age (mature-old).
Carp, F. (1987). <i>Environment and Aging</i> . In Handbook of environmental psychology (Vol. 1). Krieger Florida. 329-360.	x		x					x		Review	Review on environment and ageing that also suggests us we need to balance knowledge about older people and the environment without unjustified generalisation.
Cheng, L., Yarlagadda, R., Fookes, C., & Yarlagadda, P. K. (2014). A review of pedestrian group dynamics and methodologies in modelling pedestrian group behaviours. <i>World</i> , 1(1), 002–013.		x	x	x	x	x				Review	Literature review on pedestrian models to highlight the importance that group dynamics have when developing pedestrian simulation models.
Cheyne, J.A. & Efran, M. G. (1972). The effects of spatial and interpersonal variables on the invasion of group controlled territories. <i>Sociometry</i> , 35, 477-489.		x	x	x			x			In vivo	Experiments to investigate a number of variables influencing the intrusion of a dyad. Gender and interaction found to have direct consequences on the frequency of intrusion.

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Costa, M. (2010). Interpersonal distances in group walking. <i>Journal of Nonverbal Behavior</i> , 34(1), 15–26.		x	x	x	x	x	x	x		In vivo	Observation of spatial organisation of groups of pedestrians while walking. Gender, dyad-tryads and walking speed as main variables.
Dommes, A., Cavallo, V., Vienne, F., & Aillerie, I. (2012). Age-related differences in street-crossing safety before and after training of older pedestrians. <i>Accident Analysis &amp; Prevention</i> , 44(1), 42–47.		x	x					x		In vitro, in silicon	Comparison of the crossing ability of younger and older pedestrians before and after training.
Dosey, M. A., & Meisels, M. (1969). Personal space and self-protection. <i>Journal of Personality and Social Psychology</i> , 11(2), 93.	x		x				x			In vitro	Study on personal space as a buffer zone to protect against perceived threats and stress conditions.
Dunbar, G., Holland, C.A., Maylor, E.A., (2004). <i>Older Pedestrian: A Critical Review of the Literature</i> . Road Safety Research Report N. 37. Department for Transport, London, UK.		x	x				x	x		Review	Comprehensive review on elderly pedestrians behaviour, especially crossing and issues related to physical impairments.
Efran, M. G. & Cheyne, J. A. (1973). Shared space: The cooperative control of spatial areas by two interacting individuals. <i>Canadian Journal of Behavioral Science</i> , 5, 201-210.		x	x	x			x			In vivo	Study to test the difference in frequency of intrusion in case of 2 persons standing at a personal or social distance from each other.

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Epstein, Y. M. (1981). Crowding stress and human behavior. <i>Journal of Social Issues</i> , 37(1), 126–144.	x		x			x				In vivo	Discussion on crowd model and the perception of people in relation to crowd.
Evans, G. W., & Lepore, S. J. (1992). Conceptual and analytic issues in crowding research. <i>Journal of Environmental Psychology</i> , 12(2), 163–173.		x	x			x				In vivo	Study explaining the behavioural constraint, diminished control and overload as three major mechanisms for adverse effects of crowding on human behaviour.
Evans, G. W., & Wener, R. E. (2007). Crowding and personal space invasion on the train: Please don't make me sit in the middle. <i>Journal of Environmental Psychology</i> , 27(1), 90–94.	x		x	x	x	x				In vivo	Study on possible adverse reaction when sitting close to other passengers on trains.
Felipe, N. J., & Sommer, R. (1966). Invasions of personal space. <i>Social problems</i> , 206–214.		x		x		x					Discussion on crowding and the negative effect on humans often mediated by factors and situations.
Ge, W., Collins, R. T., & Ruback, R. B. (2012). Vision-based analysis of small groups in pedestrian crowds. <i>Pattern Analysis and Machine Intelligence, IEEE Transactions</i> , 34(5), 1003–1016.		x	x	x	x					In vivo	Investigation using automatic and manual detection and tracking of individual pedestrians travelling together.

