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Matteo Zallio
Technological University Dublin, matteo.zallio@tudublin.ie

Niccolò Casiddu
University of Genoa - Department of Sciences for Architecture

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Lifelong Housing Design: User Feedback Evaluation of smart objects and accessible houses for healthy ageing

Dr. Matteo Zallio
DIT - Dublin Institute of Technology
ESHI - Environmental Sustainability & Health Institute
Kevin Street Lower - Dublin 8 - Ireland
+353 085 840 4530
matteo.zallio@dit.ie

Prof. Niccolò Casiddu
University of Genoa
DSA - Department of Sciences for Architecture
Stradone S. Agostino, 37 - 16123
Genoa - Italy
+39 010 2095673
casiddu@arch.unige.it

ABSTRACT

According to the latest research by the European Community and ISTAT (Italian National Institute of Statistics) surveys, Europe has the highest average age for its population. According to those data, in the near future, it could be necessary to move from a welfare model based on the centralization of care systems, to a system based on the distribution of certain healthcare facilities [1]. This means that the ageing population is ever increasing, thanks to better lifestyles, innovative medical care and wider access to different services. This work seeks to observe and analyse key implications of architectural and interior design features and new, non-invasive, interactive technologies, related to user interaction design and usability of environments within the housing scenario. Those themes are particularly related to ageing people who live in autonomously or semi-autonomously within their own homes or assisted homes.

For example, according to the "community care" approach, people could live as long as possible in their familiar environment, by bringing health and social care services into people's home, providing assistance for everyday needs and re-activating the potential of local communities. Two vital aspects of the life of an individual, in order to maintain a healthy lifestyle despite ever-changing conditions, are domestic autonomy and good sustained relationships within the neighbourhood. This leads to an interesting research issue: could houses and smart appliances have the potential to improve autonomy and people's quality of life? Which kind of methods, tools and scenarios could enhance wellbeing and healthy conditions, while reducing time and costs?

Data, analysed in different scenarios, starting from a worldwide and then focusing on Europe and Italian context, provides a clear view of house's architectural and technological features and user feedback, useful to define a future household scenario suitable to meet the needs of a growing population.

The final result of this part of the research is composed of a series of blueprints called "User Feedback Evaluation" which enable people in understanding and categorising the classes of systems, aids, smart devices and features that a barrier-free house should have for improving living conditions of ageing residents. In a second stage of the research the user feedback analysis could bring the definition of a new Design approach for enabling user and facilitating professionals. This is achieved by developing a holistic method and merging innovative tools and approaches with existing ones, in order to foresee the future needs of the ageing people through provision of additional unobtrusive Smart devices. The smart appliances should be integrated in accessible, barrier-free, "Long-life friendly" houses, to allow the senior residents to remain for longer in their own home in a safer and autonomous way.

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CCS Concepts

• Human-centered computing~Usability testing • Human-centered computing~HCI theory, concepts and models • Human-centered computing~User interface design • Human-centered computing~User centered design • Human-centered computing~Interaction design theory, concepts and paradigms • Human-centered computing~Accessibility theory, concepts and paradigms • Human-centered computing~Accessibility design and evaluation methods • *Human-centered computing~User models • Human-centered computing~Graphical user interfaces • Human-centered computing~User interface toolkits • Human-centered computing~Scenario-based design • Human-centered computing~Accessibility systems and tools* • Human-centered computing~Empirical studies in HCI • Human-centered computing~Wireframes

Keywords

Design for All; ICT; Smart Home; Lifelong Housing Design; Interface Design; Interaction Design; Human factors; Ergonomics; User Centred Design; Ambient Assisted Living; Smart Objects; Healthy Ageing; Accessible homes.

1. INTRODUCTION

Demographic changes, better life conditions and the development of new media and technologies are shaping the way that we live within our environment [2]. In particular, attention to

the built environment and housing design and the potential of new technologies inside houses, are some of the main themes of many European research projects, like the Horizon 2020 programme, such as the JPI (Joint Programming Initiative – More Years, Better Lives) and the AAL (Ambient Assisted Living) research community. Data from the 2012 Ageing Report on Economic and budgetary projections for the 27 EU Member States shows that in the next forty years there will be considerable socio-demographic changes, which are highly likely to bring out an evolution of the welfare, social and national insurance system. In the near future, it could be necessary to move from a welfare model based on the centralization of care systems, to a system based on the distribution and automation of care facilities [1].

