COGKNOW: Translating Research Innovation into Products and Services

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Abstract. This paper describes an eInclusion project supported by the European FP6 research programme, called COGKNOW. The aim of this project is to develop innovative solutions from research that help people in the early stages of dementia maintain their independence and confidence. The project is heavily user-driven and relies also on significant clinical advice and guidance to provide the technical research and development team with strong pathways for development. The project is developing a cognitive prosthetic device that can reinforce feelings of safety, support recreational activities, facilitate communication and most importantly support the person by using a calendar-driven reminding function in the device. COGKNOW is also focused on ensuring that the user-driven and clinically supported development takes cognisance of the potential market for a cognitive prosthetic. Consequently there is a formal assessment of the potential market carried out in the project. At this stage in the project, the functionality identified for the first of three trials in the project has been set out, and this paper introduces these findings and relates them to the proposed business framework.

1. Introduction

This paper describes the anticipated issues inherent in carrying out research, then designing a product for the healthcare market and seeking to ensure that the significant innovation from the research matches the market opportunity as the project concludes.

In this paper we discuss the design and potential outputs with regard to devices and service delivery models for the COGKNOW project, which is designed to tackle some of the problems faced by people with early onset dementia. The aim of COGKNOW [1] is to achieve a breakthrough with research that addresses the needs of those with dementia, particularly those living in the community with mild dementia in Europe – literally helping these people navigate through their day. This entails cognitive reinforcement in the four main areas of helping people to remember, helping to maintain social contact, helping with performing daily life and recreational activities, and providing enhanced feelings of safety.

Globally nations are facing the challenges posed by the first fully aged societies in human existence. This has directly resulted in the increased incidence of chronic diseases and conditions. These are degenerative conditions that can only be controlled and not,
currently at least, cured. They include diabetes, chronic obstructive pulmonary disease, asthma, arthritis, heart failure, dementia and a range of disabling neurological conditions.

It is often the case that many ageing people are living with more than one chronic condition and this means that they face particular challenges, both medical and social. The care of people with chronic conditions consumes a large proportion of health and social care resources. Dementia is a progressive, chronic disease affecting 5% of all persons above 65 and over 40% of people over the age of 90.

The COGKNOW analysis of the state of the art found that previous research has delivered devices and services which have had mixed or little success when applied to actual living conditions among ageing people with dementia [2]. However, they have proven useful in highlighting where gaps in service and autonomy may be filled. The COGKNOW advances on the state of the art are focused on addressing these gaps and on delivering a service and technology that makes a difference in actual living conditions.

The paper describes the scale of the problem facing Europe in Section 2, and describes the COGKNOW objectives and methodology in Section 3. Section 4 describes the technology and research objectives and pathways, and Section 5 describes related work. Section 6 enumerates initial project findings, Section 7 explores the market potential and issues for the COGKNOW innovation, before Section 8 discusses the conclusions.

2. The Scale of the Problem

In Europe by 2050, it is estimated that one-third of Europe’s population will be over 60. The number of ‘oldest old’ aged 80+ is expected to grow by 180% [3]. For example, in 1951, there were 300 people aged 100 and over in the UK. By the year 2031, it is estimated that this figure could boom to 36,000 [4]. Life expectancy has been rising on average by 2.5 years per decade in Europe. There are 5.5 million cases of Alzheimer’s disease in Europe and more new cases per year. Alzheimer’s disease has been called the ‘plague of the 21st century’. There is currently no cure for this disease, however prevention and early diagnosis may play a huge role in delaying the onset of severe disease. Medicines are available but the positive effects are limited, side-effects are reported and medicines often viewed as too expensive. Significant barriers to access exist across Europe. Finding better treatment options remains a priority, as is greater investment in research.

Governments have a key role to play in raising awareness and improving outcomes for sufferers of Alzheimer’s disease. Significant resources will be required to address the clinical and social aspects of Alzheimer’s disease. New models of care that span across health and social care are needed. Budget projections need to take into account the magnitude of the costs borne by families. It is often said that the ageing of the population will bankrupt our health care systems. Yet there are several reasons to believe that the ‘catastrophic’ view of the impact of ageing on health care systems is misguided.

