

Better Living by Technical Assistance and Mobility in an Aging Society

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Abstract

The project *PASSAge* (Personalized Mobility, Assistance and Service Systems in an Aging Society), funded by the German Federal Ministry of Education and Research (BMBF, Bundesministerium für Bildung und Forschung) aims at the implementation of seamless mobility chains that smoothly connect private and public spaces with a special regard to the needs of an aging society. By extending existing means of mobility with user-oriented components, individual and self-determined mobility for elderly people shall be ensured. Individual physical adaptations for buildings, vehicles, and mobility aids shall facilitate the usage of and changing between means of mobility. For planning trips, navigating, providing contextual mobility-related information, and keeping track of the health status, the so-called 'HealthPhone' will be an electronic mobility companion that can provide safety and security for the elderly users. In this paper, we describe how the technical, information architecture and physical components and solutions are planned and evaluated, in order to create innovative solutions meeting the needs of the users, ensuring user acceptance and thereby sustaining a economically feasible solution.

1 Introduction

The demographic change in modern societies has a significant impact on the future planning of self-determined and individual mobility. For elderly people, an optimized accessibility of the means of transportation as well as their connection towards buildings and residences is required. These connections have to be modular and compatible to the users' means of mobility. Barrier-free accessibility according to the existing norms can address these problems only partially. Broader and holistic concepts are needed here. For this reason, ten interdisciplinary partners from universities and industry (compare Figure 1) with complementary expertise team up in the project *PASSAge* [1].

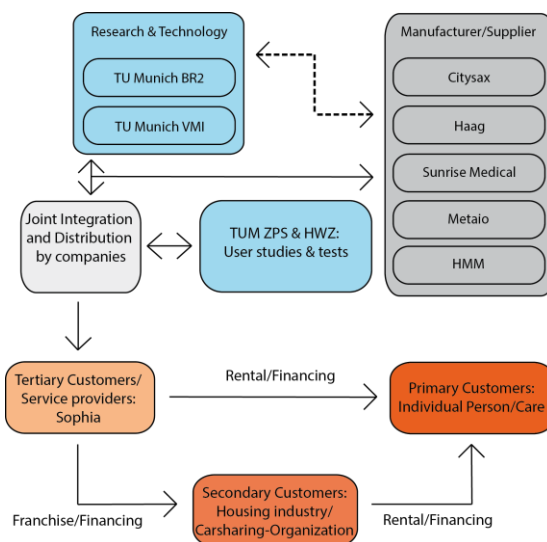


Figure 1: Tasks of the project partners

In this paper, we describe the project's approach for identifying the users' needs and for creating products with a higher probability of user acceptance.

2 The *PASSAge* Approach

The *PASSAge* concept aims at improving the quality of life of the elderly people significantly, especially in rural areas. It will enable them to live a self-determined life for much longer and to stay in their familiar environment by facilitating the access to public and individual transport. The analysis of questionnaires

and interviews with elderly groups underlined the strong wish of most of the elderly in all types of regions to stay in their environment instead of living in a senior home [2]. Taking into consideration the demographic change, it will be necessary to find ways to help people to live as independently as possible as long as possible, because there might not be enough senior nursing homes, care givers or financial means provided by the health system. The use of assistive technology to enhance mobility combined with social services is supposed to be a supporting factor [3] to achieve this.

For preserving the individual mobility, especially micro-mobility in the user's quarter, mostly electrically powered compact and micro vehicles with adaption possibilities for elderly users with special needs shall be added to the mobility chains. In many cases, the interfaces between different means of mobility, that is where the user does change between mobility means, represent the major problems for people with ailments. For this reason, the project examines both physical adaptations and information interfaces for buildings and for mobility devices. In order to ensure a seamless mobility chain, the examined mobility range is divided into *four use cases* covering different environments and distances, and the interfaces in-between:

- 1) mobility at home,
- 2) mobility in the neighborhood,
- 3) mobility in the city area, and
- 4) mobility in the surroundings.

In addition to the physical adoptions and information technology interfaces, accompanying business models are under research supporting mobility and a sustainable chain of economic value creation. Interfaces will be created for examples of compact vehicles and micro vehicles, extending their functionality both digitally and physically and thereby enabling the connection to the envisioned services. The approach aims at the development of a modular system, so that each user can configure and use the system individually to his or her personal needs. This facilitates an upgrade or downgrade, whenever the needs of the user change, e.g. due to changes in his or her personal health.

2.1 Usability

Results of user acceptance studies [5, 6] have shown that without a significant inclusion of end users, their relatives, caregivers, and second end users such as formal caregivers, general practitioners and sickness funds, technologies supporting independent living scenarios for the elderly were not implemented. For that reason, *PASSAge* aims at integrating the target group in the development process as early as possible.

Based on the technology acceptance models of Davis [7], and the model for evaluating technologies and optimizing usability by McCreddie [8] all components and the complete *PASSAge* system are tested, analyzed and adapted to the users' needs by defined user groups. Modifications of existing products are performed in close cooperation with the potential end users. In order to be able to evaluate a product at an early stage, rapid prototype development techniques are applied.

