COGKNOW

D5.7.1

Final Evaluation Report

Version 3.0

04/11/2009

Status: Published

Lead Editors: Rose-Marie Dröes (VUmc) and Johan E. Bengtsson (CDH)

SIXTH FRAMEWORK PROGRAMME

PRIORITY IST-2005/2006-2.5.11

Unit H3 - eInclusion

Contract no.: 034025

Context

WP 5	Evaluation
WPL	Marike Hettinga (Novay)
Task 5.7	Final Evaluation
TL	Marike Hettinga (Novay)
Dependencies	This deliverables uses specifically the input of the deliverables D1.7.1, D4.6.1, D5.1.1, D5.4.1, D5.5.1, D5.6.1, D7.3.1
Starting date	11/08/2009
Release date	30/10/2009

Author(s)	Rose-Marie Dröes (VUmc), Johan E. Bengtsson (CDH), Franka Meiland (VUmc), Timber Haaker (Novay), Ferial Moelaert (Novay), Maurice Mulvenna (UU), Chris Nugent (UU)
Contributor(s)	Ans Bouman (VUmc), Ricky Davies (UU), Sanne Bentvelzen (VUmc), Eilish Armstrong (BCH), Hazel Johnston (BCH), Eva Karlsson (CDH), Stefan Sävenstedt (CDH), Marike Hettinga (Novay)
Reviewers	Angele Giuliano (AL), Marike Hettinga (Novay)

Table of Contents

1. Summary 5

2. Introduction 7
   2.1. Project Process and Evaluation Aims 7
   2.2. The Final Prototype 10
   2.3. The Users in the field tests 12
   2.4. The Market in Europe 13

3. Final Human Factors evaluation 15
   3.1. User-friendliness and Usefulness 15
   3.2. Impact on daily life 16
   3.3. Discussion and Recommendations 17

4. Final Technology evaluation 21
   4.1. Development Process 21
   4.2. Security 23
   4.3. Reliability and Efficiency 24
   4.4. Portability 24
   4.5. Discussion and Recommendations 24

5. Final Business evaluation 27
   5.1. Market factors (acceptance) 28
   5.2. Business Modelling factors 30
   5.3. Viability factors 31
   5.4. Recommendations 32

6. Final Methods and Tools evaluation 33
   6.1. Human Factors evaluation methods and tools 33
   6.2. Technology evaluation methods and tools 34
   6.3. Business evaluation methods and tools 35
   6.4. Field Test procedures 35
   6.5. Evaluation of methods and tools 36
   6.6. Lessons learned 38

7. Final Conclusions 39

References 41

Annex A. ISO 9126-1 Quality Model 43

Annex B. Software Release Process 44

Annex C. COGKNOW Dissemination Report 47
   C.1. Journals and Scientific Magazines 47
   C.2. Book Chapters 48
   C.3. COGKNOW Book, Q1 2010 48
   C.4. International Conferences 49
   C.5. Workshops 51
   C.6. Webs and Videos 52
   C.7. Other Dissemination Activities and Output 52
   C.8. Planned Publications and Events 53

List of Figures

Figure 1: Project plan with main work items and methodologies 8
Figure 2. CHH touch screen with handset, CCA mobile device 10
Figure 3. Overall System Architecture of COGKNOW Day Navigator 10
Figure 4: Business assessment workshops, timing and focus 28
Figure 5: A business role model for COGKNOW services 30
Figure 6: Quality Model for External and Internal Quality [ISO 9126-1] 43

List of Tables

Table 1 Evaluation aims for each iteration 9
Table 2. Functionalities in the final prototype, with validation status 11
Table 3. Characteristics of participants in the three field tests 12

Abbreviations

COGKNOW	Project title COGKNOW; Helping people with mild dementia navigate their day
CDN	COGKNOW Day Navigator
CS	COGKNOW Server
CHH	COGKNOW Home Hub
CCA	COGKNOW Cognitive Assistant
CSH	COGKNOW Sensorised Home
MMSE	Mini Mental State Examination
GDS	Global Deterioration Scale
PwD	Person with Dementia
FT	Field Test

1. Summary

The objective of COGKNOW was to achieve a breakthrough in the development of a successful, user-validated cognitive prosthetic device with associated services for people with dementia.

The COGKNOW project was a selected showcase for the European Commission Smart Home at e-Inclusion Ministerial Conference (2008). It has received national media coverage in the Netherlands, UK, Sweden and USA. COGKNOW has produced 14 scientific articles that have been accepted for publication in peer-reviewed journals, and a book is in press.

This report consolidates the integrated evaluations of the COGKNOW Day Navigator (CDN) from human factors (Chapter 2.4), technology (Chapter 1) and business (Chapter 1) perspectives, after three field tests (one each project year) conducted in the homes of persons with dementia in The Netherlands, UK (Northern Ireland) and Sweden. This report is derived from the project-internal reports: D5.4.1 Evaluation of Field Test #1, D5.5.1 Evaluation of Field Test #2 and D5.6.1 Evaluation of Field Test #3.

A synthesis of the evaluation results across the three field tests is presented and discussed, focusing on the characteristics of the third and final CDN prototype as well as the critical business success factors. Recommendations are made from human factors, technology and business perspectives. Finally, the methods and tools used in the evaluation process are summarised and discussed (Chapter 6), and conclusions are drawn (Chapter 7).

This report is the basis for the project-internal report D7.2.1 Business Planning.

Dementia is a progressive, cognitive disabling disease affecting 10% of all persons above 65. The risk of dementia increases with increasing age, and therefore the numbers affected will increase significantly as the age structure undergoes a major shift in the coming decades. For the person with dementia the disease has symptoms involving impairments of memory, speech, thought, perception, action and reasoning, but the disease also impacts negatively by causing major disruption and stress in the lives of the families and carers where the person with dementia lives.

This ambitious project is among the first to involve persons with dementia and their carers directly, in the various stages of analysis, development and field testing. The project partners have been strongly dedicated to create and validate integrated assistive home and mobile devices, targeting persons with mild dementia. The project has developed a multi-disciplinary overall method, combining mixed-method (triangulating) human factors evaluation methods, with iterative methods for technical development and a comprehensive method for business development.

The COGKNOW Day Navigator prototype consists of a touch screen in a home environment imbued with sensors and computer-mediated controls, and a mobile device for the person with dementia to bring along when going outside of their house. Both devices offer easy-to-use functions that have been formally validated as top priority needs areas in the project: memory support, support to manage activities of daily life, support to maintain social contacts, and to enhance feelings of safety. The COGKNOW Day Navigator has been carefully designed to provide multimodal interfaces that are adaptable to the cognitive support needs and perception disabilities of individual persons, and to changing needs and disabilities over time.

The project has completed three cycles of development, field testing and evaluation. 10 persons with dementia used the prototype independently for several weeks while 32 used it for one or more days. The project's human factors impact analysis has shown that the COGKNOW Day Navigator is perceived as useful and user-friendly by the users, with a potential to maintain more autonomy in several areas of daily living and to improve their quality of life. This offers the potential for people with dementia to keep living independently in their own homes for a longer period, while giving relief to their relatives and carers.

The current direct annual costs in Europe for institutional care for a person with dementia in 2009 is around ten thousand Euro. There is thus huge economic as well as human potential in integrated assistive technologies like the COGKNOW Day Navigator, given the 3.7 million mild dementia sufferers in Europe that might stay longer in their own home. The results of the COGKNOW project will also be relevant to care providers for persons with other cognitive disabilities, to sheltered home providers for elderly, and to individuals of all ages as “comfort services”.

COGKNOW uses commercial off-the-shelf stationary and mobile devices, and commercial technologies for automatic sensing and for controlling the home environment, which keeps investments and operating costs reasonably low. The ability to adjust configurations and service settings remotely enables family and professional carers to offer support also remotely which complements and extends physical presence. The fast pace of improvements in performance/price ratios in the ICT industry suggest a further increase in the attractiveness of COGKNOW-like systems.

The COGKNOW Day Navigator has the potential to be improved and to become more stable and secure, and with more multi-modal interaction. There is also the potential to improve the capabilities of the system to configure and personalise COGKNOW services remotely. Special attention needs to be paid to the audio quality of media and phones. Key functional areas for improvement are reminders, outdoors navigation and daily activity assistance.

The prototype needs to be made more resource-efficient, so that large schedules of multimodal reminders can be supported. IP-based telephony and the ability to access music and other media on the Internet may be added to the system. The technical support tools may be improved, including tools for assessing the status of each COGKNOW Day Navigator installation and to access the system remotely for problem solving.

Further business development should focus on looking beyond the primary target group of persons with dementia, since the COGKNOW DayNavigator is also relevant to persons with other types of cognitive disabilities, and as a comfort service for just about anyone. Commercial partnerships may aim to build upon existing commercial platforms, working closely with public bodies responsible for funding care services.

The user-centric approach and mixed-method evaluation design used in the project was found to be very suitable to provide a good understanding of user-friendliness, usefulness and impact on quality-of-life, and gave valuable information to later development stages. The pre-defined research questions, the Service-Technology-Organisation-Financial (STOF) critical factors model and the ISO-9216-1 Quality Model gave good structure to the formative and summative evaluations in the project.

In order to build upon the significant findings from the COGKNOW project, there is an opportunity to carry out a broader, larger, longitudinal pilot study in order to test an improved prototype, for gaining knowledge about the impact of using an assistive cognitive device with persons from different backgrounds and in different stages of dementia.

2. Introduction

Dementia is a progressive, cognitive disabling disease affecting 10% of all persons above 65. The risk of dementia increases with increasing age, and therefore their numbers will increase significantly as the age structure undergoes a major shift in the coming decades. The disease has symptoms involving impairments of memory, speech, thought, perception, action and reasoning. Needs mentioned both by people with dementia and their carers have often remained unmet by professional care and welfare services, or have been addressed by multiple single-function assistive devices, which is complex and confusing to use.

The objective of COGKNOW was to achieve a breakthrough in the development of a successful, user-validated cognitive prosthetic device with associated services for people with dementia.

This report consolidates the integrated evaluations of the COGKNOW Day Navigator (CDN) from a human factors, technology and business perspective based on the three field tests (one each project year) conducted in the homes of persons with dementia in The Netherlands, Northern Ireland and Sweden. This report is based on the internal project-deliverables: D5.4.1 Evaluation of Field Test #1, D5.5.1 Evaluation of Field Test #2 and D5.6.1 Evaluation of Field Test #3

In this final evaluation report a synthesis of these evaluation results is presented and discussed, focusing on the characteristics of the third and final CDN prototype. Recommendations are made from each of the three mentioned perspectives. Finally, the methods and tools used in the evaluation process are summarised and discussed and conclusions are drawn.

This report is the basis for the project-internal report D7.2.1 Business Planning.

In this introduction we set the scene for this report by describing the project process, evaluation aims, the final prototype, the users that participated in the development of the CDN and the field tests, and the market for the CDN.

2.1. Project Process and Evaluation Aims

The COGKNOW project was run according to a comprehensive project implementation plan with detailed plans for technical development and evaluation [COGKNOW DoW, 2006]. During the project, project partners contributed suitable models and processes that have ensured relevant and valid results. Below a simplified view of the project work plan is given, annotated with the main significant working models, artefacts and methodologies used (see figure 1).

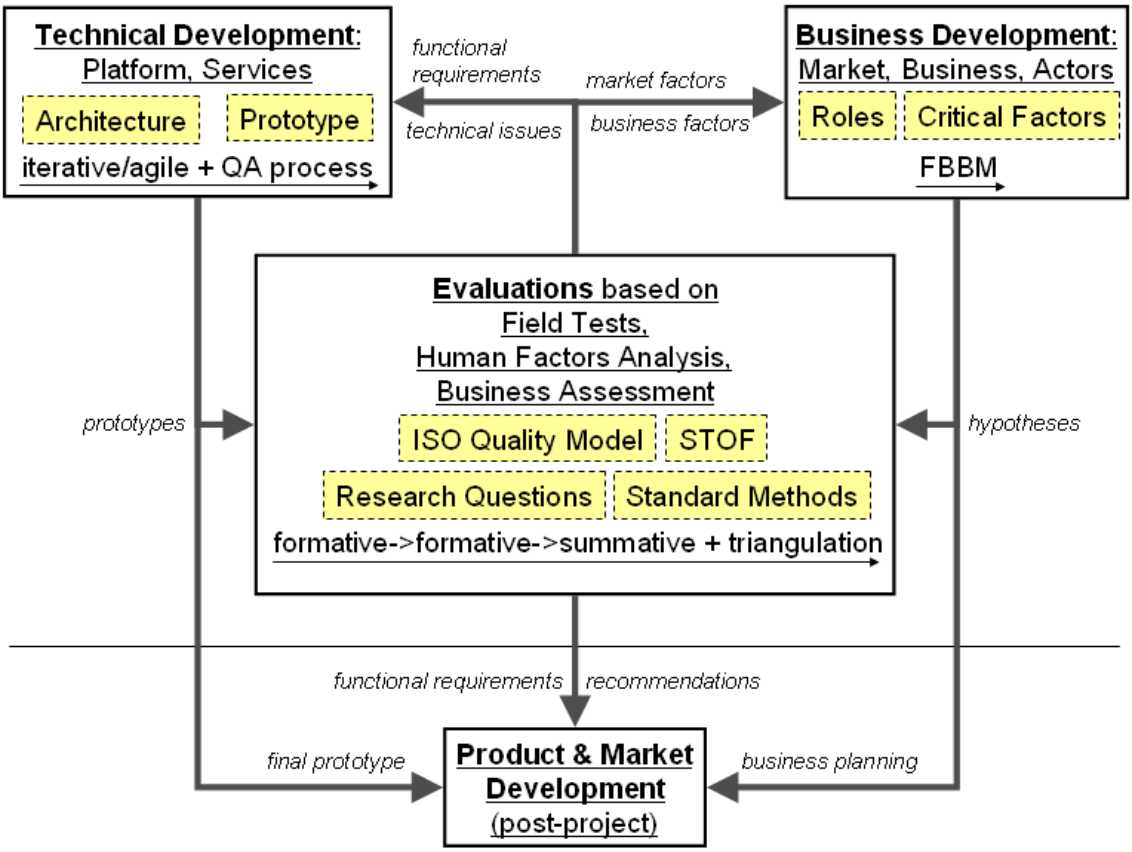

Figure 1: Project plan with main work items and methodologies

Technical development was done in a highly iterative manner using iterative development methods where prototyping was performed with frequent interaction with dementia experts and users at project test sites. User needs, state of the art in technology and use, healthcare models, and existing technical standards were initially surveyed and analysed to guide the early technical development (Lauriks et al, 2007). Initial *functional requirements* were generated based on known needs and solutions from previous field test and literature studies (Dröes et al, 2005; Van der Roest et al., 2007. 2009), own 'user needs and solutions' inquiry workshops and technical feasibility analysis. The functional requirements became the main information tool for agreeing on development priorities for each field test. The hardware used has been pre-dominantly commercially available user devices and peripheral equipment. A Quality Assurance (QA) process was defined with clear unit testing, integration testing, site test and field test stages. The architecture and *final prototype* are described in section 2.2.

Business development was carried out throughout the project, following the STOF method (Bouwman et al., 2008). It started with a state-of-the art survey followed by a market analysis. Then a business role model was created as basis for describing critical market and business success factors. Hypotheses were formulated on market and business factors, that were then assessed in workshops with external stakeholders. Field tests were also used to obtain feedback on critical success factors and design issues. In the last stage, prospective business actors for the post-project stage were invited to assess the viability of proceeding with pre-commercialisation activities. The business role model is described in section 5.2. The *business planning* material will be described in D7.2.1 Business Planning (project-internal report).

Evaluation from three perspectives was performed three times (once every year), based on field tests at three test sites (Amsterdam, Belfast and Luleå) in which qualitative and quanti-

tative data were collected by means of standardised methods and procedures (interview, observation, diaries, logging, technical issues reports). A human factors impact analysis was performed on the collected data. Results from the human factors impact analysis and from business assessment workshops were integrated into multi-perspective evaluations to inform further technical and business development. The evaluation activities were user-centric, driven by research questions that were updated before each field test. The business perspective was structured in Service, Technology, Organisation and Financial (STOF) dimensions, as defined by the FRUX Broadband Blueprinting Method [Bouwman, De Vos & Haaker, 2008]. The ISO 9126-1 Quality Model for External and Internal Quality (Annex A) was used to structure the final summative evaluation, which resulted in recommendations on the functional requirements and further recommendations from human factors, technology and business perspectives.

