

# Making Sense of Sensors:

## The Business Case Workbook

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# Introduction

The Connected Homes Inclusive Places (CHIPs) programme run by Greater Manchester Combined Authority (GMCA), with support from the Department of Science, Innovation & Technology (DSIT) under the 5G Innovation Region programme (5GIR), saw the successful implementation of a range of Internet of Things (IoT) use cases across social housing in Greater Manchester. The highlights of that work, in particular the lessons learnt, have been gathered here to help others embarking on a similar journey.

The focus here is on pragmatic, practical process. Sensors are becoming mainstream and have an obvious and valuable role to play in social housing. This workbook aims to help adoption of best practice, minimising cost and complexity to a housing body, while speeding up deployment and attainment of the benefits. It offers detailed examples and includes 'Tasks' that a housing provider might work through, perhaps in a workshop. These aggregate to a cohesive, evidenced, and robust business case.

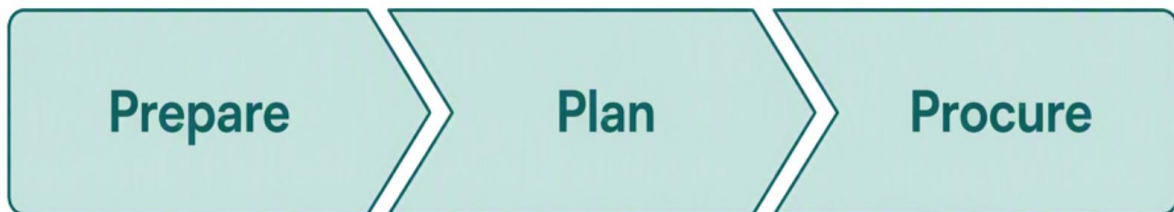
However, the pace of change is so great that the focus of this workbook is less on 'how to do' than on 'what to think about'. It is the wider context around the sensors that is critical, from the type and condition of the social housing through to the tenant profile and needs.

# How to use this workbook

This workbook is intended to provide guidance to a social housing provider developing a business case for IoT adoption.

It outlines the overall structure that is needed, provides insights and, most importantly a series of tasks.

Each step feeds into the next, building the evidence case.



Complete the tasks and they aggregate to provide the business case.

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## MAKING SENSE OF SENSORS: The Business Workbook

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# PREPARE

## Before You Start

This section provides a structured walkthrough of the steps needed before a technology plan can be developed.

It covers:

- What IoT is and what it might do.
- The multi-faceted context that housing providers must plan in.
- The assistance available – the GMCA Innovation Hub – and how to access this.
- Use cases.
- Strategic thinking and partnering.
- Cautionary notes on data and real-world limits.

### Primer: What is IoT? What benefits does it bring?

The Internet of Things (IoT) refers to a network of physical objects embedded with sensors, software, and connectivity that enables them to collect and exchange data over the Internet or other communication networks.

IoT involves everyday objects - such as appliances, vehicles, and industrial machines - equipped with devices and connectivity so they can send, receive, and process data.

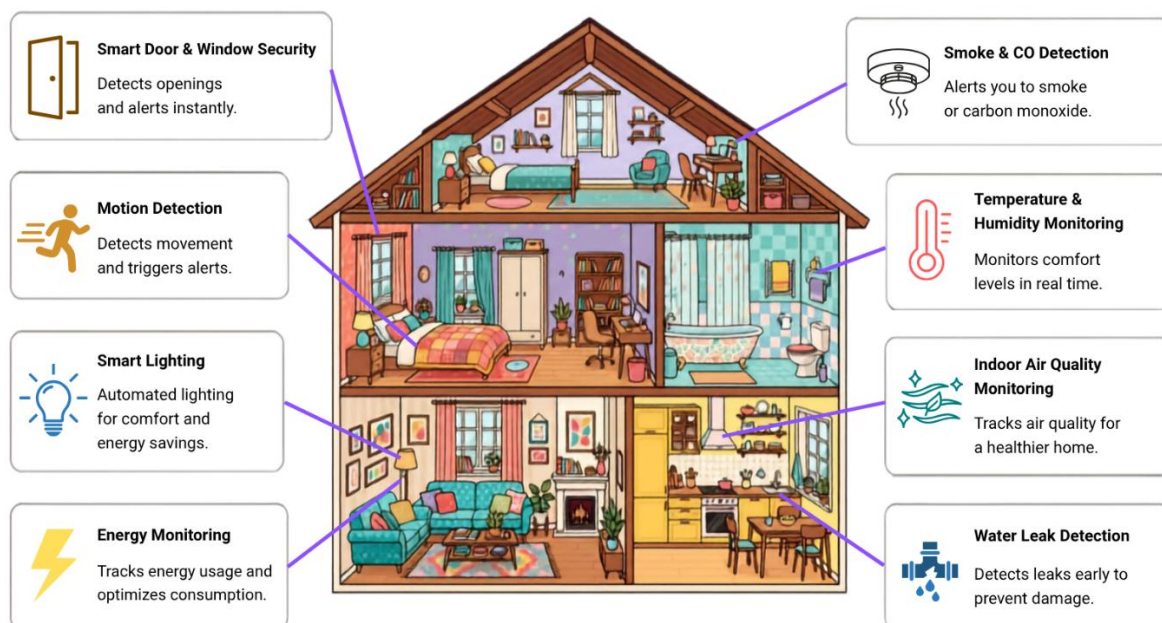
Devices typically include sensors, embedded systems and software, the connectivity is provided by technologies like Wi-Fi, Bluetooth, 5G, or Ethernet.

This enables the IoT devices to communicate with each other or with cloud systems, often with minimal or no human intervention, enabling automation and real-time monitoring. The range of uses is so wide that industry has a saying:

**“There’s a sensor for that”**

### Smart Home. Smarter Living.

A visual guide to where IoT devices are found and how they support everyday life at home.



### The Pilots – delivering impact

The potential value of such sensors is best shown through practical demonstration. GMCA pilots asked key questions on how connectivity could benefit social housing, in particular how might:

- retrofitting smart controls to existing heat pumps enable users to improve their control over their heating? This could improve comfort, help the environment and cut their bills on a smart tariff, all through a simple app. It could also reduce maintenance costs as simple issues might be treated remotely, avoiding call-out charges.
- new technology provide connected care? That could speed alerts on medical emergencies, improve communication and open the potential for additional bespoke care support.
- sensors help combat damp and mould? This could ensure that the housing was fully fit for purpose; protecting the household's health, maintaining the property in good repair and discharging legal responsibilities.
- an information system or dashboard help a housing provider? This could detect signs of fuel poverty, or unannounced departures, minimising voids.

The benefit from IoT is dependent on there being potential for improvement. It is therefore most valuable where there are currently significant stresses, for example certain properties being prone to dampness, difficulty in recruiting staff for overnight cover. Accordingly, consideration must start from the problem, to ensure that the IoT is correctly specified and applied where it adds demonstrable value.

### Getting Started

This wider context starts with legislation and regulation, includes issues around privacy and transparency, and, most importantly, the impacts on tenants and staff. The critical competencies for effective deployment are therefore not technical, but compliance and engagement. Get these wrong and any IoT deployment will not only be likely valueless, but it will also have a severely negative impact on trust, the fundamental basis of social housing.

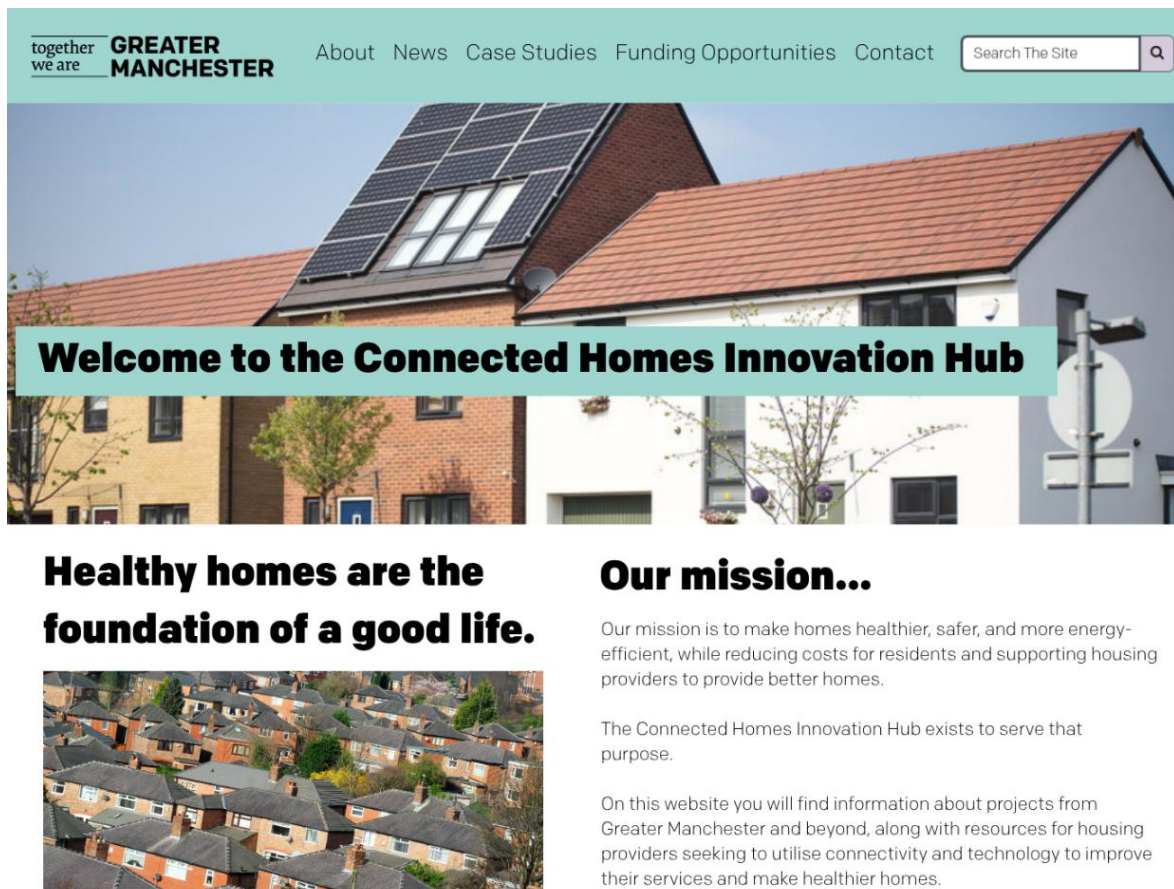
This puts the onus on the housing provider, not the technology partner / supplier, to buy the right thing, in the right way. This workbook is intended to help the housing provider articulate the challenges and be supported through the process.

It provides a structured way to think about IoT adoption in social housing, flagging both the key issues and the pitfalls. It cannot however provide a simple guide as the choice of technology, appropriate connectivity, extent of sensors and information needs are so diverse and hence dependent on the particular circumstances.

Accordingly it looks to principles, not detailed processes as these will ultimately need to be embedded in the housing provider. The right approach will in any case evolve as the market, policy and legislation develop.

As a result there is a need for up to the minute guidance. To meet this, an Innovation Hub has been developed by GMCA, described below. The later **PROCURE section** describes how to use it to simplify procurement and achieve a successful outcome.

### Connected Homes Innovation Hub



**Healthy homes are the foundation of a good life.**

**Our mission...**

Our mission is to make homes healthier, safer, and more energy-efficient, while reducing costs for residents and supporting housing providers to provide better homes.