Firstly, there is growing evidence that disability levels amongst older Europeans are decreasing, not increasing. Because there will be older people overall, the absolute numbers of dependent older people may increase in future. On balance however, the impact on future increased demand for care may be mitigated by improvements in the overall health status of older persons. Secondly, macroeconomic studies strongly suggest that ageing is not the main factor explaining the rise in health expenditure. Finally, although aggregate costs for the older segment of the population may be higher, this is not true at the individual level. Older persons often incur lower health care costs compared to individuals of a younger age with the same condition. This may be in part because they receive less intensive treatments. Also, the highest costs of care occur in the last 12-18 months of life and this is true at any age. Thus it is not the cost of ageing that is high, but the cost of dying.

From an economic point of view, a health care system can be defined as a subset of the economic system that includes all economic units involved in the production, consumption
and distribution of health care. However, in most countries health care production, consumption and distribution are not organised in a single way or according to the same sets of resource allocation principles and mechanisms for the whole population. While part of the population consumes health care according to free-market criteria, some groups may have access to care under a given set of governmental regulations, which include a mix of insurance, subsidiarity, monopsony and other market interventions. A general characteristic of health care consumption is the presence of financial intermediates or third-party payers. Health care is sometimes the object of voluntary insurance, but in most countries a large proportion of the population is covered by a so-called social or mandatory insurance, where membership or entitlement is not the result of consumer decision but legally enforced. In any event, the consumer seldom pays for health care directly to the provider.

Besides formal costs associated with ageing, a lot of pressure is put on informal carers. Between 65-80% of older people are cared for by relatives, who – as a consequence of caring - may experience changes in physical and mental health themselves [5]. To provide sufficient care in the future, formal care and welfare resources as well as help from informal carers will be needed. However, alternative strategies will also have to be found to be able to account for the needs of the growing number of ageing people. One of these strategies can be the development of assistive technologies. In COGKNOW we aim to explore and develop innovative technological solutions to support people with dementia and their carers in the community in their daily life. The services envisaged in COGKNOW should be available through the local healthcare provision, or funded through health insurance.

3. Objectives and Methodology

The project methodology for COGKNOW is to iterate development three times in the lifetime of the project where each development cycle or iteration improves the end ‘product’ and increases the research knowledge gained. Each cycle will cover assessment of user needs and preferences, prototype development, a field trial and validation.

In each cycle, user need workshops, interviews and field trials are carried out with a maximum of eighteen people with dementia and their carers (6 dyads per test site) [13] in Belfast, UK; Lulea, Sweden and Amsterdam, Netherlands. The user needs workshops and interviews are conducted with persons with dementia and carers separately, according to pre-defined guidelines. Two presentations (one with slides of different time frames and activities during the day, and one with possible ICT solutions) were used to help people express their needs, wants and demands in daily life and their preferences for possible ICT solutions. During field trials, the COGKNOW devices are installed in participants’ homes, and evaluated by means of semi-structured interviews and observations.

The first development phase in 2007 and the second in 2008 focuses on user friendliness and usefulness for supporting memory, social contacts, daily activities, and enhance feelings of safety. The third development phase in 2009 will focus on the usability and efficacy of the full COGKNOW solution. After each trial phase, human factors analysis, test reports and results from business workshops will be synthesised into an overall evaluation from user, technology and business perspectives.

A key objective of the project is to evaluate whether or not the COGKNOW service, device and platform meets the stated objectives based on the functional and technical requirements generated in the relevant work packages. In particular, the aim of the evaluation is to improve the design and integration of applications that help people with dementia to navigate through their days in the four COGKNOW support areas of memory, social contact, daily activities and feelings of safety; to identify the complex circumstances under which people with dementia operate; to obtain a better understanding of how people with dementia understand, interpret, and use technology; and to assess the overall impact on actual and perceived autonomy and quality of life factors.
Other key objectives are to identify business opportunities and appropriate business models that sustain the innovation in the market place for the products and services arising from the project and compare the overall project results with the original aim of the project.

