The International Classification of Functioning, Disability of Health as a Conceptual Framework for the Design, Development and Evaluation of AAL Services for Older Adults

Alexandra Queirós[1], Joaquim Alvarelhão[1], Anabela Silva[1], António Amaro[1], António Teixeira[2] and Nelson Pacheco da Rocha[1,3]

[1]Escola Superior de Saúde, Universidade de Aveiro, Aveiro, Portugal
[2]Dep. Electrónica Telecomunicações e Informática / IEETA, Universidade de Aveiro Aveiro, Portugal
[3]Secção Autónoma de Ciências da Saúde, Universidade de Aveiro, Aveiro, Portugal

Abstract. The paper presents the International Classification of Functioning, Disability of Health (ICF) as a comprehensive model for a holistic approach for the design, development and evaluation of Ambient Assisted Living (AAL) services for older adults. ICF can be used to systemize the information that influence individual's performance and to characterize users, theirs contexts, activities and participation. Furthermore, ICF can be used to structure a semantic characterization of AAL services and as a basis to develop methodological instruments for the services evaluation.

1 Introduction

1.1 Active Ageing

Accordingly to World Health Organization (WHO) population ageing is one of humanity's greatest triumphs [1]. It is also one of our greatest challenges: the global ageing is putting increased political, economic and social demands on all countries. To overcome these pressures, WHO argues that governments, international organizations and civil society should promote active ageing policies and programmes.

The main goal of active ageing is the promotion of older adults in social, economic, cultural, spiritual and civic affairs, while providing them with adequate protection, security and care. The implementation of active ageing requires a strategic planning based on a rights-based approach that recognizes the rights of people to equality of opportunity and treatment in all aspects of life as they grow older and also a positive thinking about enablement instead of disablement. We must be aware that a disabling perspective increase the needs of older people and lead to isolation and dependence, while an enabling perspective focuses on restoring functions and expanding the participation of older adults in all aspects of society [1].

Queirós A., Alvarelhão J., Silva A., Amaro A., Teixeira A. and Pacheco da Rocha N..
The International Classification of Functioning, Disability of Health as a Conceptual Framework for the Design, Development and Evaluation of AAL Services for Older Adults.
DOI: 10.5220/0003341700460059
In *Proceedings of the 1st International Living Usability Lab Workshop on AAL Latest Solutions, Trends and Applications* (AAL-2011), pages 46-59
ISBN: 978-989-8425-39-3

Active ageing depends on a variety of influences or determinants that surround individuals, families and nations related with personal characteristics, culture and gender, but also with societal characteristics and infra-structures (e.g. physical environments, support services, economical and social determinants) [1]. In terms of individual perspective, the three basic pillars of active ageing are [1]: full participation in socioeconomic, cultural, spiritual and civic affairs, according to basic human rights, capacities, needs and preferences; access to the entire range of health and social services that address the needs and rights of older adults; and protection, dignity and care in events that older adults are no longer able to support and protect themselves.

The framework of the International Classification of Functioning, Disability of Health (ICF) [2] is aligned with the enabling perspective of the active ageing and it focuses on the individual participation independently of theirs health state.

1.2 International Classification of Functioning, Disability of Health

The ICF offers a framework for conceptualizing functioning associated to health conditions [3] and it considers that are many factors that affect and have influence on the individual's performance and thereby on the decisions made on what type of service is needed either delivered by care staff, relatives, aid appliances and technology.

The ICF structure separates between the body, activities, participation and contextual factors [2] as part of the individual's functioning. Additionally, it considers the context (environmental factors and personal factors) as components that can enhance or limit the performance, depending on how the individual experiences limitations (e.g. due to possible weakness, illness and/or handicap). The structure is illustrated in the Figure 1 [2].

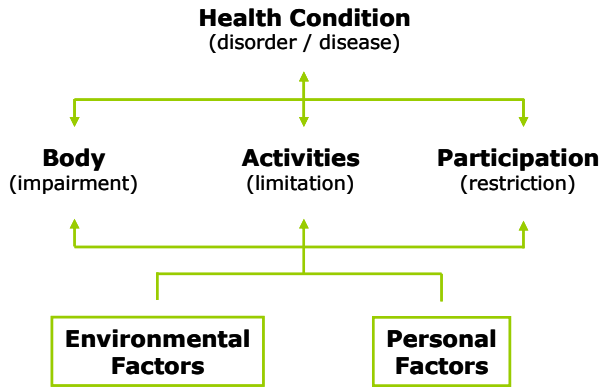

Fig. 1. Interaction of ICF concepts.