The Connected Homes Innovation Hub exists to serve that purpose.

On this website you will find information about projects from Greater Manchester and beyond, along with resources for housing providers seeking to utilise connectivity and technology to improve their services and make healthier homes.

The **Connected Homes Innovation Hub website** is an online resource developed by GMCA to help housing providers make informed decisions about the adoption of IoT. It brings together practical guidance, case studies and lessons from the Connected Homes programme and wider sector.

The Hub is intended to reduce duplication and help providers learn from work already undertaken. It covers the wider issues that determine whether a deployment succeeds, including resident engagement, data governance, connectivity, procurement, installation and integration into day-to-day operations.

Housing providers can use the Hub when developing a strategy, testing a business case or preparing for procurement.

The content will continue to develop as further evidence, guidance and examples become available, creating a shared resource for the sector and supporting a community with the common goal of maximising benefit from technology.

You can access the Hub here: **Connected Homes Innovation Hub website**

## Beginning a Strategy

IoT adoption is approached differently by different roles. Directors of Finance and Asset Managers will have a 'property' focus; their driver is housing provision and their main focus is on protecting and enhancing their asset base, while minimising spend on maintenance and repair, voids management and security.

Other roles will be attracted by the potential that IoT offers their tenants; better control over heating including lower bills, improved communication and for those with care needs, faster alerts, new possibilities such as fall detection, and additional social inclusion.

It is important that both approaches are encouraged as they generate a virtuous circle:



Reduced damp and mould saves on maintenance and voids, but also delivers on improving tenants' health. In general if there is not a clear win/win (benefit to the property and the tenant), a different approach is probably needed.

### **TASK: Build the IoT Adoption Task and Finish Group**

Create the group ensuring that all viewpoints are included and organise a series of workshops to ensure that progress is timely and agreed.

### Organisational Context

Every housing provider has the same core service and the same values, but every provider has a unique context. Defining this context is essential if provision is to be properly aligned, the aim is to ensure a bespoke solution from standard elements.

#### **TASK: Organisational Context**

List the attributes that make you unique.

This will include your organisational structure, its ethos, staff, geographical coverage, tenant profile (including elderly, vulnerable or community), scale, housing types and condition, current programmes (new build and retrofitting, repair) and financial context: balance sheet and net income.

This should be focused solely on the actual current position: plans come next.



## Challenges and Opportunities

The next step is to identify where there are pressures (such as staffing, costs, housing condition) and where there are opportunities (such as better monitoring, improved social contact for tenants).

### **TASK: Define Organisational Goals**

In the light of the above context, identify the key areas where change is most desirable, both reduction in adverse impacts and in opportunities for improvement. These should be general (not selected on the basis of technology relevance) and outcomes focused.

These goals might include:

- Reducing costs, improved financial performance
- Freeing up staff time for priority tasks
- Reducing negative environmental impact, supporting green actions
- Improving tenant safety, health and wellbeing
- Protecting the asset base
- Reducing voids, and length of void periods
- Demonstrating compliance with the law and best practice

The total number of goals should be kept to a manageable level, likely single figures.

### Use Cases

The organisational goals can then be mapped against the ever-growing list of use cases, a list which may leap forward with emerging AI.

But today there are many ‘off the shelf’ solutions that can make a housing provider more efficient or enhance their tenants’ lives. These are grouped by theme below, but there are overlaps and, in general, a holistic rather than narrow approach should be adopted.

#### Occupancy and Behaviour



- Occupancy and presence detection
- Void indication
- Behavioural pattern analysis
- Noise monitoring

#### Access and Security



- Internal CCTV
- External CCTV
- Smart locks and access control

#### Assets and Operations



- Appliance-level monitoring
- Predictive maintenance
- Remote triage and fix
- Efficiency improvement
- Optimisation

#### Property and Environment



- Damp and mould detection
- Humidity and temperature monitoring
- Indoor air quality monitoring
- Water leak detection
- Heat stress detection

#### Energy



- Energy usage / time of use / fuel mix
- Energy efficiency (usage and resulting temperature)
- Energy cost (Smart Meter)

#### Safety or immediate risk



- Smoke alarms
- Other fire systems
- Sudden temperature rise
- Gas leak, noxious gases

#### Health and Wellbeing



- Telecare monitoring
- Fall detection
- Physical signs of concern
- Movement and mobility monitoring
- Daily living support

### **TASK: Use Case Selection**

Review the above list in light of your goals and identify your preferred use case(s) – in particular the hero use case(s) that justifies proceeding at this time.

Seek universal 'buy-in' that this is a priority and welcomed by all.



## Objective Setting

With the organisational goals establishing what you are seeking to achieve, and the use cases showing how this might be achieved, the next step is to formalise the objectives.

### **TASK: Objective Setting**

Reduce the goals to measurable indicators of delivery, and the associated use case.

For example:

- Reduce maintenance callouts by x% through remote monitoring, triage and fix.
- Provide 100% of residents requiring care with a comprehensive digital package covering communication, alerts, incident detection, health monitoring and readiness for any specialist telecare provision.



## Connecting the dots: the Theory of Change

You should now have a simple relationship between your organisation, its goals, the potential benefit from use cases and a set of measurable objectives and ultimately, desired outcomes. You should be able to articulate why the use cases are needed and how they will deliver the objectives, this is a Theory of Change (ToC). Again, the emphasis is on what the technology does, not what it is.



The ToC is helpful in showing the big picture, providing on a single page an overview of the entire plan, allowing everyone to see the logic behind the proposals and how it affects their part of the organisation.

## **Examples of Interventions**

Review the following case studies, the pilots in the GMCA work funded by DSIT.

### **Case Study 1: Connected Care**

#### **Problem/opportunity**

Existing alerts for falls or other care needs were slow, not well measured and poor call quality, communication from door-entry phone audio only, considerable time pressures from staff checking on residents

#### **Intervention**

Connected Call – integrated alert and welfare reporting information system, that recorded alerts, actions and their timings, supported triage and speedier response. Greater call clarity, from an individual who may be in pain or experiencing breathing difficulties helped expedite decisions. Caller function provides high quality visual image as well as improved audio, plus ability to call other residents, building social contact and community.

#### **Technology**

Monitor based, with additional pendants and wearables as required, linking back to a Gateway for connectivity. Can be built on with additional sensors to provide a comprehensive picture of wellness / care needs.

#### **Connectivity approach**

SIM

### **Case Study 2: Damp and Mould**

#### **Problem/opportunity**

Damp allows mould, which is always present in the air, to settle and spread. Mould will damage health and is particularly dangerous to the young, elderly and people who are otherwise vulnerable. Legislation to tighten housing providers

responsibilities is starting with this issue given these concerns. This is discussed further under Awaab's Law.

### **Intervention**

Sensors are placed, ideally in every room, that can measure temperature and humidity. Only some combinations of these two factors drive mould, accordingly there is a need for an automatic analysis of the data and alert process.

### **Technology**

Environmental Sensors, a Gateway and a dashboard, that displays status and alerts.

### **Connectivity approach**

SIM

## **Case Study 3: Smart Energy**

### **Problem/opportunity**

Existing heating appliances, in this case heat pumps, can benefit from connectivity in various ways; improved control, higher efficiency, remote diagnostics and reset, reducing callouts and maintenance costs, updating software, and alerts around possible voids or fuel poverty.

### **Intervention**

Connection via Gateway, some supporting works needed in a minority of cases, where an electricity socket is not available for the Gateway.

### **Technology**

Gateway

### **Connectivity approach**

SIM

### TASK: Theory of Change

Replicate the approach set out in the above case studies for your own plans focusing on the problem/opportunity and on the intervention you are considering.

Develop this into a full Theory of Change (there are extensive resources available online, such as [\*\*the Government Analysis Function website\*\*](#)) and then review:

- Are key barriers or challenges being addressed? Is something missing?
- Is the problem or opportunity identified of sufficient scale to warrant action?
- Is IoT the best way to address this problem or opportunity, or might a change in approach work just as well, or even better?

Pay particular attention to emerging challenges, as these will become more important.



## Awaab's Law and other legislation

In response to the death of two-year-old Awaab Ishak from prolonged exposure to damp and mould in a housing association property, major changes to the law on hazards in social housing, to be known as Awaab's law, were introduced. With the Social Housing (Regulation) Act becoming law in 2023, a new section 10A was added to the Landlord and Tenant Act 1985. This clause allowed new rules on hazards in social housing to be introduced, and regulations have now been issued to bring Awaab's law into force.

It is being introduced in phases, with Phase 1 focused on damp and mould hazards, with this being extended to cover other hazards that are the responsibility of the housing provider and have arisen through a deficiency in their provision.

The new rules only apply, at least initially, to social housing tenancies. This includes local authority landlords and registered providers of social housing, such as housing associations. Awaab's law will not apply to shared ownership, homeless accommodation, supported accommodation or licenses in social housing.

Draft government guidance states that emergency hazards might include gas leaks, broken boilers, total loss of water supply, electrical hazards, significant water leaks, broken external doors or windows where there is a risk to home security, serious damp and mould or structural defects.

All of these issues can be detected with the appropriate deployment of IoT.

You can read more about Awaab's Law and guidance around it on the Government's website: **[Awaab's Law: Guidance for social landlords - Timeframes for repairs in the social rented sector - GOV.UK website](#)**

## **Strategic positioning**

A key decision for a housing provider is whether to proceed alone or with others. For some providers a leadership role will be appropriate, where they have the scale and expertise to be an early adopter. For many, perhaps most, the better approach will be piggybacking on others, though some small or niche providers might usefully develop specialist expertise, for example in radon detection and mitigation.

There is a clear case for partnership and collaboration, avoiding reinventing the wheel and sharing learnings. That is the purpose of the Innovation Hub, which aims to create a community within social housing provision with a common goal: to maximise benefit from technology.

Later sections note that joint action on procurement, notably around connectivity, could yield worthwhile savings.

For council and housing association bodies in Greater Manchester their membership body, the Greater Manchester Housing Providers (GMHP) group, is the perfect vehicle to progress this. This could seed a national framework for IoT adoption in the wider housing sector, including student housing, build-to-rent and private landlords.

### **TASK: Strategic Positioning**

Identify potential partners, review areas of collaboration, consider joint working or bulk buying, agree a way forward.

## Greater Manchester Housing Partnership (GMHP)



The **Greater Manchester Housing Partnership (GMHP)** brings together housing providers across Greater Manchester and provides an established route for collaboration. Providers can use it to share learning, identify common requirements and consider where joint action would offer better value than working separately.

This is particularly relevant to IoT, where providers may face similar decisions around connectivity, data standards, procurement and supplier management. Coordinating through the GMHP could reduce duplicated work, support common approaches and create the scale needed for joint market engagement or bulk buying.

Providers should consider using the GMHP to test interest in collaboration before progressing major IoT procurement or connectivity decisions alone.

Find out more on the **[GMHP website](#)**.

### A word about data

Before progressing any action there is a need to ensure that there is an overarching framework for governance in place. This is most critical in relation to data protection and associated implications around privacy.

IoT solutions must be:

- driven by clearly defined needs.
- aligned to service outcomes.
- deployed with appropriate oversight and accountability.
- compliant with legal and regulatory requirements.
- proportionate to the level of risk and tenant impact.

Thus, how data is used and the decisions that result from it, is critical, more so than the technology itself. Housing providers must identify when additional legal, regulatory, governance, privacy, cybersecurity, tenancy, safeguarding, or specialist input may be required before deployment proceeds.