Table 1 Evaluation aims for each iteration

Evaluation number	**Human Factors focus**			**Functionality focus**				**Evaluation aims**
	User friendliness	**Usefulness**	**Efficacy**	**Remembering**	**Social contact**	**Activities Daily Life**	**Feeling safe**	
FT#1	✓	✓		**X**	**x**	**x**	**x**	Formative evaluation of basic concepts used in the COGKNOW DayNavigator; also of evaluation methods, tools and procedures: - Evaluate basic user friendliness of mobile and stationary devices with focus on hardware-related factors - Evaluate assumptions about the user friendliness and usefulness of basic concepts used in COGKNOW DayNavigator (e.g., reminders) - Collect basic data about activities and user context in order to inform the design of context-aware features - Evaluate in-situ data collection methods, tools
FT#2	✓	✓		**X**	**X**	**X**	**X**	Formative evaluation in daily life of first full CDN prototype: - Evaluate user friendliness and usefulness in all functionality areas - In-situ collection of detailed data about activities, context and user experience in order to improve effectiveness and efficiency of context-aware CDN features
FT#3	✓	✓	✓	**X**	**X**	**X**	**X**	Summative evaluation in daily life of an improved CDN prototype: - Evaluate efficacy of CDN on actual and perceived autonomy in all functionality areas regarding overall quality of life - Evaluate user friendliness and usefulness in all functionality areas

Product and Market Development is assumed to commence after the end of the project. Product Development should focus on improving and adding significant functionality, as well as addressing any quality shortcomings in the prototype as recommended by the final evaluation. Market development should focus on working with key stakeholders that will influence the decisions of the target group identified during the project and any other business recommendations from the final evaluation. The post-project development of products and markets may require further project funding and complementary business partners.

2.2. The Final Prototype

Figure 2. CHH touch screen with handset, CCA mobile device

The final COGKNOW Day Navigator (CDN) prototype consists of the COGKNOW Home Hub (CHH), the COGKNOW Cognitive Assistant (CCA), the COGKNOW Sensorised Home (CSH), and the COGKNOW Server (CS).

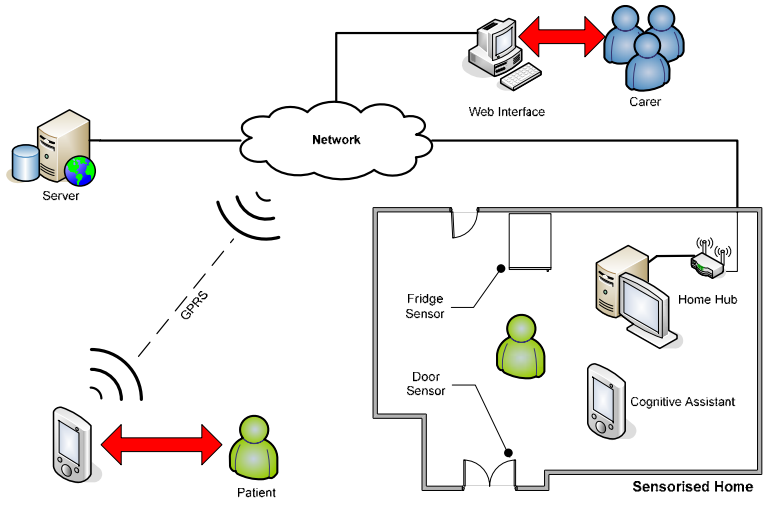

Figure 3. Overall System Architecture of COGKNOW Day Navigator

In the following table, we present an overview of the functionalities in the final prototype and their testing status.

Table 2. Functionalities in the final prototype, with validation status

	Functionality	**Validation status[1]**
General		
	Languages: English, Dutch, Swedish	FT3
	Selectable services	FT3
	Selectable icons, text captions, font sizes, CHH voice prompts.	FT3
Support in Reminding		
	Date & weekday & time indication: analogue or digital, 24-hour or am/pm, possibility to suppress the seconds indicator	FT3
	Pop-up reminders: remotely configurable, one-time or daily, user-defined text/image/audio/repetition	FT3
	Agenda & Quarter Hour Clock	FT3
	Appointment Reminders	FT2
	Find Mobile Device	FT3
	Item Locator	site tested
	Forgotten Keys Warning	unit tested
Support social contact		
	Picture Dialling: priority, photos, landline prefix, using existing phone or voice modem with handset	FT3
	Internet-based telephony (SIP)	integration tested
Support daily activities		
	Radio/lamp control using Tynetec actuators	FT3
	Radio/lamp control using X.10 actuators (unreliable)	FT2 (unreliable)
	Music/story player: Selectable music	FT3
	Activity assistant: stepwise video or image+voice instructions for daily activities	FT3
	Automatic music during lunch (MotivateToEat)	FT2
Enhance feelings of safety		
	Help/emergency: personalised contact/help icon	FT3
	Pop-up safety warnings: doors, household appliances	FT3
	Sensorised night light (NightLight)	FT2
	Navigation when outdoors (TakeMeHome)	FT3
	We-centric navigation when outdoors (TalkMeHome)	mockup

[1] The last development or evaluation stage when it could be tested.

2.3. The Users in the field tests

The users that participated in the field tests were community dwelling people with mild dementia of the Alzheimer type (MMSE ≥17) and their carers. The youngest person with dementia was 56, the oldest 90. Most of them were living together with a partner carer, some were living alone and were cared for by a son, daughter or friend.

Table 3. Characteristics of participants in the three field tests

People with dementia	**FT#1**	**FT#2**	**FT#3**
Average age	Amst 65 Belfast 71 Lulea 70 Range 56 - 78	Amst 78 Belfast 75 Lulea 69 Range 57-90	Amst 71 Belfast 74 Lulea 79 Range 57-84
Gender	11 female 5 male	10 female 4 male	7 female 5 male
Civil status	12 married 1 widowed 3 single	8 married 4 widowed 2 single	11 married 1 widowed
Carers			
Average age	Amst 59 Belfast 64 Lulea 59 Range 23-78	Amst 66 Belfast 62 Lulea 72 Range 40-79	Amst 67 Belfast 74 Lulea 71 Range 53-78
Gender	7 female 9 male	4 female 9 male	5 female 7 male
Relation to patient	11 spouses 4 children 1 cousin	9 spouses 3 children 1 friend	11 spouses 1 son of sister

All had memory problems and difficulties with orientation in time and place, many had word finding problems, some had problems with handling objects, others with understanding textual messages or pictures. All were recruited from memory clinics and day care centres or meeting centers at three project sites: Amsterdam in The Netherlands, Belfast in Northern Ireland and Luleå in Sweden.

They all voluntarily agreed to participate in the project and were free to withdraw from the field tests whenever they wished. For each field test new participants were recruited, but if couples wished to participate in a following field test they were allowed to when they still fulfilled the inclusion criteria. The majority participated in one field test, seven couples participated in two field tests, and three couples participated in three field tests. Some characteristics of the people with dementia and carers in the three consecutive field tests are presented in Table 3.

2.4. The Market in Europe

Among the elderly population in Europe about 3.7 million people (5%) have been diagnosed to suffer from *mild* dementia (EuroCoDe, 2009). The risk of dementia increases with increasing age, with a prevalence of 25% in people over 85 years and even 50% in women above 95. Life expectancy depends on country and age at diagnosis and is on average about 5 years after diagnosis (www.Alzinfo.org, 2004).

A rough estimate of the incidence rate of persons entering into dementia each year in Europe (calculated as prevalence divided by average disease duration) is about 740.000. Worldwide, more than 4 million persons are diagnosed with dementia each year, and this number is expected to quadruple until year 2040 (Bronnen: Ferri et al, The Lancet (2005) 366: 2112-17). The field studies of the COGKNOW project were small but gave indication that user acceptance can be achieved. A barrier to use will be blocking by policies not including COGKNOW for as an intervention. If we assume that 10% of the people with mild dementia would use the COGKNOW Day Navigator, then the European market potential is 74 000 persons per year.

The care costs of Alzheimer's disease and other dementias in 2005 were 21 000 Euro per PwD; of which 9 300 Euro were direct care costs. The possible yearly savings on direct care costs of enabling a person with mild dementia to remain at home rather than to move to sheltered care is therefore about 10.000 Euro per year, and much higher in some countries (Alzheimer Europe, Dementia in Europe Yearbook 2008).

Further studies are needed to determine how much the use of the COGKNOW Day Navigator will prolong the ability to remain in their own home. Let's assume that one year is achievable.

With the above admittedly uncertain assumptions, the estimated customer potential of COGKNOW in Europe today represents 740 million Euro per year in dementia care costs. If COGKNOW-based care would reduce these costs by one third, then there is an economic value of introducing COGKNOW amounting to about 247 million Euro per year, in Europe alone. Earlier diagnosis of dementia has the potential to bring further value to society by reducing the burden of carers of currently undiagnosed persons with dementia.

(even page intentionally left blank)

3. Final Human Factors evaluation

In this chapter we will draw conclusions based on the three field tests performed during the COGKNOW project (September 2006 - August 2009) and will discuss the results in relation to existing knowledge and the limitations of the Human Factors Impact analysis. We will also go into the scientific relevance of the results and the relevance for psychogeriatric care.

3.1. User-friendliness and Usefulness

The main research focus was on user-friendliness and usefulness of the COGKNOW Day Navigator. In the third field test, we also aimed to exploratively investigate in a small (one group) pilot study the impact of the developed system on actual and perceived autonomy and quality of life in the selected domains of daily life of the PwD. However, due to problems with stability of the system during the field test period, we could only evaluate the impact on daily life in a limited manner.

3.1.1. Reminding functionality

The reminding function was overall judged positively during the three field tests. The day and time indication was improved after comments received during the first field test, and PwDs and carers considered this function useful. The reminder function for activities and events were considered user-friendly and useful. Comments during the first field test concerned the wish for more personalisation and configuration of reminders and the way of attracting attention to the reminders on the screen. During the last field test carers who had some computer skills were able to set reminders themselves. Also more configuration options for the content and presentation of reminders were available: people could choose the pictures and audio that accompanied the text reminders. Inefficiencies in communication within the final prototype prevented extensive multimodal presentation of reminders (text, picture and voice) from being tested. The quarter-hour clock was considered too difficult to understand. Perhaps if the lay-out of this option could better be personalised, it would be more easy to understand and to use by PwDs (small-scale tests at the three sites indeed indicated this). However, the limited development time did not allow for attunement of the quarter-hour clock to personal preferences during the final field test.

In general the Find Mobile function was considered useful. However, PwDs and carers thought the icon was difficult to understand, and PwDs could often not use the function on their own. The function was not used much because the mobile phone itself was hardly used.

Whether the device actually supported the memory problems of the PwD in their daily lives is difficult to judge. The carers considered the reminder function helpful in reminding them to remind the PwDs. The reminder function for the PwDs themselves was less useful because they still needed some assistance. There was no impact found of the reminding functionality on the autonomy or quality of life of the PwDs.

3.1.2. Social contact functionality

The picture dialling function to support PwDs in maintaining their social contacts was evaluated positively in the three field tests, the majority considered it useful for keeping in touch with family and friends. After comments in the first field test, the icon for making a telephone call was removed from the screen so that the number of steps needed for performing a phone call was reduced. However, in the second field test this made the function less easy to understand and use. So in the third field test, the icon was replaced on the main screen again and this was considered supportive. However, some problems with the picture-phone function remained, such as: hearing problems related to the quality of the sound of the hand set and delay of the hang up function. The elaboration of the contact address book was evaluated positively and the function was considered easy to use. There was no impact found of the picture dialling functionality on the autonomy or quality of life of the PwDs.

3.1.3. Activities functionality

The radio function and music playback function were evaluated positively during the three field tests. The PwDs and carers considered it easy to use and user-friendly. After the comments in the first field test, people could add more preferred pieces of music in the device in the next field tests, which was appreciated. However, there were some comments regarding the quality of the sound and people wanted to be able to select more than one channel on the radio. Sometimes people indicated that they could still use their own radio or music player and did not need the COGKNOW device for this.

The activity support function was tested with a limited number of persons in the second and third field test. The PwDs were able to perform an activity with the activity support function, but further research is needed on how activities can be divided best into steps in order to be supportive. Further research is also needed regarding the preferred person showing the sequential steps in a video or photo (should this be PwD himself, a relative or an outsider?) or how to personalise the number of steps needed to support the individual PwD. There was no impact found of the different types of support in daily activities on the quality of life of the PwDs, nor on their way of functioning.

3.1.4. Safety functionality

All three field tests showed that the help function was difficult to understand. The (different) icons that were used for this function were not very helpful. Despite this, most PwDs and carers considered the help function useful. Only at the end of the third field test, the majority of the carers considered the help function not useful. The safety warnings were easy to use and understand during the three field tests. In general PwDs and carers considered this function useful.

The navigation support function that helps people find their way back to their house had only limited testing. This function seems useful for PwD and carers in increasing feelings of safety, but more research on this is needed.

There was no impact found of the safety functionality on the autonomy or quality of life (e.g. mood, self-esteem, feelings of isolation) of the PwDs.

3.2. Impact on daily life

The impact of using the COGKNOW Day Navigator on daily life of PwDs and carers, more specifically on the actual and perceived autonomy and quality of life of the PwD and feelings of burden/competence of the carers, was only studied in field test #3. Due to problems with stability of the system, the field test period was shortened and during the tests new problems occurred. These factors influenced the evaluation of the COGKNOW Day Navigator and a thorough impact analysis was therefore not possible. As a consequence, it was not surprising that we hardly found any differences in quality of life, actual and perceived autonomy of the PwDs, when comparing the situation at baseline (before introducing the CDN) and at post-test (after using the CDN for several weeks up to two months).

We also did not find an impact of using the CDN on the burden/sense of competence of the carer. However, people did mention several functionalities of the COGKNOW Day Navigator as most helpful in their lives. The functions mentioned by the PwDs were: day and time indication, the picture dialling function, the radio control, and the mobile phone. Carers indicated the following parts and functions as most helpful in their daily life: the reminders, radio control and music playback on the stationary device.

3.3. Discussion and Recommendations

In the COGKNOW project we employed a user-driven design method to develop and evaluate an ICT device to support PwDs in their daily life. The PwDs and carers in our project were willing to participate in this research and they provided us with lots of comments regarding their experiences and with many recommendations for improvement of the device. For future research the PwDs should be guarded against being burdened too much when testing a device by reaching adequate stability performance during lab tests prior to field tests at the persons' homes.

3.3.1. Findings in Relation to Existing Knowledge

Our experiences in this study were that PwDs and carers were able and willing to actively participate in a research project on development and evaluation of ICT services. The user-driven or user-participatory design method is advocated to enhance the chances of developing an ICT device that is user-friendly and useful for the target group and will be accepted by users (Sixsmith et al., 2007; Nugent, 2007). From a recent literature review we know that in the last decade many ICT solutions aimed to support elderly persons were developed (Lauriks et al., 2007), but only in some studies the ICT solutions were tested with PwDs and in real life situations (Woolham, 2005; Gilliard & Hagen, 2004; Ager et al., 2001; Wilson et al., 2001). The majority of studies, however, did not test the developed applications in the target group. In a recent review of Nijhof et al. (2009) the first results of ICT solutions for PwDs are promising. For instance the fall incidences of PwD decreased and their quality of life improved (see also Lauriks et al., 2008). However, Nijhof concludes that the actual effects of ICT solutions for the care of PwDs (and informal and professional carers) are not well known. It is therefore important that more studies such as the COGKNOW project are undertaken to evaluate the user-friendliness, usefulness and effects of ICT solutions in the target group.

The preferred ICT solutions that PwDs and carers brought forward during workshop interviews in our study correspond partly with other studies among persons with dementia (Lauriks et al., 2007), e.g. aids for reminding appointments of activities like NeuroPage (Hersh et al., 1994), Electronic Memory Aids (EMA) (Inglis et al., 2003; Wilson et al., 2001), an Electronic agenda (Zanetti et al., 2000) or calendar (Holthe et al., 1998), and aids to find items (Gilliard et al., 2004). To enhance communication, simple photo phones (Sixsmith et al., 2007), videophones (Sävenstedt et al., 2003) or mobile phones were proposed and tested (Gilliard & Hagen., 2004; Ager et al., 2001). Technological support for leisure activities was recommended by Sixsmith (et al., 2007) and Wherton (et al. 2008), and amongst other things an activity guidance system with music and sung messages (Yasuda et al., 2006) and a picture gramophone were tested (Gilliard et al., 2004). To enhance feelings of safety, several Global Positioning Systems to locate elderly persons with cognitive impairments were developed, such as GPS Columba and Keruve. Also, monitoring systems inside and outside the house were tested in which alarm messages are forwarded in case of potentially dangerous behaviour of the person with dementia (Masuda et al., 2002; Lin et al., 2006).

A surplus value of the COGKNOW Day Navigator is that it integrates several functionalities that can support people with dementia on a variety of need areas, i.e. memory, social contact, daily activities and feelings of safety. This is the first system that does so.