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Guo, N., Ding, J., Ling, X., Takashi, I., & Shi, Q. (2012). Walking Behavior of Pedestrian Groups in the Merchandise Streets. In CICTP 2012, Multimodal Transportation Systems, 649–659, ASCE.		x		x	x	x				In vitro, in silicon	A social force model was developed to mimic the pedestrian groups in a shopping street; dyads observation.
Hall Edward, T. (1966). <i>The hidden dimension</i> . Garden City, NY: Anchor.	x		x						x	In vivo	Work examining the concept of space across cultures and settings. Introducing "proxemics" and "four spatial dimensions".
Hayduk, L. A. (1981). The shape of personal space: An experimental investigation. <i>Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement</i> , 13(1), 87.	x		x							In vivo	Study using a two-dimensional distance measurement and shape of personal space.
Helbing, D., Buzna, L., Johansson, A., & Werner, T. (2005). Self-organized pedestrian crowd dynamics: Experiments, simulations, and design solutions. <i>Transportation science</i> , 39(1), 1–24.		x	x							In vitro, in silicon	Experiments in corridors, bottlenecks and intersections performed to test simulation models of pedestrian flow. Proposal of design solutions to increase efficiency and safety in public spaces.



	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Helbing, D., Molnar, P., Farkas, I. J., & Bolay, K. (2001). Self-organizing pedestrian movement. <i>Environment and planning</i> , 28(3), 361–384.		x	x							In vivo, in silicon	Discussion of predictable patterns of pedestrians. Simulation model pointed out that self-organising flow patterns can change the capacities of pedestrians' facilities.
Holland, C., & Hill, R. (2010). Gender differences in factors predicting unsafe crossing decisions in adult pedestrians across the lifespan: a simulation study. <i>Accident Analysis &amp; Prevention</i> , 42(4), 1097–1106.		x	x				x	x		In vitro	Study demonstrating that age, gender and driving experience have a correlation with crossing choices.
Holland, R. W., Roeder, U.-R., Brandt, A. C., & Hannover, B. (2004). Don't stand so close to me the effects of self-construal on interpersonal closeness. <i>Psychological science</i> , 15(4), 237–242.		x	x	x						In vitro	Study about the analysis of level of anxiety when person gets too close.
Ickes, W., & Barnes, R. D. (1977). The role of sex and self-monitoring in unstructured dyadic interactions. <i>Journal of Personality and Social Psychology</i> , 35(5), 315.	x		x	x			x			In vivo	Young dyads of the same gender (MM,FF) videotaped to research on interaction between partners.
Janowsky, J. S., Oviatt, S. K., & Orwoll, E. S. (1994). Testosterone influences spatial cognition in older men. <i>Behavioral neuroscience</i> , 108(2), 325.	x							x		In vitro	Study on testosterone supplementation resulted in enhancement of spatial cognition in healthy older men.

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Johansson, A., Helbing, D., & Shukla, P. K. (2007). Specification of the social force pedestrian model by evolutionary adjustment to video tracking data. <i>Advances in complex systems</i> , 10(supp02), 271–288.		x	x							In silicon	Calibrated model based on video recording and tracking of pedestrian motion used for large-scale pedestrian simulation.
Kendon, A. (2010). <i>Spacing and orientation in co-present interaction</i> . In Development of Multimodal Interfaces: Active Listening and Synchrony, 1–15. Berlin: Springer.	x		x	x						In vitro	Study on how people arrange themselves spatially in various kind of focused interaction.
Kennedy, D. P., Gläscher, J., Tyszka, J. M., & Adolphs, R. (2009). Personal space regulation by the human amygdala. <i>Nature neuroscience</i> , 12(10), 1226–1227.	x		x							In vitro	Role of the amygdala in regulating personal space. Use of neuroimaging.
Kirasic, K. C. (2000). 10 Ageing and spatial behaviour in the elderly adult. <i>Cognitive mapping: Past, present, and future</i> , 4, 166.		x	x					x		In silicon	Study on spatial learning ability and spatial tasks performance in older age.
Knowles, E. S. (1973). Boundaries around group interaction: The effect of group size and member status on boundary permeability. <i>Journal of Personality and Social Psychology</i> , 26(3), 327.		x	x	x	x	x			x	In vitro	Experiments on boundaries permeability of groups depending on its size and status.
Knowles, E. S., & Bassett, R. L. (1976). Groups and crowds as social entities: Effects of activity, size, and member similarity on nonmembers. <i>Journal of Personality and Social Psychology</i> , 34(5), 837.		x	x	x		x	x			In vitro	Investigation on how pedestrian behaviour and distance is influenced by groups' activity.

