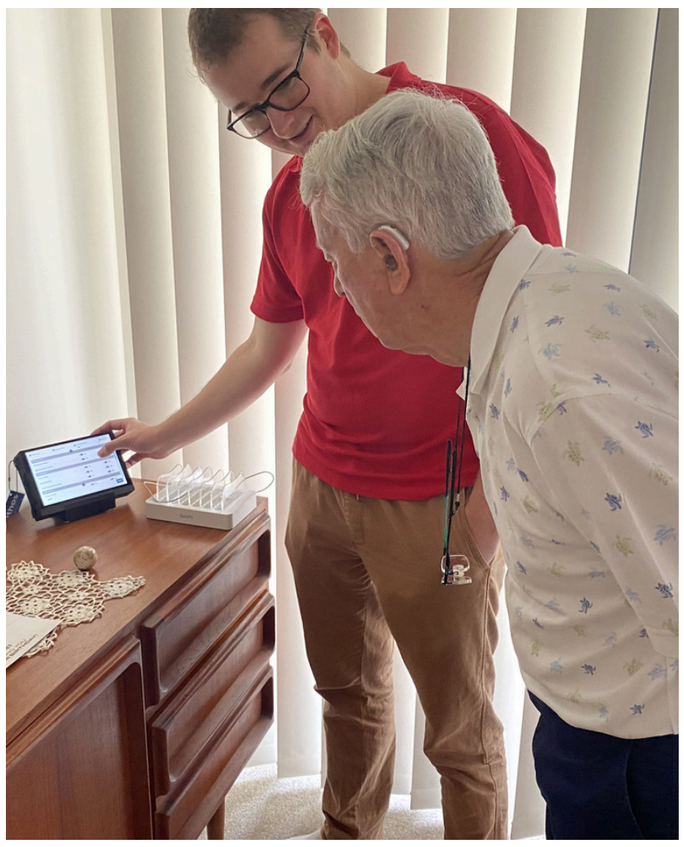
Lessons Learnt: A Summary from the Ethos Project

Overview

The Ethos System was deployed in the homes of persons over 65 yrs residing in South-East Queensland, Australia, during the summers of 2023-24 and 2024-25.

This document details the 'Lessons Learnt' across the lifecycle of the Ethos Project. Staff reflections on their experience with the Ethos System, as well as their accounts of participant feedback, has been collated into five main areas of learning: Hardware, Software, Recruitment, Field Work and In-Home Trials. The purpose of this report is to provide guidance for future research in similar or related fields.



Learning Area 1: Hardware

Equipment Lists

Sensors (4 per house)

Adafruit Feather M0 with RFM95 LoRa Radio: The Radio Frequency Module used for communicating the data collected from the sensors.

Adafruit Sensirion SHT45: Temperature and Humidity Sensor.

Base Station

Raspberry Pi Model 4 B: Single-Board Computer.

Adafruit RFM95 Radio: The Radio Frequency Module used for communicating with the sensors.

USB Speaker.

Benefits of the Chosen Equipment

- RFM95s are less battery intensive for wireless communication compared to Bluetooth and Wi-Fi.
- RFM95s are less costly for data sending compared to LoRaWAN.
- RFM95s have a larger range compared to RFM69s.
- A low level of expertise is required for sensor construction.
- Many of the equipment items were available for bulk discounts, reducing costs.

Challenges Experienced with the Chosen Equipment

- Construction of the entire system is time consuming and has many associated incidental costs (e.g. tape, screws and tools).
- The system requires two power points, which is difficult to obtain in close proximity within some homes.
- The sensors are susceptible to soldering errors during construction, resulting in some sensors that dropped offline.
- On average, 36 minutes is required to confirm the functionality of each sensor.
- Battery storage requires de-charging.
- Batteries degrade overtime.
- Unable to bulk-ship lithium-ion batteries via air freight.
- The base station fan sometimes rubs against the radio bonnet, causing noise.

Why Were Existing Commercial Solutions Avoided?

- Data availability and security
- Costs
- Ongoing availability uncertainity
- Design constraints

Learning Area 2: Software

Core Design Inputs from the Reference Group

- The font was made to be as large as possible for the available space.
- A traffic light colour system for the risk-based alerts was supplemented with emoticons for colourblind participants.
- A text-to-speech option accompanied audio alert sounds for visually impaired participants.
- The interface was designed to reduce the number of tabs and minimise information overload.