When persons with dementia accept such technological solutions, these may enhance their experienced autonomy, help them to keep in contact with family and friends, help them in engaging in useful activities and enhance their feelings of safety. All these domains are considered important determinants of quality of life by people with dementia (Dröes et al., 2006). Our impression based on this study is that PwDs and carers are willing to accept assistive technology, provided that they can trust the technical performance and stability of it. The usability of reminders for persons with dementia is well documented in previous studies (Baruch et al., 2004; Gilliard & Hagen, 2004; Lauriks et al., 2007) and the COGKNOW field tests

confirmed that people with mild dementia find this function useful and easy to use. The time and day indication of the CDN was well understood and positively evaluated by the people with dementia and is therefore expected to support the orientation in time that is a commonly faced problem in people with dementia (Nygård & Starkhammer, 2007). Also other functions, such as the picture dialling function, the music and radio function, the activity support function and the safety warnings in general were well understood after one training session and easily used afterwards, partly guided by the carers. This confirms the results from previous research that PwDs can still learn how to use prosthetic aids in combination which training schemes managed by carers (Bourgeois, 1990; Hanley & Lusty, 1984; Clare et al., 2000).

3.3.2. Study Limitations

The results of our study must be interpreted in the context of some limitations as a consequence of the user-driven design method.

First of all, the evaluation of the devices was conducted during the process of (iterative) development of the devices. This resulted in (partially) unstable systems that were tested in the PwDs homes. These instability problems will have influenced the results on user-friendliness and usefulness and limited the possibility of performing a full human factors impact analyses.

Second, the reliability of the answers of PwDs could be questioned sometimes, especially when PwDs were asked to give an opinion regarding experiences over a longer period of time. When opinions of PwDs and carers were different, we do not always know whether this is caused by cognitive problems of the PwDs or by real differences in opinions. Also, it might be possible that some PwDs were inclined to provide socially desirable answers. However, this problem that occurs more often in social research is – to our knowledge – not specific for this target group. Unfortunately, the technical instability of the system in field test #2 and #3 made it impossible to reliably check answers by means of analysis of the automatically logged data collected by SeniorXensor (Mulder et al, 2005).

Third, the expectations of the users on the device to be developed could not always be met. Reasons for this were the restricted development time and limited ability of developing additional functionalities within the research project. Since new users were included in each new iteration phase, part of their wishes could not be fulfilled, because it was not possible to develop complex new functionalities after the first iteration. New users could help, however, to fine tune the developed services by expressing their wishes and comments. Because different prototypes were tested in the field tests with different users, the progress or improvement of the developed devices was hard to assess, because new users could have new needs or other preferences. On the other hand, the design with new users in each cycle allowed for inclusion of a larger variation in the user group and therewith a better representation of the target group of people with mild dementia and carers. This was also the reason for testing the device in three different countries in Europe.

The mentioned limitations make it difficult to generalise the results to the opinions of PwDs in the general population. In a project with more development time and different PwDs, other functionalities might have been given priority. On the other hand, the support areas were selected on the basis of study results in a larger sample and our findings regarding user-friendliness and usefulness of the developed functionalities may also be relevant for other functionalities, such as the use of concrete non abstract icons, the use of multimodal messages and the need for personalisation of functionalities.

3.3.3. Scientific Relevance

In the COGKNOW project, the PwDs and carers were involved in the development and evaluation of a new cognitive prosthetic device right from the start of the study. It is rather new to involve the potential end-users in this way (Lauriks et al., 2007). We based our research on a large survey into care needs of PwD conducted by one of the consortium partners (Van der

Roest et al., in press). In this survey a large group of PwD and carers were interviewed on the (unmet) needs of the PwD. Based on the results of this study, the COGKNOW project focused on four need areas in which most frequently unmet needs are experienced in the target group. Smaller samples of PwDs and carers were included in three iteration phases to allow in depth assessment of the way ICT support could fulfill the needs and wishes of the PwDs. The study design also allowed us to optimise the user-friendliness and usefulness of the developed services and to evaluate this in a detailed manner.

Besides the needs and wishes of the PwDs and carers, the development of the COGKNOW Day Navigator was based on the state of the art of ICT solutions for elderly persons and PwDs (Dröes et al., 2005; Lauriks et al., 2007). The innovation aim in the project was not to develop totally new functionalities, but to integrate existing systems into one remotely configurable integrated system.

We used a multi-method approach to gain a more accurate insight in the user-friendliness and usefulness of the CDN (see also Maxwell, 1996; Patton, 2002). During the evaluation sessions, PwDs performed prescribed tasks that were observed by the researchers and PwDs and carers were also interviewed. During the field test period PwDs and carers kept diaries, and the actual use of the system was checked by a logging method (at least in field test #2). This multi-method approach helped us to better understand the different views on user-friendliness and usefulness.

The evaluation of the impact of using the device on the daily lives of PwDs and carers was limited in this project because of problems with the stability of the system. It is recommended to perform an impact study within the target group only when the system is considered stable and to make use of a randomised controlled design in a larger study population.

3.3.4. Relevance for Psychogeriatric Practice

In our opinion the COGNOW Day Navigator can support the PwD to become more autonomous in terms of memory, maintaining social contact and daily activities. Especially the memory support (day and time indication and the reminders) seems to stimulate PwDs to actually use the CDN. For the domain of safety we feel that more research is needed. Perhaps the functionality should be broadened, for instance it was a wish of PwDs and carers to have an opportunity to trace the PwD when outdoors by means of GPS. Also the Take-me-home function needs to be evaluated more thoroughly. In the CDN, the help function was restricted to help by the main informal carer. Possibilities to get help when the carer is not available should be investigated further. Also professional care organisations could be included in the help function of the CDN.

The fact that PwDs might be less dependent on others because they are reminded about appointments and are able to engage in social contacts and activities more easily, might enhance their feelings of self-esteem and thus their feelings of quality of life.

The advantage of the CDN is that it is not only a care service (helping people with cognitive impairments), but also a welfare or well-being service, aiming to support people in performing enjoyable activities. This well-being aspect could even be more elaborated, for instance by adding a functionality to play games (chess, cards games). If the functionalities in the CDN are extended, it might be possible to make use of the CDN from early stages of dementia to more severe stages of dementia. PwDs and carers should be able to select those functionalities that could help them with their unmet needs, and to de-select or deactivate functionalities that have become useless for them.

For the carers the CDN is also considered potentially supportive. It might diminish the burden of carers because PwDs are reminded by the system to undertake activities, such as having lunch. Even though carers may have to motivate the PwDs sometimes, for instance to make a phone call, the PwDs are able to perform the phone call themselves with the aid of the CDN. The carers may also feel more at ease knowing that the PwD takes the mobile along

when leaving the home and is supported by the CDN to find the way back home when lost or to make a phone call in case of trouble.

To conclude, the user-driven design method with a multi-method approach could be applied successfully in this study. The target group participated actively and helped us to develop and evaluate an assistive device for persons with dementia and their carers. By using this method we think it will be easier to gain acceptance by the target group. The target group was receptive to assistive technology, which is an important precondition for effectively implementing ICT as an additional means of supporting people with dementia at home in the coming decades.

3.3.5. Future Research recommendations

- It is recommended to develop devices for PwD together with PwDs and carers in a multi-disciplinary team consisting of experts in the field of dementia care, technology experts and system developers. PwDs and carers should be informed about the possibilities within a research project and about limitations regarding time, finances and technical feasibilities to avoid too high expectations.
- An extension of services offered by the CDN needs further investigation, e.g. the integration of the CDN with professional support services and an extension of the CDN with more comfort services.
- The assessment of impact of using the CDN, and assistive technology in general, on daily life should be done with a service that is stable, so that it can be tested for a longer period of time.
- A randomised controlled trial design in a large sample is the preferred research design. The device should be tested in a varied study sample to gain knowledge about the impact of using an assistive device in different (stages of) diseases, and in people with different background characteristics, such as living alone or together.

3.3.6. Development recommendations

Recommendations are given on system stability, the devices, multi-modality and functionality in all four needs areas, in D7.2.1 Business Planning annex C (project-internal), and in D1.7.1 Human Factors Impact Analysis field test #3 (public).

4. Final Technology evaluation

Technical development was undertaken in a highly iterative manner resulting in the production of a series of system prototypes. Frequent interaction with dementia experts and users at the project test sites provided further input into the design process.

From the technical perspective the project made a significant contribution in a number of areas. The iterative development process allowed progress to be guided by end users' needs and the feedback following use of prototypes. The final prototype is a highly complex system which successfully integrates a home based component, a mobile component, a sensorised environment and an overarching web based server. In addition to providing a system which offers functionality to support persons with dementia, the prototypes provided an ideal platform to deploy future areas of research which were conducted within the project.

The following sections reflect upon the development process, and summatively evaluate reliability, efficiency and portability characteristics of the COGKNOW Day Navigator.

4.1. Development Process

4.1.1. Requirements Gathering

User needs, state of the art in assistive technology and its use, healthcare models, and existing technical standards were initially surveyed and analysed to guide the early stages of technical development (Lauriks et al., 2007). To reduce development times off-the shelf technology was utilised wherever possible.

Initial *functional requirements* were generated based on the output from workshops and the assessment of technical feasibility to undertake development within the available time. In addition, the functional requirements were complemented with knowledge relating to previous studies in the area. Throughout the field tests the functional requirements acted as the bridge between the technical and clinical/user partners and were used to capture user feedback along with the dynamic needs of the project. During each iteration the functional requirements were updated and used as the basis for the next iteration of the technical development process. During the second and third iterations more detailed research questions were identified to support the final evaluations. By identifying these research questions a number of technical functions, most specifically related to the process of logging were identified and hence embedded within the development process.

4.1.2. Software Architecture

The rapid prototyping nature of the development process coupled with the short development periods resulted in a system driven more to meet desired functionality and less directed towards the development of a software architecture capable of supporting multiple heterogeneous peripheral technologies. Although data management and transfer across all system components was managed well using established XML based schemas, an improved architectural design would have benefitted the overall system integration on the CHH, and improved future maintainability, scalability and interoperability. Although this is not viewed as a major drawback in the current version of the prototype, a re-engineering process would be advisable for post prototype industrialised releases of the system.

4.1.3. Configuration Management

From the outset of the Project the driving force behind the choice of technology was rapid delivery of prototypes which could be used to support engagement with clinical experts, users and their carers. As a result, commercial hardware components were chosen with the majority of technical development during each of the three development cycles being fo-

cused towards software application development and systems integration on each of the four technical components (CCA, CHH, CS and CSH).

We selected high end hardware components at the outset, however, throughout the duration of the project anyway some of these became obsolete in addition to being faced with various challenges as major software operating system updates took effect, especially for the Windows mobile environment. In addition, the progression of the baseline technology coupled with decreasing equipment costs resulted in the final version of the system being capable of deployment on a touch-screen computer having similar costs and dimensions to the initial touch screen monitor used within the first technical iteration of the system. This was an interesting finding and indeed validated our approach of selecting high end hardware components at the outset to avoid the impact of technology becoming dated within the lifetime of the project.

The most significant change to the technology platform throughout the project was witnessed within the CSH. Initial versions of the system suffered from technical issues associated with the X.10 actuators and the necessary accompanying software architecture (Ivy Bus) within which the information could be captured, processed and stored. Ensuing developments involved the use of more contemporary sensor and actuator based technology provided by a UK based company (Tynetec) which offered improved ease of integration and technical stability.

Nevertheless, the system as a whole suffered from scalability issues as the number and diversity of peripheral devices (for example RFID, sensors, actuators, wireless speakers etc.) increased as a result of meeting new identified needs of users. Any project with a similar 'system integration' approach can be expected to suffer from this.

4.1.4. Software Programming

The overall system architecture (Figure 2) defined clear responsibilities for each of the main components (CHH, CSH, CCA, CS) to be assigned to individual technical project partners. Each component could therefore in theory be managed in software repositories at each partner's site, instead of a single central project repository. In a small number of instances detailed updates required complete transfer of the latest CHH version to another partner for updating, adding slightly to development times.

Initial developments were guided by a pragmatic approach of considering both user needs and technical feasibility. As previously mentioned the resulting functional requirements (in all stages of the project) formed the necessary bridge between the clinical and technical partners.

Following the first development cycle a large portion of the technical development was 'thrown away' in line with the prototyping approach adopted. Although this resulted in additional development effort, it supported the development of both the second and third prototypes to take on board the post evaluation feedback following each of the respective field trials.

Upon reflection a more efficient approach would have been to develop a simpler first interactive 'mock-up' type of prototype in multi-media environments such as Flash. This would have provided the opportunity to engage with the users during the first Field Test at an earlier stage and also would have required less development resources for the first prototype.

4.1.5. Integration

The technical coordinator partner was responsible together with the WP2 and WP3 leaders for ensuring the concerted workings of all components as a system. Components received from other technical partners were installed in a testing environment, and it was verified that functionalities and devices behaved as expected.

Towards the end of the project a testing checklist was created for systematic integration testing. Due to the highly iterative and fast nature of this project, no formal test specifications were used.

Upon reflection it can be stated that the integration component of the project was underestimated at the outset in terms of the amount of effort which would be required. Although the technical development was complex in terms of the functionalities desired, it was found in the majority of instances that the integration of components, largely via the CHH, was more challenging than developing the components themselves.

4.1.6. Quality Assurance

For developing the third prototype, a formal software release process was defined and appended to the Project Management Handbook. The goal of this measure was an effort to streamline the process of transfer of knowledge between the clinical and technical developers along with transferring the necessary knowledge between the technical developers and the site technicians.

For each field test, a new major CDN system configuration was defined, *first prototype, second prototype*, and *third prototype.* The CHH and CCA component had their own minor version numbering; the final versions of CHH and CCA were CHH 3.18b, and CCA 3.2.2. Using the version numbers enabled problems to be more easily addressed by technical developers, and enabled the test sites to exchange information on the stability of different versions.

4.2. Security

In the COGKNOW DayNavigator, there is a strong need for protecting personal identifiable data and to guard against any safety or health risks. The project-internal security analysis (D3.1.2), identified key security measures: restriction of access, management of personal identifiable data, and also risk analysis against information security, safety and health risks.

The final prototype was prepared to ensure confidentiality and integrity of sensitive personal data. This is achieved through usage of encrypted communication, having access control with user passwords for carer access and by using automatic authentication of the CHH and CCA devices for PwD access. Nevertheless, operating with encrypted communication enabled has not been field tested and there is no multi-layer security for protecting medication, emergency contacts and authorisation data. Further security improvements are possible for protecting storage and access of data. Suggestions for these are described in D7.2.1 (project-internal), annex C.

The system has been designed with good availability of COGKNOW devices and services, however, remaining stability problems with the CCA prevents the mobile device from remaining available for more than a few days, and the battery lifetime is limited to hours. CCA failover to CS if CHH fails is not implemented yet.

The system has only limited auditing implemented, for tracking configuration actions by carers, technicians and other authorised persons.

Security vulnerabilities of the final prototype relate to the single-level nature of the protection mechanisms. For example, if the mechanism for accessing the CHH remotely - intended for technical support - is breached, then an intruder would gain full access to all functions and personal data of that user. Similarly if the carer password for configuring reminders is breached, then all reminder information would become available to an intruder. The final prototype has been designed in a way that makes malware attacks against the system virtually impossible.

4.3. Reliability and Efficiency

Efforts were directed during the final stage of developments to provide more stable environments in instances of technical failures, nevertheless a level of instability remains in isolated components, in particular WiFi communication with the CCA and sensor battery problems. In all Field Tests, as new reliability issues arose, minor modifications were put in place to address problems with the system. During the earlier Field Tests the reliability of the system caused at times system failure, however, ensuing developments focused towards avoidance of complete system failure and recovery from all system errors. The nature of the reliability of the system has been challenged throughout the Project by the high levels of ambition and limited time within which development was undertaken.

Time characteristics and resource usage of the prototype are not main concerns at this stage. Technical effort was directed mainly to support the desired functionality as anticipated by users and carers. The final prototype has no known major resource leaks following successful deployment with users for more than three weeks.

One issue which would require immediate attention in the future is the communication between the CHH and the CS. The CHH-CS communication protocol was not optimised to transfer only near-term reminders. This had the result of causing the entire reminding schedule to be downloaded to the CHH, which may be a slow process depending on the communication link and may fail if the communication link with CS is not reliable. In addition, depending on the bandwidth restrictions of the service provider this may over longer periods of time lead to high costs.

4.4. Portability

From a software perspective, the final CHH and CSH components are written in the Java programming language, and the visual home interface is therefore highly portable to other operating systems.

The final CCA component is written in C# for Windows Mobile 6.1 and assumes a touch-screen. Changing to another mobile operating system or non touch-screen device will require significant development effort.

The CS component has been developed for Windows 2003 Server. Running under other Windows server versions might require some modifications. Running under non-Windows server operating systems will require significant development effort.