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Knowles, E. S., Kreuser, B., Haas, S., Hyde, M., & Schuchart, G. E. (1976). Group size and the extension of social space boundaries. <i>Journal of Personality and Social Psychology</i> , 33(5), 647.		x	x	x	x	x	x			In vitro	Investigation on spatial properties of small groups and individuals in relation to groups, individuals and object.
Knowles, E. S., & Brickner, M. A. (1981). Social cohesion effects on spatial cohesion. <i>Personality and Social Psychology Bulletin</i> , 7(2), 309–313.		x	x	x			x			In vivo, in vitro	Study on pairs' resistance to intrusion to protect group cohesion in case of similar and dissimilar opinions.
Lawton, C. A. (1994). Gender differences in way-finding strategies: Relationship to spatial ability and spatial anxiety. <i>Sex roles</i> , 30(11-12), 765–779.	x		x				x	x		In vivo	Self-reported use of way-finding strategies for men and women also considering age factor.
Lloyd, D. M. (2009). The space between us: A neurophilosophical framework for the investigation of human interpersonal space. <i>Neuroscience &amp; Biobehavioral Reviews</i> , 33(3), 297–304.	x		x	x						Review	Review on the evidence from social psychology with neuroscientific evidence concerning spatial coding to propose an interpretation of 'social space'.
Lobjois, R., Cavallo, V., Age-related differences in street-crossing decisions: the effects of vehicle speed and time constraints on gap selection in an estimation task. <i>Accident Analysis and Prevention</i> 39 (2007) 934-943.		x	x					x		In vitro	Experiments on how age affects street crossing decisions with upcoming vehicles under time constraints situations.
Lobjois, R., & Cavallo, V. (2009). The effects of aging on street-crossing behavior: from estimation to actual crossing. <i>Accident Analysis &amp; Prevention</i> , 41(2), 259–267.		x	x				x	x		In vitro	Examination of age-related effects on crossing decisions, crossing time and speed.

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Lomranz, J. (1976). Cultural variations in personal space. <i>The Journal of Social Psychology</i> , 99(1), 21–27.	x		x						x	In vivo	Study on effects of three different cultural background on personal space.
Moussaïd, M., Perozo, N., Garnier, S., Helbing, D., & Theraulaz, G. (2010). The walking behaviour of pedestrian social groups and its impact on crowd dynamics. <i>PLoS one</i> , 5(4), e10047.		x		x	x	x				In vivo, in silicon	Analysis of the motion of 1500 pedestrians groups, showing that social interaction generates typical walking patterns.
Nogami, G. Y. (1976). Crowding: Effects of group size, room size, or density? <i>Journal of Applied Social Psychology</i> , 6(2), 105–125	x		x		x	x	x			In vitro	Investigation on response to perceptual/cognitive tasks and the different effect that crowding has on “feelings” and “interpersonal perceptions”.
Ohno, R., Kaneko, I., Kobayashi, M. (2012). <i>Measurement of Pedestrian's Evasive Behaviour around a Person Walking with a Trolley bag or Baby stroller by Quasi-Experiment in an actual Setting</i> . Paper presented at the International Symposium on Environment-behaviour Studies 2012.		x	x							In vivo, In vitro	Study on pedestrians' behaviour and their need for extra space when walking close to a person with artifact.
Ozdemir, A. (2008). Shopping Malls: Measuring Interpersonal Distance under Changing Conditions and across Cultures. <i>Field Methods</i> , 20(3), 226.		x	x	x	x	x		x	x	In vivo	Research measuring interpersonal distances between shopping mall users under changing conditions of enclosure and density.