Coding Framework

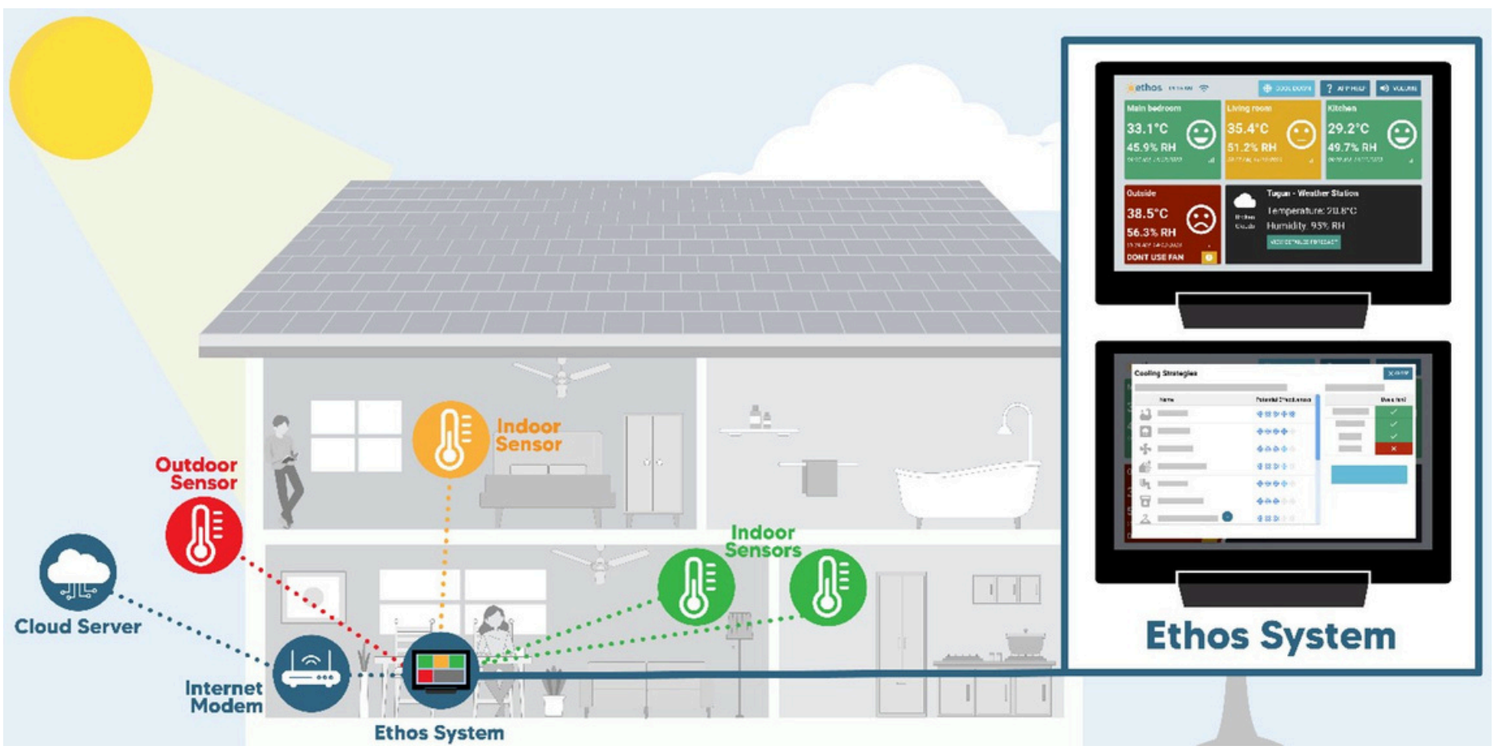
Quasar was chosen because:

a) The software developer's existing familiarity with the framework.

b) It allowed the Ethos App to be coded once and used for both IOS and Android.

Other Key Software Features

- The Ethos System was designed to allow for small changes to be deployed during the In-Home Trials as feedback was received.
- The base station was coded to respond to conventional user interactions.
- A five-day weather forecast, linked to the closest weather station on OpenWeatherMaps, was provided so participants could plan their week.



Risk Prediction Model

Assumptions: Low physical activity, low airspeed and modest clothing.

Inputs: Age, weight, sex, age, ambient temperature and ambient humidity.

Risk levels were defined as increases from baseline temperatures, which were based on the default values used in the Joint System Thermoregulation Model 3 (JOS-3).

Alerts were given for medium risk (+0.11 ◦ C) and high risk (+0.2 ◦ C).

Software Challenges and Drawbacks

- Some of the conventional user interactions applied to code the Ethos System may not be used by older populations.
- Outdated and faulty RadioHead Library links interrupted the receival of sensor data, causing dropouts during the 2023-24 In-Home Trials.
- The text-to-speech alerts function on some of the base stations was faulty, inhibiting volume muting.
- The expected 3-week approval period from Apple was exceeded, causing delays in the roll-out of the Ethos App. A 4-week buffer period is recommended.
- Requests for additional information delayed app approval. It is recommended that in-depth information on the research project be supplied initially in the app submission process.
- The current system design makes troubleshooting difficult due to limited visibility. An error analysis tool such as LogRocket should have been used and this would have required an Ethics application due to consent for interface interaction.
- App issues were reported to different staff via different methods, often with incomplete information. A issue tracker system is recommended.

Software Advantages

- Twilio proved to be useful for easily sending push/text notifications.
- Development of a live data portal allowed for easy data monitoring.,
- Establishment of a solid team with the right expertise and good communication before beginning software development ensured a smooth creative process.