User acceptance according to McCreddie and Tinker depends on several factors. Besides the needs for ambient technologies respected and claimed by users, the users' information about the technical systems is also very important. Other factors are the availability of support and delivery systems, and the question whether they would be able to afford the system. Product quality is, in terms of efficiency, reliability, simplicity, safety and security, costs and design, directly influencing user acceptance.

The mobility system will be designed to reduce user involvement to individual cognitive capabilities, and information and communication technology skills. The basic user interface is kept extremely intuitive and simple, but its open standard allows the elderly user to increase the amount of interaction with the system, i.e. by entering additional data about everyday habits. This scalability also applies to how the user is educated in maintaining health and social lifestyle factors. Input values for the will be medical data, such as heart frequency, stress level, and physical activity and others within reasonable bounds.

2.3 Communication

Besides improvements in the physical part, the concept of the project *PASSAge* is based on assisting elderly users with integrative information technology. The HealthPhone, based on a smart phone, implements a mobility companion for the elderly, providing access to different mobility related services, an augmented reality-based navigation solution, and to health-related vital data measured by different networked sensors.

To be able to test the functions of the HealthPhone already at the early stage of the project, commercial off-the-shelf hardware is used. Using available mass-market devices allows, for example, finding a trade-off between handiness and large screens before an actual device has to be modified to fit other demands. For evaluating user interface concepts, several mockups will be created and presented to the subjects in

the field test. By applying Wizard of Oz experiment techniques, the users will further be able to experience and test the planned service before they are implemented. In order to create a solution that is affordable and adapted to the individual needs, the solution consists of modular applications and hardware products. For example, the created applications can be bought individually and run on the users' devices. Users with special demands can acquire a full bundle consisting of an adapted mobile device with pre-installed applications. The HealthPhone shall further enable connecting to information technology interfaces of means of mobility, such as vehicles [8].

2.2 Human Ambient Technology Laboratory

Mobility at home and the often-problematic interface between building interior and outside area will be tested and examined in an experimental flat in the building robotics lab of BR2 (Chair of Building Realization and Robotics) at Technische Universität München (for a first model, compare Figure 2). At first, devices that have been identified as especially promising during the research and analysis phase of existing support means will be implemented in the experimental flat and tested in a first field test with subjects of the target groups. Two examples of such devices are the TK Encasa Stairwalker, which supports elderly persons walking up or down stairs, and the Physionova Rotoflex care bed, which enables persons with physical impairments to get in and out of the bed independently.

The ensuing evaluation will uncover gaps in the mobility chain and show the potential of each mean to be integrated into the *PASSAge* system. The first prototypes of new devices and add-ons for existing devices will be tested in a second field test to ensure the constant input from the target groups. A third field test will establish the final prototypes for the *PASSAge* system.

Regarding individual mobility, e-cars will be equipped with special aids for getting into the vehicle and storing mobility aids. These aids will be adapted from existing aids to the needs of the elderly and also have to be realized in a lightweight version to keep the overall weight of the electric vehicle as low as possible. Currently, the first e-car, a Citroën C Zero, is equipped with aids for the elderly and/or disabled. Apart from this, transport for people sitting in mobility aids, such as wheel chairs, is also considered. An electric Citroën Berlingo will be adapted, so that a person in a wheelchair can drive over a ramp at the back right through the car to the driver's seat, where the wheelchair will be fixed securely.



Figure 2: View into the experimental flat at the laboratory of BR2

3 Field Test Evaluation

An early inclusion of the users ensures that the market potential of the new mobility solutions will be enhanced and that the implementation of *PASSAge* mobility chains will support a healthy and independent life of the users. Therefore, at the beginning of the project, existing mobility devices and mobility chains were analyzed for different target groups. Important individual and environmental barriers, which affect mobility and independence of community-dwelling elderly people, were examined. A questionnaire was filled out by about 70 elderly people to investigate the acceptance of mobile phones, health services or the use of different means of transportation in the daily routine.

After these first analyses, further field tests are planned to investigate how the use of the planned *PASSAge* mobility chains will help to improve mobility, health, and quality of life of elderly people (e.g. general health parameters, ability to walk, fall risk, cognitive abilities, quality of life, or daily physical activity). The

data will be collected by questionnaires, interviews, 3d sensor recording, vital parameter recording and by observing the subjects in daily situations. Furthermore, frailty scores will be examined with valid questionnaires to identify the effect of mobility supporting systems on frailty. The number of subjects will be chosen high enough to ensure statistical meaningful results.

4 Conclusion

With the project *PASSAge*, we implement seamless mobility chains by integrating existing technology and devices as well as creating solutions for missing links in these chains. A HealthPhone will act as integrator and provide additional services for the user to enable autonomous personal mobility for the user. In order to increase the user acceptance of the developed solution, the components for the seamless mobility chain are evaluated throughout the project. In this paper, we have shown what system approaches and models can be applied for evaluating technical solutions in an ambient assisted living project.

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