	Approach		Variables							Method	Abstract	
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences			
Oxley, J. A., Ihsen, E., Fildes, B. N., Charlton, J. L., & Day, R. H. (2005). Crossing roads safely: an experimental study of age differences in gap selection by pedestrians. <i>Accident Analysis &amp; Prevention</i> , 37(5), 962–971.		x	x						x		In vivo, in silicon	Experiments examining age difference in gap selection decision in a simulated road-crossing environment.
Patterson, M. (1968). Spatial factors in social interactions. <i>Human Relations</i> , 21, 251-361.		x	x		x	x					In vivo	Discussion on the influence of spatial distance on small group structure, its relation to personality correlates, reactions to the invasion of personal space, and the influence of affiliation.
Seyfried, A., Steffen, B., Klingsch, W., & Boltes, M. (2005). The fundamental diagram of pedestrian movement revisited. <i>Journal of Statistical Mechanics: Theory and Experiment</i> , 2005(10), P10002.		x	x								In vitro	Study presenting experimental results about empirical relation between density and velocity of pedestrians.
Shafabakhsh, G. (2013). Micro simulation of the elderly population's effect on Iran's pedestrian's walking flow. <i>PROMET-Traffic&amp;Transportation</i> , 25(4), 331–342.		x	x						x		In silicon	Estimation of the effect of elderly presence on pedestrian flows on Iran's sidewalks using simulation software.
Singh, H., Arter, R., Dodd, L., Langston, P., Lester, E., & Drury, J. (2009). Modelling subgroup behaviour in crowd dynamics DEM simulation. <i>Applied Mathematical Modelling</i> , 33(12), 4408–4423.		x	x	x	x	x			x		In vitro, in silicon	Investigation of subgroups patterns in crowd dynamics aiming at including more realistic behaviour in simulation.

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Sisiopiku, V. P., & Akin, D. (2003). Pedestrian behaviors at and perceptions towards various pedestrian facilities: an examination based on observation and survey data. <i>Transportation Research Part F: Traffic Psychology and Behaviour</i> , 6(4), 249-274.		x	x				x	x		In vivo	Observation and survey study on pedestrians' perception toward different strategies of crosswalks, intersection and warning signs.
Schultz, M., Schulz, C., & Fricke, H. (2010). <i>Passenger dynamics at airport terminal environment</i> . In <i>Pedestrian and Evacuation Dynamics 2008</i> , 381–396. Berlin: Springer.		x	x	x	x	x	x			In vivo, in silicon	Traveling people inside airport recorded for study on behaviour and walking speed based on different parameters.
Sommer, R. (1965). Further Studies of Small Group Ecology. <i>Sociometry</i> , Vol 28(4), Dec 1965, 337-348.	x		x	x						In vivo	Investigation of spatial arrangement of pairs of students.
Sommer, R. (1969). <i>Personal Space. The Behavioral Basis of Design</i> . Englewood Cliffs: Prentice-Hall.	x		x						x	In vivo	Discussion and definition of personal space and boundaries protection.
Sumpter, D. J. (2010). <i>Collective animal behavior</i> . Princeton, NJ: Princeton University Press.		x	x							Review	Review of self-organisation cases in collective behaviour of animals.
Taylor, R. B. (1988). <i>Human territorial functioning: An empirical, evolutionary perspective on individual and small group territorial cognitions, behaviors, and consequences</i> . Cambridge: Cambridge University Press.		x	x		x	x			x	In vivo	Exploration of the consequences of human territorial functioning for individuals, small groups, and the ecological systems in which they operate.

	Approach		Variables							Method	Abstract
	Static Proxemic Behaviour	Dynamic Proxemic Behavior	Individual pedestrian	Couples	Triads	≥ 4 Members	Gender Differences	Age Differences	Socio-Cultural Differences		
Uzzell, D., & Horne, N. (2006). The influence of biological sex, sexuality and gender role on interpersonal distance. <i>British Journal of Social Psychology</i> , 45(3), 579–597.	x		x	x	x		x			In vitro	Study measuring the influence of gender on interpersonal distance through experiments.
Watson, O. M., & Graves, T. D. (1966). Quantitative Research in Proxemic Behavior. <i>American Anthropologist</i> , 68(4), 971-985.	x					x	x	x	x	In vitro	Testing of difference found by Hall between Arabs and Americans' proxemic patterns and difference among members of same ethnic group too.
Webb, J. D., & Weber, M. J. (2003). Influence of sensory abilities on the interpersonal distance of the elderly. <i>Environment and behavior</i> , 35(5), 695–711.	x		x					x		In vitro	Study about vision, hearing and mobility affecting personal space and these senses change in old age.
Willis, A., Gjersoe, N., Havard, C., Kerridge, J., & Kukla, R. (2004). Human movement behaviour in urban spaces: Implications for the design and modelling of effective pedestrian environments. <i>Environment and Planning B Planning and Design</i> , 31(6), 805–828.		x	x	x	x		x	x		In vivo	Video-based observational study aimed at exploring behaviour, walking speed, distance in urban spaces.
Winogron, I. R. (1981). A comparison of interpersonal distancing behavior in young and elderly adults. <i>The International Journal of Aging and Human Development</i> , 13(1), 53–60.	x		x				x	x	x	In vivo	Age and race tested in this study to investigate interpersonal distancing behaviour to assess intergenerational and cross-cultural interaction implications.