The important contribution that research and innovative approaches provide to the modern world is possible thanks to the cooperation and support of stakeholders, scientists, politicians, professionals, manufacturers and developers of products. Of course, in the centre of cooperation are senior people and their related organizations, who provide the knowledge on the critical issues of the ageing process while at the same time provide tools and solutions to improve quality of life. The initial hypothesis of the research has been developed by referring the demographic data analysed, to the social and generational context investigated and the way ageing people are accustomed to living in their homes. Consequently, the research aims to address the following issues:

"Could houses and appliances have the potential to improve autonomy and people's quality of life? Which kind of methods, tools and scenarios could enhance wellbeing and health promotion, while reducing time and costs?"

First of all, the research explores some of the critical aspects related to Worldwide, European and Italian ageing scenarios. Considerations, from the 2015 Report of IOTI (Alliance for Internet of Things Innovation), show that from an economic point of view, in the future it will not be possible to maintain a consistent level of healthcare for ageing populations, many of whom are suffering from chronic diseases or minor psycho-physical deficits which require ever more medical attention [3]. One of the possible answers to this issue could be allowing ageing people, who are still in good health, to remain inside their homes. Future homes have the potential to become safe, adaptive environments, integrated with barrier-free features and non-invasive technologies for life support and assistance for the residents, without the presence of a personal caregiver [32]. The studies highlight a series of fundamental elements that make up the basis of the current research. These elements can be summarized as follows:

- the scientific relevance of the investigation topic, which refers to the quantitative and qualitative case studies analysis based on barrier-free, accessible and "Long-Life friendly" houses, related to the user feedback of the last twenty-five years.

- the multidisciplinary nature of the research, which utilises various tools for understanding different issues such as: the importance of innovative technologies and the potentials of ICT (Information & Communication Technologies) in people's lives, cognitive and behavioural factors, related to the human - built environment (HBE) and human - computer interaction (HCI) [28];

- the research methods, which are based on the interrelation between the deductive method and the event study method. In particular, the "event study" method is based on a statistical analysis of how events unfold during a defined period of time, in order to assess how the underlined features impact on each experience [11];

- the analysis of Passive (architectural characteristics) and Active (assistive technologies and smart appliances) Technologies as a tool to increase people's empathy and sense of security.

On the basis of the previously mentioned elements, the main goal or output of this first of to two stages of research is to identify resources, data and courses of action to increase the knowledge and consequently the features related to an innovative type of Housing Design, in order to meet the needs of the constantly growing population. The expected results (also referred to as outcomes in this study) will try to outline the set of "User Feedback Evaluation" which allows to understand and categorize the classes of systems, aids, smart devices and features that a house should have for a better living conditions of the ageing population. The research will use specific tools for collecting and analysing data related to the case studies, in order to reach the output and outcome, trough an unobtrusive method, which do not involve direct elicitation of data from the research subjects [31].

Some of these tools, deal with the themes of usability, complexity inside systems and accessibility of physical environments and also smart devices [23]. The resources of the new systems will be evaluated, with particular focus on how they interact with the user and what features they should have to become an indispensable and easy to use add-on for the user's houses.

Subsequently, the work will take into account the interaction methods with which a user, interfaces with the physical space and a technological device. The methods are analysed by using the existing literature, to pinpoint some of the important criteria needed to understand whether a space or a device is suitable or not, for people with physical or cognitive impairments. The last tool described in the final part of the analysis is related to the collection of Worldwide case studies, based on the existing literature, with a particular focus on European and Italian scenario.

2. SMART DEVICES AND TECHNOLOGIES FOR A BETTER LIFE

The evolution of smart computing systems provides a clear example of how miniaturization is shrinking devices down to only a few cubic centimetres in size. Diffusion and acceptance of these new devices (created primarily for workplaces only) has been a rather slow process, because of how user perceive them and interface with them [18].

