Developing autonomous cart equipment and associated services for supporting people with moving disabilities in Supermarkets: The EQUAL Approach

Ch. P. Antonopoulos[1], P. Kelverkloglou [2], N. Voros[1], I. Fotiou[2]

[1] 2Department of Electrical and Computer Engineering, University of Peloponnese, Patras, Greece
[2] TOBEA SMLLC Old National Road Patras-Athens 289, Araxovitika, Patras, Greece

Abstract. The need for equal treatment of people with disabilities has led to the conception of the noble idea of "Equal" project. During its term, the main objective is to create an autonomous provision whereby disabled people have free and independent access to a supermarket. The combination of many subsystems that are related to various technology sectors, such as electrical, electronic, mechanical and informatics, make the final mechatronic system easy to use, reliable and advanced.

Keywords: Disabled, Shop-Cart, Accessibility.

1 Introduction

The development of infrastructure to support people with mobility impairments is one of the main priorities both in European and national level. However, investment in infrastructure is mainly depleted in outdoor areas, and less in the development of public indoor infrastructure based on advances in ICT. Eliminating social discrimination is a global goal, thus companies and innovative ideas meeting this goal are not only welcome but also necessary. According to official data from Eurostat [1], only in the European Union people with mobility impairments exceed 127 million. This means that improving the quality of life of these people, in addition to being a criterion for a developed society, can also be an important market for any company that decides to invest in this field. For a person with mobility problems, day-to-day shopping in a supermarket or shopping mall beyond their usable character is also a first-rate opportunity to participate in social life and hence improve the quality of life.

Once a disabled person enters a supermarket or a shopping mall, the accessibility chain is interrupted mainly at two points. Initially, handling the available baskets becomes more and more difficult as they become heavier by groceries placed inside them, especially for the elderly people. At the same time, wheelchair users are unable to reach products on higher shelves.

Driven by the above observations, shortcomings and instructions both at national and European level, the goal of this proposal is to design and develop an integrated end-to-

end solution for the development of new innovative services to support people with mobility impairments in a supermarket. At the center of the proposal is the design and development of an innovative shopping cart which will facilitate the movement and collection of objects / products in a supermarket. Consequently, the space within which the vehicle will be driven should be appropriately configured and equipped with innovative systems that will work together continuously to provide the relevant services. Finally, aiming at a truly integrated, scalable and mature solution, the development of an appropriate IT platform that will take control, coordination, storage, processing and presentation of all the necessary data and / or interaction events with the user in a trustworthy, safe and personalized manner is of critical importance. The vehicles to be introduced in conjunction with the surrounding ICT infrastructure and the offered services will have significant social impacts as they will enable people with mobility impairments to conduct their shopping in a supermarket or a mall autonomously.
For this purpose, the present partnership was created with the participation of an innovative company specializing in solutions for people with moving disabilities and two research organizations, aiming at linking research and innovation and enhancing the productivity and competitiveness of SME.

2 Project Description and Objectives Definition

The main objective of EQUAL research project is the design and development of a holistic, end-to-end infrastructure offering novel services supporting people with moving disabilities in a supermarket of a mall.
Consequently, in the context of EQUAL a novel platform will be designed allowing people with moving disabilities to do their shopping in a supermarket with the same degrees of freedom as the rest of the customers (not facing such problem). During the last few years due to the significant enhancements in domains such as computer architecture, embedded systems and communications, the issues of the accessibility is receiving active interest since it is now related to the utilization by people with disabilities of interactive systems, applications and services.
Accessibility comprises a critical human right for all people and it is related with the ability to access an area while it is a primary requirement for assuring equal and active participation of disabled people in society. It is also directly related to the smart, sustainable and unrestricted development of our society. In the EU approximately 80 million people suffer from some type of disability while, due to the aging population, this number is expected to increase to 120 million by 2020. Official records of the World Health Organization indicate that 1 in every 4 Europeans have a member of his/her family that suffer from some type of disability [2]. The International Classification of Functioning, Disability and Health (ICF), which is the World Health Organisation (WHO) framework for measuring health and disability at both individual and population levels, defines disability as “an umbrella term for impairments, activity limitations and participation restrictions”, with over one billion people estimated to have one or more disabilities equating to just over 15% of the global population. The WHO recognizes further that a range of obstacles, barriers and/or constraints hinder their full and

effective participation in society. Within a tourism context, a large number of studies has also identified barriers as one of the many reasons why participation rates in and qualities of experience of tourism are lower than that of the general population [3].
A new worldwide health research has indicated that over a billion people over the age of 15 years exhibit some type of disability. From this percentage, 110 millions (2.2% of the work population) suffer from significant functional impairments, while these percentages increase due to the increasing age of the general population. People with moving disabilities represent a significant part of the population suffering from any kind of disability, and they tend to avoid activities and interactions that highlight their disability or/and require the help of their family, friends or even a stranger to carry out these activities.
Consequently, it is of paramount importance to design services and infrastructures avoiding exclusions right from the start of the design process so as to maximize the participation of people with moving disabilities in everyday life activities. In this context EQUAL will introduce mechanized shopping trolleys in actual supermarkets and malls specifically designed for people with moving disabilities.
The final product will be targeting major supermarkets francizes and big malls which, by introducing EQUAL, will increase their revenues by attracting and entering a whole new market group and at the same time enhance their social profile.

3 Project Methodology

The whole project methodology is based on three (3) stages which are interdependent and interlinked to one another as follows:
Phase 1: At this initial stage, it is imperative to analyze all functional requirements of the mechanized shopping trolley inside the actual environment of a supermarket in order to reveal all interdependencies and define the specific goals of the system. In this context EQUAL research team will utilize its contacts with forums and social groups of disabled people to pinpoint the real needs of the end users as well as existing cooperation with AB VASILOPOULOS, probably the largest francize of supermarkets in Greece to use and access real data of relative activities.