**Appendix II**  
**Questionnaire "The Perception of Longevity"**



**QUESTIONARIO**  
**La percezione della Longevità**  
Università di Milano-Bicocca

Grazie per aver accettato di compilare questo questionario.

La sua compilazione richiede circa 10 minuti.

Le tue risposte verranno trattate in modo anonimo e i dati ottenuti verranno analizzati solo per scopi di ricerca.

**Percezione della società**

1. Innanzitutto, secondo il tuo parere, da che **età** una persona si può "**definire**" **anziana**?
  - sopra i 40 anni
  - sopra i 50 anni
  - sopra i 60 anni
  - sopra i 65 anni
  - sopra i 70 anni
  - sopra i 75 anni
  - sopra gli 80 anni
  
2. Quali di queste condizioni descrivono meglio una **persona anziana in buona salute**?  
(massimo cinque risposte)
  - serenità
  - solitudine
  - tempo libero per le proprie passioni
  - bisogno di aiuto
  - socialmente coinvolto e attivo
  - bisogno di comunicare con gli altri
  - senza occupazione lavorativa
  - lavoratore o impegnato nel volontariato
  - residente in casa
  - residente in strutture per anziani

3. Secondo il tuo parere, come **si percepiscono** le persone anziane al giorno d'oggi? (massimo cinque risposte)

- si sentono più giovani rispetto all'età anagrafica
- si sentono più vecchi rispetto all'età anagrafica
- si sentono pieni di risorse
- si sentono poco utili
- si ritengono curiosi e aperti alle novità
- si ritengono inadeguati rispetto ai cambiamenti della società contemporanea
- si sentono socialmente coinvolti
- si sentono poco partecipi alla vita sociale
- pensano di essere in grado di imparare ad usare oggetti tecnologici
- si sentono ai margini di una società sempre più tecnologica

4. Da 1 a 5, quanto ritieni **difficoltose** le seguenti attività per un **anziano in buona salute**? (Scegli un valore: "1" indica il valore più basso mentre "5" indica il valore più alto)

	Poco difficoltosa		Molto difficoltosa		
- sbrigare le faccende domestiche	1	2	3	4	5
- fare la spesa	1	2	3	4	5
- andare in banca/posta	1	2	3	4	5
- circolare con i mezzi pubblici	1	2	3	4	5
- utilizzare auto/bici	1	2	3	4	5
- gestire le spese della casa	1	2	3	4	5
- imparare ad usare il telefonino	1	2	3	4	5
- imparare ad usare internet e i suoi servizi	1	2	3	4	5
- spostarsi in sicurezza fuori casa	1	2	3	4	5
- muoversi in sicurezza fra le mura domestiche	1	2	3	4	5

5. Da 1 a 5, quanto ritieni **importanti** i seguenti elementi in una società con un **numero crescente di anziani**? (Scegli un valore: "1" indica il valore più basso mentre "5" indica il valore più alto)

	Poco importante		Molto importante		
- mantenimento della propria indipendenza	1	2	3	4	5
- aumento delle occasioni di partecipazione sociale	1	2	3	4	5
- aumento dell'età pensionabile	1	2	3	4	5
- dare il proprio contributo nella vita sociale dell'ambiente in cui si vive	1	2	3	4	5
- rendere gli ambienti più accessibili agli anziani	1	2	3	4	5
- maggiore attenzione ai servizi per anziani	1	2	3	4	5
- maggiore attenzione ai prodotti anche per anziani	1	2	3	4	5

- accesso a internet	1	2	3	4	5
- diffusione di nuove tecnologie	1	2	3	4	5

6. Quale fra queste categorie potrebbe creare maggiore **opportunità di mercato** in una società con un **numero crescente di anziani?** (massimo tre risposte)

- turismo
- cultura
- benessere personale
- digitale
- domotica
- assistenza domiciliare
- consegne a domicilio
- confezionamento prodotti (*packaging*)
- accessibilità degli ambienti
- dispositivi medici e robotici

### Famiglia&Socialità

7. Hai genitori/parenti stretti **anziani** che abitano vicino a te?

- sì, nello stesso appartamento
- sì, nello stesso stabile
- sì, nello stesso quartiere
- sì, nello stesso paese/città
- no (salta alla domanda numero 10)