The organisation must manage all resulting IoT data appropriately throughout its lifecycle, including collection, storage, access, sharing, retention, review, and ongoing control.

Particularly with AI, raw data from sensors can provide vast amounts of information around an individual and their habits, often to a surprisingly personal degree, from lifestyle choices right up to diagnosing illness.

#### **TASK: Data Responsibilities and Privacy Review**

Consider the chain of data that your use case(s) might produce. At each stage ask: why gather this, where and how it would be stored, who would have access, how long would it be kept and, importantly, could it be less personal (e.g. a pressure pad is often used to assess mobility and movement, while it can return a person's weight it can instead indicate simply whether or not it has been stepped on)?

Will data be shared, with whom and how?

The best way to avoid privacy concerns is not to have the data in a sensitive format in the first place.

## Technology and reality

A humidity sensor giving a sudden high reading on a cold dry day could likely indicate that washing is being dried on a radiator, creating conditions for damp and then mould.

But what do you do with that information? This is where the potential of technology collides with practical reality.

IoT, like all technology, is more effective when it empowers rather than constrains. However, empowerment has to operate within a framework of trust and respect.

### **TASK: Practicality and Policy Review**

Carry out a 'pre-mortem', an increasingly popular activity for group work.

This is by inviting the group to imagine that they are now three years in the future, and this IoT project has created a major problem...

What is it, and how did it happen?

What should have been done to avoid this?



### PREPARE: Summary

That completes the first section. You should now have a high-level appreciation of how your detailed context, goals, objectives, partners and data responsibilities will shape an IoT deployment.

You should also have an agreed understanding (ideally a Theory of Change) of how it all fits together. Finally, you should have reviewed it (the 'pre-Mortem') to check that it is robust to change and is the best way forward.

The Task and Finish group should also be clear on their own roles and responsibilities.



# PLAN

This section covers:

- Prioritisation: Properties and use cases
- Key documents to prepare – Digital audit and project plan
- A guide as to likely data use, to help planning and budgeting
- How to choose connectivity now, and how this might change in the future
- The critical importance of a dashboard and what to look for
- Creating a business case
- Guidance on costs
- Help in identifying and projecting benefits
- Determining payback periods, benefit cost ratios and return on investment
- Stacking the business case – adding use cases



## **Prioritising Properties**

The cheapest time to fit sensors is during new build, or retrofitting works, which could be for an unrelated issue, like windows replacement or a new kitchen, as well as changes that are directly sensor related, such as new heating system.

Properties that house vulnerable people or those with specialist needs are likely to have a greater number of benefits and thus, while their cost per premise might be slightly higher than others, on economic grounds alone they should be a priority.

Installation, engagement and other costs are much lower for densely grouped / multiple properties, particularly apartment blocks, but also terraces or bungalows in a court. Addressing these will be more economical and therefore to be prioritised too.

This leaves dispersed existing stock that is not housing the vulnerable as the non-prioritised. Provision within this group can be phased, to fit in with work nearby.

This should allow for a phased roll-out that balances priority needs with cost minimisation.

### **TASK: Priority Setting – Properties**

List planned interventions and/or locations in priority order.

Example:

- Priority – incorporate IoT in all planned renovation works.
- Priority – Deploy IoT in [example estate], where problems are emerging.

### AI and emerging capabilities

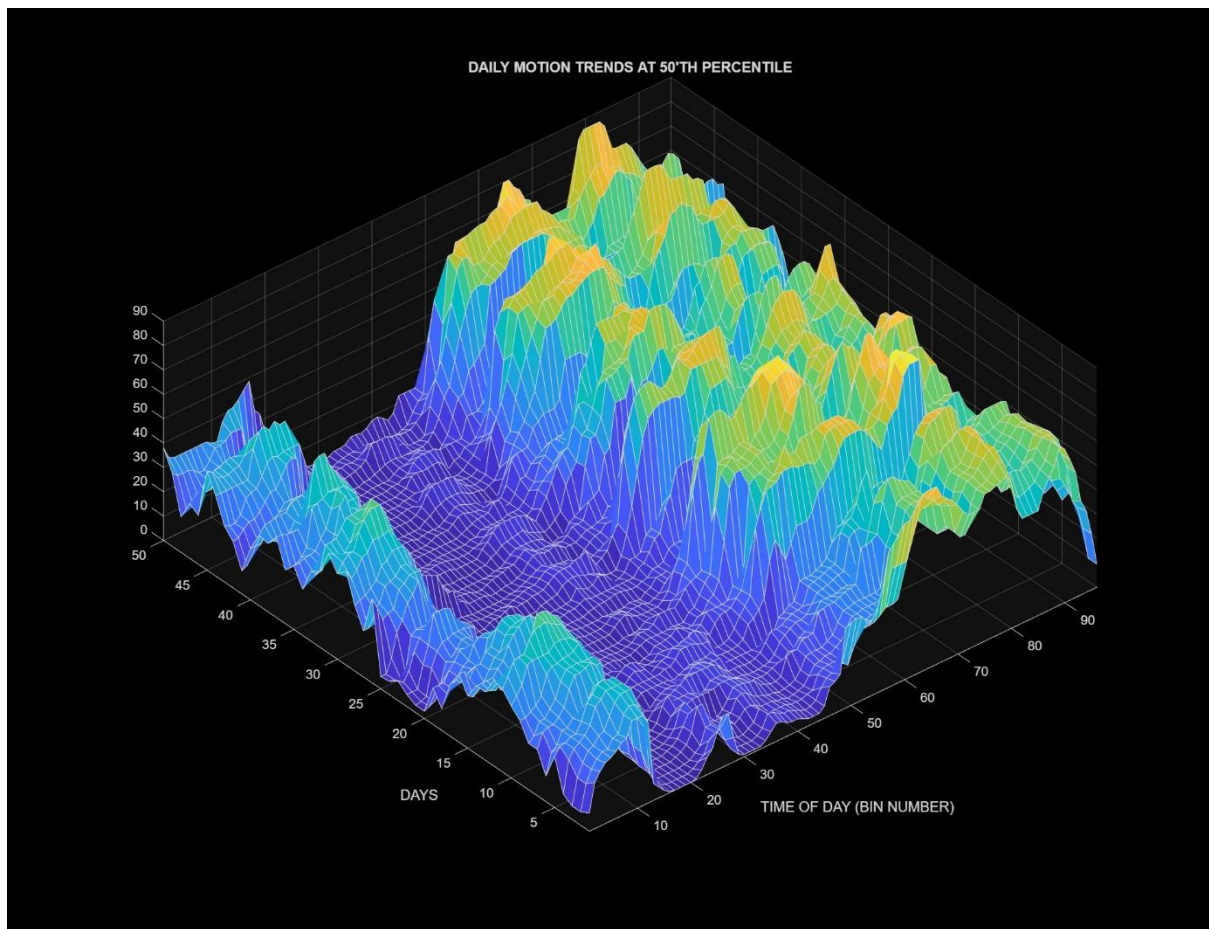
Many use cases are largely self-evident, for example, damp and mould sensors report on the interplay of temperature and humidity, highlighting when the conditions are likely to drive damp, and then mould.

However, other use cases are still in their infancy and their full potential only now being realised. The GMCA / DSIT pilot that developed connected care is instructive here as it demonstrates how motion detection can provide valuable insights.

Tunstall and Cognitive, in partnership with Stockport Homes Group, explored two broad themes. Firstly, identifying normal routines, this allows the housing team to moderate their interventions – there's no need to intrude if it is clear a tenant is up and making breakfast. Secondly, longitudinal trends allow better prioritisation and early intervention where data indicates help might be warranted. This provides potential for both reduced interventions in today's service delivery, and long-term avoidance of escalation as a result of correctly prioritised service inputs.

The figure below shows illustrates daily motion trends over a period of 50 days. While this is an inherently complex analysis of a vast array of data it allows visualisation of the typical routine of a household. The 'trough' in the image represents the lull in activity while asleep (with evidence of some restlessness in the early hours), before typical morning and afternoon peaks of activity are seen (with dips at mealtimes while seated).

*Figure 1 - Motion Tracking: Median Activity of Social Housing Residents over 50 Days (Credit: Tunstall / Cognitive)*



*Figure 1* description: Surface plot titled “Daily Motion Trends at 50th Percentile”. The chart shows household motion activity across 50 days and times of day. A pronounced trough in activity occurs overnight, indicating sleep, with small fluctuations suggesting occasional movement. Activity rises sharply in the morning, remains elevated through much of the day, and falls briefly around mealtimes. Similar patterns are repeated across the 50-day period, demonstrating a consistent daily routine.

Analysis of this nature is drawn from four sensors placed strategically around the home which relay data arising from Wi-Fi signal interference. The degree of interference is a consequence of human movement around the home enabling understanding of frequency and scale of activity, while also allowing separation of signals from pets. Distillation of these signals allow straightforward presentation via a dashboard (see below) that allows housing or care teams to understand the overall patterns of activity, or greater detail of e.g. disrupted sleep. Dashboard configuration

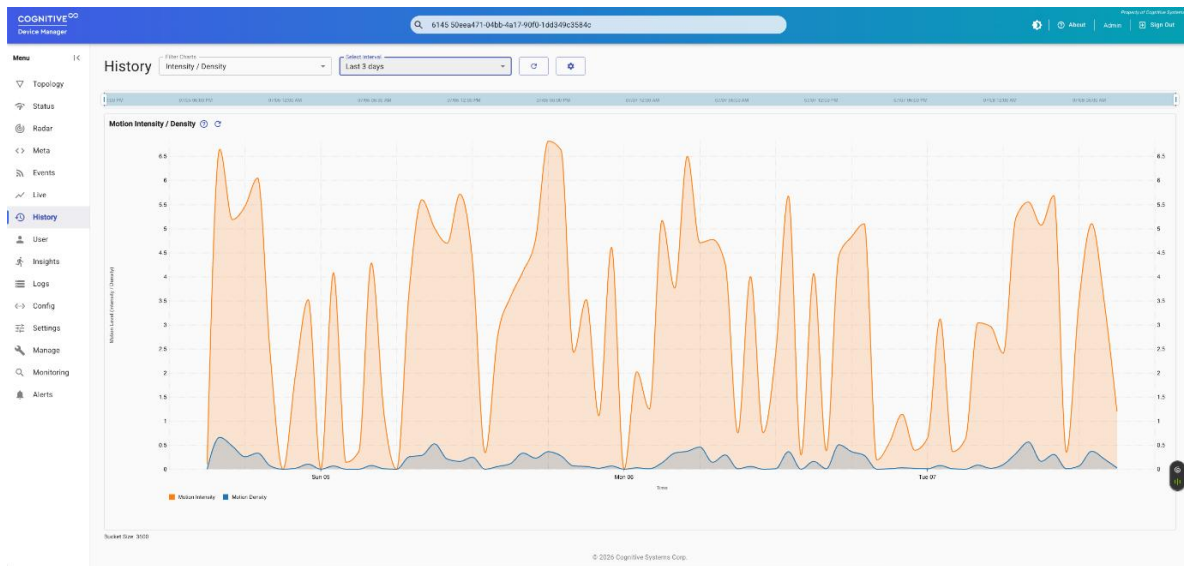
allows teams to set alerting parameters appropriate to the needs of an individual resident, or cohort as appropriate.

*Figure 2 - Sample view of Dashboard: Extent of Daily Activity for an Individual*



*Figure 2* description: Dashboard view showing household activity levels across a week. A bar chart displays the total amount of daily activity recorded on each day, with activity levels remaining broadly consistent throughout the week. Most days show between approximately three and four hours of recorded activity, with a lower level on the final day shown. The dashboard provides a simple summary of overall movement patterns, enabling housing or care teams to identify changes in routine or unusual reductions in activity that may warrant further attention.