In COGKNOW, the business opportunities are explored, explicitly defined where possible and then modelled and validated incrementally after each trial. After the first field trial a business assessment workshop will be organized at one of the project meetings, with representatives of all partners. In the second and third field trial workshops with external stakeholders will be organised.

4. Technology Description

From a technical perspective the consortium has identified a series of technological objectives in an effort to advance the state-of-the-art. Specifically, the project aims to advance the state-of-the-art in the following areas:

- Capability of predicting context;
- Mobile based delivery of reminding services;
- Ubiquitous computing within the realms of mild dementia;
- Deployment of we-centric services; and
- Use of multi-modal services.

These are discussed in the following paragraphs. Context prediction is the capability for ubiquitous computing environments to support the prediction of the possible future contexts of interaction with people [6]. The project will also explore advancing research in the utilisation of wireless and mobile device technologies, in order to provide a device that can be used in the person’s house as well as on their travels and excursions. This places our research firmly in the area of ubiquitous computing, where the project will explore new advances specifically of use to those with mild dementia. Specifically, COGKNOW will explore a people-orientated, we-centric approach, and explore the use of multimodal interfaces for information delivery. The concept of we-centric services is ‘context-aware services that support interaction between people in dynamic personal social contexts’ [7]. The we-centric concept is different from the classic ambient intelligence-originated I-centric perspective [8] primarily in its view that relations between people are potentially reciprocal. We-centric also takes a strongly service-orientated approach, which provides potential flexibility via dynamic bundling/unbundling of service offering in ubiquitous computing environments and interleaves well with the context management framework to be developed in COGKNOW.

It is necessary, given the intricate linkage between the envisaged technical elements within the project, that each individual component be evaluated in terms of integration performance with all other system components in addition to evaluation in isolated terms. Figure 1 provides a general overview of the four main components that are envisaged within the system from a technical perspective.
It is intended that the COGKNOW Home Hub (CHH) provides services for the person with dementia within their own home. The CHH, which is a commercially available tablet computer, also acts as the hub for the sensors in the person’s home. In the first trial we are testing a sensors on a door of the home. In later trials we will expand this capability. In the home the person with dementia also uses a Cognitive Assistant (CCA), which is a programmable, commercially available handheld device with mobile telephony and location-finding functionality. It is intended that the person outside of their home will also use the CCA. While outside of the house the CCA can communicate with the COGKNOW Server (CS). Carers and family can then use the COGKNOW Web Interface (CWI) to assess the situation for the person with dementia, or to update their calendar.

There are significant problems to be overcome in order for COGKNOW to succeed. The primary technical challenge is to provide a reliable, scalable platform that guarantees a high level of service provision. But there is also the challenge to advance the state of the art. In COGKNOW, we have chosen to use Commercially available Off-The-Shelf (COTS) equipment where possible, and extend the state of the art using new software components. This provides a reliable platform, which can be offer opportunities for experimentation with service provision and functionality. A video was developed to illustrate the vision of COGKNOW to those taking part in the field trials. Available on the COGKNOW site, it shows how the devices may be used in situ (www.cogknow.eu/docs/dissemination.htm).

5. Related Work

While there is some research and development in cognitive prosthetics, there are very little relevant tools, solutions or technologies specifically for people with mild dementia. It is important to note that there exists no one solution in the market or research laboratories that proffers a solution in line with our technological objectives. However, if we split the state of the art into the four areas of remotely configurable reminding functionality; communication and interaction functionality; supportive technology for performing daily life activities; and safety or anomaly detection, then there are solutions and tools that address to a greater or lesser extent each one of these areas.