These objects are referred to as "Smart Devices" or intelligent products. On the basis of a recent survey from LinkAge society [26], it is possible to understand the level of usage of new technologies for people aged 65 and over (Fig. 1).

Devices are considered to be part of the future of worldwide economic markets, especially in relation to the growing ageing population. The data outlined in this study demonstrates that the seniors represent a booming business in the technological market. The generation of so-called "Silver Surfers" have a chance to get closer to the world of technology thanks to the "consumerisation" phenomenon which makes the devices more accessible, affordable and usable.

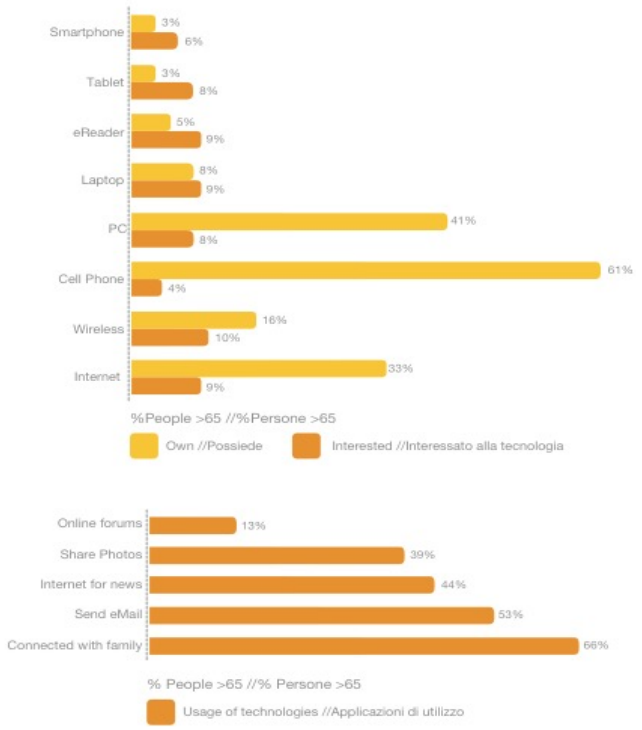

Figure 1. Graphical scheme showing the usage of new technologies for people aged 65 and more. Data from LinkAge Technology Survey, 2011

The Silver Surfer market has the potential to offer an exponential growth of technologies and has a growing purchasing potential, unlike the market targeting the younger generation, that has a linear growth and a lower purchasing potential. Even disregarding altruistic motivations, ageing populations in consolidated and emerging markets, should be taken into great consideration by researchers in the fields of Interaction Design, development and technological retail [19].

Within this framework, it is possible to understand the potentials of assistive technologies and new possibilities in the field of Home Automation in order to satisfy ageing people needs. This section of the research seeks to investigate the knowledge from different fields: from Ambient Assisted Living concepts, to market's analysis on ageing people in relation to the new technologies, to accessible and User Centred Design houses, to usability and HCI (Human – Computer Interaction) features of new devices. The intention of this activity is to join together different types of information and create a sort of "blueprint" of good principles that enables ageing people lives in their own homes.

By following these information, it is possible to outline the future trend of technological development by referring to the first generation of Home Automation. It is known as "Domotic Homes" developed around the 1980s and followed by the "Smart Home", a term coined in the late 1990s, together with wireless technology, Cloud Computing and the Internet of Things systems. The main difference between an old "Domotic House" and a "Smart – contemporary Home" is related to the type of connections that the sensors and actuators have [17]. In a Domotic House there are cable connections, instead in a new Smart House it is possible to use a good quantity of devices that communicate via wireless technology like Wi-Fi, 6LoWPAN Bluetooth SMART, Li-Fi, IR (InfraRed), NFC (Near Field Communication), Zigbee. These features and the evolution of technological systems also bring a different way to think and to design houses. It is important to research and analyse the different design methods, that will be shown in the next stages of the project, because if there is a need to integrate new disruptive and non-invasive technologies, the design paradigms are going to change radically from the way that we currently design a house [13].