*Figure 3 - Sample view of Dashboard: Intensity of Activity Over Time*



*Figure 3* description: Dashboard view showing detailed household motion activity over a three-day period. The chart plots motion intensity and motion density over time, illustrating fluctuations in movement throughout each day. Periods of higher activity are represented by repeated peaks, while extended low-level periods indicate reduced movement or rest. The data highlights changing patterns of activity and inactivity across the day and can be used to identify behaviours such as disrupted sleep, prolonged inactivity, or significant departures from an individual's typical routine. Configurable alerts allow care or housing teams to monitor for patterns that may require follow-up or support.

Data presented here is not used in isolation, rather activity measurement alongside the tenant's use of their 'I'm OK' facility provides the team with reassurance and hence supports greater independence. Further interaction with other sensors allows a rich picture around the household as needs evolve. Additional information can be obtained either from existing 'smart home' devices or specific sensors.

The benefit of this is then seen in: -

- Improved independence for tenants
- Reduced pressure on staff
- Reassurance for staff that all is well.

The key takeaway is that data drives information which, drives insight. AI is a force multiplier here, able to identify patterns within the vast amount of data generated.

## Get fully digital fit

Before embarking on procurement take time to carry out the following:

- A digital audit, listing all existing technology used; the equipment, locations, contracts and other relationships, e.g. your call handler.
- A project plan, covering operational context and resources, co-ordination with other works, timescales and any dependencies. Risks should be low and can be mitigated.

**TASK: Carry out a digital audit and prepare a project plan**

**Technology should help housing organisations to do things better and to do better things.**



### Engagement

Engagement with residents, staff and other key stakeholders should be a priority throughout any upgrades or change, with privacy and inclusion considered from the earliest possible moment.

It's important to consider how your project will impact each group, and what methods of engagement are already effective.

In the pilots, there were a wide range of approaches and they were delivered depending on the specific circumstances. For example, communal drop-in events worked in some schemes, with a one-to-one for more vulnerable people, whereas in another, producing leaflets in a different language for people who were less confident in English was highly effective in another.

This multi-layered approach works well, and time spent in engagement will always save time and avoid disruption later

The aim is for informed consent that positively welcomes the investment – you should record consent where personal information has been shared.

#### **TASK: Engagement Plan**

Prepare a simple engagement plan covering:

- **Who** – List the residents, staff and partners to involve, including any accessibility or language needs.
- **How** – Choose the best way to reach each group, such as letters, briefings, drop-ins or one-to-one conversations.
- **When** – Add each engagement activity to the project plan.
- **Feedback** – Explain how people can ask questions, raise concerns and influence the project.
- **Owner** – Name the person responsible for each activity and any follow-up.

For more detailed communications planning, use the OASIS model and guidance from the **Government Communication Service**.

### Data Usage

The amount of data required in an IoT deployment depends on:

- The use case
- The sensor used
- The sampling rate and resolution of the measurement
- Whether or not encryption is involved.

As a result, the actual data used can vary significantly, even where there appears to be a similar use: one environment sensor might be taking a simple reading every 15 minutes, while another is measuring to a higher resolution and sampling every 15 seconds. The latter will have a data requirement one hundred times larger than the former. Sensors within a household will typically all connect to a Gateway, so that onward data transmission to the internet requires only a single connection, reducing cost.

The following table provides broad indication of likely scale per household.



## Data Usage by Sensor Type per Household

| Sensor                                                                                                                                                             | Typical data use per month                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| Smart door locks and access control systems:<br>These devices typically send tiny packets of data when someone locks/unlocks a door, plus periodic status updates. | 2-5MB per month for moderate activity for a smart door lock |
| Environmental sensors: Devices monitoring temperature, humidity, or air quality usually transmit small data packets every few minutes or hours.                    | 1-10MB monthly depending on reporting frequency.            |

A housing association planning for mass provision of environmental sensors across housing must first decide on the number of sensors to deploy in each property. A single sensor, well placed, would provide a reasonable guide to temperature and humidity across the property, particularly if it is in good order. The best standard is much higher: one in every room. Connecting a bathroom sensor directly to a fan, for automatic running while humidity is high, is best practice.

Thus, for housing that comprised a mix of two and three-bedroom units the number of sensors per property will likely lie between 1 and 6. Applying the typical range of data transmission from the above table suggests a total data requirement, per month, per property, could range between 1MB and 60MB. This is obviously too wide a range to plan from. As a first guide, assuming 3 sensors per property on average, and that sampling rate is moderately paced, 20MB/month could be used to scope costs, though this level of data use would need to be confirmed with the supplier.

This demand ramps up with additional use cases. Housing with a smart lock, heating controls and an array of care related sensors, detecting falls and movement, would likely require 100MB per month.

For prudence or affordability testing these figures could be doubled.

### **TASK: Connectivity Plan – Data Use**

Gather an estimate of:

- Number and type of sensors
- Number of connections required, the Gateways, (this could differ from number of housing units if additional provision made to communal areas)
- Average data use, by type of housing
- Total devices, number of Gateways, and aggregate expected data usage

## Connectivity

Connectivity is apparently simple yet difficult in practice, as there are many options to consider (tenant Wi-Fi, Wi-Fi boosters/hot spots, SIM, LPWAN, fibre...).

To help the following table sets out guidance as to the likely 'best solution' a given form of housing (e.g. apartment blocks).

### Connectivity Choices by housing type / location

| Housing type / location                                                                                        | Assessment                                                                                                                                                                                                                                       | Connectivity Solution – base case 'likely best' in advance of contract                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rural housing – widely dispersed                                                                               | Challenging – as cellular services (4G) may not be available ('not-spots') and extension in fibre reach slowing                                                                                                                                  | <p>In the short-term it may be necessary to adopt a hybrid solution, with cellular IoT (i.e. a SIM based solution) deployed where possible, then fibre if that is available and finally acceptance that very remote housing may simply not be cost-effective to serve.</p> <p>In the medium to longer term mainstream connectivity should be available everywhere.</p> |
| Rural housing within small to medium sized settlements                                                         | Likely to be well served with 4G and fibre.                                                                                                                                                                                                      | In the short-term deploy cellular. Note that an Embedded SIM (eSIM) may offer carrier choice, selecting the strongest signal available at that location, and potentially switching to maintain service if there is an outage with the primary service. This aids quality and resilience.                                                                               |
| Housing where managed Wi-Fi is available, either communal for staff purposes or for universal tenant provision | Wi-Fi (for additional uses) is 'free' and therefore the clear winner on affordability. However comprehensive and reliable coverage can be difficult across a site, this is easing as mesh solutions and higher speed (Wi-Fi 6/7) become standard | Use the Wi-Fi. Upgrade (particularly through additional range extenders) as appropriate.                                                                                                                                                                                                                                                                               |

| Housing type / location          | Assessment                                                                                                | Connectivity Solution – base case ‘likely best’ in advance of contract           |
|----------------------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Standalone houses in Urban areas | Very good cellular provision (5G SA/4G LTE) is present, and fibre is pervasive, likely choice of networks | Cellular SIMs, at least in the short to medium term, (see following discussion). |

### **How much might connectivity cost?**

IoT specific rate plans from MNOs are structured differently from consumer mobile plans. They are typically focused on the aggregation of devices with volume-tiered pricing. Pricing structures, generally 'negotiated rather than published, reflect the overall data consumption, the device count, and contract term commitment.

Base costs are likely to be around £2-£5 per month per device unless very high data requirements are involved, such as CCTV. These costs will reduce with large quantities and longer contract terms.

### **Concerns to watch for with cellular IoT**

There is a potential challenge with relying on 4G cellular provision; it is inherently limited and accordingly may drop service if oversubscribed, even briefly, at that particular location. An example occurs with high footfall at sporting events or concerts. With surrounding crowds, the signal to the SIM might be erratic or drop out. For use cases like damp and mould this may be a minor inconvenience, for health or safety related use cases it is self-evidently more concerning.

There are technical workarounds that can mitigate this issue, and full 5G offers the potential for a dedicated virtual network, through 'slicing'. These solutions do come at a cost, and therefore the need for them should be carefully considered.

Thus, before plumping for cellular based connectivity – check the service actually available at those times when it might be expected to be busy.

### **Summary on connectivity**

For most social housing, in most locations, at least in the short term, using SIMs and connecting to the cellular network is a reasonable base case for most use cases, particularly where instant response is not needed, and signal drop-out can be easily and safely accommodated.

Where housing is in blocks or otherwise concentrated, and especially if use cases include those that have higher data demands such as those linked to care, the

expectation will be for fibre, either through establishing a dedicated Wi-Fi network or hardwiring.

### **TASK: Connectivity Plan: Contract**

Select your preferred connectivity approach, aiming for 3 to 5 years contract length, long enough to secure best rate, while short enough to avoid supplier lock-in.

Seek bids for the data usage and device count you defined in the last task and check your preferred provider's signal strength and plans for the area.

### **Beyond the short-term: Future Strategies**

Reliance on cellular provision into the medium and long term is less attractive. As well as higher ongoing costs it may be difficult to flex in line with evolving demands, and reliability may be a continuing challenge for some locations and properties, those that are shielded from a good signal or occasionally experience very high demands for service.

As a minimum, given the discount for volume and the benefits of data pooling (allowing underuse somewhere to avoid charges for overuse elsewhere) it makes sense for housing bodies (and other organisations) to procure on a combined basis.

The GMHP group of housing providers would provide a perfect framework for such bulk buying, which could then extend beyond the Greater Manchester region, bringing benefit to all housing providers, including those outside the social housing sector, such as student housing. The benefits of expanding from a single housing provider are substantial:

- Better coverage
- Less interference
- Lower costs
- More flexibility in the future.

Most housing providers are tightly geographically focused. Accordingly, a provider could create their own network, and those with a tower block might be able to utilise

its roof for antennae. Working with other providers could create a mesh network covering all of GMCA, and eventually wider, even national coverage.

Using low power and unlicensed spectrum, for low to moderate data uses, would be highly cost-effective, with a single point (mast or tower block) serving everywhere within up to 10km.

Of course, public networks (cellular and emerging low power) might continue to fall in price: data is being increasingly commoditised.

The takeaway from all the foregoing is that there are no simple answers for connectivity, and that it might become more complex in the future. However, while 'perfect' or 'correct' connectivity might be challenging to define, the easy option, cellular, is likely 'good enough', though very long contract lengths should be avoided.

### **Policy Issues: the rise of Wi-Fi**

Every year the proportion of social housing with Wi-Fi rises. Ofcom estimate only 5% of housing is now without an internet connection; as social housing is 16% of all housing it follows that the clear majority of social housing already has Wi-Fi. This has developed largely without clear policy direction and raises an interesting possibility – should housing providers adopt a default position of offering Wi-Fi as standard? This will produce net savings through bulk buying of a social tariff, with no marketing costs or subsequent churn (customers leaving). This could add around £10 per month to rents, though majority of tenants are better off through eliminating their own Wi-Fi.

For the housing provider the universal Wi-Fi enables all IoT to be easily deployed, potentially making savings for it compared to renting capacity on a wireless network (cellular or low power). The housing provider also sees benefits in providing staff access to Wi-Fi and simpler communal provision, such as CCTV installations.

Resilience is also increased as a neighbour's Wi-Fi or the communal provision can step up to maintain sensor links if household connectivity lost.

