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# RETROFITTING DWELLINGS BY APPLYING THE SMART HOME PRINCIPLES

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***Abstract****:* By ageing, which means mainly that the essential regenerative cells are reduced, a person may have difficulties concerning motion, vision, hearing, touch, grip, speed in reacting, speech, sleep, memory etc. At the same time, the probability of getting ill, with multiple affections as well as physical and mental disabilities increases. As a response to the ageing phenomenon the housing quality must be improved through new techniques.
The concept of "Ageing-in-place" promotes the independency of the inhabitants by remaining in their own home as long as possible, regardless of the age or level of abilities. The concept targets the wellbeing, convenience, security, care of the inhabitant and also aspects of universal design, adaptability and accessibility that become possible through smart home technologies [3].
The paper presents the way an existing house can be adapted structurally and/or technologically through smart home system to the needs of an elderly couple facing the diminishing of muscle strength, vision and hearing [5].

## 1. The Phenomenon of Aging

According to Eurostat (2012) elderly people aged 65+ of the European Union population will increase from 17.5 % in 2011 to 29.5 % by 2060. The share of those aged 80+ is projected to almost triple between 2011 and 2060. As a result of the population movement between age groups, the European Union old-age dependency ratio is projected to rise from 26.2 % in 2011 to 52.6 % by 2060 [7]. Concerning Romania, old-age dependency ratio between 65+ and 15-64 years increased from 15.8% in 1990 to 21.3% in 2010. The demographic aging index increased from 44.1% in 1990 to 98.6% in 2010 [4].
Due to the accelerated aging of the population the living environment must be reorganized.
The concept of "Ageing-in-place" emerged in the early 1990-ies promotes the independency of the occupants by remaining in their own home as long as possible, regardless of the age or level of abilities [3].
The concept targets the wellbeing, convenience, security, care of the inhabitant and also aspects of universal design, adaptability and accessibility that become possible through smart home technologies [3].
In order to enable older adults to age-in-place, the houses must be adapted through constructive and technological solutions.

## 2. Smart House System

'Smart homes' is the term for houses with smart technology installed. Smart House systems consist of a wide ranging set of services, applications, equipment, networks and that act together in delivering the "intelligent" or connected home.

According to Delta Centre in Norway - Smart Home technology is described as "a collective term for information and communication technology (ICT) as used in houses, where the various components are communicating via a local network. The technology can be used to monitor, warn and carry out functions according to selected criteria and covers social alarming, medical monitoring and safety monitoring." [2]

There is a big difference between accessibility performed with information and communication technology systems and the accessibility related to the building, provided by means of construction elements and architectural solutions.

### 2.1 ICT - Information and Communication Technologies and AAL - Ambient Assisted Living

The ICT supporting systems can connect to neighbours, family members and service institutions such as food or emergency services. These systems are also able to monitor the patient's health condition continuously in order to achieve both, a higher quality of medical data and better safety owing to the automatic emergency calls. Moreover, they are often capable of communicating with providers of ICT-related tele-care, tele-therapy, or tele-rehabilitation services.

Therefore ICT - Information and Communication Technologies can make key contributions to the independent living of elderly people.

**"ICT enabled independent living for elderly - A status-quo analysis on products and the research landscape in the field of Ambient Assisted Living (AAL) in EU-27**" is a study performed on behalf of the European Commission that concentrates issues of Ambient Assisted Living (AAL) and ICT for Independent Living of Elderly, undertaken in 27 countries throughout the European Union.

Figure 1 presents a model developed by the German company VDI/VDE-IT in association with the European Executive Board of the AAL that classifies the needs of the elderly in accordance with important stakeholders.