Following there is a description of each of the ICF elements [2]:

– Activities - Activities are the individual's recital of assignments and tasks. Difficulties with these activities are noted as activity limitations. Limitations are

usually due to function depreciation of bodily functions but also due to environmental hindrances.

- Participation - Participation covers the individual's involvement in daily life and society. Difficulties in participation are classified as participation restrictions.
- Body - The body's functions entail the individual's physiological functions. ICF defines disability as any problem of the individual with his/her bodily functions. Physical functions depreciations can, in principle, have no consequences for the individual's ability to do activities, especially if there are help aids that compensate particular functions depreciation (e.g. an individual with weak eyesight wearing glasses would not have a limitation.
- Contextual factors - The contextual factors are the environmental and personal factors which either enhance or limit the individual's functioning. These factors are indirectly understood in the sections of evaluation of activities and participation; however, they are important to explain certain situations (e.g. two individuals with the same diagnosis/ physical function depreciation may have different limitations when it comes to activities and participation). The environmental factors are the physical, social or attitudinal world ranging from the immediate to more general environment. The personal factors entail elements that make people different and unique, such as life style, education level, sex, race, life events or psychological characteristics.

Differences in mastering capacity are a possible explanation to why individuals with the same physical function depreciations do not have the same limitations when performing various activities. For example, when it is windy outside, some individuals will put up wind shelters, whilst others put up windmills. Dependent on whether one looks upon changes as strenuous or as a challenge which contains new options.

The environmental factors can have a positive (i.e. be facilitators) or negative impact (i.e. be barriers) on the individual's performance as a member of society, on the individual's capacity to execute actions or tasks, or on the individual's body function or structure. When coding an environmental factor as a facilitator, issues such as the accessibility of the resource, and whether access is dependable or variable, of good or poor quality, should be considered.

In the case of barriers, it might be relevant to take into account how often a factor hinders the person, whether the hindrance is great or small, or avoidable or not. It should also be kept in mind that an environmental factor can be a barrier either because of its presence (e.g. negative attitudes towards people) or its absence (e.g. the unavailability of a needed service).

The classification has individual items or codes defined within each chapter. The ICF contains 1,424 codes organized according to an alphanumeric system. Each code begins with a letter that corresponds to its component domain: b (Body Functions), s (Body Structures), d (Activities and Participation) or e (Environmental Factors). The letter is followed by between one and five numeric digits. Items are organized as a nested system so that users can telescope from broad to very detailed items depending upon the needs presented by particular applications of the ICF.

1.3 Living Usability Lab Project

Over the last decade, considerable research efforts have been pursued by the European Commission, national governments and relevant industries to provide an adequate technology response to the challenges of an ageing society [4]. In terms of technology uses, the so called independent living or Ambient Assisted Living (AAL) domain today comprises a heterogeneous field of applications ranging from quite simple devices such as intelligent medication dispensers, fall sensors or bed sensors to complex systems such as networked homes and interactive services. Some are relatively mature and some are still under development.

Considering the growing importance of AAL services, the Living Usability Lab (LUL) intends to develop AAL services to fulfill some needs that are common to older adults: full participation in society, health and quality of life or living with security.

Dependency is strongly related with the ability to perform Activities of Daily Living (ADL). There are two groups of ADL: the basic ADL consist of those skills needed in typical daily self care, namely personal hygiene, dressing and undressing, eating or moving around; and instrumental ADL are skills that let an individual live independently in a community, beyond basic self care, and that may include typical domestic tasks, such as driving, cleaning, cooking, and shopping, as well as other less physically demanding tasks such as operating electronic appliances or handling budgets.

Basic ADL are out of the scope of the LUL since most of the times require the caregiver intervention. The impossibility of perform instrumental ADL like housekeeping (e.g. cleaning, cooking, shopping, or ironing) usually implies that the individual needs help and although, in some circumstances, he/she can live alone, although in border of the dependency. It is clear that AAL services can not supply these needs completely but they can mitigate the effects by means of specialized service (e.g. an e-commerce solution for shopping or a well managed external housekeeping service) [5].

