Smart Home Technology and Special Needs
Reporting UK activity and Sharing Implemention Experiences from Scotland

Jeremy Linskell
Electronic Assistive Technology Service
Ninewells Hospital, NHS Tayside
Dundee, Scotland
jeremy.linskell@nhs.net

Abstract

This position paper discusses experiences gained in Scotland over the last 10 years in supporting the planning, design and implementation of solutions for independent living, based on off-the-shelf, structured cabling, smart home technology. It reports on successful implementations, the inclusion of preparatory cabling in other projects, considers the case for wider application and expands on some issues to be considered. These experiences are presented in the context of related developments within the UK, ascertained from a review carried out by the author.

Keywords: Smart home technology; Special needs; Implemention experiences

1 Introduction

Smart home technologies have been available commercially for over 20 years and first began to be looked at seriously as tools to support independent living about 15 years ago [1-2]. This was followed by a short period of intense activity focused on identifying and evaluating their uses and benefits, with some notable advances [3-5]. But overall the impetus was lost and the focus moved to standardised, commercial, plug and play, wireless solutions within the tele-care domain. Recent large-scale tele-care evaluation projects have started to demonstrate the potential benefits in terms of service quality and cost-effectiveness, of this approach, such as U.K. Department of Health Whole System Demonstrator (WSD) Programme[1]. There have been a number of real-life implementations of smart home technology that have been realised in the UK and it is useful to review these and understand where progress has been made.

[1] *http://www.wsdactionnetwork.org.uk/about_wsdan/index.html*

2 Overview of Generic Issues in the U.K.

A review of real-life, smart house projects in the UK was performed by the author starting from known, relevant review articles [6-8], and followed up where possible with direct communication with principle investigators and stakeholders, in order to identify what progress has been made and what further developments may have occurred that had not been formally reported. A small number of observations from this review are worth noting here (Table I-III)[2] [3].

3 Personal Experience

The Author has over fifteen years experience in assessing for and providing Electronic Assistive Technology (EAT) within the NHS. He has designed and implemented a number of smart house systems to support individuals with complex needs. This activity commenced over 10 years ago with participation in the CUSOTODIAN project [9], from which Dundee received a demonstration smart home and a smart home system for an individual with acquired brain injury. The latter was the first recorded real-life implementation of smart home technology to meet a specified, neurological need [10-12]. Following formal training as an KNX[4] installer the author developed a comprehensively configured facility, the Smart TLU [13] and has since developed another similar facility elsewhere in Scotland. Three separate projects for 15 individuals with complex needs and challenging behaviour, who had previously been considered unsuitable for community placement, have been designed and implemented and the ethos documented [14]. Under the guidance of the author a young adult with a high-level spinal cord injury has been provided with a lifetime home,

[2] *Note: does not include recent, telecare-based lifestyle modeling*

[3] *see also LonWorks: http://www.echelon.com/solutions/home*

[4] *see http://www.knx.org/knx/what-is-knx/*

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TABLE I **RANGE OF USER GROUPS**

Range of user groups that smart home technologies have been applied to within the UK
a. Older people b. Dementia c. Physical disability d. Acquired brain injury e. Learning disability f. Challenging behaviour g. Sensory impairment

TABLE II **RANGE OF APPLICATIONS**

Range of applications of smart home technologies within the UK
a. Automation b. Safety Monitoring c. Support of lifestyle d. Lifestyle monitoring e. Carer support

TABLE III **RANGE OF TECHNOLOGIES**

Range of smart home technologies used within the UK (No. of systems in parentheses)
a. EIB/KNX (22) b. LonWorks (6) c. PC with off the shelf data capture card and sensors (3) d. Proprietary controller with a combination of custom and off the shelf sensors (5)

Figure 1. Summary of observations

incorporating a comprehensive smart house, with control of all its functionality incorporated into an environmental control system. Preparatory cabling has been specified and included for a number of new homes that have been built to meet the needs of identified individuals with pre-existing medical conditions. Advice has been provided to local authorities and housing associations on the requirements for preparatory cabling for KNX systems, which has subsequently been installed as a contingency in a variety of newly built types of accommodation. In relation to this Dundee City Council has included the strategic aim of considering preparatory smart house cabling in all housing designed to meet community care needs, within its Local Housing Strategy[5]. The author is currently advising a number of care organisations regarding proposals to develop smart house systems in a variety of environments.