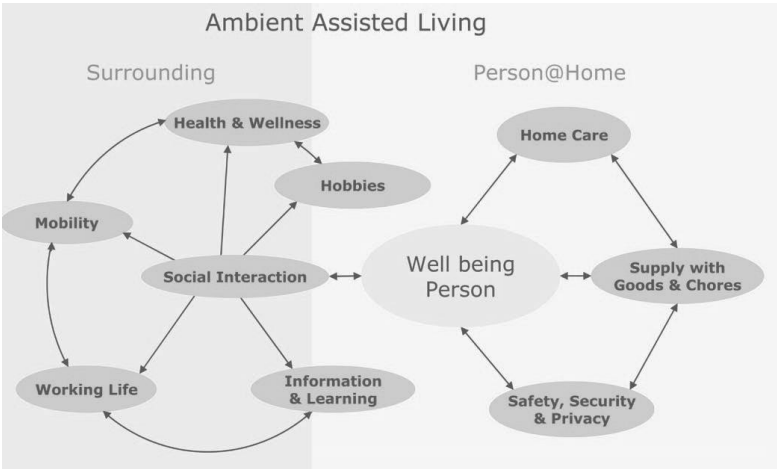


*Fig. 1: The needs of elderly [2]*

The use of Smart House technology in houses for elderly and disabled people is new in many countries, especially Romania where the services related to this technology are not yet developed.

## 3. Current situation

The inhabitants are 80 years old elderly couple with no real disabilities yet but gradually losing muscle strength as well as hearing and vision ability. The task was to improve their residential house by adapting it structurally and/or technologically in order to ensure improved comfort conditions, safety and assistance for the every day life [5].
The house has three floors, basement included. The main entrance has no stairs, but there are stairs between the different levels and from the cellar into the garden. The ground floor consists of entrance hall, wardrobe, bathroom, kitchen, dining room and living room. On the first floor there are: the main bedroom with its own bathroom, a guest room, a hobby room, a separate bathroom and a terrace. In the cellar there is a storage room, the heating room and a utility room with washing machine and dryer.

## 4. Structural and technological interventions

The items and the technology proposed for this house increase the comfort and the safety giving the residents the feeling of independency.

### 4.1 Auxiliary spaces

#### *4.1.1 Throughout the house [4]*

Communication is an important part of the smart home adjustments. The house benefits of an iPad system (Fig.2) which controls different functions of the house like: intensity of light, temperature, switching on and off the lights, opening or closing the windows and blinds, climate control for fresh air. Motion sensors can be installed throughout the house providing appropriate lighting in every room whenever the user needs it. For increasing visibility and safety, the house is equipped with orientation lights installed on the stairs (Fig.3) and in the areas that are usually circulated at night. The burglar, fire, smoke and carbon monoxide alarms are connected via WiFi to the home controller. The smart TV which is linked to the internet can be used for contacting the family and the doctor. For the general wellbeing and health monitoring, the elderly can use a healthcare system that measures the saturation, heart rate, blood pressure and blood glucose (Fig.4).

*Fig.2: iPad [5]*

*Fig. 3: Light orientation on the stairs [5]*

*Fig. 4: Healthcare system [5]*

Door opening mechanisms must be suitable in shape and the power required for their operation. Spherical knobs which require a twisting motion are difficult or impossible to use by people with

limited hand grip and by many elderly people (Fig.5). Considering this, most of the original doors were replaced by sliding doors with pull handles (Fig.6).

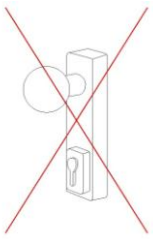

*Fig 5: Spherical knob*

*Fig.6: Pull handle [1]*

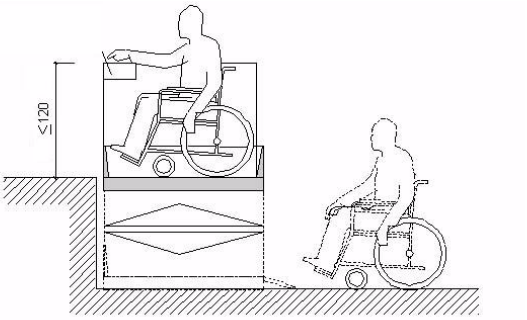


*Fig.7 Lifting platform [1]*

A lifting platform was installed, making the cellar and the first floor accessible (Fig.7). The lifting platform can be used to transport laundry from and to the washer/dryer located in the cellar. Also if the residents might end up using a wheelchair, this platform is a good solution.
The step edges and landings (partially) are marked with tactile floor covering in contrasting colour (Fig.8) which is stable, slip-resistant, continuous and should be kept free from moisture. Good visibility is of fundamental importance for people with low vision.
On both sides of stairs double handrails were installed, overrunning the flight length by min. 30 cm (Fig.9).