From a hardware perspective the portability issues are mainly concerned with the CHH and the CSH. Any system offering such high levels of service provision with an intelligent environment will be composed of a large number of heterogeneous components and as such requires a complex process of installation. Although the process for home based installations was significantly improved in the final prototype, the portability of the system still has room for improvement. Usage of newly introduced technology such as touch-screen PCs and platforms which can integrate all peripheral devices using a single wireless receiver will move one step closer towards the vision of a universally portable system.

4.5. Discussion and Recommendations

A number of comments can be made upon reflection of the entire technical development throughout the project.

4.5.1. Development Complexity

The technical development suffered from two main challenges, one of which was related to the technical complexity of creating a system with a highly intricate set of functionalities and

secondly from the logistical complexities of the physical geography and technical/clinical communication differences. As the project progressed it was evident that an increased amount of effort was directed towards working in closer collaboration with non-technical partners. Although this process was not fully refined, it was considered that an improved level of understanding between technical and non-technical partners had been reached by the end of the final technical development phase.

It was felt that at times the integration of individual components within the overall system was sometimes a greater challenge than the component development. An increased amount of effort was directed towards addressing the logistical issues surrounding geographically distributed technical development along with increasing the testing both in the lab and at each of the sites prior to deployment within the PwD's homes. The process of transferring knowledge from the development environment to the technical installation environment was not perfect. Again this reflects the difficulty in the process of transferring the knowledge from developers to other partners within the project team.

4.5.2. System Limitations

The majority of the services throughout the project were fully implemented. Nevertheless, the underlying context engine, item tracking functionality and the use of VoIP technology, although implemented, were not fully integrated and exploited within the final prototype due to time and resource constraints. These approaches represent advances in the state-of-the-art in context-aware computing and telecommunications and should be highlighted as key areas requiring further development in future iterations of the system.

Finally, and although not a main concern, the system supported only Tynetec, RFID and X.10 based sensor/actuator technologies.

4.5.3. Technical Future Research Recommendations

In terms of future recommendations from a research perspective the following have been identified:

- Mechanisms for accurate context reasoning and context prediction should be studied and their suitability for Activity Assistance and Context Predicting Services should be evaluated. Item Locator mechanisms should be further explored, based on RFID or other technologies, and the relevance of item locations for context reasoning and prediction should be evaluated.
- User profiling and stereotyping algorithms should be studied and their relevance for intelligent personalisation of services and multi-modal interfaces should be evaluated. Semi-automatic recording of user content (life-logging) should be explored and its relevance for creating highly personalised integrated services for PwD and other user groups should be evaluated.
- Reliable and secure home area networking systems encompassing user devices and sensors should be studied, aiming for long range, security and auto-configuration. Ideally such a new home communication infrastructure should support positioning at room resolution, and fast proximity detection. Such home networking systems should work with communication systems found in mainstream user devices like WiFi and long-range Bluetooth, but might require extensions to existing industrial standards.

4.5.4. Technical Development Recommendations

Recommendations are given on technical stability, security, bandwidth requirements, personalisation, variety of payloads, technology platform, service integration, user interaction and remote system assessment, in D7.2.1 Business Planning annex C (project-internal).

5. Final Business evaluation

Innovations require not only new technology but also new business models. Getting innovations from the pilot state to actual innovations in the market is notoriously difficult, especially in health care. This requires cooperation by multiple parties to provide valuable service offerings. As part of the COGKNOW evaluation, a series of business assessment workshops were organised to consider business opportunities and business models for COGKNOW services and applications that sustain the COGKNOW innovations in the market place.

The aim of the business assessment was:

- to identify and explore COGKNOW business opportunities and business models, and
- to identify and evaluate critical market and business factors for COGKNOW commercialisation.

The project uses an established conceptual framework for the description, design and assessment of the COGKNOW business models, i.e. the STOF model and method (Bouwman, De Vos & Haaker, 2008). The business model is viewed as a blueprint of how a network of cooperating organisations intends to create and capture value from new, innovative services or products.

For the business model the required business roles that are needed to deliver the COGKNOW services were identified. The potential actors or type of actors that can fulfil these roles were considered as well as potentially viable business scenarios for providing the services. Business scenarios may for example differ with regard to what kind of party is offering the service, but also with regard to the content of (elements of) COGKNOW services.

The evaluation described here is based on other deliverables, mainly D7.3.1: Reports on the Business Assessment Workshops (Haaker et al., 2009) and D5.3.1: Business Assessment Workshops Methodology and Planning (Haaker et al., 2008).

Critical factors

The critical factors for COGKNOW opportunities and business models are grouped in three categories: *market* factors that relate to the demand or customer side of COGKNOW opportunities, *business* factors that consider supply or provider side issues, and *viability* factors focusing on selected collaborating actors. The critical factors described below, are taken from the STOF framework and are adapted to fit the specific COGKNOW situation.

Market factors

- Target group: what is the target group(s) for the COGKNOW Day Navigator (CDN)?
- Context of use: In what context is CDN used (e.g. at home/away, living alone or not)?
- Value proposition: what is the value for users (PwD, informal carer) and customers?

Business factors

- Business roles: what business roles are required to deliver the CDN and its services?
- Business actors: what actors can fulfil the business roles?
- Business scenarios: what are viable business configurations and propositions?

Viability factors

- Customer reach: how can selected actors reach the target group?
- Profit potential: what are possible revenues sources, and how should (elements of) the CDN be positioned?
- Value network: what are sustainable partnerships between commercial actors?

The business assessment was organised in a series of workshops, involving project partners as well as representatives from a large number of potential stakeholders (health insurance

companies, (dementia) patient organisations, care organisations, government, technology providers and IT services companies) from several EU member states. The assessment workshops were organised according to the schedule below.

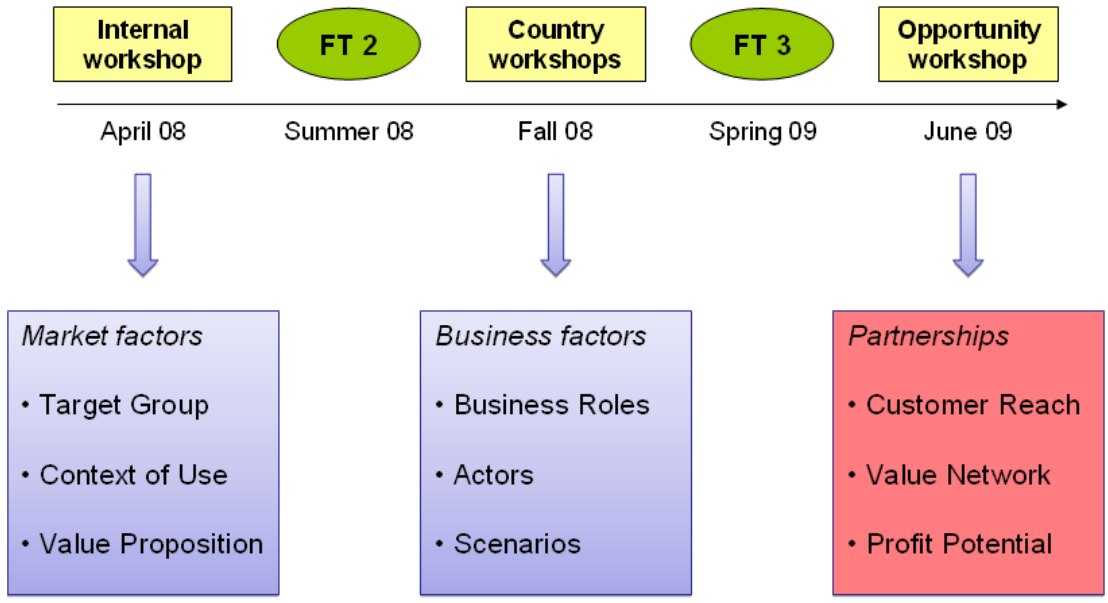

Figure 4: Business assessment workshops, timing and focus

The project internal workshop addressed the value proposition(s) of the potential COGKNOW services in relation to different target groups, and an initial generic business role model showing the required business roles for providing COGKNOW services.

Follow-up country business assessment workshops were held in Northern Ireland, The Netherlands and Sweden. The country workshops took the local health care context into account, e.g. with regard to existing health care organisation, legislation and also financial and organisational arrangements. The workshops use the generic business role model as a starting point to identify different business configurations for each country, i.e. mapping of actors that fulfil certain business roles.

The final European business opportunity workshop, held in Malta, focused on how COGKNOW can move forward and can develop further business development activities. It focused on how to deal with the viability factors.

As shown in Figure 4 the process alternated between field tests and business workshops. In particular in the final field test (FT#3) participants were interviewed about their perceptions regarding some of the critical factors.

In the next sections the findings regarding the evaluation of the critical factors from the business perspective are summarised.

5.1. Market factors (acceptance)

5.1.1. Target Group

A distinction has been made between customers and users of a service. With this in mind, the workshops participants identified the following primary customers and users.

First of all ‘health care providers’ were considered as customers with PwDs and their carers (both formal and informal) as primary users.

Next ‘elderly care providers’ or other ‘social care providers’, both public and private, could be customers with their clients as users, i.e. older people living at their own home, possibly with their partner or other family.

Secondary target groups and further target group insights are described in D7.3.1 Reports on the Business Assessment Workshop (project-internal), sections 4.2.1 and 7.1.

5.1.2. Context of Use

Several parameters that describe the context of use may influence the design of the business model, e.g. with regard to the service composition or the way it is offered to customers. A stable contextual element is that users will use the COGKNOW functionality as part of their everyday life. Other context parameters, such as the locations of use may vary. The location of use has different aspects or dimensions. First whether the user is living at his or her own home versus living at an elderly (sheltered) home. The location of the service within the home (kitchen, living room) may also have an influence. Next, the actual location at which the service is used may vary, this may be usage at one’s home versus usage while being on the move (mobile) or being elsewhere. Functionality at these different locations may vary, or may be restricted to usage at one’s own home only. Also the home situation is of relevance, i.e. whether the user (e.g. PwD) lives alone or lives together with an informal carer. In the latter case it is important to consider the proposition towards the informal carer as well. Also the context in which the service is offered, for example within healthcare, homecare or private wellness sector, may have an important influence on the definition of the business model, e.g. with regard to funding.

Finally, considering the primary target group of persons with mild dementia, the degree of mild dementia is a very important context parameter as it heavily influences the user value of the different COGKNOW services. Since dementia is a progressive disease, PwDs will experience more cognitive problems and become more in need of support in their daily functioning when time goes by. This means that the service composition may also have to change over time.

Notably, PwDs involved in FT#3 mention ‘in need of help’ as the prime context of use. Either in emergency situations, when they can push an emergency button or when they are lost and need assistance with finding their way home can be sought of. Carers more often mention the reminders and remembering functions as the prime context of use, e.g. for appointments when the carer is away.

5.1.3. Value Proposition

The assumed benefits of the COGKNOW services are discussed for the two main users of the service, i.e. PwDs and carers, as well as the mentioned customers.

PwD benefits. The overall potential benefits and ‘experience’ of the different service categories for PwDs are described as continued independence, self-reliance and autonomy, increased self-worth, enhanced quality of life and improved confidence. Other benefits include better social inclusion and cohesion, related to the social interaction service category, and enhanced safety related to the safety service category. Finally, increased activity ability is related to the reminding support and daily activity support service categories.

One PwD in FT#3 mentioned missing a ‘how to use this machine’ button, that connects you to a person who can explain how it works. Many PwD’s mention that the system in the current state it is too unstable and disruptive to be useful. Some say that they would consider using an improved version, i.e. more stable and with more control regarding the systems options and functionality to fit needs.

Carer benefits. The main benefit for the (informal) carer of the PwD is respite (relief of duty), and peace-of-mind when leaving the home.

Customer benefits. Benefits of the mentioned customers (health and care providers) revolve around increased care quality/capacity, i.e. more flexibility in care offerings, supporting more PwDs, more integrated services, and more automated services, and cost reduction, because of less needs for shelter, and also economies of scale and extended scope through more integrated systems.

5.2. Business Modelling factors

5.2.1. Business Roles

In a business model all the necessary business roles for providing the intended COGKNOW services and applications are shown, together with the relationships with the other roles. Table 5 provides an overview of COGKNOW business roles.

Table 5: Overview of identified COGKNOW business roles

Business role	Activity
User	Uses the service
Customer (Health/Care/Lifestyle provider)	Buys or commissions the service
Service provider	Provides the COGKNOW services
Service centre	Provides service support
Technical service provider	Provides technical support and customization
Funding provider	Provides funding for the service
Connectivity provider	Provides connectivity
Software developer/application provider	Develops services and provides applications
System integrator	Integrates software and hardware
Device provider	Supplies devices, terminals, etc.
Innovation provider	Provides continued development & innovation

The businesses roles can be combined into a business role model, showing the service relationships between the different business roles (see Figure 5).

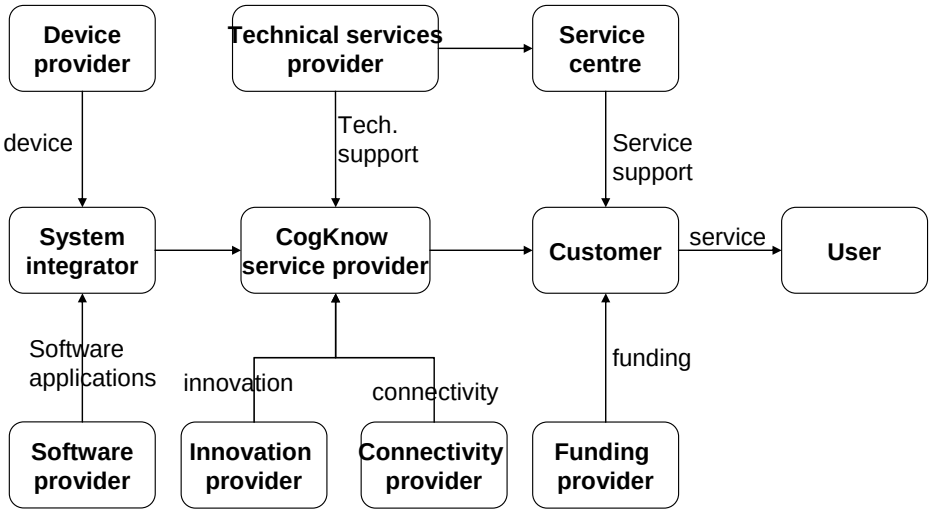

Figure 5: A business role model for COGKNOW services

There are also other stakeholders that have an influence on or are influenced by the COGKNOW services and/or business model. These include governmental organisations, e.g. healthcare ministries, city councils, as well as politicians, patient organizations, e.g. Alzheimer organisations, and relevant lobbying organizations. All of these stakeholders may exert their influence. Finally, since COGKNOW services build on research carried out by research institutes and companies, these parties are obvious stakeholders as well.

5.2.2. Business Actors and Scenario

To realise the COGKNOW Day Navigator and provide the related services, different actors are required to take up the business roles. Actors may come from technology providers, telecom operators, care organisations, municipalities, insurers and different kind of service providers. The actual actors selected will have an impact on the final proposition towards customers, and on the aimed for revenue sources. Business scenarios describe on a high-level the COGKNOW proposition, involved actors and sources of revenue. Here we consider a main business scenario that emerged during the country workshops. Secondary business scenarios are described in D7.2.1 Business Planning, section 4.1.

In the main business scenario the services are ordered by the local council or a home care provider. Also in this case the options for a stand-alone service are considered limited. Rather it is one of the services in a portfolio of services provided by the care provider to its future and current customers. In both scenarios the national health care system may support the initiation of the COGKNOW services if a sound business case can be provided. The business case may consider such aspects as increased quality of life, cost-efficiencies or increased productivity of work force.

In this example municipalities would commission and pay for the service. The service would be delivered by an IT solutions provider, knowledgeable about health services, and build and operated by a COGKNOW ltd., typically a cross-border provider, in cooperation with various soft- and hardware providers.

5.3. Viability factors

5.3.1. Customer reach

Reaching customers, and reaching them at the right moment, is a critical factor for a viable COGKNOW business model, especially if the service's main target group is persons with *mild* dementia. As one workshop participant said, "there is no such thing as 'mild' dementia, only a limited window of opportunity in which COGKNOW services can be of help". According to the business assessment workshops' and FT#3 participants, potential users can be made aware that these kind of systems exists via NGO's, like Alzheimer Europe, Alzheimer centres and national Alzheimer associations, forums for patients, and via service providers, GPs, or local councils. An additional approach may be to organise demonstrations for stakeholders and carers, e.g. when diagnosing patients at hospitals and via health professional education.

Potential users may become acquainted with such systems via initial training at home by someone installing it (supplier) or a knowledgeable care professional. Continued (technical) support is considered necessary. One carer mentioned that the carer should be trained so that the carer can explain the system to the PwD. FT#3 participants stress the importance of continued support and training for users (carers and PwDs). A reliable party for the Service Centre business role is therefore required.