3. DESIGNING FOR INTERACTION: BUILT ENVIRONMENT & EVERYDAY OBJECTS

Since prehistory, tools and artefacts characterized human life, as elements to help people in daily activities, but also for entertainment. They can be considered as artificial prosthesis which enable humans to overcome their physical limitations [27]. Until a few decades ago these objects were very simple artefacts, which gave humans the possibility to significantly enhance their body's capabilities as well as assist them in many practical activities. At the same time, it was necessary to develop specific manual skills, essential in making the best use of these artefacts, which often required long periods of training. With the progress of technology and the development of manufacturing techniques, there was a large increase in the production of new tools that were able to perform complex tasks independently and were no longer powered by the energy of human labour, but from carbon-fossil or renewable energies [27]. This scenario has evolved radically in the last few decades thanks to information technology and smart systems (both software and hardware). It is now possible to perform complex procedures and program devices to be autonomous in a very short time. The use of these systems does not require learning specific manual skills, but it can be achieved thanks to the mediation of specifically designed interfaces that allow a close interaction between user and device [27].

This part of the research is intended as a review of a set of tools, useful to understand and identify the key points that the new ICT systems must have, and how the user (particularly ageing user with minor psycho-physical deficits) interacts and relates with technological devices within the household scenario. A clear and easy example of different interface design, that could be also used as a parallel example of usability feature for interior design elements, is provided by the smartphone alarm setting (Fig. 2).

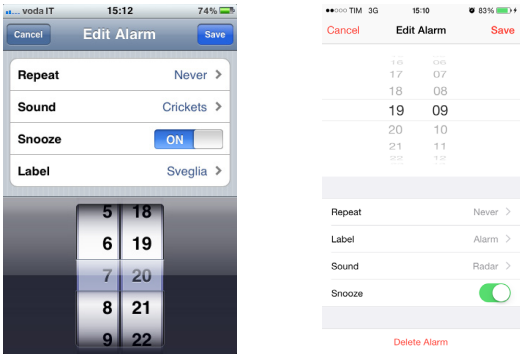

Figure 2. Interface of an Apple iPhone 3GS and an Apple iPhone 5. Different graphical interface for alarm settings

By just changing colours, layouts and ways to provide information, it is possible to set up an "easy to understand interface", that could work for a large number of people; or to set up a more minimal and stylish interface that could be used by a restricted number of people, who are well accustomed to using technology. The same approach, for example, could be used for designing houses for ageing people or people with disabilities. These aspects, focus especially on different user's needs, that have to be satisfied by a tailor made smart built environment.

This focused Design approach will be better defined in a second stage of the research, after the data collection. The data collected with reference to a significant number of case studies of "Good Design Practice" and "Good Usage of Smart Technologies" are related to the user feedback. The case studies, linked to the theoretical knowledge will enable the creation of a "User Feedback Evaluation" diagram, that constitutes the "blueprint" catalogue of the indispensable, and usable features that a "Life-long house" for ageing people should have. The set of studied features, that relates to the discipline of Interaction Design, will be used as a parameter to understand the level of usability and affordance [20] of technological devices, with respect to the cognitive and behavioural factors, the Human - Built Environment (HBE) and Human - Computer Interaction (HCI).

4. CASE STUDIES: HOUSING AND TECHNOLOGIES FOR SENIOR CITIZENS

The existing literature describes how social, cultural, behavioural aspects and welfare arrangements differ radically, depending on the country [2]. A clear example of this issue is represented by the differences between the welfare model of Southern Europe in contrast with those applied in Anglo-Saxon, Scandinavian, Asian or American countries [1]. It is essential to bear in mind that the household experiences, examined by research institutions, foundations or private companies, offer a vast wealth of information as well as providing useful input in outlining new life scenarios. These concepts represent the starting point for defining the analysis method (Event study method) for Senior Friendly homes. This baseline data is derived from the research of different case studies, limited to a period of about twenty-five years, where, as previously mentioned in paragraph two, a large number of technologies and usability features were developed and upgraded within the household scenario.

