# Smarter Safer Homes for Older Australians: providing feasible, virtual in-home care

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## Context and overview

Smarter Safer Homes for Older Australians (SSH) was a collaborative project undertaken by the University of New England (UNE), CSIRO, NICTA and NBNCo, from November 2012 until September 2014. The project acknowledged the significant issue of a rapidly ageing global population, as indicated by United Nations' demographic projections showing that the number of people aged 60 and over was expected to triple from its 2007 figure, to reach two billion by 2050. The projections also suggested that "the number of those [people] over 80 [years of age] is likely to quadruple to nearly 400 million by then"[1]. SSH further acknowledged the urgent call to action by the World Health Organisation and the United Nations, for member countries to review their aged care strategies, to address the anticipated and unprecedented social and financial challenges that such a swell in the number of older people would bring to the welfare, pension and health care systems of developing and developed nations. In response to this call, SSH examined the potential impact of high-speed broadband internet connectivity as an enabler for e-Health service delivery, with attention focused upon videoconferencing for social and professional connection/interaction, and in-home as well as remote monitoring systems for older people.

This paper initially provides an overview of the SSH project, incorporating scholarly literature and reflective practice to support perspectives about the way that technology impacted upon the Quality of Life (QoL) and Family Quality of Life (FQoL) of participants, explaining that the feasibility of in-home systems of care is an issue that can be considered from a number of perspectives. The paper then extends discussion beyond the parameters of the SSH project, and introduces a new study informed by SSH research and built upon the SSH model of virtual in-home care and its delivery. The focus of the new study however, is to consider the way that older people interface with technology, and to provide a set of outcomes that will assist with the development of strategies for the successful uptake and engagement of technology by older people, and specifically, the implementation of e-Health technology and support to older people in rural and remote areas of Australia.

## Smarter Safer Homes

Twenty volunteer participants took part in the SSH project. They were drawn from a pool of residents housed in independent living units of an aged care facility in northern New South Wales, positioned within the National Broadband Network (NBN) footprint, at the first mainland town in Australia to be connected to high-speed broadband internet using optic fibre technology provided by NBNCo. The choice of an aged care facility as the study site, offered researchers a controlled environment, with residents living in units that were mostly identical in terms of size and floor plan, allowing for the installation of the project's non-invasive sensor monitoring system to be undertaken using a consistent approach and outlay – with researcher observations and data gathering then able to focus upon the operation of the system and the perspectives of the participants who were using it. In accordance with project specifications, participants were 70 years of age or over, receiving no regular in-home care, and were without serious medical conditions or known risks that might have required regular hospitalisation. In the case of SSH participants and indeed, for older people living in any area of Australia, isolation was as much a consequence of their increasing immobility and age-related decline in health, as it was a result of their physical location.

High-speed broadband internet connectivity was a pivotal feature of the project for all collaborating parties. It underpinned the development and delivery of sensor monitoring and e-Health solutions introduced into the homes of project participants and it also allowed for seamless, meaningful social/professional engagement and support via an ITU standards-based (H.323) videoconferencing application to connect participants with a number of significant others (including friends, carers, and healthcare professionals). Over the project's timeframe its researchers sought to determine whether the technology improved participants' QoL and FQoL. In turn, they hoped to better understand the

feasibility of virtual, in-home care and the solutions it may offer to address some of the anticipated challenges to be faced by older people and those who care for them.

## Sociological drivers, technological responses

Scholarly literature associated with the sociology of an ageing demographic indicates that typically, older people will live alone, with reduced opportunity for physical contact with their friends and adult children.[2,3,4] Research suggests this may lead to depression[5,6], limited physical activity[7] and a general deterioration of health and wellbeing.[8] An understanding of health issues expected to impact all nations as a result of an ageing global population, coupled with findings in scholarly literature surrounding QoL and its potential deterioration with increasing old age, were key sociological drivers that underpinned the development, introduction, installation and monitoring of the project's non-invasive sensor monitoring and support system, trialled within the homes of SSH participants.

The system enabled remote monitoring of daily living activities within participants' households. In each case, data was available to participants and (with consent) their family, carers and healthcare professionals via a purpose-built application (app) installed upon a touch-screen device (participants were provided with an iPad for this purpose). The SSH app was designed using the enLIVEn platform, and provided participants with access to a range of features including video call, health check information, reminders and alerts. Its internal architecture consisted of three modules: a sensor network module, Activities of Daily Living (ADL) recognition module, and a user interface module.[9] The ADLs aligned with Katz' Index of Independence in Activities of Daily Living and consequently incorporated its associated six functions, being: bathing, dressing, toileting, transferring, continence and feeding.[10,11,12,13,14]

The system and its app integrated both health monitoring and lifestyle, recording applications using a number of biomedical devices. These transmitted data to a secure, remote server where it could be relayed and made available to participants, their carers and healthcare professionals via the SSH app, for examination and follow-up as required. The system addressed the anticipated social, health and wellbeing issues of participants in the following ways:

**By addressing issues of emotional wellbeing and socialisation**[15] via a secure videoconferencing link from older people to their families, carers, support services and healthcare professionals (for delivery of general and specialist non-invasive e-Health consultations for participants).