In the past concerns around charging for Wi-Fi to a significant proportion that would not want it were valid. But now the numbers of such individuals are declining, the

cost has fallen sharply, in part through social tariffs, and the wider benefit, primarily around IoT adoption has soared.

A gateway approach – where all sensors interact with a single point which then connects to the internet has obvious value – with Wi-Fi the interaction is similar, but the gateway is the resident's existing Wi-Fi router.

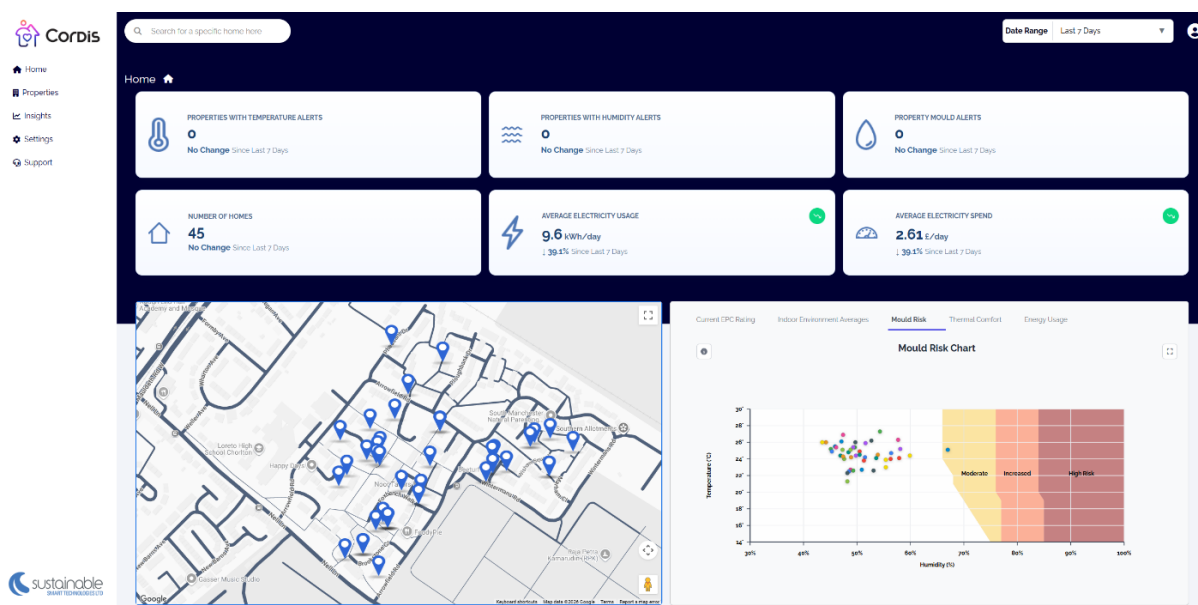


### Dashboard

For most IoT deployments the dashboard – a world of data on a single pane of glass as one company lyrically describes it – is key.

When designed well, it should be able to convey information at a glance, with urgent or atypical data being highlighted. Examples from the Damp and Mould are shown below that illustrate this.

*Sample Dashboard View: Map View with Chart (Credit: Cordis Platform – Sustainable Smart Technologies Ltd)*



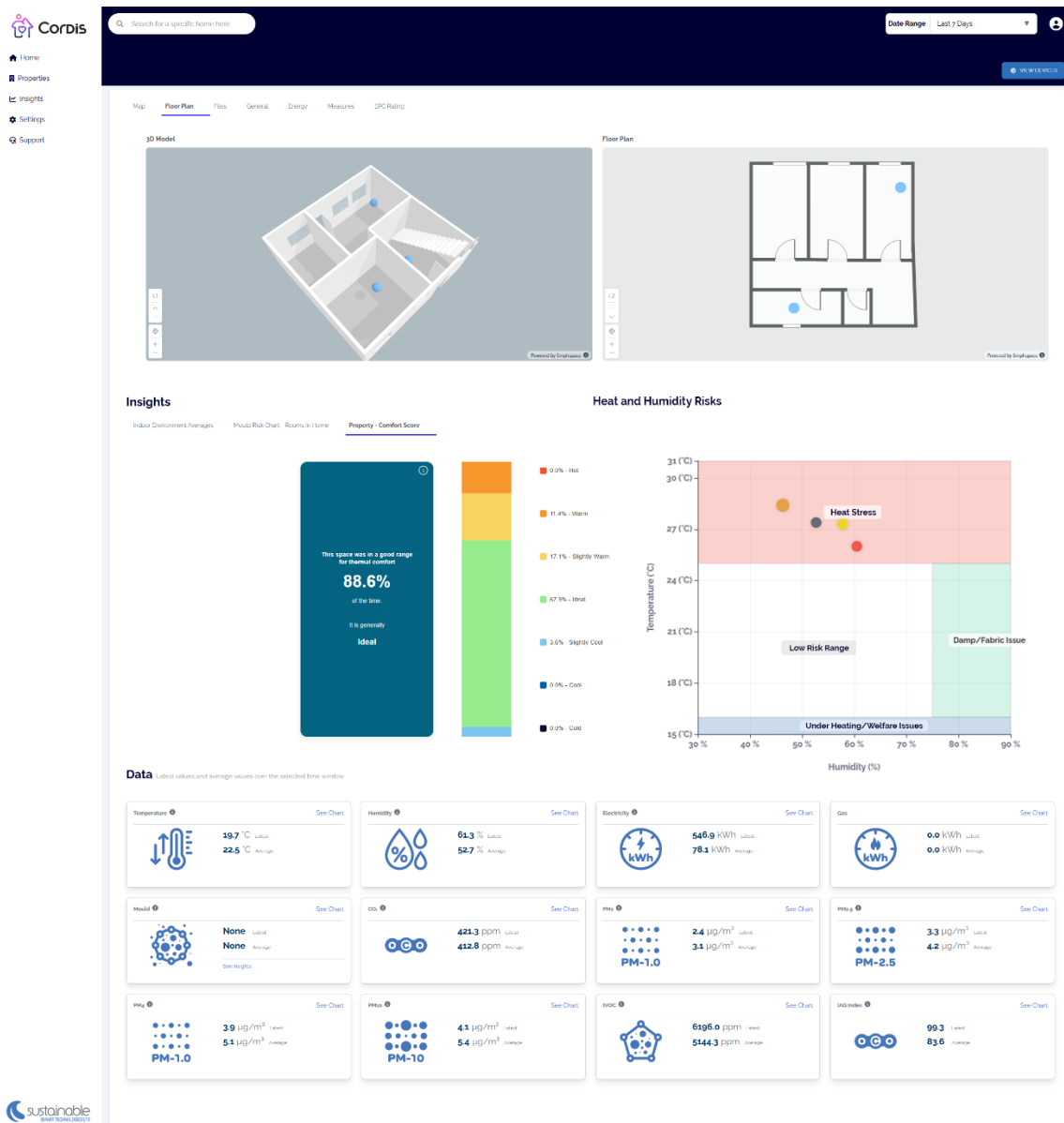
*Image description: Housing monitoring dashboard showing summary indicators, a map of connected properties and a scatter plot comparing temperature and humidity readings with colour-coded damp and mould risk zones. Most properties fall within the low-risk zone, with one property close to the moderate-risk boundary.*

The chart above shows that the vast majority of housing units have readings that place them well away from a susceptibility to damp and mould. A single unit does though lie just within the yellow zone, where damp and mould may gain a foothold. While this case bears some closer inspection, as prevention is better than cure, the overwhelming picture is one of reassurance, that threat is very low.

A detailed view of an individual property is also possible, as shown below.

*Sample Dashboard View: Individual Property (Credit: Cordis Platform – Sustainable Smart Technologies Ltd)*

## MAKING SENSE OF SENSORS: The Business Workbook



*Image description: Dashboard for a single monitored property showing a 3D property model, floor plan and sensor locations, alongside comfort and heat-risk charts. Several rooms fall within the heat-stress zone, while detailed readings cover temperature, humidity and indoor air quality.*

The above snapshot of an individual property was taken during the early heatwave of summer 2026. It shows that rooms in the property are too warm, sufficiently so that they may cause health problems through heat stress.

The dashboard's map quickly aids prioritisation of welfare checks, by identifying the properties experiencing the highest heat. Similar houses in the same location may experience it very differently, for example some are on the shaded side of the street

and other benefit from trees, while others suffer as they are south facing, adjacent to large areas of tarmac or near aircon equipment outlets.

This demonstrates how sensors deployed for one use case, measuring the risk of damp and mould, associated with wet winters, can prove invaluable for new use cases, in this case coping with unusually warm weather. If climate trends continue this use case might become as important as damp and mould, or even more so, as it is harder to deal with excessive heat than with humidity and it may be more dangerous.

### **TASK: Dashboard**

Ask potential suppliers for sight of their dashboards and develop your ideal dashboard. Typically, full customisation is possible.

A housing provider in an area with high radon may, for example, choose to add an indicator covering this.

## **Costs – Setting a budget**

Perhaps the most critical question is - What does it all cost?

This section provides a guide, providing midrange estimates, rounded and subject to negotiation. It is possible to spend more or less than these figures, but as with any procurement, quality and the broader attributes of the offer must be taken into account.

### **Sensors are generally Cheap...**

But implementation can be expensive, often including the following:

- Survey, planning and design.
- Engagement – residents and staff.
- Installation – sensors and possibly works to the premises electrics. It may be necessary to carry out preliminary works, perhaps making an attic accessible, before it is utilised for the actual works.
- Repair / decorating as required.
- Training in the device.
- Post installation monitoring and replacement if necessary.

### **Installation**

Stand-alone and retrofit deployments face practical blockers:

- asbestos
- fire stopping
- incomplete building records and
- heritage constraints.

There is quite a strong case for a procurable survey/design stage to derisk pricing.

New builds present a major opportunity to design in energy conservation, ventilation, security and sensing from day one. Installation requires careful planning.

- Installations may vary from 'light touch' tenant led, to survey-based ones to identify specific places to deploy sensors.
- Access is one of the most significant blockers; high performing installs require organised comms, champions, and well-designed install models.

- Installers that are familiar with working with HPs can be beneficial.
- Issues with asbestos and fire breaks can be barriers to deployment.
- Some HPs have archaic and manual processes to manage existing fire alarm replacement and electrical testing.

### Costed Examples

The following tables represent common forms of IoT adoption and illustrate likely costs. All costs presented are exclusive of VAT. Costs have been rounded and also adjusted towards industry averages where this is appropriate to protect commercial confidentiality amongst the suppliers.

The three examples provided below cover key use cases but also give an indication of the principles underpinning cost; the need for design and engagement as well as the sensors, the likely scale of associated work in installing the sensors including electrical work, and ongoing costs, connectivity and subscriptions.