In the area of reminding, the EU project Technology, Ethics and Dementia (TED) under the EU programme Biomedicine and Health (and the Enable project – see later) has
produced some devices for reminding and reinforcing – including the Forget-Me-Not device (see picture) [9], which is an electronic calendar to aid persons suffering from memory problems or cognitive impairment. The researchers found that the calendar could be useful for persons who are confused about day and date.

In the area of communication, mobile phones with one button have been developed for elderly persons with cognitive disabilities to allow direct contact with a family member or carer. Only a few small-scale studies were carried out with mobile phones in patients with dementia. Kort [10] reported on the positive social experiences and positive effect on self-esteem of some people with dementia using a “Mobile TeleCoach”, which answers automatically and contains just one button for calling, to keep in contact with the informal carer. The users were not very satisfied with the design of the mobile phone.

In the area of performing daily activities, the multi-national ENABLE (Enabling Technologies for People with Dementia) project assessed the effect of assistive devices to support memory, to provide pleasure and comfort, and to facilitate communication (calendar, medicine reminder, lamp, locator, gas cooker monitor and picture phone) among people with dementia with regard to their quality of life, and the burden on their carers [11]. Finally, in the area of safety, we are aware of several detection devices used in different diagnostic groups and alarm systems in the home used for people with dementia. However, we have only found a small number of scientific studies investigating the results of these applications in people with dementia. Miskelly [12] investigated electronic tagging (bracelet and monitoring station) in patients with dementia in residential homes and found it to be reliable and successful in detecting external wandering and argues for using the system also for people living in the community with a relative.

6. Initial Findings

The technical goal of COGKNOW is to research and prototype a portable, remotely configurable, user-validated cognitive prosthetic device, together with associated services for people with mild dementia that will provide cognitive reinforcement in the four key areas described earlier. The project iterates through three cycles of development, from identification of user needs and preferences, through to validation of requirements, development field trials and validation of prototypes. Initial results from the first set of user need workshops from the initial cycle are now available.

In terms of the area of support for memory, the early indications from user need workshops and interviews suggest that reminding services and item locator services are of key importance to users [13] (see Table 1 for example scenarios).

<table>
<thead>
<tr>
<th>Key area</th>
<th>Scenario description</th>
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<tbody>
<tr>
<td>Reminding functionality</td>
<td>At 10 o’clock the COGNOW navigator reminds Martin to take his medicine using a specific sound that is backed up by a written message on the display. Martin reads that it is time to take his medicine.</td>
</tr>
<tr>
<td>Picture dialling</td>
<td>To call his son or daughter, Martin has to touch the phone symbol under their photographs. He presses the phone symbol and a connection is made to his daughter, with whom he talks for a while.</td>
</tr>
<tr>
<td>Support for activities for pleasure</td>
<td>During the evening Martin frequently uses the COGNOW navigator to turn on the television because he has trouble finding the right TV channel and programme on his television.</td>
</tr>
<tr>
<td>Safety warning</td>
<td>When Martin goes out for a walk and he forgets to take his mobile and/or his keys with him, the front door sensor will always provide a gentle reminder as he passes through it. If he doesn’t know where he left his mobile, he can touch a pictogramme of a mobile at the COGNOW stationary device and a buzzer sound leads him to the place were he left it.</td>
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For the area of support for social contacts, the top selections are picture dialling and the highlighting of social events. For the third area of support with daily activities, the users identified needs for entertainment management (activities for pleasure). In the fourth area of enhancing feelings of safety, the identified needs included safety warnings when keys/mobile phone are forgotten or doors are left open and contact capability to emergency services integrated within the cognitive prosthetic. The project is moving forward to develop solutions that address these areas in the first development cycle.

7. Meeting the Market

Getting health care innovations from the pilot state to actual innovations in the market is notoriously difficult, especially as the technical components (hardware and software) must marry with existing or modified services that add value to the health care provider. In addition, there must be significant value-add to the circle of carers, both informal and formal, and finally, for the person with dementia, it must work.