Additionally, AAL services can contribute to increase the older adults' performance in a broad spectrum of activities and participation [5]: personal care, planning of the weekly menu, nutritional advisor, maintenance of house and garden, self administration or agenda; support in finding and carrying out work, establishing and maintaining contacts with other people, and, in general, in spending the day (through the participation in different leisure activities) and social integration participation.

Furthermore, AAL services can contribute to the reorientation in health systems that are currently organized around acute, episodic experiences of disease, namely, by allowing the development of a broad range of services such as care prevention and care promotion and home-caregiver support.

Some of the AAL services for older adults consider their users as people who are weak and passively assisted by others [6, 7]. The position should be the opposite: those services should help encourage the older adults to actively participate in society (i.e. the enabling perspective of the active ageing paradigm). However, older adults are usually scared by the application of new technology. Therefore, we should construct user friendly interfaces, and also provide appropriate trainings to their users.

Developing adaptive, natural and multimodal human computer interfaces is the main challenge of future interfaces in AAL [8]. This is the main goal of the LUL project.

2 Our Position

Taking in consideration the needs of the target users for the AAL services aimed by our Living Lab and the state of the art, we defend that integration of a holistic view of the individuals and their context is needed and has the potential for advantages in terms of the adequacy of the services being developed.

The existence of a conceptual framework based on standardized concepts can provide a common language between strategic planners, technological innovators, care providers and users for the development of new services in general and, in particular, new AAL services. We argue that ICF can be used as a conceptual framework to systemize the information that can influence individual's performance, not only in terms of health conditions or physiological functions, but also in terms of contextual (both personal and environmental) factors and it can be used as comprehensive model for a holistic approach to characterize users, theirs contexts, activities and participation:

- The ICF body (physiological functions) and personal factors (e.g. life style, education level, sex, race, life events or psychological characteristics) can be used to model the final users and theirs specific needs.
- The ICF contextual (environmental and personal) factors either enhance or limit the individual's functioning and, clearly, must have an important role in AAL services for older adults, considering that one of their main goal is to maintain older adults activities and participation in society. In particular, ICF environmental factors (e.g. physical, social or attitudinal) must be considering when modeling the immediate or more general environment.

ICF fundamental concepts are related with functioning and performance in activities and participation. On the other hand, the goal of AAL services for older adults is the development of technological solutions to enhance theirs activities and participation in all aspects of society. Therefore, it should be possible, and desired, to use ICF for:

- The specification, development and characterization of AAL services.
- The development of suitable instruments for the evaluation of the AAL services and their impact on the daily life of older adults (i.e. activities and participation).

Potential advantages of ICF usage in several aspects of the AAL services for older adults will be addressed in the following sections, namely: user modeling and profiling, essential for adaptable and intelligent services; development of complex AAL services; and AAL services evaluation.

3 Users Modeling and Profiling

Users modeling and profiling provides the methodology to enhance the effectiveness and usability of services and interfaces in order to: tailor information, predict user's future behavior, help the user to find relevant information, adapt interface features to the user and the context in which it is used, and indicate interface and information presentation features for their adaptation to a multi-user environment.

As a variety of users may operate with AAL services, a users' model serve as a description of the users of a system and a prediction of how they will behave and perform tasks. These goals are achieved by constructing, maintaining and exploiting user models and profiles, which are explicit representations of individual user's preferences.

Different models have been considered for the development of applications and information systems for support in activities based on new paradigms that promote the human ability to solve problems. These models differentiate the users in terms of information processing capabilities, according to individual differences of a physical nature, according to individual differences of a psychological nature, and also considering environmental and cultural factors. As a result of this research a set of meaningful international usability standards were defined.

One of this international usability standards (the ISO/IEC 24756 [9], which defines a framework for specifying a Common Access Profile of needs and capabilities of users, computing systems, and their environments) was used together with ICF by the Vaalid [10] project as an attempt to characterize the user profile [10, 11], namely to qualify the abilities of the older adults that have direct impact on successful use of ICT product and services, following the recommendations of the ETSI EG 202 116 [12]: sensory, physical and cognitive abilities.