The case studies were catalogued according to the construction chronology, divided into three geographical areas, starting from a global level, then narrowing it down to Europe and finally focusing on the Italian context. This classification is fundamental in order to easily group the cases and gain a reasonable basis for comparison according to different welfare and lifestyle models. A valid tool for evaluating the complexity and usability of each experience is the analysis of different case studies, which were divided into four complementary categories: Co-housing, Assisted Homes, Private Homes, Expo-Research-Workshop Houses. All the data examined in the three different contexts (Worldwide, European and Italian scenario) show different aspects of the "Passive" and "Active Technologies" that designers and caregivers included in different buildings. There have been defined two categories, which are the "Passive Technologies" that are related to all the architectural and interior design features for an accessible house and the "Active Technologies" related to the area of smart objects and IoT devices for smart houses. The so called "Passive Technologies" refers to the group of architectural accessibility features, belonging to the User Centred Design and Design for All approaches (Fig. 3). Some important characteristics are:

- Less use of stairs, with a continuous and step free path of travel or the aid provided by elevators;
- Minimum doors and corridors dimensions that facilitate comfortable and movement with a wheelchair or walker aid;
- Toilets that provides easy access and with handles, grab rails, accessible accessories and a step-free shower access;
- Handrails or elements inside corridors and rooms that provide a help in people standing or resting.
- Use lighting system and surfaces for floors and walls that would not provide any aberrations or unpleasant reflections for users;
- Use colours in order to design a hierarchy between spaces, that facilitate the recognition of rooms, doors and spaces, especially for people with Alzheimer or Dementia syndrome.

The "Active Technologies" are referred in general to all the set of smart communication systems such as:

- Systems for controlling the house comfort like light systems, heating system, security systems, safety and security appliances;
- Systems for monitoring people's healthy and safety like, wearable devices, personal robots, posture and fall prevention systems, app for smartphones and tablets;
- Systems for socialising and edutainment like, robot companion, App or services provided by the Cloud.

The literature based case studies were finally evaluated by collecting and summarising feedback from primary and secondary user and feedback from experts and designers related to each case study. The user feedback analysis is one of the most important parts of the research, because it provides: positive, negative or neutral feedback directly from the ageing people who are currently living or lived in the analysed house; from the professional; from family caregivers if present in the house.

Figure 3. Placeholder figure: summary of Passive technologies and Active technologies, positive or negative Feedback from primary, secondary or tertiary users

4.1 Worldwide scenario

The following table shows the feedback related to literature based case studies, from the Worldwide scenario, which is composed by American, Asian and Australian case studies (Fig. 4).

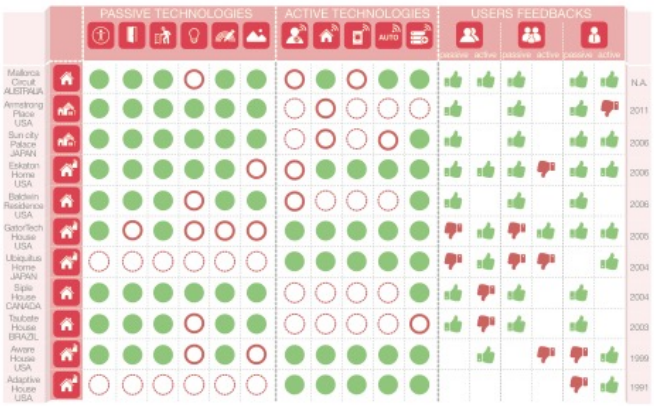

Figure 4. Worldwide case studies analysis, Passive, Active Technologies and User Feedback

Within the totality of the case studies analysed, some stand out compared to others because they have a particularly high number of Active or Passive Technological elements. The scheme is composed of eleven case studies located on horizontal axis, categorised in chronological order and three macro-vertical columns divided into Passive and Active Technologies and user feedback. Each column is composed by different characteristics for Passive and Active Technologies (following the paragraph 4 explanation) and finally, the user feedback column is divided into three sub-columns for identifying the primary, secondary or tertiary users. Each case study has a green dot or a red circle in order to make an easier to read and clear indication, as far as the "like" on the user feedback section, which indicate a positive or negative feedback.