Combined with the review of UK experiences, and extensive experience in assessing for and providing EAT, this has informed the author's opinions on the roles that smart home technology can perform in supporting those with disability, and the range of issues that can affect its successful implementation.

3.1 Applications of Smart Home Technology

Technology has to demonstrate that it adds some value to the process if it is to receive funding from any of the sources associated with providing accommodation or care. It should be possible to argue for its inclusion on a case-by-case basis, given the range of potential beneficiaries and benefits, summarised in Table I and Table II respectively. However a user-centered design process, understanding the nature and implications of the condition, as well as the individual's preferences and social needs, is required [15]. Such an approach facilitates an appreciation of the range of issues associated with attempting to implement smart home technologies in support of independent living. Examples of relevant issues are presented here, based on the author's experience and categorised according to Table II:

a_1. - Automation: the context for automation can be viewed from a number of perspectives; necessity; alteration of ergonomics for manual control to reflect abilities whilst maintaining dignity; provision of selective automation in shared living spaces, especially where there are varying needs and abilities; is it right to assume that full automation is necessarily the ultimate goal, as automation has to reflect individual aspirations, which may vary with the condition?

a_2. - Safety monitoring: this is important but can be too much of a focus; simple systems can lead to alert-based care, but smarter systems can also limit an individual's freedom to take risks if poorly configured; implementation may require subtlety and flexibility in routing of and feedback from alerts

a_3. - Support of lifestyle: the application of technology can be proactive, reactive or passive; rehabilitating, maintaining or augmenting function; clear goals are required for the technology to ensure appropriate and effective system design

a_4. - Lifestyle monitoring: noisy, limited data sets, of unproven value; much contextual information is required; output from models should map onto any care regimes, to support the decision making process; are we asking questions or answering them?

a_5. - Carer support: the needs of carers are being formally recognised; systems need to take account of

[5] *see* `http://www.dundeecity.gov.uk/dundeecity/uploaded_publications/publication_617.pdf`

these; systems should support flexible division of care between formal and informal carers.

3.2 Benefits of preparatory cabling

The Author believes that systems based on structured cabling remain a key solution and that preparatory cabling should be considered for inclusion in all new builds and refurbishments proposed for independent living:

b_1. - Economical at time of build or re-wiring - additional costs associated with preparatory smart house cabling is insignificant relative to the other associated costs

b_2. - Allows for economical and efficient installation of a system at any time as long as the routing is considered and effectively documented

b_3. - Contingency for change of usage - there is a relatively fixed stock of special needs housing and it is likely that different clients will use each accommodation over its lifetime, often with very different needs from those who were originally intended as occupants. The adaptability that smart home technologies offer to a living space facilitates and supports such reconfiguration and the presence of preparatory cabling significantly increases the ease of introduction of such technology. There are a number of instances locally where challenges associated with change of usage have been faced.

3.3 Plug and Play Wireless Systems

Plug and play wireless systems are not necessarily a straight solution to problems associated with structured cabling:

c_1. - Integration with basic services within the home creates a pervasive environment and full incorporation is still best obtained with structured cabling

c_2. - Data demands to support a fully integrated smart home system require a sophisticated data transport system, which will have significant cost and management issues in own right.

c_3. - Transmission issues - many modern buildings have extremely poor radio transmission so full transmission surveys and arrays of repeaters are likely to be required

c_4. - Still probably best considered in conjunction with structured cabling backbone [16].

