

SYMPOSIUM SESSION 4: INFORMATION AND COMMUNICATION

HAAL: A healthy ageing eco-system for people with dementia

H. H. Nap, D. R. M. Lukkien, C. C. Lin, C. J. Lin, H. F. Chieh, Y. T. Wong, F. C. Su, R. Bevilacqua, G. Amabili, N. Morresi, G. M. Revel, S. Casaccia

Purpose The world is facing similar challenges in respect to the ageing population and shortages of care personnel, with dementia as one of the largest challenges (Gauthier et al., 2021). Across Europe and beyond, various dementia friendly eco-systems are in place with Active and Assisted Living (AAL) products and services to empower people with dementia (PwD) and their informal- and formal carers (Nap et al., 2018; Nap et al., 2020). However, it can be burdensome for (informal) carers to use multiple devices, applications and UI's, and particularly in care – where workload is high – bandwidth is limited to use multiple devices. With the HAAL project, The Netherlands, Italy, and Taiwan combine their expertise and experiences in development, co-design and evaluation to iteratively design an AI-driven cloud-based dashboard for formal carers to share data, collected from integrated sensors, that measure the well-being and quality of life of PwD. The dashboard is linked to a state-of-the-art bundle of HAAL products and services for PwD in various stages (see Reisberg et al., 1982) and their (informal)carers (see Figure 1.). **Method** All end-users are involved from the start of the HAAL project in co-design, business modelling, responsible innovation (Lukkien et al, 2021) and during the evaluation in the later phases of the project. Over 75 end-users will be involved in co-design, meaningful try-outs and formative evaluations. In the final summative evaluation, 90 end-users will be involved in 3 pilots (30 per country), consisting of triads of PwD, their informal and formal carers with a major focus on evaluating workload of carers and quality of life of PwD. **Results and Discussion** The first results from the co-design phases and meaningful try-outs show that formal carers are positive about a central AI-driven dashboard, as well as about a number of products and services in the HAAL bundle. In Taiwan, PwD were also involved in trying out the products and they showed their interest mainly in serious games and social robotics. In addition, within the HAAL project, a first UI design of the AI-driven dashboard has been iteratively developed, along with the software and the hardware architecture. Responsible innovation workshops supported in an early critical assessment of the merits and perils of AI in care for PwD. In HAAL, PwD, their relatives, and care professionals are the focal point for the testing, development, and design. In the following phases of the HAAL project, we will further co-design with these groups to assess the bundle of selected technologies, learn from the best practices and eventually develop and evaluate the AI-driven dashboard that offers the most useful solutions for dementia care.

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Address: Vilans, Postbus 8228, 3503 RE, Utrecht, The Netherlands

Email: h.nap@vilans.nl

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Figure 1. HAAL products to support the dementia stages (GDS 1-7)

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The co-design of an AI-driven healthy ageing eco-system: User requirements from dementia formal carers

P. Koowattanataworn, N. E. Stolwijk, H. H. Nap, S. Ipakchian Askari, B. M. Hofstede, R. Bevilacqua, G. Amabili, A. Margaritini, C. C. Lin, C. J. Lin, H. F. Chieh, Y. T. Wong, F. C. Su