From a purely financial perspective, the proposed services supported by new technology as envisaged in COGKNOW must make financial sense. In COGKNOW, preliminary assessments have been made of the business implications of the increasing needs of people with dementia for different territories in Europe. For example, in the United Kingdom, the market can be sized, based upon assumptions from statistical data that is readily available. Around 5% of all people over the age of 65 have dementia. The proportion of people aged over 65 is projected to increase from 16 per cent in 2004 to 23 per cent by 2031 [14]. Five percent of 23% of around 60M of population translates to 690,000 people in the UK, who are likely to suffer cognitive decline. Souetre et al. [15] estimated the total mean three-monthly cost per patient with mild Alzheimer’s in the UK as £6,616. The per annum cost then is around £40,000. It could therefore cost the National Health Service and carers in the UK around £27.6 trillion (690,000 x £40,000 per annum). Institutionalisation is responsible for the largest proportion of costs [16]. Using COGKNOW to allow 10% of people to remain independently at home annually would save (let’s make an assumption that COGKNOW services are 25% cheaper) around 10% of 25% of £27.6 trillion, which equates to £690M annually. Clearly, this is only an initial estimation but it shows the potential of technology to address people’s needs in a cost-effective manner.

Significantly, as a European collaboration, the COGKNOW solution and associated service offering must provide integration routes for a broad and heterogeneous range of countries and regions across the Community. At this stage, the project seeks to identify viable COGKNOW business opportunities, researching what a viable business model for these business opportunities could look like; and seeking to identify positive business factors that can be fed back into the development of COGKNOW services.

There are significant areas of interest to the consortium in terms of the shaping of the COGKNOW business model. For example, defining what constitutes a viable business model for the service bundle of the four service areas to be developed, defining the core service or value of the COGKNOW bundle, as well as learning from business models for the provision and dissemination of other comparable ICT services, or service bundles, for ageing people (with dementia) that are already on the market. There needs to be an investigation into the roles needed to deliver the COGKNOW services, the actors involved, and the identification of the most viable business configurations. The project must also examine the critical design factors, the key differentiators that mark the COGKNOW service (bundles) apart from the alternatives in the market. Most importantly, the consortium must identify viable routes to introduce the COGKNOW services into the market.
8. Conclusions

Innovation often requires not only new technology but also new business models. The critical success factors for the COGKNOW innovation are grouped into the three areas of market, business modelling and actor viability. In terms of market factors, key considerations are a clear target group, compelling value proposition and non-obtrusive customer retention potential. For business modelling factors, the project seeks to explore the complexity of different business models, for example, single-actor versus networked business models, as well as researching profitability issues. In terms of actor viability factors, a key consideration is the sustainability of a selected business model, provision of an acceptable quality of service delivery and the customer reach of the selected actors.

The consortium has selected a framework for successful business concepts upon which the COGKNOW business evaluation will be based. The consortium uses four interrelated components or domains that together define the business model as defined by Haaker [17]:

- Service domain: a description of the service offering, its value proposition (added value of the service offering) and the market segment at which the offering is targeted;
- Technology domain: a description of the technical functionality required to realise the service offering;
- Organization domain: a description of the structure of the multi-actor value network required to create and provision the service offering, and to describe the focal firm’s position within this value network; and
- Finance domain: a description of the way a value network intends to generate benefits and/or revenues from a particular service offering and of the way risks, investments and revenues are divided across the different actors in a value network.

There is no single recipe for developing successful business models. But it is possible to identify critical design factors, which should be taken into account if the COGKNOW concept business model is meant to be successful at all. These critical design issues may provide business criteria for the further development of the COGKNOW services [14].

To date, in the working through of the first development iteration within COGKNOW, the research has focused on requirements within the context of the four identified need areas of cognitive reinforcement in the areas of support for reminding, social contacts, activities of daily living, and enhancing feelings of safety. The services identified from this research encompass reminding, item locating, picture dialling, social event highlighting, entertainment management, safety warnings and emergency contact services. The next step for the COGKNOW consortium is to map these service bundles into a framework such as that described by Haaker, in order to identify the optimum way to create value in a new business model to the stakeholders in the project.

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