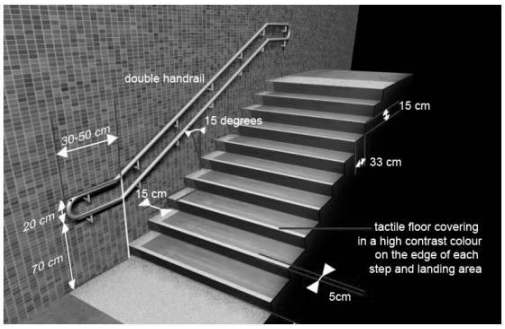


*Fig.8: Stairs with tactile and visual markings [1]*

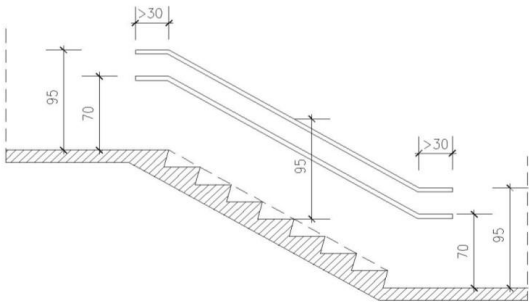


*Fig.9: Handrails[1]*

For safety reasons, the house has non-slippery parquetry floors with aluminium oxide, non-slippery tiles and tonal contrasts between the floor and walls.

### *4.1.2 Approach to the building [5]*

The front access area is heated with sensitive-temperature cables buried under the pavement, in order to facilitate access in snowy and icy weather.

### *4.1.3 The entrance [5]*

The front door is automated. It is possible to open the door with the house controller via touch panel. One can see who is at the door on the controller as well. The door lock works with a card (Fig.10). To gain entry one only has to place the card near the access reader.

*Fig.10: Access card [5]*

***4.1.4 The entrance hall [5]***

The entrance hall is wide enough for parking the electrical wheelchair or scooter. The power sockets near the front access door can be used to charge the battery of the vehicles.

***4.1.5 The wardrobe [5]***

To prevent the users from having to bend, stretch or climb on a chair, an automatic clothing rail should be used in the wardrobe. A light with motion sensor should be installed in all closets.

***4.1.6 The terrace [5]***

For comfort on the terrace an automated sun shading is recommended (Fig.11). The shade can roll out using the house controller. The material used for the terrace floor is made of deck board impregnated with resin and grit making it a non-slippery material (Fig.12).

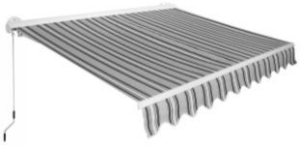

*Fig.11: Automated sun shading [5]*

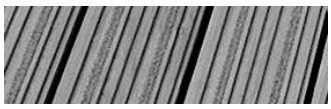

*Fig.12: Deck board impregnated with resin and grit [5]*

**4.2 Living spaces**

***4.2.1 The bathroom [5]***

The bathroom is equipped with an adjustable height toilet and armrests (Fig.13); a fold up shower chair (Fig.14), various safety bars and adjustable mirror (Fig.15). Thermostatic faucets are recommended (Fig.16) preventing the user to burn himself. In order to avoid trip hazards, accessibility has to be taken into account in the entire bathroom including the shower area where thresholds should be removed (Fig.17). It is recommended to install an alarm. One of the best systems is a cord unrolled along the walls of the bathroom that can be pulled if the user would fall down.