The abilities were classified using body functions and structures and some concepts related with activities and participation of ICF. However, we argue that a step forward is possible due to the fact that other individual factors, such as anthropological characteristics or preferences can be considered using the ICF framework. ICF, as a model that offers a balance between a purely medical and a purely social approach, contains essential information for the profile characterization of body functions and structures, personal factors and activities and participation: body functions and structures allow the definition of the type of access to services, as well as, the definition and configuration of its interfaces; personal factors allow the characterization of personal preferences in the definition and configuration of services and interfaces; and activities and participation allow the characterization of the services that best fit the person's functioning.

Detailed information associated with these components determines the type of AAL service access, the need for assistive technology and appropriate adaptation of its interfaces.

From the point of view of users, we can not forget that their models have to be dynamic in order to adjust to the context in which they operate. Context can be considered as any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves [13]. Additionally, it is also clear that not all types of contextual

information can be easily sensed. Some types of contextual information (e.g. the mood of the individuals) can only be derived by intelligent combination of other information or by human inputs [13].

The ICF model is consistent with these requirements as a person's performance can be characterised as the result of a complex relationship between health conditions and personal and external factors. External factors represent the circumstances in which the person lives, i.e. the functional performance of a person in the activities and participation is influenced by his/her individual characteristics and participation, and the environmental factors can be considering a facilitator or barrier to his/her functioning.

Therefore, concerning the user model, the individuals are a combination of body functions and structures, activities and personal and environmental factors. Personal factors include gender, age, coping styles, social background, education, profession, past and current experience, overall behaviour pattern, character and other factors that influence how disability is experienced by the individual [2]. Additionally, environmental factors can be grouped in the following classes: products and technology; natural environment and human-made changes to environment; support and relationships; attitudes; services, systems and policies.

However, we must be aware that the development of ICF is still work in progress what may pose some challenges:

- Personal factors still need an in depth study to avoid the need to use concepts outside the ICF for the complete definition of the user model.
- In the context of AAL services, it is urgent to identify habits and routines. These are the recurring patterns of a person's behavior, usual activities performed and resources used. These concepts are not explicit in the ICF, but they are highly relevant to the classification of environmental factors.
- The capture and systematization of environmental factors is one of the biggest challenges [14]. Measure the impact of the environmental factors on human functioning is becoming an important subject to optimize interventions and reduce participations restrictions [14]. In recent years different instruments have been developed for assessment of impact of environmental factors in human functioning, reflecting the concern about the inclusion of this component of ICF in a comprehensive assessment.

Despite the difficulties listed, we believe that the ICF can help modulate users and theirs contexts from a holistic viewpoint. Additionally, we believe that the difficulties mentioned must be seen as opportunities and challenges: the use of ICF beyond the restricted field of health will bring interesting contributions to its own development and will help the ICF to meet all the requirements identified for user model within the AAL services.

4 Development of Complex AAL Services

The System Architecture proposed for the LUL follows the paradigm of service orientation, which allows developing software as services that are delivered and consumed on demand. The benefit of this approach lies in the loose coupling of the

software components that make up an application. Discovery mechanisms can be used for finding and selecting the functionality that a client is looking for. Many protocols already exist in the area of service orientation.

The architecture components are divided into three layers: the base middleware layer contains the functionality that is needed to facilitate the operation of the networked environment; the intelligent middleware layer contains the functionality that is needed to facilitate the usability and acceptance of the services (it provides users modeling and profiling, user interface management and context awareness and notification); and the application layer allows dynamic services composition, which is essential to allow the congregation of different services to build domain specific applications.

Therefore, the application services have a hierarchical structure in which a particular service is made up of components. Each one of these components could be composed by more elementary services.

Furthermore, the interactions between the assistive devices, human services and end users, must be under a service oriented management perspective. Assistive devices and human services interactively work together to express potentials from both sides providing high quality services to the people with needs [6]. Effective and efficient solutions to meet the AAL challenges should combine the forces from both the technological part and the societal ones. The participations of human beings could help fully express the potential of smart devices, and maintain the social awareness of the older adults. Although informal caregivers may help reduce the needed social resources, and increase the social connections, they are inherently very dynamic: the availabilities of the caregivers are continuously changing.

A scenario is a specific context where the activities and participation, features and resources are well defined. It gives us the information about which AAL, human and technological support services are necessary to assist older adults in social, economic, cultural, spiritual and civic affairs.