**By monitoring the home environment** of participants via the installation of wireless electronic devices throughout the living areas of their homes, to identify:

- movement inside the house (using motion sensors to identify movement patterns, alerting to irregularities that may be associated with slips and falls)
- the opening and closing of doors (using reed switches to identify comings and goings throughout the house)
- mattress movements (using an accelerometer to identify participant patterns of movement during sleep)
- time spent seated/laying on the lounge or lounge chairs (using pressure sensors)
- water flow in wet areas, to identify any taps left running or not used for a period of time (where acoustic sensors identified a 'sound', rather than recording identifiable information)
- heat and humidity within areas of the home (using temperature and humidity sensors)
- the use of selected electrical appliances such as the hot water jug or heater, the stove or oven (to monitor the frequency of cooking meals etc. using power sensors).

**By providing participants with a station of medical sensors** (for identifying systolic/diastolic, heart rate, blood glucose levels, body weight, body temperature) to monitor and upload data accessible via the SSH app.

Sensor data collected throughout the project was analysed via a series of support algorithms and results, which were correlated and aligned with the recorded health events of participants. This was used to identify health decline or anticipate potential critical health situations, based upon changes offered up by the ADLs[9]. Push notification alerts were activated when anomalies were identified and with permission, these were also made available via the system's user interface module to participants, their carers and healthcare professionals for action.

### Smarter Safer Homes – developing outcomes

The project's remotely collected data clearly identified straightforward tasks undertaken by participants (eg. turning on a tap, turning off the heater) but a greater challenge was presented when more complicated activities were being undertaken. For example, how would someone using the system to monitor participants, recognise whether they were preparing a meal, or simply boiling a saucepan of water on the stove? How would they recognise whether the shower had been turned on and left running for a period of time, or whether a participant was using the shower to wash themself? Acknowledging these challenges, Zhang, et al. (2013) explained that the project drew upon the strengths of both rule-based activity recognition[16] and probabilistic recognition models[17,18] to assist with the identification of these daily activities.

The project's scientifically based outcomes and the work undertaken to develop the project's app using enLIVEn, have created a strong foundation from which further developmental designs and improvements can be built. It is intended that work undertaken on the project, incorporating biomedical devices, technological hardware, software and high-speed internet connectivity (see 2.1.1 – 2.1.3 above) could assist with the assessment of older people's health status. Such an integrated system would allow for predictive models of triage and wellbeing support to be created and feedback models to be constructed, resulting in participant self-management, empowerment and engagement[9] and consequential improvement of QoL. The system as it was incorporated into the SSH project, achieved its objectives. When older people were sufficiently confident in their use of the system and its technology, data confirmed that the system could be used as a tool to improve QoL and subsequent FQoL, identifying the SSH system as a feasible option for assisting and supporting older people to remain in their homes, living independently, for longer. This adds to and enhances current research and literature investigating the use of technology to assist with ageing in place. [19]

### Feasibility from whose perspective? What do we mean?

Considering the issue of whether or not technology could be used to monitor health, wellbeing and safety (and thus improve QoL and FQoL) from the perspectives described in 2.1 above, brings into question the issue of feasibility overall, in relation to e-Health technology. The first perspective (2.1.1) appears to be focused upon the meaningful connection, engagement and two or multi-way communication offered via videoconferencing (which enabled synchronous transmission of both audio and visual cues) as a communication channel. [20,21,22] The second and third perspectives (2.1.2) and (2.1.3) focused upon biomedical technology, the capacity of equipment and systems to record, monitor, analyse and deliver quantifiable information[23]. Was feasibility determined by whether or not users were inclined to engage with the technology, or was it determined by whether or not the technology could be operationalized and deployed? Research suggests that a determination of feasibility involves the complementary intertwining of both perspectives [24,25].