4 Lessons Learnt

4.1 General barriers to technology uptake

There are a number of general barriers to technology uptake that have been noted, including:

d_1. - A lack of suitable outcomes to validate experience

d_2. - A lack of effective frameworks for driving the process for assessing, "prescribing" and delivering technological solutions to meet specific needs

d_3. - A lack of a conviction over where and when the technology will be beneficial (*see* a_2.)

d_4. - Experience with tele-care initiatives has demonstrated that pilot projects do not necessarily lead to wide scale roll out. Sometimes the benefits are self evident and need to be argued (*see* a_2.)

d_5. - The use of "Design and Build" contracts to drive the development of social housing projects does not encourage innovation

4.2 Issues with Design and Build contracts

Specific issues with Design and Build contracts as a resistor to innovation, include:

e_1. - Minimise the unexpected; additional costs reduce profit; time penalties reduce profit; causes a tendency to low risk solutions even in the face of a clear, progressive remit

e_2. - Protection of reputation is a paramount concern in relation to future contracts i.e. *"a safe pair of hands"*

e_3. - Smooth operation - maintain relationships with existing contractors; seen as competition and a *"cat amongst the pigeons"*

e_4. - Tight margins leave little resource for innovation

e_5. - All risks are borne by the contractor; innovation requires sharing of risks, costs and benefits

4.3 Developing customised, adapted accommodation

Developing highly-customised, adapted accommodation has challenges at every stage and requires a fully coordinated approach to the entire process, which has many key steps:

f_1. Commissioning - vision by organisation; collective will; strong lead; key personnel

f_2. Planning - clear goals; effective/appropriate assessment of need; clear translation of needs into system requirements

f_3. Contracting - commitment and buy-in from contractor; effective and unambiguous technical specifications and guidance for contractors

f_4. Implementation - continuity of contractor personnel across negotiating/operational phases; strong vision of what is required; joint ownership of goals for technology

f_5. Handover - matching of result to brief; transitional phase from functioning to fully operational system, a possible area of ambiguity for contract fulfillment (importance of brief/spec); staff training

f_6. Operation - support; modification; maintenance; long term commitment from commissioner, an ongoing responsibility

f_7. Funding - the apportioning of costs between accommodation and care budgets is complicated by a technology that straddles both domains

4.4 Lack of Skilled System-Integrators

In our experience, there would appear to be a lack of commercial concerns able to provide smart home solutions for individuals with special needs:

g_1. - Few have the skill sets and these have not been formalised

g_2. - Most of the skill sets exist in academia and with others outside the commercial environment

g_3. - Difficult to develop the skills for different client groups, as there is no clear path to developing and validating them

g_4. - Work practices of System Integrators are not generally conducive to successful outcomes in special needs environment; *"open-ended"* approach to projects, *"foot in the door"* with technology; *"laissez-faire"* approach to system configuration due to system flexibility; little appreciation of the need to meet the remit effectively at first attempt and no tools to support this in any case

4.5 Why are UK implementation experiences under-reported?

An informal review of UK activity has revealed a significant number of smart home systems that have been implemented in the special needs arena, so why does this rich experience seem to be under-reported in the literature?

h_1. - Developments seem to be driven forward by dedicated enthusiasts, often beyond their formal remits, meaning that resources to support reporting are limited

h_2. - Such enthusiasts, by their nature are primarily problem solvers, i.e.*"doers"*, and in general terms, not natural *"reporters"*

h_3. - Most projects are commissioned by care organisations with remits, resources and timescales that are not conducive to formal scientific frameworks for implementation and reporting.

h_4. - Those organisations that ultimately commission many of the projects intended for special needs are often private entities, such as Registered Social Landlords (RSL), or charitable bodies. The provision of the technical expertise generally comes from outside the organisations. Therefore the technical experts have no ownership of the intellectual property associated with the projects, which are often protected for organisational reasons and concerns associated with a duty of care to the service users

h_5. - When projects fail, or fail to live up to expectations, organisations generally do not wish to advertise the fact, so valuable lessons are not reported (i.e. the *publication bias*)

5 Conclusion

There has been considerably more practical activity in the UK, associated with smart home technology for the disabled, than might be anticipated from the formal, scientific literature. There are a number of reasons for this and for why developments have not proceeded at a faster pace. Formalising of the existing knowledge and better reporting would facilitate developments but there are also many barriers to be overcome associated with how care and housing are funded and provided; and, how technology is incorporated and provided.

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