Considering this services organization, an efficient infrastructural support for building AAL services aggregation is needed [15]. It consists of the following infrastructure services which act as basic service components: service registration; semantic service descriptions; semantic match service; and service binding.

The services must be described based on a standard, commonly declarative, service description language to enable service discovery and invocation independently of its implementation details. An example of a suitable service description language is the XML-based WSDL language, used to describe web services. Additionally, there must be an ontology able to classify the different AAL services and thus facilitate their re-use.

There are a huge number of possibilities in terms of possible classifications of AAL services:

- Persona [5] project defines usage scenarios (these provide a basis for subsequent specification and evaluation of services and basically define specific contexts and how users carry out their tasks in these contexts. Since the number of available scenarios is rather big, the end users have been asked to identify the most interesting scenarios. This led to the selection of the following eight scenarios [5]: peer to peer exchange; meeting other people; enhanced activity assistant; personal

safety; behavior detection; health status management; neighborhood assistant; help in planning and conducting a journey using public transportation.

- In a different approach [16] AAL application are considered as composed of a set of services that can be grouped into two categories: health-oriented services and comfort services. Health-oriented services (e.g. health and activity monitoring) allow the older people to access to medical and emergency services, and facilitate collaboration among medical staff. Comfort services are services that allow the older adults to maintain social and familiar contacts or that allow them to access information to which they are interested or shopping assistance.
- Different services do not require the same properties of the execution environment such as security, confidentiality or urgency. This could lead to another type of classification [16, 17] based on three type of assistance: emergency assistance (e.g. assistance detection, prediction and prevention); autonomy enhancement services (e.g. drinking, eating, clearing, dressing, medication, shopping assistance or traveling assistance); and comfort services (e.g. logistical services, services for finding things, infotainment services transportation services or orientation services).
- The European Ambient Assisted Living Innovation Alliance focuses on the needs of older adults to categorize all products and research activities [11]: social interaction (i.e. all kinds of products, services and research projects that enable older adults to stay in touch with the world beyond their domestic environment); health and home care (i.e. combination of supporting assistive technologies and rather conventional health or home care solutions might be best suited to provide the framework necessary for autonomous living conditions of older adults that can be further divided into prevention, assistance or therapy); supply with daily goods and chores; and safety (i.e. for fulfilling the safety, privacy and security needs of older adults).

Considering the broad range of sub domains used to classify AAL services (which is natural taking in consideration the maturity level of this technology) is not an easy task to identify an appropriate semantic knowledge base to precisely describe the advertised services. The question of how to automatically map the available/requested services is still a big challenge in AAL.

We consider that the conceptual framework of ICF could be useful to solve critical issues related with the services organization. Since the activities and participation, i.e. involvement of the person in real life situation, is what justifies the use of AAL services, we can and we should used ICF for the structuring and classification of AAL services.

The component activities and participation is a neutral list of domains indicating various activities and areas of life (learning and applying knowledge, general tasks and demands, communication, mobility, self-care, domestic life, interpersonal relationships and interactions, major life areas, community, social and civic life), which are subdivided into three levels increasing the accuracy of the classification.

The list of areas of activities and participation covers the full range of functioning that can be coded at the individual and social level. This component can have different uses, considering the concepts of activities and participation. The ICF defines four ways to use this list of domains: different groups of domains of activities and domains of participation (not allowing overlap), partial overlap between the

groups of domains of activities and participation, the existence of detailed categories of activities and broad categories of participation, with or without overlap and use the same fields for both activities and participation with complete overlap of the fields [2].

For the definition of an ontology to categorize the AAL services we proposed the ICF participation domains. This implies that we have to define a border line between activities and participation [18]: we consider the first two activities and participation domains (learning and applying knowledge, general tasks and demands) as activities (used to define the user profile, as they qualify the user abilities to perform activities) and the remainder five domains (communication, mobility, self-care, domestic life, interpersonal relationships and interactions, major life areas, community, social and civic life) as participation because they are more related with the individual's performance [19].

Figure 2 represents a layer organization's services for a specific scenario (peace of mind), using the example of a choreography of AAL services conceptualized by the Persona [5] project in attempt to maintain peace of mind of adult child concerning the well-being of their parents [20].