Purpose The world population is ageing with a decreasing workforce of care personnel, with dementia as one of the largest challenges in long-term care (Gauthier et al., 2021). Assistive technologies and services on several aspects of lifestyle could be of support because dementia impacts the daily lifestyle of people with dementia (PwD) and (in)formal caregivers. The HAAL project proposes an approach of an integrated ecosystem; a bundle of Ambient Assisted Living (AAL) products and an AI-driven dashboard. The vision of the HAAL project is to adopt Machine Learning to extract valuable information on a central dashboard. With global rapid development, user requirements for a state-of-the-art integrated ecosystem need iterative and local revisions. To achieve a feasible result, HAAL takes the Living Lab methodology (Bergvall-Kåreborn et al., 2009) as the core methodology – an approach of co-creation amongst stakeholders (i.e. researchers, PwD, informal caregivers, formal carers and technology developers). This research aims to study the end-users perceptions and opinions of an integrated-technology ecosystem. In addition, a rating and ranking study of the AAL products and technology combinations supports a careful consideration for implementation. Finally, the study sets the direction of the design of the future AI-driven dashboard. **Method** Three studies were conducted; user requirement investigation, HAAL technology demonstration and MoSCoW prioritisation (Kuhn, 2009). 32 PwD, 19 informal caregivers and 114 formal carers participated in the Netherlands, Italy, Taiwan and Denmark. The methods included interviews, focus groups, technological trials in demo rooms and survey research. Meaningful Tryout cards (Cornelissen & Suijkerbuijk, 2022) and working AAL products were used during the HAAL technology demonstration. The analysis techniques are thematic analysis and quantitative data exploration. User requirements were developed based on a motivational goal model (Burrows et al., 2018; Taveter et al., 2019). **Results and Discussion** PwD, informal caregivers and formal carers expressed the need to increase technology adoption to prolong the independent lives of PwD at home and avert the risk of health complications. In particular, formal carers recognise the potential of data utilisation. Four functional requirements for the ecosystem that emerged from the study are daily assistance, monitoring, alarm and prevention. According to end-users, the main emphasis should be on prevention (e.g., prompting actions before accidents happen and slowing dementia progression), because it could partially solve the current high workload and the shortages in the healthcare workforce. Fall detection and the GPS positioning are the best-rated features because of the concern of falling and wandering. The compulsory quality requirements of the ecosystem are usability and that the products are failure-proof. While giving back PwD autonomy was preferred in the Netherlands and Denmark, enriching the meaning of PwDs life was often addressed in Taiwan and Italy. The requirements serve as input for the iterative co-design of the AI-driven dashboard for formal carers. A potential challenge is related to change management. It is necessary to change the mindset of all end-users that digital care is care.

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Address: Vilans (The Netherlands)

Email: p.koowattanataworn@vilans.nl, n.stolwijk@vilans.nl

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SYMPOSIUM SESSION 4: INFORMATION AND COMMUNICATION

Technical development of a holistic platform to monitor people with dementia and measure their well-being
N. Morresi, G. M. Revel, S. Casaccia

Purpose In recent years, an extensive bulk of technology was developed for helping PwD and its caregivers. Low-cost sensors, wearable devices, electronic health records and artificial intelligence (AI) spread in the healthcare system to gather and analyze data collected from PwD to get insights into his/her physical condition, behavior at home and lifestyle (Bevilacqua et al., 2020). Assistive technologies can improve the quality of life of seniors and support caregivers to detect and monitor the onset and progression of diseases. Future developments should apply a holistic approach that analyses multiple aspects of the quality of life of PwD using devices such as GPS trackers, tablet/mobile applications, lifestyle monitoring systems, and sleep monitoring sensors (Wójcik et al., 2021). Currently, there are many devices that work alone and focus on one or two needs of the PwD (Casaccia et al., 2019; Aloulou et al., 2013). This is the premise of the European HAAL project, (AAL-2020-7-229-CP), which aims at integrating a set of devices developed in past projects, into a system able to target and evolve with PwD through the whole course of the disease. A milestone of HAAL is that the combination of two or more devices, specifically chosen to monitor the most important aspects of the PwD's life, will provide added value to the platform and moreover, the combination of multiple heterogeneous collected data from the devices can give detailed insights into PwD's life. This work describes the preliminary sensor network integrated into the HAAL platform, to support the different stages of dementia. **Method** The software and hardware architecture was developed by integrating the following devices: a smart mattress (Whizpad), a social tablet (Compaan), a lifestyle monitoring system (Sensara) and a GPS sensor (Kompy Pico). Each device collects different data that are sent to a database developed in Amazon Web Service (AWS). Data from each sensor are retrieved by using dedicated HTTP requests that communicate with the API of each device. Data collected are stored in the database and are accessible for filtering and analysis. The resulting heterogeneous dataset is processed with the aim of choosing the most suitable combination of data that can be given as input to AI algorithms, to measure one or more aspects of PwD well-being. **Result and Discussion** The results of the proposed platform show that the sensor network chosen has multiple strengths: it is adaptable to different living environments, regardless of the layout of the user's home. The sensor network is minimally invasive, as the ADL monitoring system is installed at home and the GPS is a wearable device and can support the caregiver during the overall day, both in indoor and outdoor activities. The result is a heterogeneous dataset that together with the input provided by the users will be adopted in combination with AI algorithms to predict users' well-being and evaluate the progression of the dementia disease.