*Fig.13: Adjustable toilet [5]*

*Fig.14: Fold up shower chair[5]*

*Fig.15: Adjustable mirror[5]*

*Fig. 16: Thermostatic faucets [5]*

*Fig. 17: Accessible shower without threshold [5]*

### *4.2.2 The kitchen [5]*

The kitchen is equipped with adjustable cabinets, drawers, table and stove that increase the comfort and safety, eliminating the risk of falling while bending (Fig.18). The induction stove is the safest device because one cannot burn himself. The pressure-activated anti-flood system is the best solution to prevent the sink from flooding (Fig.19). For closing the fridge/freezer door automatically, the hinges with ramps are recommended. Because the couple is losing their strength, cutlery with special grasps is recommended (Fig.20).

*Fig. 18: Adjustable cabinets/stove [5]*

*Fig. 19: Anti-flood system [5]*

*Fig. 20: Special cutlery [5]*

### *4.2.3 The bedroom [5]*

For the bedroom, the best solution for the out of bed assistance is the transfer pole (Fig.21). Along with the transfer pole a hospital adjustable bed can be installed. To overcome the difficulty of standing up from a chair, seat assist is a cushion that fits in every chair and moves upwards when standing up (Fig.22). The nurse call button can be used when the elderly are not able to leave the bed by themself or when they are sick (Fig.23). For safety reasons fall detection can be installed. It is recommended to use the system of pressure sensitive mats "SensFloor" under the floor that can send an alarm to family or caretaker (Fig.24).

*Fig.21: Transfer pole [5]*

*Fig.22: Seat assist [5]*

*Fig.23: Nurse call button [5]*

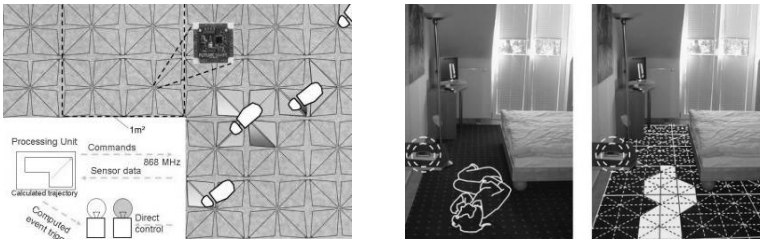


*Fig.24: SensFloor [5]*

Figures 25, 26, 27 present the house plans with all the smart home facilities incorporated.