There is one indisputable factor underpinning feasibility within the SSH project environment, that being the system's reliance upon internet connectivity, secure file transfer and IT server availability. With that in place, and to apply the SSH model more broadly, healthcare providers might expect to deliver many services remotely and reduce their costs significantly. In turn, Australians in regional and rural areas would be provided with an alternative to expensive trips to larger towns or cities for non-invasive medical consultations, follow up meetings with health professionals, counselling, support and assistance. It is not unreasonable to suggest however, that rollout of SSH or systems similar to it, is only truly feasible if there is underpinning internet connectivity of a calibre to carry its requirements. This service is not currently available to all Australians, with many areas of Australia unable to access

high-speed broadband internet using optic fibre via NBN initiatives (see Fig 1). Australians in many regional and remote areas have no choice other than to rely upon copper wire or satellite connectivity which is less than optimal for the efficient up and downloading of large information files, or for quality connectivity and videoconferencing.[26]

Figure 1 Indication of NBN rollout at March 2015


Key: A = Service available; B = Build commenced.
Source: http://www.nbnco.com.au/sell-nbn-services/rollout-map.html

## SSH – a platform for further sociological research

A review of available literature, coupled with anecdotal evidence and reflective practice as a result of researcher involvement with SSH and a range of other IT-focused initiatives for older people (including the Australian Broadband for Seniors Project) suggests that even though systems and technological devices have been developed as part of a toolkit to monitor and assist older people to live independently, uptake and ongoing engagement has met with reticence. This reluctance on the part of older people to utilise available e-Health technology, also appeared to extend to some healthcare professionals responsible for their care. These findings add credence to the notion that there is a lack of positive success stories around the embedding of technology into the day-to-day activities of older people. The findings and observations also suggest that there is a substantial disconnect between the communities designing, developing and delivering technology, and those for whom the technology has been designed to assist and support. [27,28,29]

In the case of SSH, although the technology was successful in its capacity to monitor activities, identify anomalies, provide alerts, etc., there were clear indications that some participants were confused about its use and purpose, even after training on site and the distribution of customized manuals – especially when the technology required them to participate in some form of interactive activity. Researchers noticed a participant had covered a touch screen device within the home, with a lace doily to dim its screen, and others waved at sensor lights (thinking the glowing indicator light was filming participant activities, as opposed to simply showing that a power switch was ‘on’).

Using two evaluative tools, the RAND 36-Item Health Survey 1.0[30,31] and the Quality of Life Profile (Seniors) (full version)[32], it was determined that the impact of technology upon QoL and subsequently FQoL was positive overall, as long as reliable connectivity between participants and significant others was possible. However, issues such as fine motor skills required for plugging in connectors to personal devices, remembering to charge devices, the need for simple but large icons on a tablet screen, a suitably easy method to adjust the volume of personal devices or dim a screen, and far end

quality call connectivity were all factors that either contributed to diminished engagement or reinforced any preconceived ideas and values of participants around technological devices.

A further review of the literature suggests that these observations and findings are not unique. They agree with the outcomes of other studies investigating the relationship between older people and technology, where barriers to learning include embarrassment by participants at their perceived lack of technical ability, and physiological barriers such as short-term memory loss, a decline in manual dexterity and a decline in visual acuity.[33,28] And yet, 21st century society acknowledges its position in an increasingly digital world. Studies suggest that older people's exclusion from information contained within the digital space, will only contribute to their greater sense of isolation, and that "this isolation will continue to increase as technology develops and becomes more pervasive".[34]

The SSH project directed attention to the issue of isolation amongst communities of older people in regional and remote communities. Those participants at the project's field study site were already isolated by their physical location (being distant to many health services available at a larger town or metropolitan centre). Quite possibly, they might have been further isolated by a number of other variables such as a lack of available or affordable transport, the loss of similarly aged friends who may have passed away, by distance from family members who may have moved to other towns or cities for work, and at a more personal level, by deterioration in their own health, physical movement and consequently, their general wellbeing.

It seems that for older people of the 21st century (*especially* those located in remote or regional areas) there is no more critical time to harness the opportunities offered by e-Health technology to deliver services and support to their homes. And for those designing and using technology to support older people, there is no more critical time than right now, to develop strategies that can be applied to bridge the divide between communities of older people, communities of healthcare professionals and other communities of practice responsible for the design and delivery of technology to support them.

## A new project: "Developing strategies to support the successful implementation of technological innovations to older people within the Northern Inland region of New South Wales"

The perceived disconnect between those designing technology to support and assist older people within the context of e-Health, and those for whom it has been developed to serve, has formed the basis for a separate research project. Overarchingly, the new project will explore stakeholder communities at a deep level, to determine whether technology delivers the claimed promises to improve the QoL of older people. It acknowledges that there will always be winners and losers wherever technology is introduced – and older people may well become the losers unless there is an understanding about the profoundly cultural factors that might prevent the technology from being incorporated into their lives (and subsequently improve their QoL).