AAL services highlight the technology as a facilitator of the person's performance improving functioning. This means that the results associated with the development of AAL services are strongly oriented to technology, i.e. services are conceptualized and developed considering the potential of technology. This can cause problems when trying to classify, according to ICF, services already developed or being developed. However, it is clear that a structured classification of AAL services should not be oriented to technology, but to individuals. This is a strong argument to use the ICF as the basis for an otology for the AAL services and its components.

5 AAL Services Evaluation

The AAL services evaluation is an approach to the technology design and development process that can be divided in two main phases: anticipation of impacts and consequences and performance assessment.

The publication, in 1999, of the ISO 13407 standard (Human-centered Design Processes for Interactive Systems) [21] was an international recognition that the human factors have processes which can be managed and integrated with the project processes. According to this ISO standard the first steps within the user centered design process are [22]: understanding and specifying the context of use; and collecting and analyzing users' needs and requirements.

However, the usually approach for involving users throughout the whole R&D process is typically followed by the development of prototypes by experts. By doing this, decisions about the conceptual design, i.e. what kind of functions are to be developed and what the interaction should be like, are made by experts. The prototypes, based on those conceptual design ideas, are then evaluated by users. Therefore, the initial design ideas are not based on the mindsets, experiences and mental models of the users but on the experts. The user can intervene only through the user based assessment [23].

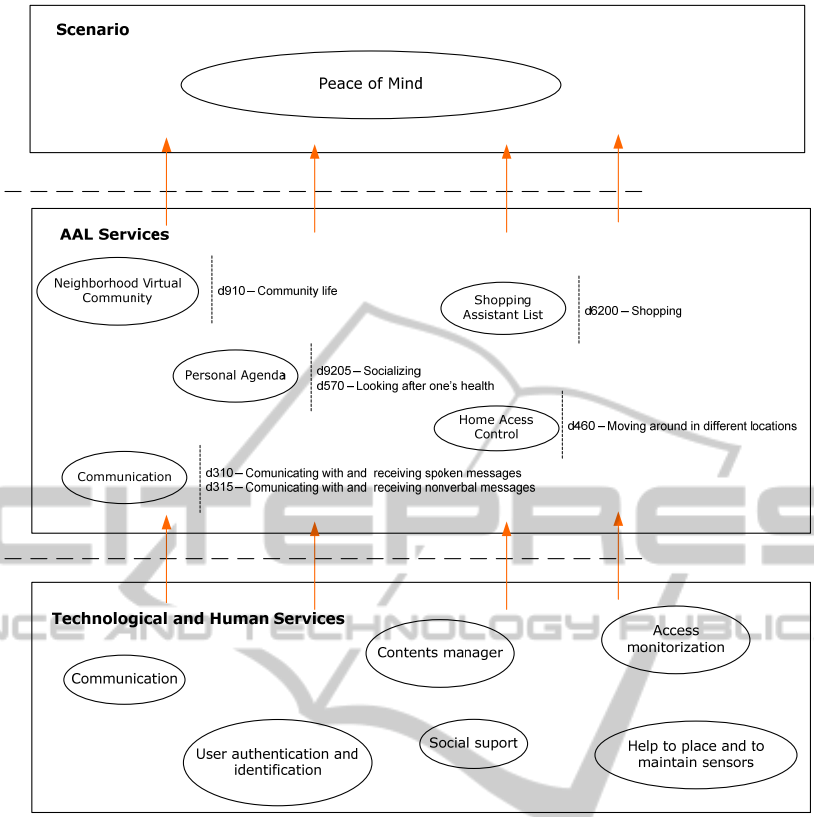

Fig. 2. Peace of Mind scenario.

A central idea of the Living Lab concept is a strong involvement of the users in all the development phases, including the conceptual design and, later, the prototypes. Therefore, new methodologies are required to allow the generating of new design solutions and the evaluation of design solutions derived from the first phases of user involvement. Focused design discussions, theatre and multilevel prototyping [23].

Although the process is cyclic, it should be flexible enough to move forwards, backwards, and crosswise between phases. Notably, practice and use are tightly interwoven by these phases, since the output from one becomes the input for another. In particular, the prototypes that that evolve from empirical studies may become part of the Living Lab infrastructure for use in future studies. These prototypes together with the evaluation results are additionally useful for future model and tool building, and they lead to further cycling though the Living Lab [23].