Figure 1: EQUAL Trolley design

Phase 2: The overall infrastructure is comprised by three main components that need to be developed.
(1st) The design and development of a mechanized shopping trolley (indicative design depicted in Figure 1), which will comprise the main foundation upon which all novel ICT technologies will be integrated. A critical nonfunctional requirement is to design a trolley that will not occupy a space significantly larger that a ordinary trolley, it is move with a speed controlled by the user in conjunction with a safe specifically designed controlling unit.

(2nd) The trolley movement in the supermarket area will be assisted by a specifically design software component interacting with a cloud-based backend infrastructure offering real-time pricing services, logistics, warehouse management services etc. depicted in Figure 2. The same infrastructure will offer real-time and accurate localization services based on Bluetooth Low Energy (BLE) sensors, proximity sensors, laser scanning etc. Additionally, the infrastructure will assist the end user to pick up the object and place it in the trolley.

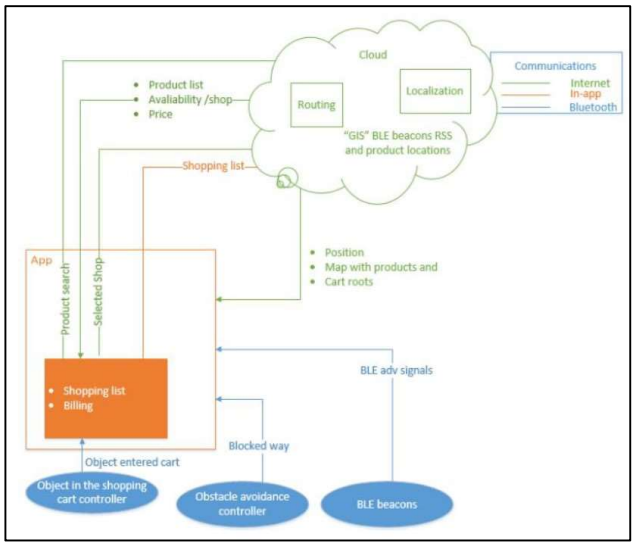

Figure 2. EQUAL Backend Infrastructure

(3rd) The user-supermarket interaction will be supported by a range of application specifically designed for this purpose. Specifically, the developed application will support by a GUI developed on a Tablet or Smartphone attached on the trolley, while the processing will also follow a distributed approach which specific part of the software executed on the tablet and others on the cloud infrastructure.

Phase 3: After the functionality and safety are validated in a lab environment, rigorous field trials will be conducted (selected site depicted in Figure 3). From these trials, the correct functionality will be verified, optimum parameter configuration will be defined, and conclusions will be extracted regarding the further improvement of the system as a whole. Apart from the technical aspects critical conclusions will be extracted regarding the degree of acceptance of the proposed solution by the end-user, the employees of the supermarket and rest of the customers.

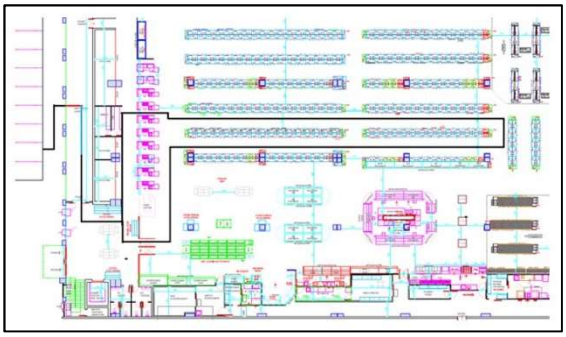

Figure 3. EQUAL Supermarket Trial Site

4 Expected Impact

EQUAL plans to achieve a significant social and economic impact by focusing on research and development excellence through the integration of new knowledge and novelty.

Social Impact: The mechanized EQUAL trolley will lead to important social impact, enabling people with moving disability to carry the shopping autonomously. It is drastically enhancing their quality of life since the process of shopping enhances the social interaction of the end-user and increase the confidence and feeling of being self-sustained.

Economic Impact: Companies, such as supermarkets, malls etc. integrating EQUAL infrastructure is expected to have two faceted profit: increase of revenue due to accessing and attracting a significant market and enhancement of their social profile comprising an important objective of any such big company.

Academic/Research Excellence: Transportation institute and University of Peloponnese, ECE Dept will significant strengthen their position in the academic domain through prestigious publication, participation to major conferences and open access journals. The cooperation TOBEA with two major research/academic partners is expected to lead to the development of a successful product and, lay the foundation for further cooperation and pursue new opportunities.

5 Conclusions & Future Work

Accessibility is a human right for all categories of the population and concerns access to space and is a basic prerequisite for equal participation and an active role in society. It can contribute to smart, sustainable and inclusive growth. Consequently, we can understand the social, economic and technological impact of this innovative product. Its operation in practice will highlight the points that improve the quality of life of people with disabilities. Its vulnerabilities from a technological point of view, can be a reference point for further research and development.

Acknowledgement

This research has been cofinanced by the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation, under the call RESEARCH CREATE INNOVATE (project code: T1EDK- 04183 EQUAL)

References

[1] https://ec.europa.eu/eurostat
[2] Ian Patterson et al. “Developing a Meaningful Identity for People with Disabilities through Serious Leisure Activities”, ResearchGate, 2011.
[3] Dimitrios Buhalis et al. “**Accessible Tourism: Concepts and Issues”, ResearchGate, 2011**.