A minimum level of computer and technology literacy is required to use COGKNOW kind of systems and assistive technology in general. Participants suggest starting with the service as early as possible after diagnosis. If a combined 'comfort and care scenario' is considered,

then elderly will already be familiar with assistive technology, for example in a sensorised home, and may more easily adopt the additional functionality provided by COGKNOW.

5.3.2. Value network

To make sure that the COGKNOW system addresses the needs of the target group it was suggested that 'dementia experts' are involved in the COGKNOW implementation. A *stakeholder group* acting as service provider, is a way to involve such expertise. The stakeholder group involves care providers, local government, insurers and technical services providers. The combination of these parties provides for bundling of demand which makes it more attractive for other actors to develop adapted hardware and software for this group.

COGKNOW is a cross-border initiative targeting the European market and can therefore seek economies of scale. However, this requires country business models for synergetic cooperation between per-market COGKNOW initiatives. The demand side in country business models will require different partnerships to fit with local regulation and context. Sustainable business models require viable partnerships possibly spanning the fields of care, welfare and comfort.

If COGKNOW does not provide enough as a stand-alone system, it may be built on top of or join existing platforms, e.g. existing smart home platforms. Partnerships could be sought with the parties already exploiting such platforms.

5.3.3. Profit potential

As a primary aim the COGKNOW system would help people to live independently in their homes for longer. Estimates about involved potential savings for society amount to €10k per year. With an ageing population and expected strong increase in the number of people suffering from dementia, combined with societal and lifestyle developments, the potential target group is growing rapidly. An obvious threat is that not enough users from the potential target group will actually use the service. Participants in the opportunity workshop expressed their doubts regarding the readiness of the market for the COGKNOW system and assistive technologies in general. On the one hand users may not be ready for this kind of support due to limited computer and technology literacy, and on the other hand the offered solutions may not yet be good enough in terms of user friendliness and personalisation.

All Dutch carers in FT#3 showed a willingness to pay themselves for the CDN system in the range of €10- €30 a month. The same amount was mentioned by some participants in Luleå, but some other participants did not want to pay for it. None of the Belfast participants would pay for the CDN system. The willingness and amounts depends a lot on the perceived value and the field test experiences. Most carers prefer to rent the system (as part of a monthly subscription), especially as usage will only be temporary.

Models for sharing revenues, costs and business risks are discussed in D7.2.1 Business Planning (project-internal), section 4.3.

5.4. Recommendations

Detailed recommendations are given on secondary target groups, alternate business scenarios, product development, business models, partnerships, and market awareness actions, , in D7.2.1 Business Planning annex C (project-internal).

6. Final Methods and Tools evaluation

In this chapter the methods and tools used in the COGKNOW project are described and evaluated from human factors, technical and business perspectives. The chapter ends with some lessons learned from the methods and tools used in COGKNOW.

6.1. Human Factors evaluation methods and tools

In the COGKNOW project, potential end-users were involved in the development process and in the evaluations, to ensure that user prioritised needs were well understood, taken into account and included in the design of services. Because of this user involvement, and because the four functional areas in COGKNOW were based on a review of the literature (Van der Roest et al., 2007) and a large survey among PwDs (Van der Roest et al., 2009), we consider our approach strongly user-driven and user-participatory. COGKNOW directly involved people with dementia and informal carers as end-users, which provided special challenges in data-collection due to the cognitive impairments of the PwDs and the fact that the carers are also burdened by their care tasks To achieve a more accurate and complete evaluation of the user-friendliness, usefulness and impact on daily life of the CDN a mixed-method approach was adopted (Mulvenna et al., 2010).

The data were collected in three iterative cycles with users who participated in workshops, field tests and evaluations. The data collection procedures consisted of:

- *Pre-test workshops:* The aim of the pre-test workshops was to ask each PwD and carer about their needs and problems in their daily life (in the four functional areas) and, in the first year workshop, about their preferences for ICT support . In the second and third year workshops the perceived usefulness and user-friendliness of prototypes of the CDN were assessed and any additional needs and wishes were inventoried. Furthermore, in the second and third year workshops the possibilities to personalise the COGKNOW stationary device were discussed (background colours, icons, the quarter-hour clock for reminders and the different functionalities on the CDN).
- *Pre-test interviews and observations:* Approximately one month before each field test, all potential participants were interviewed and asked for their willingness to participate. Information on changes in background and context variables (compared to the initial interview) of the PwD, as well as information necessary to personalise the functions and features of the CDN were gathered. Preferred pieces of music, photos and telephone numbers of relatives were collected. In addition, the placement of the stationary device in the home was discussed, taking into account the participants' normal habits, available space, and technical requirements. When necessary the cognitive status of the PwD was re-assessed with the Mini-Mental State Examination (MMSE) in order to determine if the PwD still fulfilled the inclusion criteria for participation in the project.
- *Field test interviews and observations:* Semi-structured interviews and observations were conducted using prepared forms adapted to the research questions and available CDN functions in each field test (see D4.6.1 Final Field Test Report). The PwD form had open questions for each function and also observation items. The carer form had only open and structured questions. The questions focused on assessing usefulness and user-friendliness. Some of the questions in the PwD form were designed to be used while performing a prescribed task and others were intended to be asked just after the tasks had been performed. The questions in the form for the carer were intended to be asked afterwards, independent of the tasks. In the final field test, a number of (user) benefits and provisioning questions were added, to aid in the evaluation for the business perspective. Also questions were added in the semi-structured interviews relating to the impact of the CDN on actual and perceived autonomy of the PwDs and on quality of life of PwDs and carers. An extensive evaluation of these impact variables was carried out using several standard questionnaires in individual interviews. The questionnaires were selected based

on the following considerations (Mulvenna et al., 2010): the four functional areas that are addressed by the CDN, the target group (PwDs and carers), and on psychometric properties and international usage of the instruments (Moniz-Cook et al., 2008). In the first field test the semi-structured interviews and observations were carried out during a one-afternoon test, in the second and third field test they were carried out twice, one session at the beginning of the field test, shortly after installation and explanation of the device, and another at the end of the field test three to eight weeks later. At each evaluation session, prescribed tasks covering key aspects of interacting with the CDN were performed by the PwD. This included general use of the stationary and mobile device, and using individual functional areas of the devices. Interviews to evaluate the impact of the system were also held twice, at the beginning and at the end of FT #3.

- *Diaries and in-between interviews:* During the first field test a bottle-necks list was filled in, while during the second and third field test PwDs and carers kept a diary to record any problems and positive experiences with using the CDN. In the longer third field test, also in-between interviews were conducted, during bi-weekly home visits and telephone calls. Positive and negative experiences regarding the use of the system and on possible problems (bottlenecks) were gathered, and also occurrences of important life events and/or changes in medication were checked.
- *Expert evaluation sessions:* Before and after the third field test, the user-friendliness and usefulness of the system was tested and evaluated by dementia experts to further assist the technical development of the CDN, supported by a demonstration of the different functionalities. Interfaces intended for the PwD were assessed by the experts following a pre-structured framework and notes were taken of the feedback expressed by the dementia expert. Results were reported on a common template in Amsterdam and Luleå, and in Belfast on the workshop report form.
- *Logged in-situ measurement:* Logged in-situ data were collected throughout the field tests with a specifically adapted program called the SeniorXensor. On the stationary device, data were collected with modules for logging basic operation of the device, usage of reminders, use of picture dialling, use of the help function, and use of activity support. On the mobile device, data were collected with modules for logging the performance of the battery, the location of the mobile device, events related to general usage, and usage of the navigation support. In addition several other modules were in use, collecting data about the proper operation of SeniorXensor itself.

6.2. Technology evaluation methods and tools

For the technical analyses data were collected by means of observation and experiences of the technical experts and by system error and performance logs that were recorded by the software itself.

- *Observations and experiences:* In general there were three phases in relation to observing system operation from a technical perspective:
  1. During the first phase of development and testing observations took place within a laboratory based environment. The approach adopted within this phase was to document any technical issues or problems and schedule them for resolution. The ranking procedure involved the technical team ranking the severity of issues or problems but also taking into consideration the estimated effort required to resolve the issue. This was an iterative process whereby the technical team would meet on a weekly basis to assess progress.
  2. The second phase involved assessing the technical performance of the system while observing the PwD interacting with the system or by the technical expert interacting with the system directly.

3. The third phase involved the technical team observing the system from a remote location. The system would be checked on a daily basis to verify components such as internet connection and successful download of any pending schedule information.

- *System and performance logging:* The system was able to log various parameters concerning its use such as how often services were used, how often the software was restarted and more technical information such as system up time. Any major system crashes were also logged by email to the primary technical developer. All of the logging was sent to a central server where it could be viewed and analysed at a later time. Each system produced a software heart beat which was activated once every minute which was used as an indicator to assess system performance. The server component also performed some logging tasks in the background. These logs were then translated and viewed in a graphical interface whenever needed throughout the field test. This graphical interface provided information about the performance of the home hub in relation to retrieving schedule information from the server.

6.3. Business evaluation methods and tools

For the business factor analysis data were collected via business assessment workshops and by means of some specific questions asked during the semi-structured interviews with users.

- *Business workshops:* To assess the business opportunities of COGKNOW several business workshops were organised based on the STOF model and method (Bouwman, de Vos & Haaker, 2008). The key critical issues for COGKNOW business models were derived from the STOF model and assessed. After the first field test an internal project workshop was organised, after the second field test country workshops were organised in the countries that participated in the field test, and after the third field test a European business opportunity workshop was organised. The internal workshops involved group work on market and business factors. A written report was made of the discussions in the workshop. The country workshops involved many representatives from interested parties, ranging from care providers to technology vendors to public authorities. The workshop participants were given an introduction to the CDN and the COGKNOW project via presentations, COGKNOW videos and demo's. Again written reports were made of the discussion, focusing on critical factors for COGKNOW business models. The reports provided input for a final business opportunity workshop which considered in group discussions the options for solving some of the critical issues for COGKNOW business planning. Notes from the group discussions were collected in a written report.
- *Interviews:* Specific questions regarding acceptance by the potential end-users and business factors were included in the semi-structured interviews (see Human Factors perspective) that were performed with the PwDs and carers at the start and the end of the third field test.

6.4. Field Test procedures

Detailed procedures of the three field tests are described in D4.6.1 Final Field Test Report.

The procedures used for recruitment and participation of PwDs and their carers in the field tests were based on the ethical guidelines developed for the project (in the project-internal Project Management Handbook). The vulnerability of the PwDs was addressed by a rigorous process of informed consent involving both the PwDs and their carers. Prior to participation in the workshop or interviews, an informed consent form was signed by the PwD and the carer. An information flyer with a brief description of the project was also provided. The process followed the national ethical approvals for the project at all test sites.

The evaluation activities were conducted by trained researchers. These researchers worked under direct supervision of the responsible test-site clinical managers to ensure that proper practice was followed. The technical staff at each site was responsible for system setup, pre-testing and on-site installation and de-installation. A use manual was given to the participants during the field test. The participants could contact the researchers or site technicians in case of (urgent) problems with the system. A helpdesk was organised and a helpdesk manual was provided for all involved researchers, consisting of first line contacts (human factors researchers and local technical staff) and second line contacts (technical specialists on the different CDN functions from COGKNOW technical partners).

Due to delays in technical development and delivery of the equipment at the sites, the field tests had to be delayed and/or shortened. The final field test period was originally intended to last 2 months, but due to technical problems before and after home installation of the system, the test periods varied at the different sites, and lasted approximately three to eight weeks (except for two participants that withdrew from the test after about one week). The main functions of the COGKNOW stationary and the mobile device were tested at all three test sites. Some functions like the Take-me-home navigation function and the Activity Assistant, were only tested by one participant for each function.

6.5. Evaluation of methods and tools

6.5.1. Human Factors

The Human Factors Impact Analysis of the COGKNOW Day Navigator was designed to answer the general research questions on user-friendliness and usefulness of the COGKNOW Day Navigator, and (in FT #3) on the impact of the system on the daily functioning of the PwD. Important aspects of the evaluation were “to what extent was the used research design useful?” and “to what extent could the evaluation process be labelled user-centric?” And further, “what is the impact of the system on the perceived autonomy and quality of life of the PwD?”

The *user participants* were recruited at all test sites, Amsterdam, Belfast and Luleå, with the inclusion criteria: a confirmed diagnosis of Alzheimer’s disease (DSM IV-TR), having mild cognitive impairment (Global Deterioration Scale stage 3 or 4, and/or MMSE 17-25), and willingness to participate. An effort was made to include PwDs with diverse backgrounds, e.g. gender, age and living conditions. In the first field test 16 couples (PwDs and carers) participated, in the second 14 couples and in the third field test 12 couples. For each field test new participants were recruited, but couples from previous field tests were also allowed to participate if they still fulfilled the inclusion criteria. The methods and tools for recruiting users generated a sufficient degree of variation within the group of participants, for instance with respect to age, gender, and living area. However, the variation in the type of carer was rather small: the majority of the PwDs was living together with a partner who cared for them.

All *data were collected* according to predefined guidelines that were agreed upon by all test sites. In some cases there were minor variations in the data collection methods, because not all participants were able or willing to participate in the group workshops. Therefore different procedures were followed and, besides group workshops, individual interviews were conducted. In Belfast professional carers also participated in the workshops. In Amsterdam, the diary was used as intended, while in Luleå and Belfast the information was collected by the researchers through regular interviews with users. Despite these variations, all relevant data were collected at the research sites. The in-situ data were also collected at the three sites, but could unfortunately not be analysed because of the large amount and complexity of the data (partly caused by instability of the prototype).

The evaluation used a *mixed-method design* (as described in section 6.1) where different types of data were first analysed separately and thereafter combined in a comprehensive

integrated analysis to understand the user-friendliness and usefulness of each function for the PwD, and to explore the impact of the system on the quality of life of the PwDs and carers. Different ways of collecting data allowed us to analyse the results from different perspectives: the PwDs, the carers, dementia experts and researchers. Sometimes opinions between PwDs and carers differed, which may have been caused by cognitive problems or by real differences in opinions. The opinions of PwDs regarding, for instance, their ability to use the CDN were verified by observations made by the researchers during the semi-structured interviews at the start and at the end of the field test and during intermediate visits made at the homes of the PwDs.

The challenges of understanding the thinking and perceptions of PwDs are well documented by many researchers (Kitwood, 1997; Lloyd, 2006; Nygård, 2006; Dröes et al., 2006). The experiences from the evaluation process confirm that the used mixed methods provided a good understanding of user-friendliness and usefulness of the tested devices from the perspective of the PwDs. The mixed methods approach provides a more accurate and complete account then any single method could on its own (see also Maxwell, 1996; Patton, 2002).

A limitation in the evaluation in FT #3 was that, due to technical problems and instability of the system, the evaluation was limited in duration and number of functions tested. This may have influenced the results on user-friendliness and usefulness, and limited the possibility of performing a full impact analysis. As mentioned above, the *in-situ* logging data could not be analysed, and therefore could not provide additional information on the reliability of answers given by the participants. Although this leaves the validity of the evaluation results in some doubt, this final evaluation is deemed to provide sufficient information for guiding the future development of the next generation of prototypes.

6.5.2. Technical development

The technical development process was split into three phases which allowed for an iterative approach to facilitate extending the system in terms of functionality.

The first phase of development focused on testing the system for a period of one day. The level of technical effort that was used to produce a system for a one day evaluation was significant.

The second phase of development ensured that the system being developed could be easily extended for the last stage. The second phase included the development of a large number of functional requirements which were ranked in order of importance. Each functional requirement was developed in turn and the system was released for site testing at the end of this phase. An alternative approach would be to release a new version of the system to the sites as each functional requirement is completed. This iterative approach within each phase of development would allow testing and development to run in parallel and allow for more extensive feedback about individual functional requirements.

The third phase of development aimed to improve and add some functionality but also to provide a more stable system for the third field test with an intended duration in the PwD's homes for up to two months.

It is worthwhile to reflect upon how the system development related to best-practice software engineering methods. On the whole the system development process would have benefited from more unit testing at each developing partner, (automated and systematic) more integration testing, more time for site testing, and separate usability testing with experts. In terms of testing the system prior to each of the field tests it would have been beneficial to produce successive stable release versions so that a multidisciplinary face to face meeting could be scheduled where a stable prototype to be tested would be demonstrated and explained in detail to all parties that were conducting the field test. Though these meetings were planned before all field tests, due to technical delays they unfortunately all had to be cancelled.

6.5.3. Business assessment

The business assessment workshops, in particular the country workshops, generated a lot of useful insights regarding the options for local, country specific business model implementations. The business role model, as defined in the internal business workshop, proved to be a valuable tool in structuring the discussions on business actors and business scenarios. Involving external parties in a business assessment is a clear benefit. However, insight in at least some 'ballpark figures' regarding COGKNOW costs would have been beneficial in the assessment process.