### Philosophical and methodological underpinnings

From a scholarly perspective, the new project is a qualitative study underpinned by the Aristotelian philosophy of phronesis (the practical application of wisdom and knowledge, to address the sociological problem of an ageing population).[35,36] Phronesis allows for the exploration and utilization of a number of theories in conjunction with the practical findings of empirical studies, to assist with the development of strategies to support the successful implementation of technological innovations to older people.

The project will initially rely upon data from twenty people over the age of 75 years, at two case study sites (towns) in Northern Inland New South Wales. The two towns differ in size, service capacity and the socio-economic status of residents. Data gathered from participants via interviews and observations, will allow for a better understanding of the way older people perceive themselves within the context of their community, as well as an understanding of their experiences in the use of technology as a component of their everyday life.[37] The project's constructivist methodology ensures participants are the focus of research attention, and enables the relationship that participants have with their community and technology, to be described from their own, unique point of view.

The project will also work with communities supporting older people, those of healthcare professionals and those who develop and design biomedical devices, to gather data about their own use of technology and the perceptions they have about older people and their place within the community.

Interview notes and data observations will provide a pool of information, from which an inductive analysis can take place. The researcher's experiences obtained while being immersed in the participant's environment, will allow for an emerging deductive analysis to develop key concepts about culture and subcultures associated with communities of older people, from the field. These two methods combined, allow for a deep, interpretive analysis to be undertaken, with key concepts forming the backbone of a series of typologies (descriptors) about the culture (and subcultures) of older people within the context of communities.

## Contributing theories

There are a number of key theories that will be relied upon to inform the project (see Fig 2). A thorough understanding of each, allows the researcher to view participant data through different disciplinary and theoretical lenses, with the researcher drawing upon one or a number of these to make sense of behaviours, responses and reactions to technology and issues of ageing throughout the course of the project. By way of example, it is anticipated that many participants will see the introduction of technology as a significant change to the status quo of their daily life. An understanding of change management theory and models of planned change[38,39,40] as well as situation-specific behavioural reactions to change within community cultures and subcultures[41] will inform the typologies associated with cultures and subcultures of older people and allow for flexibility to be built into strategies associated with implementing technology.

Figure 2 Philosophical and theoretical underpinnings of the project


## Anticipated project outcomes

The typologies will form a body of knowledge that within the scope of the project, explain different types of participant communities and sub-communities of older people, their needs (health, wellbeing, social etc.) and the agency of technology to meet those needs. The typologies can be drawn upon by other communities of practice such as hardware/software developers and healthcare professionals, to inform IT design and assist with the creation of more culturally sensitive communication strategies for engagement. [42,43] In turn, it is anticipated that this will lead to an increase in uptake of technologies amongst older people (increasing the feasibility of models of aged care that are grounded in technology and supported by high speed broadband internet connectivity) and a more comfortable translation to practice for the communities of professionals who serve them.

The development of successful strategies to support the implementation of technological innovations to the project's participant cohort, will be of immediate benefit to those researchers and organisations seeking to develop and implement technological tools and systems to support an ageing population (particularly in remote areas). The approach will assist them to better understand the needs and perspectives of older people, as well as to develop successful communication strategies to assist with their engagement.

In the longer term, the development of strategies to connect and improve communication flow between the cohort of older people and those designing, utilizing and implementing technology to improve their quality of life, has rollout potential and application to other rural/remote areas of Australia. It will allow for the continued development of sensitive and informed channels of communication between stakeholder groups working upon other projects where technology is being developed as a feasible approach to assist and support a range of isolated community groups at a local, national and global level.

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## Presenter

**Leanne Nisbet** is a PhD student at The University of Queensland, who brings a sociological lens to the issue of stakeholder engagement with eHealth technologies. Her research interest is drawn from her background in business sociology, organisational communication and behaviour. Leanne worked as a researcher on the Smarter Safer Homes for Older Australians project, conducting interviews with participants about the Quality of Life that the project's non-invasive sensory monitoring system had worked to deliver. Anecdotal evidence suggested a cultural disconnect between the stakeholder communities of practice involved with the design and delivery of technology and the communities of older citizens for whom the technology was designed. With any technology, there are always winners and losers—and many older citizens (remote, for whatever the reason) may well become the losers unless there is an understanding of the deeply cultural factors that might prevent the technology from improving their quality of life. Leanne's PhD research will develop a series of typologies aimed to bridge that disconnect, describing the culture of older citizens in two case study towns. Her PhD topic is "Developing strategies to support the successful implementation of technological innovations to older citizens within the Northern Inland region of New South Wales."