Opportunities for Improvement

- More information could be included with the weather data (e.g. humidity and 'feels like' temperature).
- The risk prediction model could be trained to more accurately estimate risk for populations with higher physiological heat sensitivity.

Learning Area 3: Recruitment

Recruitment Methods

- Physical fliers
- Digital fliers
- Local newspapers
- Magazines
- Radio
- Community group newsletters
- Radio
- Local events
- Word-of-mouth
- TV

Key Challenge

Given the seasonal nature of extreme heat intervention analysis and the awareness and recall gap of humans, despite sufficient advanced planning, recruitment did not gain traction until it started to get hot, limiting the time available for the multiple stage screening required before equipment installation.

The Essentials of Media Outreach

- Use a table to catalogue the name and details of key contacts for local publication sources and events.
- Begin recruitment early in the year, prioritising events.
- Verify the project scope clearly and concisely and have it ready early in the recruitment process for stakeholders and potential participants.
- Discussing the recruitment media with the steering committee and reference group early helps identify and answer potential questions in advance.
- Include photos of the research and staff in recruitment media.
- Have a variety of small fliers and longer, more detailed documents.
- Pre-prepare a recruitment slide deck that clarifies main points in advance of media stories.
- Always follow-up verbal exchanges with written information.
- Pre-prepare a script so all staff can answer the phone and respond to recruitment questions.
- A project mobile phone makes receiving documents easier.
- Approaching organizations in-person to display fliers is more effective then emailing.
- TV and videos are the most effective sources of engagement.
- Create a timesheet with researcher availability to promptly respond to media appearance requests.
- Following up on people, publications and emails/calls and writing and editing media content is time consuming. Scheduling dedicated time for these tasks (and lots of patience!) is key.

Learning Area 4: Field Work and Installation

Planning Field Work

- Coordinating and planning field work is a one-person job.
- A user-centred approach prioritises the participant's availability before navigating staff schedules.
- Google maps is valuable for identifying the most efficient use of time.
- Campus departure times, expected return times, staff breaks and catch-up buffers must be included in scheduling.
- Notifying all parties well in advance reduces unexpected schedule changes.

Main Installation Issues

- Coordinating participant and staff availability can be extremely difficult.
- Finding power points within peoples homes can be time consuming.
- Batteries must be charged just before deployment under constant supervision because of a potential fire risk.
- Some homes, mostly in rural areas, had unexpected connectivity issues.

The Basics of Field Work

- Staff would visit homes in teams of two. One person would text ahead to confirm arrival times, navigate and organise paperwork while the other person would drive. Once in the participant's home, one person installs the hardware and the other works with the participant to input information into the system.
- A staff member must be available in the office to liaison with the field team and participants.
- A staff member must be dedicated to the organisation of equipment and paperwork prior to installation days.

Learning Area 5: In-Home Trials

Streamlining Participant Interactions

- Thoroughly pre-testing all equipment beforehand is critical to proactively identifying potential issues and either a) fixing them, or b) preparing staff and participants on how to navigate them. Therefore, scheduling a buffer period between pre-testing and installation is essential.
- Schedule additional time during installation to walk participants through how to handle expected challenges in advance of their occurrence, instead of communicating remotely when they do arise.
- Schedule additional time during installation to simply sit and talk with participants. Take the opportunity to connect with the participants and provide space for questions to be asked.
- Dedicate additional staff during the first month of the In-Home Trials to answer calls and emails as participants become settled and technology issues are resolved.
- An equipment replacement protocol should be developed before installation to outline how many times certain pieces of technology should be reset or replaced. This will reduce waiting times for the resolution of technology problems and decrease the costs and hours associated with travelling for equipment replacement.

Other Helpful Hints for a Smoother In-Home Trials

- It is best practice to have a dedicated staff member available for full-time participant communication in the period leading up to the In-Home Trials and following the installation period.
- All staff members interacting with participants should have some level of customer service training- there is no research without participants, so ensuring their experience is as positive as possible is paramount.
- Creating a decision-tree for addressing equipment issues will reduce participant wait-times and enable problems to be addressed in the most effective and efficient way.
- Mass emails are a useful way for addressing common problems and reducing communication delays.
- Photos and videos are a valuable way of explaining and demonstrating concepts to both staff and participants.
- Having as many online and in-person participant feedback sessions as possible is recommended to boost participant engagement and allow for the prompt identification of improvement opportunities.
- Pre-trial screening should also ask more detailed questions regarding the participant's plans and schedule over the trial period to proactively identify ineligibility.
- Pre-testing the equipment in different locations is recommended to identify areas with problematic connectivity, which can be integrated into pre-trial screening.

If you have any questions about these learnings or require further details, please contact the Ethos Project Leadership Team: s.rutherford@griffith.edu.au, a.bach@griffith.edu.au or s.binnewies@griffith.edu.au