6.6. Lessons learned

- The mixed-method design provided a good understanding of the user-friendliness and usefulness of the tested devices for the PwD and provided an efficient way of collecting diverse data, limiting the burden on user participants where possible.
- The mixed-method design was suitable to measure the impact of the system on the quality of life of the PwD, but was hampered by a shortened duration of the field test period due to instability of the system.
- Logged *in-situ* measurements may be valuable for providing additional information in field tests with a longer duration, but a stable system is required to obtain reliable results.
- The user-centric approach of the evaluation process was confirmed suitable for formative evaluation.
- Defining research questions in advance of the field test gives a systematic structure to the evaluation process, and makes it possible to add any needed logging instrumentation to the prototype or preparing other data collection methods. Separate research questions should be defined for human factors, technical and business perspectives.
- Distributed technical development of complex systems is challenging. Software Engineering best-practice should be studied and adapted to the project at an early stage , and the quality process should be carefully communicated to all technical partners and individuals.
- Using the STOF model for defining business research questions has worked quite well for structuring business assessment workshops and evaluation from the business perspective.
- Targeting specific quality characteristics helps to focus on the most significant research questions. The Quality Model for External and Internal Quality [ISO 9126-1] (see Annex B) has been helpful in analysing the research questions and preliminary results.
- In FT #3 part of the semi-structured questions were asked to the PwDs and part of them were reformulated into observation questions and this worked effectively because this shortened the interview time.

7. Final Conclusions

The project has developed a COGKNOW Day Navigator (CDN) prototype that has been generally confirmed to have the right functionality and overall user interface design to be potentially user-friendly and useful for persons with mild dementia.

The COGKNOW partners have gained invaluable experiences and extensive insight on critical success factors from human factors, technical and business perspectives. We hope to leverage this body-of-knowledge to make our vision come true - integrated cognitive support devices that significantly increase autonomy and quality of life for persons with mild dementia, while enabling enourmous savings in dementia care and commercial success.

During the project, evaluation was carried out from the three perspectives: human factors, technology and business. From the human factors perspective the focus was on user-friendliness, usefulness and efficacy. The technology perspective focused on advancing the state-of-the art primarily in the area of mobile based delivery of reminding services, ubiquitous computing within the realms of mild dementia and use of multimodal services. From the business perspective, the focus was to identify viable COGKNOW business opportunities, and to identify business factors that fed back into the development of COGKNOW services. The evaluation from multiple perspectives helped the researchers from different disciplines to get more understanding of the implication of choices in different perspectives and contributed in general to the improvement of the design in each field-test iteration and to final recommendations for the adaptation of functional requirements of the CDN and future research.

The project consortium believe that the COGKNOW project is quite unique in that it directly involved persons with dementia and their carers in all aspects of the project, during analysis, development, field testing and evaluations. As such it has sought to be a fully inclusive project. Project partners have been strongly dedicated to achieve the aim of creating and validating integrated assistive devices for home and mobile use, targeting persons with mild dementia. In order to reach its goals, the project has developed a multi-disciplinary overall method, combining mixed-method human factors evaluation methods, with iterative methods for technical development and a comprehensive method for business development. Guidelines based on European Standards on Confidentiality and Privacy in Healthcare (EuroSOCAP project) have guided researchers, system developers and site technicians.

The prototype is not yet technically stable enough for multi-day use without attendant technical support. Further research is needed to investigate how the CDN improves the autonomy and quality of life of people with mild dementia and if it helps them to stay longer in their own home.

The business assessment workshops have confirmed that targeting persons with dementia as users addresses a potentially attractive market by offering either care-orientated services enabling the users to live in their own homes longer. Integrated services in few devices appears a compelling service offer, since it gives both ease-of-use and a lower cost than using separate assistive devices for the diverse needs of PwD. The business workshops have also confirmed the tentative model for business roles. It has also become clear that the COGKNOW consortium will need complementary business partners for commercialisation, in particular mobile hardware providers and service providers in diverse geographical areas.

The project partners produced a large variety of publications, and reports as well as several video films in the past three years and the project results were (and will be) presented on many symposia and congresses. In 2010 the COGKNOW partners will publish a book, titled ‘Supporting People with Dementia Using Pervasive Health Technologies’, in which many of the lessons learned in COGKNOW will be included (see Annex C). More information on COGKNOW is available on the project website www.cogknow.eu.

(even page intentionally left blank)

References

Ager, A., Aalykke, S., (2001). TASC: A microcomputer support system for persons with cognitive disabilities. *British Journal of Education Technology*,32, 373–377.

Baruch, J., Downs, M., Baldwin, C., Bruce, E. (2004). *A case study in the use of technology to reassure and support a person with dementia.* In: J. Moriarty (ed.) Innovative practise in Dementia: The international Journal of Social Research and Practice, 3(3), 327-377.

Bourgeois, M.S. (1990). Enhancing conversation skills in patients with Alzheimer's disease using a prosthetic memory aid. *Journal of Applied Behavior Analysis*, 23(1) 29-42.

Bouwman, H., De Vos, H., Haaker, T. (2008). *Mobile service innovation and business models*, Springer Verlag, Heidelberg Berlin, 2008.

Clare, L., Wilson, B.A., Carter, G., Breen, K., Gosses, A., Hodges, J.R. (2000). Intervening with Everyday Memory Problems in Dementia of Alzheimer Type: An Errorless Learning Approach. *Journal of Clinical and Experimental Neuropsychology*, 22, 132-146.

COGKNOW Description of Work. Proposal no. 034025. Accepted EC 19-04-2006.

Dröes, R.M., Boelens-Van der Knoop, E.C.C., Bos, J., Meihuizen, L., Ettema, T.P., Gerritsen, D.L., Hoogeveen, F., Lange, J. de, Schölzel-Dorenbos, C. (2006). Quality of life in dementia in perspective; an explorative study of variations in opinions among people with dementia and their professional caregivers, and in literature. *Dementia: The International Journal of Social Research and Practice*, 5(4): 533-558.

Dröes, R.M., Meiland, F.J.M., Van der Roest, H.G., Maroccini, R., Slagter, R., Baida, Z., et al. (2005). *Opportunities for we-centric service bundling in dementia care*. Amsterdam: Freeband Frux Project Partners.

EuroCoDe (2009). Alzheimer Europe Press release: Numbers of people with dementia in Europe higher than previously reported (13-07-2009): http://www.alzheimerportugal.org/xfiles/files/Doc1375.doc

Gilliard, J., Hagen, I. (2004). *Enabling technologies for people with dementia.* Cross national analysis report D4.4.1. QLK6-CT-2000-00653, p. 1-69.

Haaker, T., Bengtsson, J.E., Mulvenna, M., et al. (2008). *Business assessment workshops, methodology and planning*. COGKNOW Deliverable D5.3.1 (confidential).

Haaker, T., Bengtsson, J.E., Mulvenna, M., et al. (2009). *Reports on the business assessment workshops*. COGKNOW Deliverable D7.3.1 (confidential).

Hanley, I., Lusty, K. (1984). Memory aids in reality orientation: A single-case study. *Behaviour Research therapy*, 22, 709-712

Hersh, N.A., Treadgold, L.G., (1994). NeuroPage: the rehabilitation of memory dysfunction by prosthetic memory and cueing. *Neurorehabilitation* 4, 187–197.

Holte, T., Hagen, I., Björneby, S., (1998). *Evaluation of an electronic calendar as helping aid for persons suffering from memory problems or cognitive impairment.* Report of the TED-group.

Inglis, E.A., Szymkowiak, A., Gregor, P., Newell, A.F., Hine, N., Shah, P., Wilson, B.A., Evans, J., (2003). Issues surrounding the user-centred development of a new interactive memory aid. *Universal Access Information Society* 2, 226–234.

Kitwood, T. (1997). The experience of dementia. *Aging and Mental Health*, 1, 13– 22.

Lauriks, S., Osté, J., Hertogh, C.M.P.M., Dröes, R.M. (2008). *Meer levenskwaliteit met domotica. Effectonderzoek naar de toepassing van domotica in kleinschalige groepswoningen voor mensen met dementie*. [A better Quality of Life with home technology. Effect study into the appliance of home technology in small scale living arrangements for people with dementia.] VU University medical center/ GGD Amsterdam.

Lauriks, S., Reinersmann, A., Roest, H. van der, Meiland, F.J.M., Davies, R.J., Moelaert, F., Mulvenna, M.D., Nugent C.D., Dröes, R.M. (2007). Review of ICT-based services for identified unmet needs in people with dementia. *Ageing Research Reviews*, 6(3): 223-46.

Lin, C.C., Chiu, M.J., Hsiao, C.C., Lee, R.G., Tsai, Y.S., (2006). Wireless health care service system for elderly with dementia. *IEEE Transactions on Information Technology in Biomedicine*, 10, 696–704.

Lloyd, V., Gatherer, A., Kalsy, S. (2006). Conducting Qualitative Interview Research With People With Expressive Language Difficulties. *Qualitative Health Research*, 16(10), 1386-1404.

Masuda, Y., Yoshimura, T., Nakajima, K., Nambu, M., Hayakawa, T., Tamura, T., (2002). *Unconstrained monitoring of prevention of wandering the elderly*. In: Engineering in Medicine and Biology, 24th Annual Conference and the Annual Fall Meeting of the Biomedical Engineering Society (EMBS/BMES Conference). Proceedings of the Second Joint 2. pp. 1906–1907.

Maxwell, J.A. (1996). *Qualitative research design; An interactive approach*. Sage publications, Thousand Oaks: Sage.

Mulder, I., ter Hofte, G.H., Kort, J. (2005). SocioXensor: Measuring user behaviour and user eXperience in ConteXt with mobile devices. In: L.P.J.J. Noldus, F. Grieco, L.W.S. Loijens and P.H. Zimmerman (eds.). *Proceedings of Measuring Behavior 2005, the 5th International Conference on Methods and Techniques in Behavioral Research, August 30 – September 2, 2005, Wageningen, the Netherlands*, pp. 355-358.

Mulvenna, M.D., Nugent, C.D. (Eds.) (2010). Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, Springer, ISBN: 978-1-84882-550-5, in press.

Nugent, C.D. (2007). ICT in the elderly and dementia. Editorial. *Aging & Mental Health*, 11 (5), 473-6.

Nijhof, N., Van Gemert-Pijnen, J.E.W.C. , Dohmen, D.A.J. , Seydel, E.R. (2009). Dementie en technologie. Een studie naar de toepassingen van techniek in de zorg voor mensen met dementia en hun mantelzorgers. [Dementia and technology. A study into the application of technology in the care of people with dementia and their carers] *Tijdschrift voor Gerontologie en Geriatrie*, 3.

Nygård, L., Starkhammar, S. (2007). The use of everyday technology by people with dementia living alone: Mapping out the difficulties. *Aging & Mental Health*, 11(2), 144-155.

Nygård, L. (2006). How can we get access to the experiences of people with dementia? *Scandinavian Journal of Occupational Therapy*, 13, 101-112.

Patton, M. (2002). *Qualitative Research & Evaluation methods*. (3ed.) Sage publications, Thousand Oaks.

Sävenstedt, S., Brulin, C., Sandman, P.O., (2003). Family members' narrated experiences of communicating via video-phone with patients with dementia staying at a nursing home. *Journal of Telemedicine and Telecare* 9, 216–220.

Sixsmith, A.J., Gibson, G., Orpwood, R.D., Torrington, J.M. (2007). Developing a technology 'wish-list' to enhance the quality of life of people with dementia. *Gerontechnology*, 26, 2-19.

Van der Roest, H.G., Meiland, F.J.M., Maroccini, R., Comijs, H.C., Jonker, C., Dröes, R.M. Subjective Needs in People with Dementia. A Review of the Literature. International Psychogeriatrics, 2007 Jun,19(3):559-92.

Van der Roest, H.G., Meiland, F.J.M., Comijs, H.C., Derksen, E., Jansen, A., Hout, H. van, Jonker, C., Dröes, R.M. What do community dwelling people with dementia need? A survey among those who are known by care and welfare services. International Psychogeriatrics, 2009 21(5)949-965.

Wherton, J.P., Monk, A.F. (2008). Technological opportunities for supporting people with dementia who are living at home. *International Journal of Human-Computer studies*, 571-86.

Wilson, B.A., Emslie, H.C., Quirk, K., Evans, J.J. (2001). Reducing everyday memory and planning problems by means of a paging system: a randomised control crossover study. *Journal of Neurology, Neurosurgery and Psychiatry*, 70(4), 477-82.

Wimo, A., Jönsson, L., Gustavsson, A. (2008). The socio-economic impact of dementia" Ch. 4.5 The cost of illness and burden of dementia in Europe. Dementia in Europe Year book 2008.

Woolham, J., (2005). *Safe at Home*. In: The effectiveness of assistive technology in supporting the independence of people with dementia: the Safe at Home project, Hawker Publications, London.

www.alzinfo.org (2004). www.alzinfo.org/newsarticle/templates/archivenewstemplate.asp?articleid=76&zoneid=6

Yasuda, K., Beckman, B., Yoneda, M., Yoneda, H., Iwamoto, A., Nakamura, T., (2006). Successful guidance by automatic output of music and verbal messages for daily behavioural disturbances of three individuals with dementia. *Neuropsychological Rehabilitation*, 16, 66–82.

Zanetti, O., Zanieri, G., Vreese, L.P.d., Frisoni, G.B., Binetti, G., Trabucchi, M., (2000). *Utilizing an electronic memory aid with Alzheimer's disease patients. A study of feasibility.* In: Paper presented at the Sixth International Stockholm/Springfield Symposium on Advances in Alzheimer Therapy.

Annex A. ISO 9126-1 Quality Model

The ISO 9126-1 Quality Model for External and Internal Quality has been used to structure research questions for field tests and for the final summative evaluation.

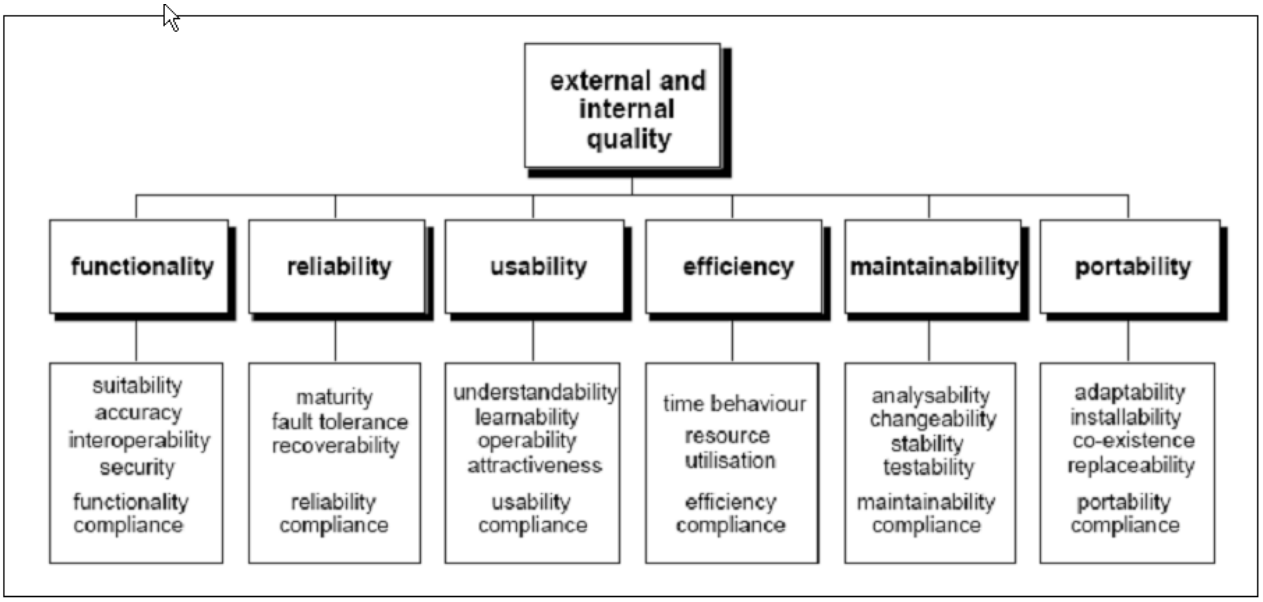

Figure 6: Quality Model for External and Internal Quality [ISO 9126-1]

Annex B. Software Release Process

Quality assurance (QA) is the set of planned and systematic actions necessary to provide appropriate confidence that a product or service will satisfy the requirements for quality (Wikipedia).

Below is the description of the COGKNOW internal Software Release Process (from the project-internal Project Management Handbook).

The process of software development for inclusion in consolidated releases will be subject to a quality assurance process carried out by the authors of the software, technical workpackage leaders (WPLs) and the Technical Coordinator (TC).