The evaluation has several goals: evaluate process/ways of working changes; measure hard data of the improvements/changes; evaluate fit between software concepts and users real way of working; evaluate acceptance, satisfaction, motivation and individual performance of users; evaluate usability, bugs, functionality of software; and create ideas about improvements and new features.

For the performance assessment the technological developments have been based on a fairly limited view and, in particular, the evaluation methodologies focus on

instrumental factors, such as mobility, physical and sensory deficit and ability to perform activities of daily living and rarely on advanced activities of daily living and social roles. There's an imperative for changing this paradigm as the result of higher levels of performance that health and social interventions demands. In fact, we also need to understand how the technology influences the (re)motivation and the (re)organization of the human performance within a particular context. Humans as open systems can accomplish changes over time through the engagement in meaningful activities with the propose of fulfill the sense of achievement and control of own life. As we state before this level of functioning is a dynamic interaction between the person and the environment where the personal causation, values, interests, habits and routines play a very important role. To this dynamic interaction we call it meaning.

An ecological model focused on practical aspects of everyday activities of the person, highlighting opportunities for technology and design solutions to support these activities is a useful framework for guiding the evaluation process. The activities that comprise a person's everyday life are shaped by a range of different factors, including attributes of the person (e.g. functional ability, cognitive ability or psychological factors) and attributes of the immediate and wider socio-cultural contexts (e.g. formal support network, social network, physical environment or cultural and political determinants) [11].

Assuming that AAL services intend to highlight environmental factors referring to technology to improve participation and quality of life, such services should be evaluated taking into account theirs impact on activities and participation of the user, particularly on his/her quality of life, which includes the meaning and the satisfaction of the performance.

Therefore, it is extremely important to develop new methodological approaches to include not only the performance of the individual but also the meaning and satisfaction with their performance.

ICF model contemplates some of the factors previously listed and also considers that environmental factors and the individual cannot be conceptually separated. The ICF ecological perspective are reasons strong enough to use this conceptual model to develop methodological instruments to evaluate in a holistic perspective the impact of AAL on older adults quality of life, including the meaning and the satisfaction of the performance. On the other hand, it is of utmost importance to adopt the ICF as this is a WHO classification internationally used.

6 Conclusions

In the previous sections we had presented arguments that sustain the possibility of using ICF in different aspects of design, development and evaluation of AAL services for older adults. ICF can be used as a universal framework to characterize users' profiles and theirs environments, to structure a semantic characterization of AAL services and to develop methodological instruments for the AAL services evaluation.

Therefore, we believe that ICF can be used as a conceptual framework for the design, development and evaluation of AAL services. Within the LUL project we

intend to demonstrate that such a conceptual framework can overcome some of actual difficulties related with AAL services design, development and evaluation.

One of the problems of using technology and information systems for care provision is the communication difficulties between technology professionals and caregivers. Different professionals with different backgrounds and needs but who speak a common language increase the efficiency of teamwork. This leads to a better performance when developing new services or when improving existing services. In particular, the use of a conceptual framework from WHO, as is ICF, facilitates the work of multidisciplinary teams.

Additionally, although it may be needed to complete ICF with additional models, it can help to overcome a recurring problem that is the lack of data to create robust user's models. Properly safeguarding ethical issues, the ICF can allow almost unlimited access to appropriate information properly encoded.

Last but not least, using the ICF to enhance the semantic interoperability facilitates the generation of knowledge: the existence of universally accepted conceptual models, and its terminology, concepts and coding of information allows the aggregation and consolidation of the available information, which will be essential for the strategic planners, technological innovators, care providers and users involved in the development of AAL services.

Acknowledgements

This work is part of the COMPETE – Program Operacional Factores de Competitividade and the European Union (FEDER) under QREN Living Usability Lab for Nest Generation Networks (hrrp://www.livinglab.pt).