#### Worked Example 1:

Providing Connected Care, including alerts, communication, monitor/screen to each unit, door entry and common works to a 40-unit block.

| Providing Connected Care to a 40-unit block              | £             |
|----------------------------------------------------------|---------------|
| <b>Implementation Costs - Common Areas:</b>              | N/A           |
| <b>Survey / planning</b>                                 | 2,000         |
| <b>Tenant engagement</b>                                 | 1,500         |
| <b>Core implementation and provision to common areas</b> | 51,000        |
| <b>Door Entry system</b>                                 | 17,000        |
| <b>Total Implementation Cost to Common Areas</b>         | <b>71,500</b> |

*Table description: Common-area implementation costs for connected care in a 40-unit block. Survey, engagement, shared infrastructure and door-entry works total £71,500.*

| <b>Providing Connected Care to a 40-unit block</b>                       | <b>£</b>      |
|--------------------------------------------------------------------------|---------------|
| In Unit Costs (per unit)                                                 | N/A           |
| In unit connection                                                       | 100           |
| Call/alert - full communication - screen based, with additional features | 500           |
| Pendant / other wearable device / for call/alert                         | 10            |
| Integration of existing fire sensor / smoke detector                     | N/A           |
| Remote Door Controller)                                                  | 100           |
| Hardwired pull cords                                                     | 20            |
| Total In Unit Cost (per premise) rounded                                 | <b>1,000</b>  |
| <b>Total In Unit Cost (40 apartments)</b>                                | <b>40,000</b> |

*Table description: In-unit equipment costs for connected care, including connectivity, communication and alert devices, door controls and pull cords. Costs are approximately £1,000 per unit, or £40,000 for 40 units.*

| <b>Providing Connected Care to a 40-unit block</b> | <b>£</b>       |
|----------------------------------------------------|----------------|
| <b>TOTAL ALL COSTS</b>                             | <b>111,500</b> |

*Table description: Combined connected care costs for a 40-unit block: £71,500 for common areas and £40,000 for in-unit equipment, totalling £111,500.*

The cost breakdown is thus around £2,000 per unit on addressing common areas, including the new door entry systems to each apartment, and a further £1,000 within each unit, a broad £3,000 a unit for the complete works and equipment.

#### *Ongoing cost*

The connectivity cost per apartment in this example was £15 per year (£600 total), equivalent to £1.25 per month. In addition, there is a continued subscription to the alert manager, CareCall.

## Worked Example 2:

Providing Damp and Mould sensors plus connectivity and dashboard to 20 units

| Providing Damp and Mould sensors (20 units) | £            |
|---------------------------------------------|--------------|
| Overhead Implementation Costs:              | N/A          |
| Survey / planning                           | 2,000        |
| Tenant engagement                           | 1,500        |
| <b>Total Overhead Implementation Cost</b>   | <b>3,500</b> |

*Table description: Overhead implementation costs for damp and mould monitoring across 20 homes. Survey, planning and tenant engagement total £3,500.*

| Providing Damp and Mould sensors (20 units)           | £             |
|-------------------------------------------------------|---------------|
| In Unit Costs (per unit)                              | N/A           |
| In unit wiring – 5 connections at £40 each            | 200           |
| Gateway / router                                      | 400           |
| Environmental sensor (heat/humidity...) 4 at £75 each | 300           |
| Smart Meter integration                               | 150           |
| Total In Unit Costs (per unit) - rounded              | <b>1,000</b>  |
| Total in Unit Costs (20 units)                        | 20,000        |
| <b>TOTAL ALL COSTS</b>                                | <b>23,500</b> |

*Table description: In-unit technology costs for damp and mould monitoring, including wiring, a gateway, environmental sensors and smart meter integration. Costs are approximately £1,000 per home, or £20,000 for 20 homes.*

| Providing Damp and Mould sensors (20 units) | £             |
|---------------------------------------------|---------------|
| <b>TOTAL ALL COSTS</b>                      | <b>23,500</b> |

*Table description: Total cost of deploying damp and mould monitoring across 20 homes, combining £3,500 in overhead implementation costs and £20,000 in in-unit technology costs, totalling £23,500.*

Despite the difference in use case the in-unit capex comes out again at around £1,000, as the absence of a communication monitor / screen is offset by a higher number of sensors and connections.

### *Ongoing cost*

Connectivity in this example was £2.50 per unit per month. In addition, there was a charge for alerts handling and a dashboard subscription, totalling £7.50, making ongoing costs £10 per month.

### *Optional Costs*

An air quality monitor could be added for circa £1,000; this is necessary only where the household has a respiratory illness or similarly at risk.

### Worked Example 3

Providing connectivity to existing (dated) heat pumps with the aim of reducing maintenance callouts, improved comfort to the resident and better environmental outcomes.

Costs, for a block of flats, Clifford Lamb Court, with a total of 57 units, of which 54 units had a heat pump which was connected to a ground array, were as follows: (costs rounded).

*Case Study: Making existing heating appliances Smart*

| Item                                                      | Cost (each) (£) | Total Cost (£) |
|-----------------------------------------------------------|-----------------|----------------|
| Gateway (54 units)                                        | 160             | 8,640          |
| Install (54 units)                                        | 250             | 13,500         |
| Additional install (extra electricity socket to 10 units) | 75              | 750            |
| Average Cost per unit                                     | N/A             | 424            |
| <b>Total Cost</b>                                         | <b>N/A</b>      | <b>22,890</b>  |

*Table description: Table showing the costs associated with converting existing heating appliances into smart, connected devices across 54 properties. The costs include the provision of gateways, installation work and additional electrical socket installations where required. Gateway equipment costs £8,640 in total, installation costs £13,500, and additional installation work costs £750. The table shows an average cost of £424 per property and a total project cost of £22,890 for all 54 properties.*

This cost excludes management overheads associated with the pilot, including team meetings, data provision including historic, and reporting.

Connectivity costs were not explicitly measured for this pilot as spare SIMs from other pilots were utilised, but the likely true cost was around £2.50 per month, per unit.

### Summary Conclusions from the costed examples

In the worked examples capex for the supply and installation of the sensors was around £1,000 per unit for the more intensive delivery seen in Connected Care and Damp and Mould use cases, compared with half that (£424) in the case of simply connecting a heat pump in the Smart Energy pilot.

Upgrading premises to make full use of the new connected care capability however added £2,000 per housing unit, reflecting the high costs around upgrading the entire door entry system and communal provision. This stresses the need to identify the costs around the wider actions that might follow from IoT adoption.

There are overheads around design and engagement, these are relatively fixed, accordingly projects should avoid small scale interventions which push the per unit cost of these overheads up.

Recall that in most cases there is a worthwhile benefit from timing the IoT works to fit with others, such as retrofitting or even simple decoration. This also minimises the disruption to the tenant.

### **TASK: Costs Plan**

For the properties identified as a priority apply the following broad costings:

£1,500 per unit for full IoT deployment – two or more use cases

£1,000 per unit for focused IoT deployment – which centres on a use case that requires a number of sensors to deliver – for example Damp and Mould

£500 per unit for IoT deployment based around a single sensor – such as a heating appliance.

If there are likely to be any associated costs, such as new door locks, identify this and include an allowance for it in the total.

This will provide an estimate of the total spend for that initial phase.

### Benefits

Some benefits arise from day one: improved communication, security, energy management and others. All these benefits arise in a continuous flow and are easily measured and can be valued. Other benefits are infrequent, and therefore may not occur for some time after installation. These benefits may though be very valuable when they do occur, in the same way that a smoke alarm provides no benefit (except perhaps to peace of mind) until it acts, possibly saving lives and property.

Smoke alarms are accepted as essential, yet a business case would struggle to model them, the vast majority being binned after a long life, having never 'worked'.

#### **TASK: Benefits Plan**

For your use case(s)

Decide which explicit metrics / KPIs you want to improve. This will be useful in establishing the business case and, post deployment, useful for determining if the investment in IoT has been successful.

Examples:

- % of homes with a damp problem / or reported damp
- expenditure related to damp on maintenance per home per year

Gather baseline, and historic, if possible, data for these metrics / KPIs.

### Return on Investment / Benefit Cost Ratio (BCR)

With a broad estimate of costs, and an understanding of benefits, a return on investment or Benefit/Cost Ratio (BCR) can be estimated.

The earlier three worked examples are revisited below, from this standpoint.

#### **Connected Care**

Expensing capital over 10 years and adding in ongoing connectivity payments gives an annual cost of just over £300 for the connected care use case. Estimating benefit in this use is challenging. It is only over a long timeframe, involving a large number of

residents, that a reasonable estimate might be made of the impact that quicker and clearer communication has on hospitalisation and other costs.

Using cost collection data for 2020/21, the most recently available data, the unit cost per day of NHS hospital beds was estimated in 2023 to be: Elective - £2,349, Non-elective - £901, Critical care £1,881 and a Standard bed - £345, around £500 a day today. Avoiding a three day stay thus saves at least £1,500, but £6,000 if this is in critical care. If the new provision, over the course of a year, resulted in one in twenty residents avoiding a hospital stay in a critical care ward this would justify the expenditure. Note however that the saving here is captured by the NHS, or taxpayer, not the housing provider.

The superior offering may also act to delay an individual's transfer to a care home; here the saving will accrue to the Council. The cost of a care home depends on location but is around £800 a week more than the cost of social housing. Delaying this by 3 months (13 weeks) would save £10,400, enough to cover the costs of connected care for 35 units for a year.

Unsurprisingly, the greater the care needs that might be managed with connected care, rather than hospitalisation or transfer to care home, the larger will be the savings. Housing providers with an elderly or vulnerable population can make a judgment on this.

### **Damp and Mould**

Annual equivalent costs for this use case are around £200, equally divided between ongoing costs (connectivity, dashboard, helpline) and capex apportioned over 10 years.

Again, benefit will depend on the avoided costs, where undetected damp and mould damages property as well as being injurious to health. Highest returns are found in properties susceptible to damp, perhaps failing flat roofs or located where they are subject to driving rain. The benefit from installing sensors in recently built housing is thus likely to be lower than average. A policy decision, rather than a financial one, might be made for universal deployment in light of the potential harm to health from undetected mould.

### Smart Heating: Preventative maintenance and online triage

Appliance monitoring can help in four ways; firstly, it can extend periods between maintenance by indicating all is well. Secondly, it can reduce large repair costs by indicating that failure is imminent, which may avoid catastrophic failure that causes significant damage. Thirdly, it can provide the opportunity for remote correction of a fault, for example by carrying out a simple reset. Finally, where a fault cannot be fixed remotely it will generally be able to supply an error code, which will allow the right trade (electrician, plumber) to attend, complete with the required part.

Maintenance is a regular event, and so this use case generates well understood cash savings from the outset. In the case study of the GMCA pilot supported and funded by DSIT (Clifford Lamb Court) it was noted that implementation lowered maintenance callouts by 65%.

At an average cost per callout of £150, the reduction from 4.25 callouts per month to 1.5, produces a saving of £412.50 a month, £5,000 a year. This gives a payback period of under 5 years, which is highly attractive, even on purely financial grounds. In addition, there is less disturbance to residents and temporary loss of heating.

This reduction in callouts was though abruptly reversed for an unrelated issue, concerning water pressure at the block, which generated a large number of service calls. This reinforces that sensors are helpful but not a silver bullet, ultimately outcomes will be driven by a range of factors, some outside sensor control.

#### **TASK: Assess Initial Return on Investment**

First estimate costs, aided by the worked examples.

Then, for each use case, identify a key benefit, or more than one, and calculate potential benefit, listing assumptions.

Examples:

Delaying transfer to a care home, currently see x% transferring annually, a delay of y months would produce a total saving of £z per individual, £Z in total per year.

Early detection of mould, would mean a saving of £x per affected unit on treatment and avoidance of repair and decant costs of £y, possible void costs of £z. Based on

historic figures this might affect p% of all properties, giving an aggregate saving of £Z.

Comparison with the costs (including ongoing connectivity and support costs) will yield a Benefit Cost Ratio (BCR). A BCR need not exceed one if there are wider benefits not included in the calculation, such as resident's peace of mind.

If detailed figures are available and greater accuracy sought, a discounted cash flow (DCF) can be carried out, with the capex upfront and a flow over ten years of net benefit, after ongoing costs. This will determine the rate of return on the investment.