The QA process will consist of the following activities:

- **Planning:** The TC in collaboration with the WPLs will establish internal deadlines which will be in agreement with all the technical partners for incremental integration and testing goals.
    - The targets for incremental integration and testing will be defined for every month starting from September 2008, and will be finalised by the TC prior to the next General Meeting.
    - *QA Action: the plan is to be reviewed by the Operational Management Team (OMT) before the next General Meeting, to ensure that it is timely and provides enough confidence that the next field test will evaluate a prototype addressing the goals of the project.*
- **Risk Management:** The TC, in conjunction with WPLs, will - as part of OMT-level Risk Management, establish and keep updated, the probability of development delay of the remaining components to be developed and integrated, according to their complexity.
    - In instances of high probability of risks occurring, the TC will inform the OMT immediately, through the ad-hoc scheduling of an OMT teleconference, about the risk, and will together with the other technical partners prepare a mitigation plan that decreases the probability of the risk occurring and minimises its potential impact.
    - The test sites will make a contingency plan specifying what to do if the risk occurs. This may involve either delaying the field test in case of risks being associated with highly prioritised functionality, or removing the functionality in instances of lower-priority functionality.
    - *QA Action: the risk management plan is to be presented and reviewed at each OMT meeting, to ensure that risks have been analysed and that proper mitigation plans are defined.*
- **Component Testing**: Those responsible for specific technical components should use an internal development plan to release their software in accordance with the Project plan in addition to identifying any possible delays in advance. In instances of increased probability of delay, the responsible partner should contact the TC immediately.
    - Release versioning and documenting should be undertaken in accordance with the normal procedures at each of the technical partner's organisation and should be updated in conjunction with each new software release.

- Each component should behave reasonably and in accordance with the technical specification even when other components are not available or return unexpected data.
- The components should, as far as possible, be tested against actual or simulated versions of the other components in the system, before being submitted for integration testing.
- All the software components will be released 2 weeks in advance before the integration deadline.
- *QA Action: peer review or any other suitable methodology is to be established by each responsible partner and the selected quality assurance method is to be reported to the TC. Each module submitted for integration should be accompanied by a test report indicating the current behaviour of the desired functionality and robustness.*

- **Integration Testing**: The TC will be responsible to coordinate the integration and testing of the software releases into the whole system according to the deadlines, and will inform the OMT about its results.
  - Those technically responsible for each component shall normally take direct part in the integration activity, by remote access to the system, or by going in person to a venue where technical partners can work together on a complete system. Each component submitted for integration should be accompanied by succinct installation and use instructions.
  - The result of an Integration activity shall be a new major release of involved system components, marked as version 1.0, 2.0 etc for each component. The resulting main prototype version shall have a version number, for example CDN v3.1, v3.2. All new major releases will be documented and made available to all partners to provide further visibility in the development process.
  - The CDN version intended for the next field test ("the main prototype") shall be delivered to all test sites one month in advance of the start of the field test, including any required equipment not already present at the sites. It is recommended to hold a "delivery meeting" at this time, where the sites can bring one of the stationary and mobile devices, to have the software installed and tested against a complete system. Recommended venue: one of the test sites. Sites should not schedule appointments with PwDs to take place within the first month following delivery of the third prototype.
  - *QA Action: a demonstration of the system should be made to independent persons appointed by the field test workpackage, to ensure that the functionality behaves as expected. This can be made via a simple video conference link or through the recording of a rudimentary video demonstrating functionality which can be made available on the Project co-ordinator. The views of the independent persons from the field test workpackage of the status of the system following demonstration will be presented to the OMT during the following monthly teleconference.*

- **Usability Testing**: The clinical partners will advise the technical partners on usability issues relating to for example, screen layout, navigation, the use of text, voice, imagery, language etc. This feedback will be in line with the user centred approach intrinsic to the Project's methodology.
  - In conjunction with the aforementioned planning, when a new main prototype version is ready, it will be submitted to the sites in an effort to solicit usability feedback from the target users in addition to receiving feedback from demen-

tia experts. Dementia experts will be appointed by the human factors workpackage and are anticipated to provide feedback on how cognitive limitations for PwD might impact the use of the proposed interfaces.

- The sites will provide suitable translations to Dutch and Swedish.
- *QA Action: following release of each planned incremental prototype, consolidated feedback on usability issues will be provided to the TC by the human factors workpackage.*

- **Site Testing**: Before the field test, the sites will adjust the prototype to local conditions, and verify that the prototype works with the equipment at the test site.
  - The site technician will have to put together and adjust any hardware that is not already connected upon delivery and will be supported in this activity through the Installation Manual.
  - The site technician will install or clone the software onto the fixed and mobile devices.
  - The site technician will configure to local conventions for the technical system (like IP addresses, port numbers etc).
  - Structured test runs will be made of the system using any available specification material (for example priority lists, user manual, functional requirements and prescribed task lists), and structured reports will be provided to technical partners for correcting any discovered bugs. These structured tests will not be performed within the PwD's home.
  - The site researchers will be invited for a demonstration of the system, and any significant user-level problems with functionality or usability will be written down in a structured report to be sent back to the technical partners. Only small and quick changes to the system may be made at this time, considering that any change carries a small risk of introducing a bug or destabilising the system. The decision of changes to be made will be the responsibility of the TC.
  - Following the aforementioned demonstrations and with the approval of the test sites that the third prototype is performing as expected, previous arrangements for pre-test interviews and dates for the next field test will be confirmed with each of the PwDs for all sites.
  - Per-user configuration will be performed based on information from pre-test interviews.

QA Action: demonstration will be given to site researchers as the last quality check for functionality, usability and stability, before the actual field test.

Annex C. COGKNOW Dissemination Report

C.1. Journals and Scientific Magazines

2006

- Dröes, R.M., Mulvenna, M.D., Nugent, C., Craig, D., Scully, T., Martin, S., Moelaert-El-Hadidy, F. (2006) Research Vision: Helping People with Mild Dementia Navigate Through Their Day. Journal of Dementia Care, Volume 14, Issue 2 (March/April), pp.17, ISSN 1351-8372.

2007

- Dröes, R.M., Insight in coping with dementia: Listening to the voice of those who suffer from it, Aging & Mental Health, Volume 11, Issue 2, March 2007, pages 115 – 118
- Dröes, R.M., Mulvenna, M.D., Nugent, C.D., Finlay, D., Donnelly, M., Mikalsen, M., Walderhaug, S., van Kasteren, T., Kröse, B., Puglia, S., Scanu, F., Oreste Migliori, M., Uçar, E., Atlig, C., Kiliçaslan, Y., Uçar, Ö., Hou, J., (2007) "Healthcare Systems and Other Applications," IEEE Pervasive Computing, vol. 6, no. 1, pp. 59-63, ISSN: 1536-1268
- Lauriks, S., Reinersmann, A., Roest, H. van der, Meiland, F.J.M., Davies, R.J., Moelaert, F., Mulvenna, M.D., Nugent C.D., Dröes, R.M., (2007) Review of ICT-based Services for Identified Unmet Needs in People with Dementia, Ageing Research Reviews, Vol. 6 No.3, pp.223–246, ISSN 1568-1637
- Martin, S., Nugent, C., Wallace, J., Kernohan, G., McCreight, B., Mulvenna, M.D., (2007) Using Context Awareness Data from a Smart Home Environment to Support Social Care for Adults with Dementia. Journal of Technology and Disability. 19(2-3), pp.143-152, ISSN 1055-4181
- Meiland, F.J.M. Reinersmann, A., Bergvall-Kareborn, B., Craig, D., Moelaert, F., Mulvenna, M.D., Nugent, C., Scully, T., Bengtsson, J., Dröes, R.-M., (2007) COGKNOW: Development of an ICT Device to Support People with Dementia, The Journal on Information Technology in Healthcare; 5(5): pp. 324–334, ISSN 1479-649X
- Meiland F.J.M., Reinersmann A., Bergvall-Kareborn B., Craig D., Moelaert F., Mulvenna M.D., Nugent C., Scully T., Bengtsson J.E., Dröes R.M., (2007) COGKNOW Development and evaluation of an ICT-device for people with mild dementia, Studies in Health Technology Informatics,127:166-77, ISBN: 0926-9630
- Meiland F.J.M., Reinersmann A., Bergvall-Kåreborn B., Craig D., Moelaert F., Mulvenna M.D., Nugent C., Scully T., Bengtsson J.E., Dröes R.M., COGKNOW Development and evaluation of an ICT-device for people with mild dementia, Medical and Care Compunetics 4. L. Bos & B. Blobel (eds). IOS Press, Amsterdam, 2007. pp 166-77, ISBN: 978-I-58603-751-2.
- Nugent, C.D., (2007) ICT in the elderly and dementia, Aging & Mental Health, vol. 11, no. 5, pp. 473-476.
- Nugent, C.D., Mulvenna, M.D., Moelaert, F., Bergvall-Kareborn, B., Meiland, F., Craig, D., Davies, R., Reinersmann, A., Hettinga, M., Andersson, A-L., Droes, R.-M., Bengtsson, J., Home-based Assistive Technologies for People with Mild Dementia, pp. 63-69, Pervasive Computing for Quality of Life Enhancement, Lecture Notes in Computer Science, Vol. 4541, Okadome, Takeshi; Yamazaki, Tatsuya; Mokhtari, Mounir (Eds.), 2007, ISBN: 978-3-540-73034-7

2008

- Nugent, C.D., (2008) The use of technology to facilitate independent living, Signpost Journal of Dementia and Mental Health Care for Older People, vol. 12, no. 3, pp. 4-9.

2009

- Bouman, A., Meiland, F., Dröes, R.M., Sävenstedt, S., Moelaert, F., Mulvenna, M., Craig, D., Bengtsson, J.E., Nugent, C. COGKNOW: Development of a Cognitive Prosthetic for People with Mild Dementia Living at Home. IPA Bulletin, Vol. 26 (2), 2009.
- Davies, R.J., Nugent, C.D., Donnelly, M., Hettinga, M., Meiland, F., Moelaert, F., Mulvenna, M.D., Bengtsson, J.E., Craig, D., Droes, R.-M. (2009) A User-Driven Approach to Develop a Cognitive Prosthetic to Address Unmet Needs of People with Mild Dementia, Journal of Pervasive and Mobile Computing, 5(3) pp. 253-267, ISSN: 1574-1192, http://dx.doi.org/10.1016/j.pmcj.2008.07.002.

- Maged N. Kamel Boulos, Ricardo Castellot Lou, Athanasios Anastasiou, Chris D. Nugent, Jan Alexandersson, Gottfried Zimmermann, Ulises Cortes, Roberto Casas, Connectivity for Healthcare and Well-Being Management: Examples from Six European Projects, Int. J. Environ. Res. Public Health 2009, 6(7), 1947-1971; doi:10.3390/ijerph6071947

C.2. Book Chapters

2007

- Meiland F.J.M., Reinersmann A., Bergvall-Kareborn B., Craig D., Moelaert F., Mulvenna M.D., Nugent C., Scully T., Bengtsson J.E., Dröes R.M., COGKNOW Development and evaluation of an ICT-device for people with mild dementia, Medical and Care Compunetics 4. L. Bos & B. Blobel (eds). IOS Press, Amsterdam, 2007. pp 166-77, ISBN: 978-I-58603-751-2
- Mulvenna, M.D., Meiland, F.J.M., Moelaert, F., Castellot, R., Wallace, J.G., Nugent, C.D., Martin, S., Davies, R., Devlin, S. COGKNOW: Translating Research Innovation into Products and Services, Expanding the Knowledge Economy, Issues, Applications, Case Studies, Cunningham, P., & Cunningham, M., (Eds), pp. 575-583, IOS Press, Amsterdam, 2007, ISBN 978-1-58603-801-4
- Nugent, C.D., Mulvenna, M.D., Moelaert, F., Bergvall-Kareborn, B., Meiland, F., Craig, D., Davies, R., Reinersmann, A., Hettinga, M., Andersson, A-L., Droes, R.-M., Bengtsson, J., Home-based Assistive Technologies for People with Mild Dementia, pp. 63-69, Pervasive Computing for Quality of Life Enhancement, Lecture Notes in Computer Science, Vol. 4541, Okadome, Takeshi; Yamazaki, Tatsuya; Mokhtari, Mounir (Eds.), 2007, ISBN: 978-3-540-73034-7

2008

- Meiland, F.J., Lauriks, S., Dröes, R.M. COGKNOW Elektronische assistent voor mensen met lichte dementie, F. Meiland, S. Lauriks, R.M. Dröes. In: Langdurende zorg en technologie, H. Kort, A. Cordia L. de Witte (red.). Den Haag: Uitgeverij Lemma, 2008. ISBN: 978-90-5931-485-6
- Moelaert, F., Dröes, R.M., Meiland, F.J.M., Bengtsson, J., Sävenstedt, S., Hettinga, M., Mulvenna, M.D., Nugent, C.D., Martin, S., User-Centricity in the Development of Services for People with Mild Dementia, in: P Cunningham & M Cunningham (ed.), Expanding the Knowledge Economy: Issues, Applications, Case Studies, IOS Press, 2008, pp. 71-78, ISBN: 978-1-58603-924-0.
- Nugent, C.D., Moelaert, F., Davies, R.J., Donnelly, M., Savenstedt, S., Meiland, F., Droes, R.-M., Hettinga, M., Craig, D., Mulvenna, M.D., Bengtsson, J.E., Evaluation of Mobile and Home-based Cognitive Prosthetics, In: Helal, S., Mitra, S., Wong, J., Chang C. K., Mokhtari, M., (Eds.), Smart Homes and Health Telematics: Proceedings ICOST-2008, Lecture Notes in Computer Science 5120, Springer Berlin, pp.18-25, ISBN: 978-3-540-69914-9.

C.3. COGKNOW Book, Q1 2010

Book: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.

Includes the following chapters:

- MD Mulvenna, C Nugent, F Moelaert, D Craig, R.M. Dröes, J Bengtsson Supporting People with Dementia Using Pervasive Healthcare Technologies, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- D Craig, FJM Meiland, AP Passmore, RM Dröes. Prevalence and clinical features of dementia, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- R Castellot, A Giuliano, S Martin, State of the Art in Electronic Assistive Technologies for People with Dementia, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- S Lauriks, A Reinersmann, HG van der Roest, FJM Meiland, RJ Davies, F Moelaert, MD Mulvenna, CD Nugent RM Dröes, Review of ICT-based services for identified unmet needs in people

with dementia, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.

- F Meiland, RM Dröes, S Sävenstedt, B Bergvall-Kåreborn, AL Andersson, Identifying User Needs and the Participative Design Process, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- M Hettinga, H Holthe, AL Andersson, F Moelaert, R Davies, CD Nugent, Managing the Transition from User Studies to Functional Requirements to Technical Specification, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- RM Dröes, S.C.L., Bentvelzen, F. Meiland, D Craig, Dementia-related and other factors to be taken into account when developing ICT-support for people with dementia – Lessons from field trials, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- M Baumgarten, MD Mulvenna, The Role of Context-aware Computing in Support of People with Dementia, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- R Davies, M Donnelly, C Nugent, M Hariz, J Hallberg, M Mokhtari, Prototyping Cognitive Prosthetics for People with Dementia In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- J Wallace, MD Mulvenna, S Martin, S Stephens, W Burns, ICT Interface Design for Ageing People and People with Dementia, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- S Andersson, AL Andersson, Practical Issues When Planning for Field Trials, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- S Sävenstedt, F Meiland, RM Dröes, F Moelaert, Evaluation of Cognitive Prosthetics In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- F Meiland, RM Dröes, S Sävenstedt, Measuring the impact of Cognitive Prosthetics on the daily life of people with dementia and their carers In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.
- Jeffrey Kaye, Technology and Dementia: The Way ahead, In: Mulvenna, M.D., Nugent, C.D. (Eds.), Supporting People with Dementia Using Pervasive Health Technologies, Series: Advanced Information and Knowledge Processing, 2010, Approx. 200 p., ISBN: 978-1-84882-550-5.

C.4. International Conferences

2006

- Dröes, R.M. The COGKNOW project; helping people with mild dementia navigate through their day. Lecture at Interdem symposium, Paris, France, 29 June 2006.