In the Worldwide scenario, there have been numerous attempts, since the nineties, to produce almost completely automated environments. Just look at the case of the "Adaptive House" [22] developed at the University of Colorado in the United States, where all the features of an automated and accessible house were already present. Obviously, from the manufacturing point of view, the computing capacity of the technologies was not comparable to the one of a recent smartphone.

Other examples instead have been chosen for adopting a very sophisticated synthesis between technology and design features, where it is possible to perceive a high standard of accessible design characteristics, especially for people with severe disabilities, together with the use of smart technologies. These are: "The Aware House" in USA, or the "GatorTech House" in USA, or the Mallorca Circuit House in Australia [16]. Some examples in Japan, Brazil and Canada, show that, from a qualitative and quantitative perspective, the issues of care services for older people is still marginal, or rather is tackled differently than in the European scenario and in particular the Italian one [7].

4.2 European scenario

The following table shows the feedback related to literature based case studies from the European scenario, which is composed from all the major European countries (Fig. 5).

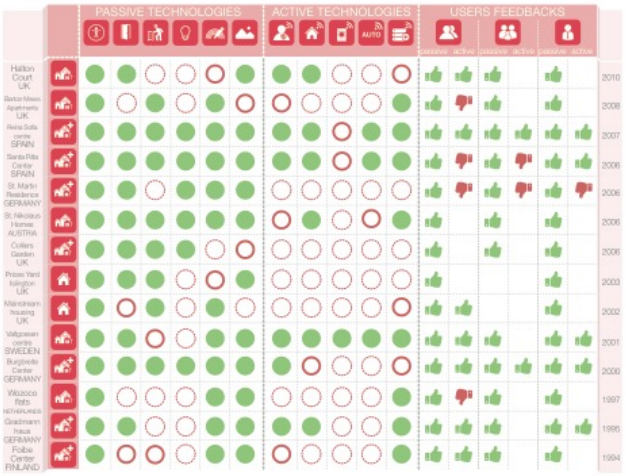

Figure 5. European case studies analysis, Passive, Active Technologies and User Feedback

As the research shows, focusing on the welfare aspects and the ability to create fully-functioning housing with an excellent management plan, the research experiences from Northern Europe countries represent the most interesting examples. Some of these, especially in the UK and Sweden, effectively combines a high level of interior design quality, related to building refurbishing ("Halton Court - Kidbrooke Village" located in London or "Vallgossen residences" located in Stockholm) [6], with the integration of smart technologies, for safety and people's health monitoring. However, in the case of the "Wozoco" apartments in Holland or in the "Senior Citizens Center" located in Wernigerode in Germany, the social component of the project, related not only to the interior design elements, but also to the neighbourhood, outlined one of the major aspects which provide a condition of high quality life and safety for people who lived there. Without forgetting the good design features within these projects, the attention of the architects and engineers was focused more on how to create a social mix of people, older couples, young families with children, singles, in order to facilitate the integration into the living environment and especially increasing the neighbourhood relationship between individuals. One of the reasons that prompted to opt for this choice was the fact that, despite the presence of some technologies to simplify ageing people's life, the proximity with a young family who can be of help in case of need or emergency is one of the most important cognitive aspects that made the project winning, accepted by users and well managed from a social, welfare perspective.

4.3 Italian scenario

The following table show the feedback related to the literature based case studies, from the Italian scenario, considered one of the one of the countries with the oldest average population all over the world [4] (Fig 6).

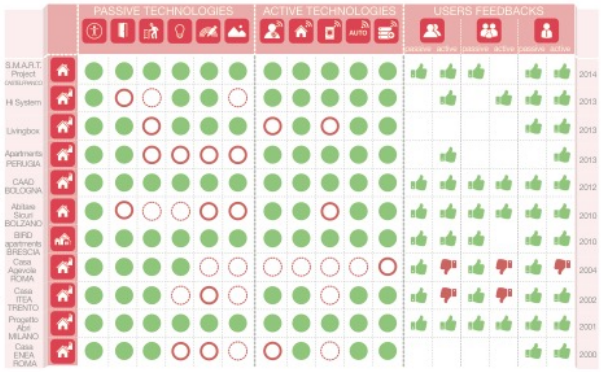

Figure 6. Italian case studies analysis, Passive, Active Technologies and User Feedback