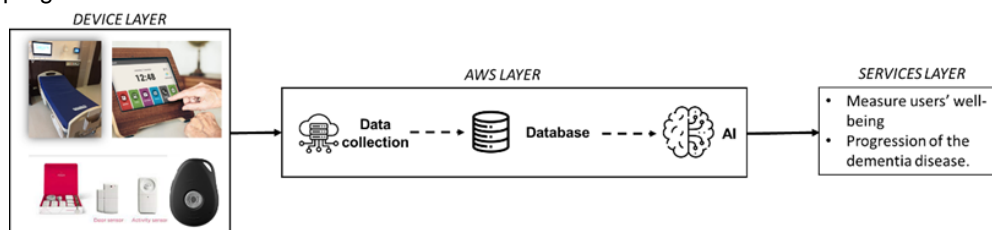


Figure 1. Schematic representation of the HAAL platform architecture.

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Address: Via Breccie Bianche 12 60131, Università Politecnica delle Marche (DIISM), Ancona (Italy)

Email: s.casaccia@univpm.it

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A cross-cultural study on responsible AI innovation in the homecare of people with dementia

D. R. M. Lukkien, H. H. Nap, N. E. Stolwijk, P. Koowattanataworn, W. P. C. Boon, E. H. M. Moors

Purpose In the European-Taiwanese project Horizon AAL (HAAL), a dashboard is being developed that can act as a decision-aid for caregivers of community-dwelling people with dementia (PwD). In the dashboard, which is driven by artificial intelligence (AI), the data from a number of interoperable AAL (Active and Assisted Living) solutions are gathered and analysed in order to provide insights and predictions about the health and well-being of the PwD. In addition, the dashboard may provide recommendations that help caregivers to assess the care and support needs of their clients. The increasing advancements of AI-technologies such as the HAAL AI-driven dashboard come with benefits such as faster, more accurate, and more efficient data-analysis and the augmentation of human decision-making (Hassani et al., 2020), but also with challenges from a social and ethical perspective, e.g. related to privacy, transparency, human control and trust. In this line, it is broadly acknowledged that the proper embedding of healthcare technologies driven by AI requires innovators and other stakeholders to actively anticipate and reflect on, and be responsive to promises and risks and to societal values, needs and expectations (Morley et al., 2019; Tsamados et al., 2021; WHO, 2021). In the ongoing HAAL study, it is therefore explored what decisions and actions can be taken in the design of the dashboard and its cross-cultural implementation in order to account for the needs and values of end-users, and to achieve responsible innovation (RI) that is socially desirable, ethically acceptable and sustainable (Von Schomberg, 2013). **Method** Through a mixed-methods approach, a survey, focus groups and semi-structured interviews were performed in the Netherlands, Italy and Taiwan, to explore the perspectives of (1) HAAL project partners, (2) end-users and (3) experts outside the consortium on RI in HAAL. Two scenarios about the HAAL dashboard, with differing degrees of autonomous decision-making and learning by AI, were used to help respondents reflect on the potential positive and negative impacts and the values at stake when deploying such an AI-based application. Also, we explored the respondents' views about the decisions and actions that could be taken in the design and deployment of the dashboard to foster RI. Finally we compared the views of Dutch, Italian and Taiwanese respondents, thereby exploring how to be sensitive to both the local embedding and the wider applicability of the technology. **Results and discussion** As argued by ÓhÉigeartaigh et al. (2020), responsible AI innovation requires cooperation and the inclusion of diverse cultural perspectives. In this line, a cross-cultural study is being performed, involving Northern European, Southern European and East Asian (in particular Taiwanese) perspectives on RI with regards to the AI-based HAAL dashboard that is supposed to be a decision aid in home-based dementia care. Responsible AI innovation requires attention for individual situations and local context-of-use (Hagendorff, 2020), while at the same time catering to the need to offer somewhat standardized, scalable solutions (Peine & Moors, 2015). Therefore the insights from this study can provide researchers and AI practitioners with inspiration about how to address RI *in and across* contexts.