8. Se sì, dove **abitano** i tuoi genitori/parenti stretti **anziani** abitualmente?

- in casa (locazione o proprietà)
- in strutture per anziani
- in clinica-ospedale
- altro

9. **Quante volte** alla settimana svolgi le seguenti **attività?**

- incontrare i genitori/familiari anziani	raramente / qualche volta/ spesso
- fare la spesa per/con loro	raramente / qualche volta/ spesso
- fare commissioni per/con loro	raramente / qualche volta/ spesso
- accompagnarli a fare visite	raramente / qualche volta/ spesso
- cucinare per/con loro	raramente / qualche volta/ spesso
- accompagnarli in spostamenti fuori casa	raramente / qualche volta/ spesso
- aiutarli nelle faccende domestiche	raramente / qualche volta/ spesso

10. Se ci fossero dei **servizi** (es. consegne a domicilio, assistenza alla persona, taxi per spostamenti fuori casa) pensati per gli **anziani**:

- non avrei problemi a utilizzarli come alternativa al mio aiuto
- continuerei ad aiutarli a svolgere queste attività in ogni caso
- non so

11. Qual é la qualità dei **servizi rivolti alla popolazione in età avanzata** nella località dove abiti?

- alta
- abbastanza alta
- scarsa
- non ci sono servizi né attività organizzate

12. Quale **categoria di servizi** vorresti fosse **più sviluppata per gli anziani**? (massimo tre risposte)

- attività di socializzazione al chiuso (es. ballo, cultura, laboratori)
- attività di socializzazione all'aperto (es. passeggiate, sport, viaggi)
- attività lavorative o volontariato
- assistenza medica a domicilio
- assistenza alla persona (es. aiuto nelle faccende domestiche)
- trasporti

### Nuove tecnologie per l'anziano in casa

13. Quale fra queste situazioni ti fa pensare ad una **migliore qualità della vita**? (una sola risposta)

- vivere in una residenza dove l'assistenza è sempre garantita
- vivere con i figli
- vivere a casa con regolari visite a domicilio di operatori assistenziali/medici
- vivere in casa autonomamente con l'ausilio di strumenti tecnologici
- altro

14. Come **accoglieresti** tecnologie in grado di dare **assistenza** all'anziano che vive autonomamente? Ad esempio, se la telemedicina, cioè fornire servizi sanitari a distanza, fosse più sviluppata saresti:

- molto interessato
- poco interessato
- non interessato

15. Una **Smart Home**, casa intelligente che gestisce tutte le tecnologie interattive in modo automatico, potrebbe rendere possibile ad un numero maggiore di persone di **vivere autonomamente** a casa?

- si
- no
- non so

16. Ha maggiore occasione di **partecipazione sociale**:

- chi vive in casa autonomamente
- chi vive in una residenza per anziani
- non so

17. La **tecnologia** può migliorare la **qualità della vita** in una società con più **anziani** se diffusa soprattutto in quali di queste categorie? (massimo tre risposte)

- comunicazione interpersonale (es. telefonino, schermi video-audio)
- comunicazione online (es. blog e gruppi online a tema specifico)
- mobilità domestica (es. domotica, robot-assistente)
- mobilità extra-domestica (es. carrozzine elettriche, arti robotici)
- sicurezza (es. sensori di rilevazione caduta, sistemi videosorveglianza)
- tempo libero (es. giochi elettronici per la mente e fitness)
- assistenza medica da remoto (es. telemedicina, dispositivi per rilevazione dati medici)
- benessere psicologico (es. illuminazione per regolare ritmo sonno-veglia)

### Informazioni personali

18. Genere:

- donna
- uomo

19. Età:

- meno di 18 anni
- 18-29
- 30-49
- 50-69
- over 70

20. Titolo di studio:

- licenza scuola elementare
- licenza scuola media
- licenza scuola superiore o equivalente
- laurea

21. Condizione:

- casalinga
- commerciante
- dirigente
- impiegato
- imprenditore
- lavoratore autonomo
- libero professionista
- operaio
- studente
- pensionato
- non occupato/disoccupato

altro

22. Stato civile:

nubile/celibe

coniugato/a, convivente

separato/divorziato

vedovo/a

23. Figli:

sì (indicare il numero: \_\_\_\_\_)

no

24. Comune di residenza:

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## Appendix III Walkability Checklist