In the South-European area, in particular in Italy, there are many prototypes oriented mostly to the use of active technologies. One of the examples of greatest prominence, is represented by the residential complex "BIRD" (Italian acronym for green Building, social Inclusion, Energy saving, home Automation) developed in the Milan area, where residences were designed with embedded assistive technology for ageing people, with great attention to issues of social inclusiveness, accessibility and Green Building certification. It is a private project, supported by the City Council and there was an expectation to incorporate all the features that a home for senior people should have. The project meets different important topics like: the basic home automation equipment (lights control, heating and conditioning systems control, alarm and security services, video monitoring and health facilities monitoring), the surrounding services such as a central service centre with canteen, meeting room, ambulatory, gyms and green area and effective management system of the complex, based on social rent, mixed with housing purchase. In parallel, it is possible to see that a large number of case studies are mostly "showroom", laboratories or demonstration homes, where users and carers try to push to the limits of technological equipment, to assess replicability and propose new assistance systems or automation. The "CAAD" (Italian acronym for Centre of Home Environment Adaptation) of Bologna, today is one of the rare national reality where it is possible to visit two fully equipped apartments, both from a technological and barrier-free point of view, that respond to the typical characteristics of a User Centred Design approach. The research of an adequate quantity of case studies located in different areas of the world has been a key instrument to discover, to categorize and to define what is already done and to highlight the established facts.

5. USER FEEDBACK EVALUATION

In perspective, this research is important to understand and clarify the possible innovations and upgrades of existing Design approaches concerning all the aspects of house improvements for senior people. Looking at the Italian context, the house is considered a protective place, a shelter from daily stress, a comfortable and private environment. Today in Italy there are two different life scenarios for those affected by physical fragility or senility. The first scenario relates to the ageing persons, who could no longer live in their own homes and need to be moved into healthcare homes or nursing homes. In many cases an exponential decline of physical and mental condition can be observed. The second scenario involves a wider range of the over 65 population (today we would refer to them as the Baby Boomers), defined generally by the term elderly or ageing: they usually live in their own homes, without losing contact with their relational, emotional and social background.

Nowadays, the current Mediterranean European area and the Italian context, show that seniors prefer to remains long as possible with their families in their own residential context [1, 4]. Analysing the issues with healthcare homes and the problems that the people living in them encounter, a possible solution could be the home refitting, following the principles of Design for All [8], the User Centred Design approaches, linked to the Interaction Design guidelines. To achieve this goal, it is necessary to take into account the needs of the seniors and study existing buildings as well as the limitations and potentials of smart technologies. The house should have adaptable equipment that can be modified depending on the special requirements of different users. “Building Automation” plays a crucial role in providing technological support to perform daily activities efficiently and rapidly.

5.1 Extrapolating data and feedback

The case studies analysed were indispensable to investigate the world panorama of senior housing and provide a wide and complete view of the Passive Technologies and Active Technologies elements that could be installed in each home. The "User Feedback Evaluation" diagrams represent, through the opinions of the primary users, secondary users (experts, designers and researchers directly involved in each case study), what are the positive and negative aspects related to the experiences categorized in different geographical scenarios. The three diagrams represent the percentage value, related to the feedback of each group of users, which refers to the Passive or Active Technologies of the three different scenarios.

They are useful to understand where is the lack of Passive or Active features in different geographical areas and what are the issues that has to be solved within the second stage of the research. This is important in order to draw a common line of user’s needs, which are essential to create a basic knowledge on what are the essential characteristics that designers and engineers have to design for a “Senior Friendly” house.

Figure 7. User Feedback Evaluation diagrams for the Worldwide Scenario

Figure 8. User Feedback Evaluation diagrams for the European Scenario

Figure 9. User Feedback Evaluation diagrams for the Italian Scenario

In the second stage of the research there will be developed different tools and a comprehensive Design approach, that identify and classify the number of tangible aids for increase autonomy, safety and health in private homes. It is possible to see from the diagrams, which refer to the three examined scenarios, how the time factor and also the geographical area of each case study, played a key role in sensitizing designers, engineers and users, in using architectural elements and technological devices for developing Senior Friendly homes (Fig. 7, 8, 9).