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Address: Vilans, Dutch Expertise Centre of Long-term Care, Utrecht, The Netherlands

Email: d.lukkien@vilans.nl

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SYMPOSIUM SESSION 4: INFORMATION AND COMMUNICATION

Co-design priorities and components of AAL technologies with formal caregivers to support dementia care in Taiwan

D. Bai, M. C. Ho, M. Y. Chu, K. C. Huang, Y. L. Hsu

Purpose Dementia has become one of the most important and challenging areas in health care (Gauthier et al., 2021). Improving quality of life for people with dementia (PwD) relies heavily on optimal care quality and efficiency, which however, is difficult to be achieved as most health institutions are understaffed. Ambient Assisted Living (AAL) technologies provides an alternative approach of increasing the health outcomes of PwD as well as reducing the care burden for caregivers. As part of the European Union 'Active and Assisted Living Programme' project "HAAL: HeAlthy Ageing eco-system for peopLe with dementia", this study aimed to investigate the perspectives of formal caregivers working with PwD to establish priorities and components of designing a HAAL platform which combined different AAL technologies. **Method** There were nine major technologies combined in the HAAL platform to assist and/or improve the care quality for PwD including a senior tablet, indoor sensors, a smart mattress, a GPS tracker, a medicine dispenser, a care robot, cognitive and physical game, rehabilitation game, and a fall detection sensor. MoSCoW analysis (Kuhn, 2009) and Meaningful Try-out cards (Cornelissen & Suijkerbuijk, 2022) were mainly used as the co-design methods. We recruited 24 participants between Dec 2021 and Feb 2022. At the beginning of the session, all products were introduced to them, and then they were asked to rate individual products or combinations of the technological products as whether they thought a certain technology or combination as a 'must have', 'should have', 'could have' or a 'would (nice to) have'? To evaluate the requirement levels of different technologies, weighted average was applied by taking into account the varying degrees of the number of participants who chose different levels. We labelled the level 'must have' as 4 and 'would (nice to) have' as 1, with higher scores indicating higher requirement level. In addition to the requirement level, we also asked participants the reasons why they gave that rate for a certain product or combination. The Meaningful Try-out cards contains seven themes as functionality, usability, stakeholders, communication, organization, environment, and suppliers. We recruited 20 formal caregivers in Feb 2022 and interviewed them for their perceptions of the HAAL platform regarding different Meaningful Try-out themes. Twenty participants were asked to choose two themes out of seven and gave their opinions for each product. We received 39 replies for functionality, 79 replies for usability, 3 replies for stakeholders, 52 replies for communication, 2 replies for organization, 40 replies for environment, and 10 replies for suppliers. **Results and Discussion** Twenty-four formal caregivers attended the MoSCoW analysis session, and rated the requirement levels for all nine products and twenty combinations of different products based on their functions. Of all the nine products, the weighted requirement level was ranged from 2.0 to 3.6. The first three high rated technologies were fall detection sensor, smart mattress, and GPS tracker. The primary reasons of such rating were the wellbeing of PwD, psychological relief, and workload reduction. The top rated combinations of different technologies were (1) indoor sensors + smart mattress; (2) indoor sensors+ GPS tracker + fall detection sensor; (3) indoor sensors+ smart mattress + fall detection sensor. Despite of the high requirement level for these technologies, formal caregivers proposed valuable concerns and suggestions for the design of more feasible features or concise interfaces to solve the dementia care problems or fit the care process. For the Meaningful Try-out session, design components for each product were collected for further development. Take usability as example, we asked the learning time to start using each product, and the results were less than 0.5 hour (39%), 0.5-1 hour (46%), 1-2 hours (11%), and more than 2 hours (4%), we further asked them if this was acceptable and if not, what possible suggestions they would like to propose. The co-design process provided both quantitative and qualitative data on both priorities and components of the HAAL platform to help achieve a more adaptive user centered technological design for dementia care.

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Address: School of Gerontology and Long-Term Care, College of Nursing, Taipei Medical University, Taipei, Taiwan,

Email: dbai@tmu.edu.tw

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