2007

- Andersson, A.-L., Andersson, S., Cogknow: Helping People with Mild Dementia Navigate their Day, Tromsø¸ Telemedicine and eHealth Conference (TTeC-2007), 2007

- Davies, R., Nugent, C.D., Donnelly, M.P., Mulvenna, M.D., Craig, D., Evaluation of a Pilot Study to Assess the Usefulness and User Friendliness of a Cognitive Prosthetic for Persons with Mild Dementia (COGKNOW Project), 2007, British Geriatrics Society Bi-Annual Conference.
- Davies, R.J., Nugent, C.D., Donnelly, M.P., Craig, D., Mulvenna, M.D., Martin, S., Wallace, J.G., Evaluation of a Pilot Study in Northern Ireland to Assess the Utility of Mobile-based Cognitive Prosthetics, 12th Annual Conference & Scientific Symposium, Healthcare Informatics Society of Ireland, November 2007, Dublin, Ireland.
- Dröes, R.M., Lauriks, S., Roest, H. van der, Reinersmann, A., Meiland, F.J.M., ICT- opportunities in the care for people with dementia, Symposium 'Dementia Update 2007', VU University medical centre, Amsterdam, March 2007, pp. 30-33
- Dröes, R.M., Meiland, F.J.M., Moelart, F., Craig, D., Mulvenna, M.D., Nugent, C., Scully, T., Bengtsson, J. (2007). ICT-solutions for unmet needs in dementia; COGKNOW - helping people with dementia navigate through their day. In: The sound of silence. 17th Conference of Alzheimer Europe, Estoril, p. 76.
- Holthe, H., Developing and Prototyping the Cogknow 'Day Navigator' - A Device Supporting People with Mild Dementia, Tromsø¸ Telemedicine and eHealth Conference (TTeC-2007), 2007
- Meiland, F.J.M. Reinersmann, A., Bergvall-Kareborn, B., Craig, D., Moelaert, F., Mulvenna, M.D., Nugent, C., Scully, T., Bengtsson, J., Dröes, R.-M., COGKNOW: Helping people with mild dementia navigate their day, 4th International Council on Medical & Care Compunetics, (ICMCC-2007), Amsterdam, Netherlands, 2007
- Mulvenna, M.D., Craig, D., Dröes, R-M., Nugent, C., Technology & Aging: Telerehabilitation and Technology Assisting People with Dementia, Proceedings IAHSA, St. Julian's, Malta, June 2007
- Nugent, C.D., Mulvenna, M.D., Moelaert, F., Scully, T., Meiland, F., Bergvall-Kåreborn, B., Craig, D., Reinersmann, A., Andersson, A.-L., Droes, R.-M., Martin, S., 2007. Mobile Assistive Technologies. Proceedings Festival of International Conferences on Caregiving, Disability, Aging and Technology (FICCDAT), Toronto, Canada, 2007 Advances in Neurorehabilitation, pp.363, ISSN 1536-1268, June 2007, Toronto Canada

2008

- Bengtsson, J.E., Castellot R., invited attendance, exhibited and selected to demonstrate in the European Commission Smart Home showcase, European Ministerial e-inclusion conference, Vienna, Austria, 30 November 2008.
- Burns, W.P., Nugent, C.D., McCullagh, P.J., Zheng, H., Finlay, D.D., Davies, R.J., Donnelly, M.P., Black, N.D., Personalisation and configuration of assistive technologies, Proceedings of the 30th Annual International IEEE Engineering and Medicine and Biology Society, 2008, pp. 3304-3307.
- Dröes, R.-M., Meiland, F., Sävenstedt, S., Martin, S., Moelaert, F., Craig, D., Bengtsson, J., Holthe, H., Andersson, A.-L., Davies, R., Donnelly, M., Andersson, S., Nugent, C., Mulvenna, M.D., Towards an Integrated Cognitive Prosthetic for People with Mild Dementia; a User Centered Approach, International Psychogeriatric Association European Congress (IPA-2008), 2008, Dublin, Ireland.
- Martin, S., Dröes, R.M., Sävenstedt, S., Meiland, F., Moelaert, F., Bengtsson, J., Holthe, H., Andersson, A.-L., Davies, R., Andersson, S., Lauriks, S., Donnelly, M., Mulvenna, M.D., Nugent, C., Wallace, J., User Validation Of An Integrated Cognitive Prosthetic Device For People With Mild Dementia, International Conference on Aging, Disability and Independence (ICADI-2008), Saint Petersburg, USA, 2008, University of Florida, p.75, ISBN: 0-9754783-0-5.
- Meiland, F.J.M., Lauriks, S., Moelaert, F., Craig, D., Mulvenna, M.D., Nugent, C., Scully, T., Bengtsson, J.E., Dröes. R.M., COGKNOW: ondersteuning van mensen met dementie thuis door ICT, DOMOTICA Congres, Ede, The Netherlands, 14 May 2008
- Mulvenna, M.D., Martin, S., Nugent, C.D., Craig, D., Moelaert, F., Dröes, R.M., Meiland, F.J.M., Providing Reminding and other Services for People with Mild Dementia: Results from The COGKNOW Project, Dementia Services Development Centre (DSDC) International Conference: Celebrating Innovation & Excellence: Making Change Happen, 1-3 September 2008, Stirling, Scotland.
- Mulvenna, M.D., Martin, S., Donnelly, M., Nugent, C.D., Craig, D., User-Validation of a Cognitive Prosthetic for People with Mild Dementia, DSDC-NI, International Conference: Embracing the Challenge: Citizenship & Dementia, 6-8 May 2008, Belfast, UK.
- Nugent, C.D., Smart technologies for smart homes, The Second International Health and Social Care Modelling Conference, Coleraine, 2008, pp. 35, .

- Nugent, C., Davies, R.J., Donnelly, M., Hallberg, J., Hariz, M., Craig, D., Meiland, F., Moelaert, F., Bengtsson, J.E., Mulvenna, M.D., Dröes, R.M., The Development of Personalised Cognitive Prosthetics, 30th Annual International IEEE Engineering in Medicine and Biology Conference (EMBS-2008), pp. 787-790, 20-24 August, 2008, Vancouver, Canada.
- Sävenstedt, S., & Holthe, H., The COGKNOW Day Navigator :An evaluation of the first research cycle, Tromsø Telemedicine and eHealth Conference 2008 - Innovation in eHealth, 9-11 June 2008, Tromsø, Norway.

2009

- Dröes, R.M., Mulvenna, M.D. COGKNOW: Assistive Technology for People with Mild Dementia, International Association of Homes and Services for the Ageing's (IAHSA) 8th International Conference - Leadership Beyond Borders, London 19-22 July 2009.
- Dröes, R.M., Meiland, F.J.M. "E-mental health and Dementia" on the first international congress "E-mental health summit 2009." 14-16 October 2009 in Amsterdam. http://www.ementalhealthsummit.com/en/programme
- Meiland, F.J.M., Sävenstedt, S., Moelaert, F., Craig, D., Davies, R.J., Nugent, C.D., Andersson, A-L., Dröes, R.M. Electronic assistance for community dwelling people with dementia; user-driven development of a cognitive prosthetic device. Abstractbook Alzheimer Europe congress, Brussel, België, 28-30 May 2009, P17.2
- Dröes, R.M., Meiland, F.J.M., Sävenstedt, S., Hettinga, M., Moelaert, F., Craig, D., Holthe, H., Andersson, A.L., Martin, S., Davies, R.J., Donnelly, M., Andersson, S., Mulvenna, M., Bengtsson, J., Nugent, C.D. Assistive Technology for people with Mild Dementia; results of the COGKNOW project. 37th Congress of the European Association of Geriatric Psychiatry, 16-18 September Tours, France.

C.5. Workshops

2007

- Andersson, S., Vårdstämman, Sweden, April 2007
- Andersson, A-L., Andersson, S., Vitalis, National Care Congress, Sweden, March 2007
- Bengtsson, J.E., presentation and demonstration at Medicinteknikdagarna, Swedish Society for Medical Engineering and Medical Physics, Örebro, Sweden October 2007

2008

- Andersson, S., Andersson, A-L., presentation at Vitalis, national care congress, Gothenburg, Sweden, May 2008
- Bengtsson, J., Mulvenna, M.D., Moelaert, F., Nelson, J., Bierhoff, I., Workshop on User Involvement in Connected Health and Wellness Design, Workshop Proceedings eChallenges-2008, Stockholm, Sweden, 22-24 October 2008, pp. 62-63.
- Castellot, R., Escriche, Andrés, J.J., Nugent, C.D., Alexandersson, J., Zimmermann, G., Cortes, U., Casas, R., Fagerberg, G., Suarez, M., Kung ,A., Cluster workshop of eInclusion projects to share knowledge and coordinate joint activities, Madrid, 24th June 2008.
- COGKNOW session at ASPROM workshop in Paris, on 13th and 14th November 2008, coordinated by the European Project MONAMI, as a result of the cluster activities.
- COGKNOW Business Assessment Workshop for the Dutch context, Organised with practitioners in Enschede, The Netherlands, 15 October 2008.
- COGKNOW Business Assessment Workshop for the UK/Ireland context, Organised with practitioners in Holywood, UK, 14 November 2008.
- Craig, D., Nugent, C.D, Assistive Technology, CARDI-SPARC Workshop on Ageing, Belfast, June 2008
- Meiland, F.J.M., Lauriks, S., Moelaert, F., Craig, D., Mulvenna, M.D., Nugent, C., Scully, T., Bengtsson, J.E., Dröes. R.M., ICT solutions for unmet needs in dementia - COGKNOW - Helping people with dementia navigate through their day, Wetenschapsdag, Vaste Commissie voor de Wetenschapsbeoefening, VU Medisch Centrum, Amsterdam, The Netherlands, 8 February 2008
- Moelaert, F., COGKNOW presentation at SENIOR Workshop, Brussels, Belgium, 6 October 2008.

- Moelaert, F., “Users, Applications & Services and User Centricity”, Workshop: Home Based Assistive Technologies for People with Dementia, DKIT, Dundalk Institute of Technology, Dundalk, 11 March 2008
- Nugent, C.D., Cognitive prosthetics and dementia, British Geriatrics Society Spring Meeting, Glasgow, 23rd-25th April, 2008.
- Nugent, C.D., Smart environments to support independent living: non-vision based practical technologies, Thematic Winter School - Understanding Behaviour from video sequences, France, March 2008.
- Nugent C.D., Bengtsson J.E., Moelaert, F., Davies, D., Donnelly, M., Global Village workshop, demonstration, panel and presentation in User Perspective session (chair), Paris, France, February 2008

2009

- COGKNOW Business Assessment Workshop for the Swedish context, Organised with practitioners in Piteå, Sweden, 4 June 2009.

C.6. Webs and Videos

- COGKNOW Public Web, 2006-2009, http://www.cogknow.eu
- COGKNOW Video, 2006, http://www.youtube.com/watch?v=EJVpFTAariM
- COGKNOW Activity Assistance Video, 2008, http://www.youtube.com/watch?v=nzFWvoDR5ds
- Nova TV documentary about COGKNOW on Dutch TV, 6 December 2008, http://www.novatv.nl/page/detail/uitzendingen/6540
- COGKNOW on National Maltese TV, on EU programme (19:10), 10 February 2009, http://public.di-ve.com/streaming/on_demand_event_library.aspx.
- COGKNOW Field Test #3 Video, June 2009, http://www.youtube.com/watch?v=UKJTmzp33Z4

C.7. Other Dissemination Activities and Output

2006

- 11/05/06, Tracer, Magazine of VU University medical center, nr 10, HTML
- 19/09/06, University of Ulster - "Helping People to Navigate their Day", HTML
- 27/10/06, Website of Helpdesk Meeting centers for people with dementia and their carers, HTML
- 09/11/06, Website of Institute for Research in Extramural Medicine of VU University medical center, PDF
- 07/11/06, Luleå University of Technology - "Framgång för norrbottnisk forskning om e-hälsa", HTML
- 01/11/06, Informatiebulletin GGZ-Buitenamstel (information bulletin of the Regional institute for Mental Health Service Amsterdam South/New-West), HTML

2007

- 05/03/07, University of Ulster - "UU Leads Way in European Dementia Research Project", HTML
- 06/04/07, CORDIS News - "European research helps people with dementia to navigate their day", HTML
- Dutch article in magazine of Telematica Instituut: “Geheugensteuntjes: De Day Navigator ondersteunt mensen met milde dementie”. Knowhow 4/2007. p13-14
- 11/04/07, Scientist Live - "COGKNOW Project helps elderly with dementia", HTML
- 20/05/07, istworld - "COGKNOW: Helping people with mild dementia navigate their day", HTML
- Halgeir Holthe audio recording from Tromsø¸ Telemedicine and eHealth Conference (TTeC-2007), June 2007
- Summer 07, Dementia Perspective (Northern Ireland newsletter), PDF
- KRO radio interview with Ferial Moelaert about Cogknow on 07 December 2007

2008

- Presentation at Digital Life Seminar: “Geheugensteuntje: de Day Navigator ondersteunt mensen met milde dementie” Ferial Moelaert. Digital Life seminar – innoveren met MKB. 11 januari 2008
- Bengtsson J.E., COGKNOW material for Paul Timmers' keynote at Annual IT Conference, Hjälpmedelsinstitutet (National Institute for Assistive Technologies), Stockholm, Sweden, April 2008
- Craig, D., Nugent, C.D., Assistive Technologies - How can advances in technologies assist user needs, CARDI Seminar, Dublin, 2008.
- Meiland, F.J.M., Van der Roest, H.G., Dröes, R.M. De ontwikkeling van elektronische hulpmiddelen: voor en door mensen met dementie? Praecox, June 2008, pp. 10-13.
- Bengtsson J.E., Karlsson, E., demonstration at “På äldres villkor”, workshop with 400 participants hosted by NLL, Luleå, Sweden, September 2008
- Nugent, C.D., Systems, Services and Devices to Support Independent Living, Neuroscience and Mental Health RRG, Belfast, 2008.

2009

- Dutch popular article in journal: “Huistechnologie voor ondersteuning van dementerende ouderen: Een ontluikende Europese markt”. Interview with Ferial Moelaert, Telematica Instituut by Marcel Ham. Publisher: Hmf: Health management forum. Tijdschrift voor toekomstverkenning, strategieontwikkeling en innovatie. Thema: zorg over de grenzen. Nr 1 2009. p32-33
- Ferial Moelaert, Ambient assisted support for people with mild dementia, European AAL day, Berlin, 2009
- COGKNOW Stand on the national Congress Innovatieve Technologie in de Langdurende Zorg [Innovative technology in long-term care] in Amsterdam, 10 March 2009
- Exhibition with demonstration and vision video at Socialtjänststämman, national social care congress with 900 leaders and staff, Luleå, 17-18 March, 2009.
- Invited presentation 24th Conference of Alzheimer’s Disease International (ADI) in Singapore, 25-28 March 2009.
- Exhibition with demonstration and vision video at Vitalis, national care congress, Gothenburg 21-23 April, 2009.
- Meiland, F.J.M., Dröes, R.M. COGKNOW presentation at Interdem Meeting 2009, Brussels, 28 May 2009.
- Demonstration of COGKNOW at national conference Högskolor och Samhälle i Samverkan (Academia and Society Collaboration) with 300 participants from Scandinavia, Luleå, June 2009. http://www.hss09.se/.
- Demonstration of COGKNOW at FIRE and Living Labs conference with 330 participants and experts from Commission and ITU, Luleå, 1-2 July, 2009. http://www.fireandlivinglabs09.eu/
- Demonstration of COGKNOW at ICOST 2009, Paris, France, 1-3 July 2009.
- COGKNOW Nieuwsbrief. Meiland, F., Bentvelzen, S. & Dröes, R.M. (eds.), Volume 3, nr 2 august 2009.
- Think Technologically, Act Globally by Michele Hayunga in FutureAge magazine, published by American Association of Homes & Services for the Aging, 2009 (AAHSA)

C.8. Planned Publications and Events

- Online article for The Swedish Dementia Centre, http://www.demenscentrum.se/English1/, September 2009.
- Coordination Action AALIANCE Newsletter, 2500 copies to leading industrial and research organisations within Ambient Assisted Living, autumn 2009, invited.
- National TV coverage in Sweden, SVT or TV4, autumn 2009, invited.
- Meiland, F.J.M., Reinersmann, A., Sävenstedt, S., Bergvall-Kåreborn, B., Hettinga, M., Craig, D., Andersson, A.L., Dröes, R.M. User-participatory development of assistive technology for people with dementia – from needs to functional requirements. First results of the COGKNOW project. Accepted: Non-pharmacological therapies in dementia, 2010.
- Mulvenna, M.D., Martin, S., Galbraith, B., Haaker, T., Jansson, M., Castellot, R., Melander-Wikman, A., Moore, G., Moelaert, F., Isaksson, L., Wallace, J., Nugent, C., Bengtsson, J., Provid-

ing Inclusive Healthcare Services: From Unmet Need to Business Model, International Journal of Computers in Healthcare, Accepted, Q1, 2010.

- Nugent, C.D., Moelaert, F., Davies, R.J., Donnelly, M., Sävenstedt, S., Meiland, F., Droes, R.-M., Hettinga, M., Craig, D., Mulvenna, M.D., Bengtsson, J.E., Evaluation of Mobile and Home-based Cognitive Prosthetics, Special Issue on 'Ambient Intelligence in Smart Homes: Eldercare with Interventions and Activity Modeling, Reasoning & Recognition' in the International Journal of Assistive Robotics and Mechatronics (IJARM), In preparation.
- Dröes, R.M. Invited plenary presentation planned for 25th Conference of Alzheimer's Disease International (ADI) in Thessaloniki, 10-14 March 2010.