References

1. World Health Organisation: Active Ageing: A policy framework (2002)
2. World Health Organization: The International Classification of Functioning, Disability and Health (ICF). Geneva, Switzerland (2001)
3. Peterson, D. B.: International Classification of Functioning, Disability and Health: An Introduction for Rehabilitation Psychologists. Rehabilitation Psychology, Vol. 50, No. 2, (2005) 105–112
4. O'Grady, M. J., Muldoon, C., Dragone, M., Tynan, R., O'Hare, G. M. P.: Towards evolutionary ambient assisted living systems. Journal of Ambient Intelligence and Humanized Computing, Vol 1, Number 1, Springer-Verlag (2009) 15-29
5. Ochoa, E. [et al]: PERSONA - PERceptive Spaces prOmoting iNdependent Aging - Deliverable 2.1.1 - Report describing values, trends, user needs and guidelines for service characteristics in the AAL Persona context (2008)
6. Hong Sun, V. F., Ning Gui, C. B.: Promises and Challenges of Ambient Assisted Living Systems, Sixth International Conference on Information Technology: New Generations (2009)
7. Hong Sun, V. F., Ning Gui, C. B.: Towards Longer, Better, and More Active Lives - Building Mutual Assisted Living Community for Elder People. In the Proceedings of the 47th European FITCE Congress, FITCE, London (2008)

8. Kleinberger T., Becker M., Ras E., Holzinger A., Muller P.: Ambient Intelligence in Assisted Living: Enable Elderly People to Handle Future Interfaces, Universal Access in Human-Computer Interaction. Ambient Interaction, Part II, HCII (2007)
9. Janse, M. (ed.), Ramparany, F., Kladis, B., Rozendaal, L., Broens, T., Eertink, H.: IST Amigo Project Deliverable D2.3 Specification of the Amigo Abstract System Architecture (2005)
10. Mocholí, J. L., Sala, P., Navarro, A.: VAALID - Accessibility and Usability Validation Framework for AAL Interaction Design process. D2.2 - Concept & Services ontology description, VAALID Project (2010)
11. Broek, G. [et al]: Ambient Assisted Living Roadmap. Alliance – The European Ambient Assisted Living Innovation Alliance (2009)
12. ETSI EG 202 116 v1.2.1 (2002-09): Human Factors (HF); Guidelines for ICT products and services; "Design for All" (2002)
13. Ramparany, F. [et al]: IST Amigo Project. Deliverable D2.2 - State of the art analysis including assessment of system architectures for ambient intelligence (2005)
14. Lemberg, I., Kirchberger, L., Stucki G., Cieza A.: The ICF Core Set for stroke from the perspective of a physicians: a worldwide validation study using the Delphi technique. European Journal of Physical and rehabilitation Medicine, 46 (2010)
15. Hong Sun, V. F., Ning Gui, C. B.: Towards Building Virtual Community for Ambient Assisted Living. 16th Euromicro Conference on Parallel, Distributed and Network-Based Processing, IEEE Computer Society (2008)
16. Segarra, M. T., André, F., Building a Context-Aware Ambient Assisted Living Application Using a Self-Adaptive Distributed Model. ICAS 2009 : Fifth International Conference on Autonomic and Autonomous Systems , Valencia (2009)
17. Avil´es-L´opez, E., Villanueva-Miranda, I., García-Macías, J. A., Palafox-Maestre, L. E.: Taking Care of Our Elders Through Augmented Spaces. LA-WEB '09: Proceedings of the 2009 Latin American Web Congress (la-web 2009) (2009)
18. Kostanjsek, N.: Semantic Interoperability – Role and Operationalization of the International Classification of Functioning, Disability and Health (ICF), International Journal of Integrated Care, Vol 9 (2009)
19. Jette, A., Tao W., Haley, S.: Blending activity and participation sub-domains of the ICF. Disability and Rehabilitation (2007) 1742 – 1750
20. Rowan, J. T.: Digital Family Portraits: Support for Aging in Place, in partial fulfillment of the requirements for the degree Doctor of Philosophy, College of Computing, Georgia Institute of Technology (2005)
21. DIN EN ISO 13407: Human-centred design processes for interactive systems (1999)
22. Storf, H., Becker, M., Riedl, M.: Rule-based Activity Recognition Framework: Challenges, Technique and Learning. Pervasive Computing Technologies for Healthcare, 2009. PervasiveHealth 2009. 3rd International Conference on In Pervasive Computing Technologies for Healthcare, 2009. PervasiveHealth 2009. 3rd International Conference on (2009) 1-7
23. Muller, S., Santi, M., Sixsmith,A.: Eliciting user requirements for ambient assisted living: Results of the SOPRANO project, eChallenges Conference 2008, Stockholm (2008)