**Complex Systems and Artificial Intelligence research center**

**Università degli Studi di Milano-Bicocca**

*Ai sensi del D.Lgs. 196/2003, sulla tutela delle persone e di altri soggetti rispetto al trattamento dei dati personali, il trattamento delle informazioni che La riguardano, sarà improntato ai principi di correttezza, liceità e trasparenza e tutelando la Sua riservatezza e i Suoi diritti.*

Intervistatore:  1 Nami Avento  2 Andrea Gorrini  3 Claudia Prospero

Intervista Numero:

Data Intervista:

Genere Intervistato:  1 Uomo  2 Donna

Età Intervistato:

Residenza:  1 Abita in zona  2 E' di passaggio

Cammina in coppia:  1 Sì  2 No

Se sì, cammina con:  1 No  2 badante  3 coniuge  4 familiare  5 conoscente

Quanto spesso cammina accompagnato?  1 mai  2 raramente  3 qualche volta  4 spesso  5 sempre

Eventuale ausilio per deambulazione:  1 No  2 bastone  3 tripode  4 stampella  5 deambulatore

### **1. E' piacevole passeggiare in questa parte del quartiere?**

Voto: 1 2 3 4 5 6 7 8 9 10

1/a Ci vorrebbe più verde

1/b L'illuminazione è scarsa

1/c In strada c'è spazzatura

1/d L'aria è inquinata a causa del traffico

1/e Si sente poco sicuro/a

1/f Altro \_\_\_\_\_

### **2. C'è abbastanza spazio per camminare agevolmente sui marciapiedi?**

Voto: 1 2 3 4 5 6 7 8 9 10

2/a Non ci sono marciapiedi e/o si interrompono

2/b La pavimentazione è sconnessa e ci sono buche

2/c Ci sono diversi ostacoli (ad esempio pali della luce, cartelloni pubblicitari)

2/d Ci sono spesso lavori in corso

2/e Le auto vengono parcheggiate sul marciapiede

2/f Ci sono troppe persone

2/g Altro \_\_\_\_\_

### **3. E' facile attraversare la strada?**

Voto: 1 2 3 4 5 6 7 8 9 10

3/a Non ci sono semafori

3/b C'è poco tempo per attraversare

3/c Le auto parcheggiate ostruiscono la visuale

3/d Gli scivoli sono danneggiati o inesistenti

3/e Altro \_\_\_\_\_

**4. Reputa corretto il comportamento dei guidatori di auto/moto/bici nei confronti dei pedoni?**

Voto: 1 2 3 4 5 6 7 8 9 10

- 4/a Fanno retromarcia o svoltano senza guardare
- 4/b Non si fermano per far attraversare
- 4/c Guidano ad una velocità eccessiva
- 4/d Superano l'autobus quando è in sosta alla fermata
- 4/e Parcheggiano l'auto in doppia fila o sul marciapiede
- 4/f Altro \_\_\_\_\_

**5. Se accompagnato da qualcuno si sente più sicuro a camminare e/o attraversare la strada?**

- 5/a Sì
- 5/b No

**6. Quanto da 1 a 10?**

Voto: 1 2 3 4 5 6 7 8 9 10

Perché? \_\_\_\_\_

**7. Si sente più sicuro se:**  7/a tenuto a braccetto/per mano  7/b con a fianco qualcuno

**8. Si sente più sicuro se:**  8/a giovane  8/b adulto  8/c coetaneo

**9. Si sente più sicuro se:**  9/a uomo  9/b donna

**10. Si sente più sicuro se:**  10/a badante  10/b coniuge  10/c familiare  10/d conoscente

**11. Quali di queste soluzioni potrebbe essere utile per attraversare la strada in modo più sicuro?**

- 11/a Mettere dei semafori
- 11/b Colorare l'asfalto di rosso in prossimità delle strisce pedonali
- 11/c Rialzare l'attraversamento pedonale
- 11/d Aumentare l'illuminazione in prossimità delle strisce pedonali
- 11/e Cambiare la segnaletica stradale
- 11/f Abbassare il limite di velocità
- 11/g Mettere dei dossi per far rallentare le auto
- 11/h Vietare il parcheggio delle auto nell'area vicino all'incrocio
- 11/i Altro \_\_\_\_\_