It is stressed though that as many valuable benefits are necessarily uncertain around their magnitude and timing, the emphasis should be on a 'sense check' – does the required level of improvement seem highly likely, possible or not at all likely?

Firm data around the existing position – from the KPIs and metrics gathered earlier – along with actual costs from a tender process will greatly aid the accuracy here.

### **Adding benefit – the Stacked Business Case**

With one attractive use case identified, attention should turn to adding sensors. Here the economics are transformed as the heavy lifting has been done through providing a gateway and connectivity for the initial use case. The result is a very low marginal cost for any further sensors, often simply their individual cost.

As a result, an additional use case generally needs only to indicate that it may bring some benefit at some stage to be worth adopting.

Of course, there is a need to ensure compatibility and manage phasing while climbing the innovation ladder and adding capability. But always aim for practical, pragmatic steps, more iterative than innovative.

Within the pilots the Damp and Mould provision was extended through connecting sensors on existing heat pumps to the new Gateway. This allowed heating to be integrated with the temperature and humidity sensors, which adds powerfully to both use cases.

### **TASK: Stacking the Business Case**

Review other use cases and implement those likely to justify their marginal cost.

### Integration with existing operational processes:

Identify which of the following will need process changes to accommodate the new solution:

- housing management systems
- repairs systems
- CRM systems
- asset management systems

#### **TASK: Integrate to workflow**

Think about how the proposed solution will be incorporated into existing operational processes and identify any required changes to roles, procedures or systems.

Be particularly cognisant of 'day one' issues, where new information is available but staff may be unaware, untrained or unclear as to its value.



## **PLAN: Summary**

You should now have:

- A use case and probably further ('stacked' use cases)
- A priority list of properties and their types for this / these to apply to
- ROM (Rough Order of Magnitude) costings for this phase, providing a budget figure that is affordable
- A list of benefits / KPIs and baseline figures, ideally also historic levels and trends
- A sense of the cash return – savings – that will flow from deployment, and the wider qualitative benefits, allowing for an informed decision as to whether or not to proceed, or pause while further data is collected.

If the decision is for proceeding the next step is procurement.



# PROCURE

This section describes:

- Getting procurement right
- Help from the Connected Homes Innovation Hub
- Best practice
- Choosing a supplier
- Managing the contract
- Social Value

### Procurement

The key steps are:

- Define the specification
- Choose the appropriate procurement framework
- Decide on open competition or select list of suppliers
- Procure, decide and enact.

In engaging with procurement, it may help suppliers to summarise your past and current concerns into a simple information briefing, as follows:

- Your information governance – architecture, standards, controls and strategy. What is it and how might it evolve, including incorporation of IoT.
- How many dwellings does your organisation operate / support?
- What issues are you trying to solve, or tenant outcomes are you seeking to achieve, through the deployment of IoT and digital solutions? (improved health, tenant security, building security, broadband connectivity, reduced energy consumption, reduced maintenance? – scoring 1 to 5 (highest priority))
- What IoT and digital solutions have you recently deployed and were these across your entire housing estate?
- Were these solutions deployed using direct award, a framework or something else? If so, which ones (name the framework)?
- What IoT and digital solutions are you planning to deploy in the next two years across your housing estate? What longer term ambitions do you have? (mould and damp, fuel poverty / energy reduction, telehealth, building / tenant security, broadband connectivity, smoke, heat, CO alarms, other)
- What are the budgets to deploy these solutions in the next two years and beyond that?
- How do you envisage IoT solutions being deployed, standalone, as part of wider refurbs, newbuild, a mix, or something else?

- What technical and commercial requirements are most important when it comes to deciding which solutions to deploy?
  - technical – e.g. compliance with standards, scalability, integration, interoperability (technical and data), breadth of support for IoT use cases
  - commercial – e.g. total cost of ownership, social value commitments, ability of one supplier to deploy solution end-to-end, ability to provide managed IoT service, deliver specific contract terms (service levels, warranties, contract length)

### **TASK: Procurement – setting the scene for suppliers**

Answer the above questions and turn it into a short briefing document and share with potential suppliers.

It is vital that by this stage you have a 'SSOT' approach to data, that is a Single Source of Truth, an authoritative centralised data repository. This ensures that there are no inconsistencies or errors and reduces duplication.

The preceding sections have set out that before procurement is progressed that you should:

- Strongly define outcomes, use cases and operational workflows first.
- Separate core requirements from optional or future capabilities.
- Challenge any 'mandatory' technical requirements against evidence, cost and measurable benefit.
- Subject to timetable, undertake proportionate market engagement to test supplier appetite, delivery models and the likely commercial consequences of the proposed scope.
- Only then confirm the technical requirements, specified in terms of capabilities to address the above.

### **TASK: Craft a High-Level ITT**

Frame the ITT around measurable housing outcomes and officer workflows.

Define priority use cases, service outcomes and acceptance criteria - not prescribing technology.

Develop a technology neutral approach to the capabilities you require – focused on ‘how many’, ‘how much’, ‘how fast’, ‘how resilient’ etc, and have a coverage study, and specify those performance requirements - e.g. coverage, availability, battery life, security, interoperability and installation outcomes.

Use an options appraisal or whole-life cost comparison, driving final choices given cost, affordability and ability of your organisation to manage change at this time

Identify any constraints – if none present define final capability requirements against the performance requirements, everywhere retain technical constraints only if supported by operational, safety or regulatory evidence.

Consider how any legacy services might operate – in parallel?

Consider procurement by lots – where there are distinct services, localities

Be clear where you stand on the continuum from simply having sensors installed to having a full managed information and intelligence service, potentially agentic (issuing work to frontline teams)

Then carry out a structured pre-market engagement with a wide range of suppliers, as set out in the following task.

### **TASK – Pre-Market Engagement**

Run a Prior Information Notice and market-engagement exercise to test appetite and delivery models.

Consider an open procedure, competitive flexible procedure or appropriately broad framework with consortium participation. See how the Innovation Hub can help here.

Test the scope with sensor vendors, network providers, housing-platform suppliers, integrators and field-service organisations.

Provide a complete data room covering current devices, keys, gateways, data volumes, schemas and transition obligations.

Use lots, consortium-friendly rules or a flexible procedure to widen viable participation.

And finally, consider a 'Critical Friend' review before issue of the ITT. That's the time to fix any issues around drafting, privacy, SLA and commercial inconsistencies. If it is not sufficiently comprehensive there will be queries and risk pricing by bidders.

Revisit the issues around data and privacy, ensure that all is safeguarded, as set out in the task below

### **TASK: ITT Protecting Data and Privacy**

Assume sensors have the potential for personal information, including movement and other behavioural aspects. Note that Inferring occupancy from CO2 and environmental data is personal data processing and arguably surveillance of tenants' living patterns.

Have a Data Protection Agreement in place, with controller/processor allocation and data protection schedule, defining roles, legal basis, retention and tenant visibility / transparency.

Review what, such as household composition data, will be shared with the contractor.

At all times be aware that this is a tenant-trust risk that could cause access refusals and engagement problems.

Require bidders to describe privacy-by-design measures, data minimisation and how occupancy analytics are controlled and auditable.

This enables a move to finalising the procurement ITT by providing bidders with clarity on the performance to be achieved. This task is detailed below.

### **TASK: ITT on Technology**

Finalise in light of above engagement, publish clear minimum capability requirements and allow delivery through named partners and subcontractors.

These requirements should be fully defined across device management, connectivity, data ingestion (where does data come from, when, how...), analytics, case management and systems of record. Define committed volumes, sensors per property (how many one bed, two-bed, three bed?), installation assumptions, failed-visit rules and replacement rates.

Define SLAs around the outcomes that matter: data timeliness, alert-to-notification times, platform availability and integration uptime.

Set sensor estate health measures (offline detection and replacement cycle times) with meaningful remedies.

Scale service credits to contract value and link persistent failure to escalation, improvement plans and termination rights.

Allow bidders to propose LoRaWAN, NB-IoT, LTE-M, Wi-Fi or hybrid designs – use their expertise to drive the final design / solution, requiring them to provide a target architecture, migration plan, data model and transition assumptions.

Build a whole-life cost model (by architecture option, not only by sensor unit price) and share this structure with bidders to allow fair and accurate comparison between bidders.

Require transparent pricing for hardware, connectivity, installation, monitoring, integration and optional modules.

Encourage optional extras but challenge each premium requirement against a measurable operational benefit.

Assess futureproofing across data, device, network, platform and contract—not data export alone.

Protect control and legacy - require ownership or transferability of SIMs, credentials, firmware access, decoders, schemas and configuration. Mandate open APIs, periodic export testing and practical exit rehearsals. Include technology refresh,

benchmarking, price review and rights to introduce alternative devices or connectivity. This issue, integration of data platforms is key, not only to the project, but to the future of the organisation itself as it becomes digitally based.

Absolute clarity is also required on all accountability and responsibility going forward.

**In procuring the preferred solution, don't just buy the technology, have it wrapped in agreements.**

### **TASK: Ancillary Requirements**

Include a formal stakeholder and tenant-engagement workstream in the ITT.

Require a communications plan, tenant materials, FAQs, privacy messaging and routes for questions or complaints.

Define your and contractor responsibilities for contact, appointments, supporting vulnerable tenants, refusals and repeat visits.

Insist on pilot messaging and installation processes before scale, with access-rate and engagement KPIs.

Align battery, warranty and replacement obligations into a single, priceable lifecycle position linked to the realistic contract term.

Set availability targets and exit timescales into one authoritative schedule.

Set coverage and ramp-up with defined annual profiles.

The ITT is then complete and ready for issue.

### **TASK: Issue the ITT**

Follow your standard procedures and processes around the tender.

Ensure these cover the issues that may arise with IOT:

supplier financial stability, dependency on subcontractors, long-term viability, and business continuity arrangements

Cyber Security, specifically device security, firmware management, vulnerability management; penetration testing, incident response

Pilot testing: Consider attaching success criteria to be met before scaling.

Then evaluate the bids and determine the winning bid.

### **TASK: Bid Evaluation**

Treat data quality, interoperability, analytics, workflow and exit capability as higher-value criteria than sensor brand or one connectivity method.

Use scenario demonstrations covering alert-to-case workflow, portfolio analysis, data export and supplier migration.

A possible starting ratio is 60–70% quality and 30–40% price, this is subject to procurement advice and affordability.

Within quality, score outcomes, implementation, engagement, architecture, data/analytics, security and future-proofing separately. Overweighting hardware compliance may lock you into a device-led solution; overweighting price may weaken future analytics and adoption.

Futureproofing should be a scored, evidenced capability rather than a generic contractual statement.

Note that the evaluation model will materially shape the solution. The strategic question is whether the enduring asset is the sensor estate or the data, analytics and operational insight.

## **Social Value**

Gain some social value through the procurement. This might reflect the supplier's capabilities, for example Tunstall installed Wi-Fi for residents within an apartment block free of charge.

A key opportunity of any investment in IoT and connected technologies should be to deliver wider social value alongside improved housing outcomes. Housing providers should view every procurement and deployment as an opportunity to support digital inclusion, resident wellbeing, skills development, local employment, affordability and stronger communities. Social value commitments should be directly linked to the needs of residents and communities, helping to ensure that technology investment

delivers meaningful and lasting benefits rather than simply meeting procurement requirements.

Housing providers are encouraged to work with suppliers to identify relevant and measurable social value opportunities, while GMCA can provide guidance, support and examples of best practice to help organisations maximise the impact of these activities and secure the greatest possible value for residents and communities.