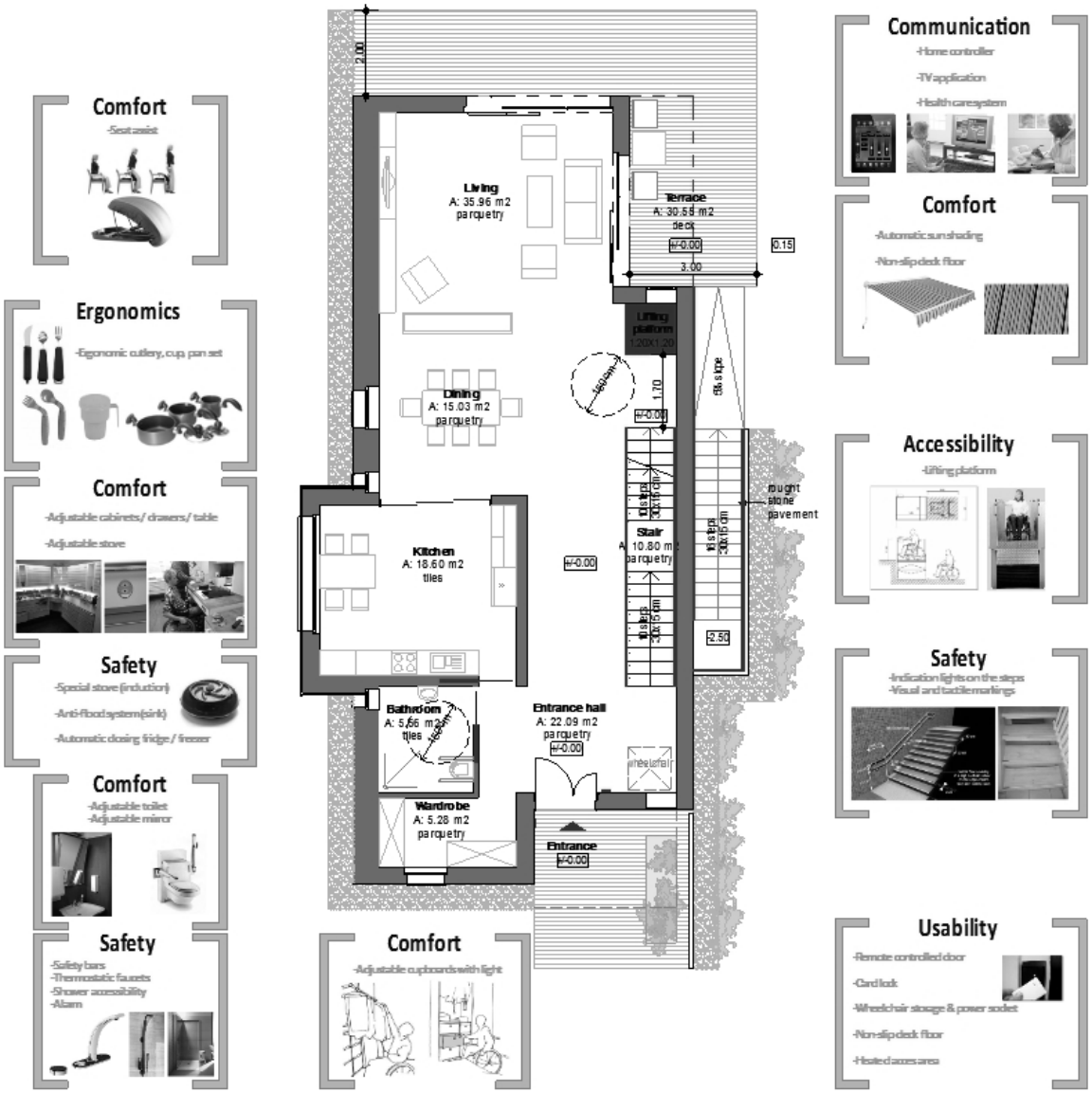


*Fig.25: Ground floor plan*

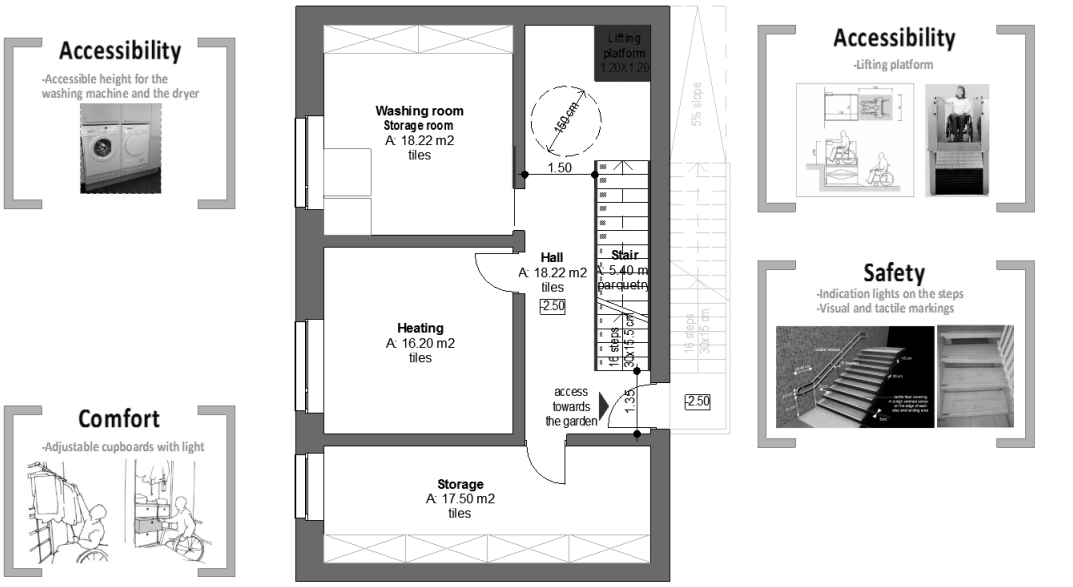


*Fig.26: Basement plan*

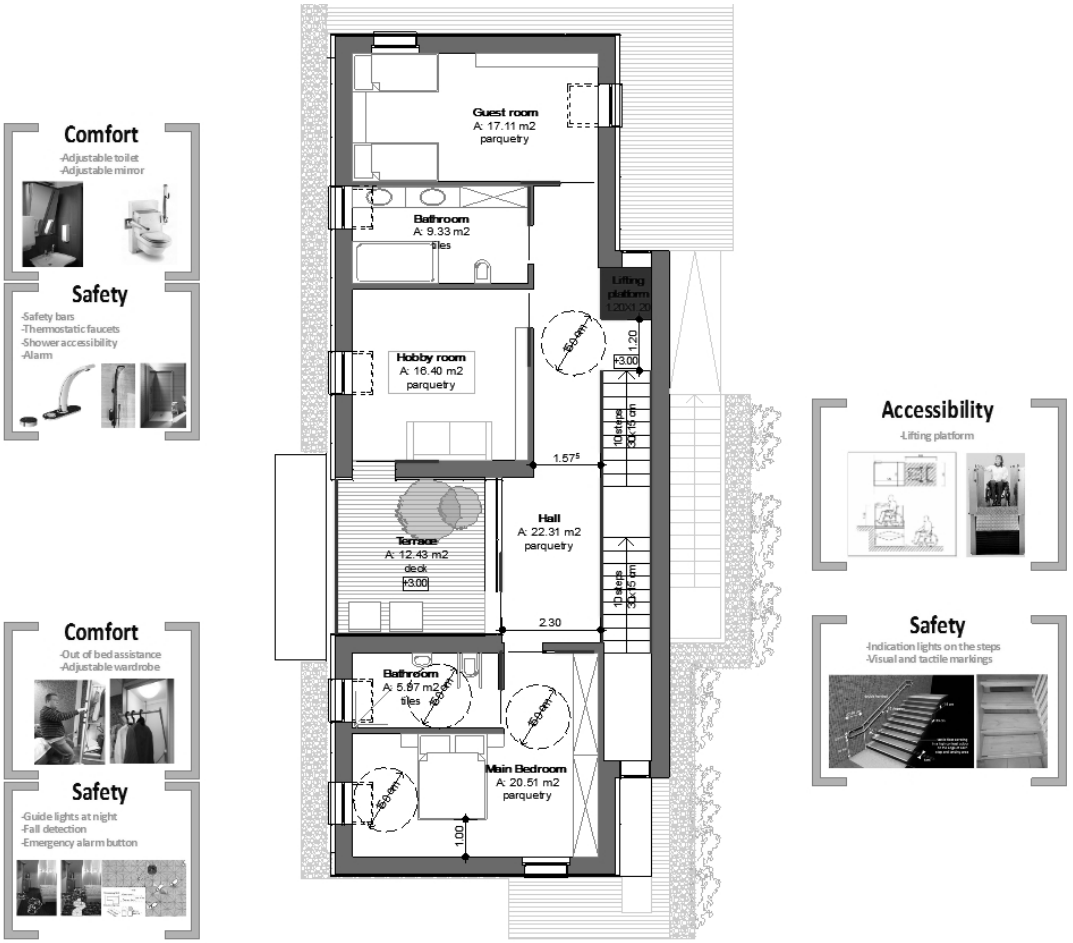


*Fig.27: First floor plan*

## *5. Conclusions*

Statistics on ageing cause a growing need for accessible houses. Worldwide most of older people prefer to be independent and autonomous, rather than move and live in an institution.
In Romania, the vast majority of older people choose to live in their own homes, usually with the informal support of their family. The mentality and the tradition in Romania, especially in the rural area, is to accommodate the extended family - grandparents, parents and children - in the same residence/household [6].
Taking into consideration this situation it is a must to provide accessible houses based on smart home principles.

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