From the point of view of the architectural features, especially in the European and Italian context, the designer's awareness in recent years has been remarkable and the feedback results proven this theory (100% positive feedback in the cases analysed in Europe). The "democratization" of new technologies and more inclusive design methods, show that over the past decade, according to European users and expert feedback's, the perceived quality, usability and smartness of the houses is greatly improved. In contrast, in Italy, this process didn't grow as quickly as in Europe and the feedback of primary users shows that there is still a gap to be filled (Fig. 9). However, it is necessary to continue to grow the application of technologies and the use of smart devices, where roughly half of the opinions correspond to positive results. The Italian context has, in fact, a particular weakness factor related to a generally limited diffusion of smart home technologies. Differently it is possible to confirm that, in the United States and Australia (Fig. 7), designers tend to refer to Universal Design method, while in Europe and Italy the methods usually used are the Design for All and Inclusive Design, which tend to be closer to the real needs of disadvantaged users and people with minor impairments. According to this, it is possible to think that the range of results seen in the global context, compared to those found in the European area, are a direct result of the different approaches and design methods used to design Senior Friendly houses. The identified features show that the added value of a house designed to be upgraded and adapted during the different stages of life, represent a huge benefit for people who live in it, when compared to the people who live in a traditional house.

Moreover, the percentages show that, with the passing of the years, the accessibility features and, consequently, the smart devices equipment of housing, are becoming an essential for designing "The Good House" for seniors. This will increase the knowledge on AAL homes features, that can be further developed in the second stage of the research, by designing an assessment system of AAL certified homes.

6. CONCLUSIONS

As analysed, renovating and adapting a house, to meet the ageing people needs is often excessively expensive and sometimes also inefficient with respect to the altered physical condition of the user. This research has sought to define an overview of the existing AAL international case studies, by creating different "blueprints", in order to increase the knowledge related to innovative ways of living in adaptive houses.

Some of the research outcomes are summarized into the "Scenarios Case Studies Analysis" (Fig. 4, 5, 6) and "User Feedback Evaluation" diagrams (Fig. 7, 8, 9). They become a easier to understand tool to categorise the group of products, systems, aids, smart devices and accessible features that a house should have for improving living conditions of the senior residents. The research analysis is also useful to outline a basic knowledge, indispensable to create a new standard of houses in which user can live in a healthy and safe condition, enjoying all the opportunities of ICT; technologies that shall be "enabling" (using Norman's definition) and integrated in a non-invasive way so as to be accepted by the user [24].

In the following stage of the research the User Feedback Analysis could enables the definition of a new Design approach which enhance the collaboration between architects, designers and HCI engineers for creating usable and successful environments and products. This can be achieved by using innovative tools together with existing ones and a holistic method, able to foresee the future needs of seniors, by providing additional smart appliances, integrated in an accessible and "Long-life friendly" house. This could improve the quality of life within the home context, improve the autonomy and sense of security and increase the usage of smart devices for senior people.

Two useful tangible results of the final phase of the research could be: the creation of domestic systems, designed according to accessible and usable standards, and technological devices, integrated in a non-invasive way to simplify daily activities that become more difficult for the seniors.

The second stage of the research will be focused on defining the guidelines for a new Design approach based on to two empirical strategies. This will create the potential to develop a new enhanced classifying system for AAL Home's Design features that includes assessment of unobtrusiveness.

With this in mind, the research does not however aim to discover the most advanced innovation or to overlap with existing Design approaches, consolidated on a European and global level. There are still many ways to improve critical issues related to the growing ageing population. According to the data and the research carried out, this scenario underlines one of the possible and diversified solutions to raise awareness in Design culture, to increase the affordance (known as is the design aspect of an object which suggests how the object should be used) [20] of products and technology to allow people the chance to live for as long as possible in their own homes. An environment equipped with the architectural facilities and integrated with smart objects, could improve people's quality of life, increase security, assist in daily activities, encourage socializing, becoming easy and manageable for caregivers, family and friends.

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