**When engaging suppliers, ask not only how their solution will improve homes, but how it will improve lives, communities and opportunities for residents.**



## **PROCURE: SUMMARY**

Completing this section will result in a procured solution.

This does not however complete the work as integration, monitoring and further plans and phasing all continue.

The next section rounds out the business case planning.



# POSTSCRIPT

This section covers:

- Integration with workflow
- Monitoring and Evaluation
- Emerging technology
- Lessons Learned and pitfalls to avoid
- Checklist of actions

## **Integration with workflow**

The work starts when the deployment is complete. From finetuning the dashboard to defining procedures around alerts there is a need for integration with your activities.

This is not about adding a digital layer of cost but transforming activities to make them better, more efficient, quicker and cheaper. This will also lay a foundation for AI.

### **TASK: Realising the benefit – transforming workflow**

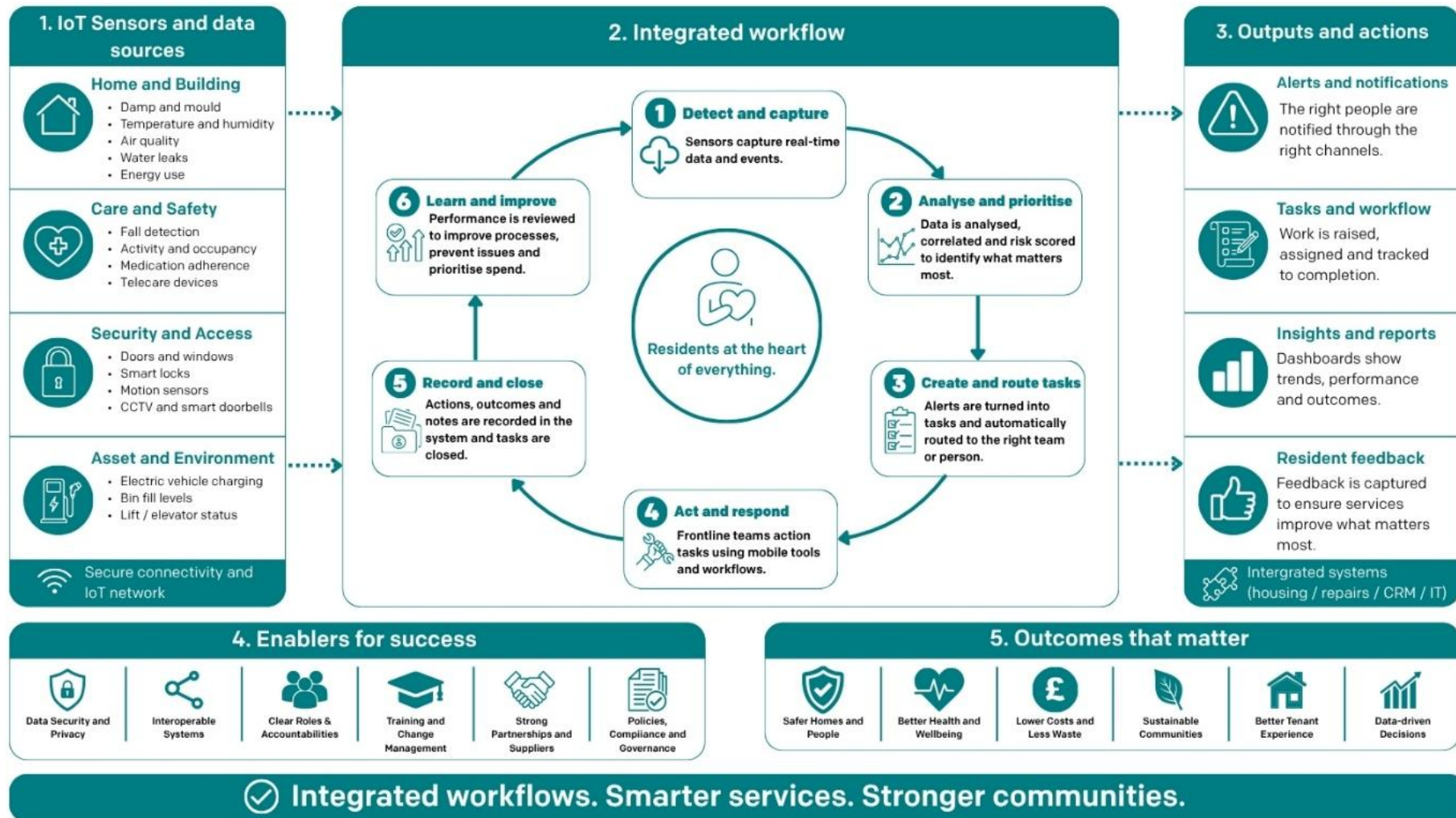
Provide detailed guidance on how the IoT is to be used.

This should cover roles and responsibilities, with detail, for example on the format of reports to be generated, their frequency and who they should be sent to.

The extensive privacy and data protection issues considered earlier should be included in the guidance.

# Integration with Workflow

Turning IoT insights into the right action, by the right people, at the right time.



## Monitoring and Evaluation

This is central to the work, assessing the effectiveness of the deployment.

### **TASK: Monitoring and Evaluation**

Draw up a monitoring and evaluation plan.

This should cover the key metrics to be measured throughout delivery, and any additional data gathering, such as a survey of users.

An evaluation should be planned for, and the plan state when and how and by whom this should be carried out.



### Technology trends

The rise of the super-sensor, often AI powered, which can generate more sophisticated data and analysis, is fast approaching. In other tech, drones can give a thermal image of housing in winter, potentially showing significant heat loss (indicative of poor insulation or building defects) or very low heat loss (indicative of void or need for welfare check).

AI will increase the value of existing sensor data by identifying combinations and trends that may not be obvious from a single reading. Examples include predicting component failure, identifying homes moving towards damp or heat risk, or detecting a significant change in a resident's normal routine. These tools should support professional judgement, not replace it, and any automated recommendation or action will require clear oversight, testing and accountability.

The direction of travel is from devices that report individual readings towards connected systems that interpret patterns, predict risk and support action. More processing will take place within sensors or gateways, rather than sending all raw data to the cloud. This can allow faster alerts, reduce connectivity costs and limit the amount of personal data transferred.

Digital twins may also become more practical for housing. By combining information about a property, its systems and live sensor readings, a digital model could be used to test interventions, plan maintenance and understand performance across an estate. The immediate value is likely to be in bringing existing data together, rather than creating a highly detailed model of every home.

Technology is also becoming more interoperable, with devices, connectivity and platforms increasingly expected to exchange data through open standards and interfaces. Housing providers should avoid designing around one supplier's current product. Procurement should instead protect access to data, support the addition or replacement of devices and allow connectivity or analytics services to change over time.

### **TASK: Review emerging technology**

Review developments at least annually against your objectives and existing estate. Identify where a new capability strengthens an agreed use case, but do not adopt technology solely because it is new. Check the evidence, privacy implications, compatibility, whole-life cost and the operational change required to use it effectively.



## **Avoiding pitfalls / Maximising benefit.**

The pilots identified a number of helpful pointers for any housing provider embarking on an IoT based transformation.

Combining across the pilots the key lessons were:

- Treat it as business change, not just kit installation. The value of the workstream depends on landlords being able to use the dashboard and follow up alerts. Handover packs, credentials, training and post-installation support need to be planned as delivery items, not afterthoughts.
- Sensors alone do not create value. Landlords need named owners for all data, clarity on dashboard access, triage processes, escalation routes and how data will be used to change day-to-day decision-making.
- Active participation from all parties involved is essential. Open communication and collaborative problem-solving create a strong foundation of trust among stakeholders. Regular project meetings are needed, as often as every week with the main supplier.
- At the outset of the pilot some staff roles and expectations were not fully clear, which made it hard for teams to balance the new project alongside day-to-day duties. The lesson is to establish clear internal roles/responsibilities and secure management buy-in early so that the organisational culture is ready to embrace the new ways of working.
- Allow realistic timelines and to communicate roles, plans, and updates clearly from day one to mitigate the barriers that will inevitably surface.
- For engagement with tenants, clear, simple communication and personal contact were essential. Plain-English letters built early trust, and coffee mornings/drop-ins let residents see the equipment and ask questions. One-to-one visits in dispersed homes helped tailor installations and encouraged voluntary take-up. Installers stayed until residents felt confident and left easy user guides. Having a single point of contact made support straightforward. Overall, meaningful, face-to-face engagement drove resident confidence, higher participation, and smoother implementation.

- Plan privacy and consent explicitly. Make data gathering, storage, access and disposal all privacy respectful from the outset.
- There are currently overly long management chains – manufacturer, distributor, supplier, contractor, housing body, dashboard integrator, connectivity supplier (and possible wider building works). This needs to be successfully bundled by a single supplier to eliminate issues around responsibility.
- Connectivity is central to delivery and needs consideration to be reliable, resilient, affordable and serve all appropriate users including staff.
- Some benefits – e.g. reduced maintenance – were immediate, ongoing and generating cash savings to the housing provider from the outset, with a high rate of return. Other benefits are likely to be incident driven and infrequent, may occur early or later, typically though these have a very high benefit. Importantly these benefits are typically captured by others, so that business cases need to be holistic, recognising, say, care and NHS savings.
- Installation has a significant upfront capital cost – as care is taken to make the devices resilient (in respect of both electricity and connectivity) and tamper proof. One installation required health and safety modifications to an attic space before work could commence. These costs need to be anticipated.
- Dashboard and other information / alerts need to be integrated into action, and workflow, to be of value
- Start baseline data capture early – collecting as much information as possible across all indicators

Above all see it as managing a transition, so take your time, be careful of being tied into long contracts but do work with a trusted technology partner. Always work from your own objectives and make sure that the technology is helping you change, to be more effective and efficient, rather than you changing to fit the technology.

# Checklist

Use this quick reference checklist to track your progress.

## PREPARE

| No. | Checklist item                                                                                                                    |
|-----|-----------------------------------------------------------------------------------------------------------------------------------|
| 01  | Organisational Context                                                                                                            |
| 02  | Objectives                                                                                                                        |
| 03  | Technology Audit                                                                                                                  |
| 04  | Strategic Plan for 5 years                                                                                                        |
| 05  | Priorities - taking account of housing areas, forms and condition, legislation and regulatory duties, staffing and cost pressures |
| 06  | Scope - identification of initial use cases                                                                                       |
| 07  | Theory of Change                                                                                                                  |

## PLAN

| No. | Checklist item                                       |
|-----|------------------------------------------------------|
| 08  | Connectivity Plan - data use and technology choices  |
| 09  | Cost model and Budget                                |
| 10  | Benefits Realisation table - with key metrics / KPIs |
| 11  | Engagement Plan - tenants and staff                  |

## **PROCURE**

| <b>No.</b> | <b>Checklist item</b>                                                                                                                            |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>12</b>  | ITT High Level (finetuning in light of ongoing engagement including with suppliers)                                                              |
| <b>13</b>  | Procurement - framework choice, supplier identification / assessment / appointment as a technology partner, SLAs, ownership and responsibilities |
| <b>14</b>  | ITT detailed and issued                                                                                                                          |

## **INTEGRATE AND REVIEW**

| <b>No.</b> | <b>Checklist item</b>                                                   |
|------------|-------------------------------------------------------------------------|
| <b>15</b>  | Workflow adaptation                                                     |
| <b>16</b>  | Monitoring - technology, work productivity, engagement all stakeholders |