WP1-D3: Barriers to Improving the Smartness of Buildings and Associated Barriers to the Deployment of Smart Technologies and Services

SMARTLAB | Work Package 1, Task 1.3

SMART LAB

Deliverable version	v.04
Dissemination level	Public
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Document Information

Project Acronym	SMARTLAB
Project Title	The Smart Building Lab
Principal Investigator	Professor Stephen Kinsella, University of Limerick
Project Duration	12 September 2022 – 11 September 2024
Deliverable Number	WP1-D3: Barriers to Improving the Smartness of Buildings and Associated Barriers to the Deployment of Smart Technologies
Dissemination Level	PU-Public
License	CC-BY4.0
Status	Completed
Due Date	27-03-2023
Work Package	WP1 – Stakeholder Engagement and Living Lab Processes
Lead Beneficiary	UL
Contributing Beneficiaries	CCI, IESRD, LCCC, TCL

Revision History

Date	Version	Author	Substantive changes made
24-02-2023	v.01	As above	First version of document drafted
27-02-2023	v.02	As above	Circulated for QA by SMARTLAB Team
10-03-2023	v.03	As above	QA Revisions
24-03-2023	v.04	As above	Final revision prior to submission

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List of Acronyms

CCI	Carrig Conservation International
EPC	Energy Performance Certificate
EPBD	European Energy Performance of Buildings Directive
EU	European Union
IESRD	Integrated Environmental Solutions Research & Development
LCCC	Limerick City and County Council
O	Objective
SEAI	Sustainable Energy Authority of Ireland
SMARTLAB	Smart Building Living Lab
SRI	Smart Readiness Indicator
TCL	The Convex Lens
UL	University of Limerick
WP	Work Package

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Executive Summary

SMARTLAB is exploring the lived reality of Irish building users and their buildings, in order to investigate the potential of enhanced smart-readiness in buildings and the market for the deployment of smart technologies and services. One of the core objectives of the project is to explore the possible application of the European Union (EU) Smart Readiness Indicator (SRI) in Ireland, exploring the opportunities that could arise from the adoption of this Framework. Measures such as the SRI are being put in place by the EU to promote smart building investment because smart buildings can enable energy efficiency and enhance comfort for occupants. As part of the preparation for implementation of the SRI, the EU Commission has implemented research projects to explore its potential, and part of that research has involved identifying common barriers associated with improving the smartness of buildings. Accordingly, the SMARTLAB project has made a similar exploration in the Limerick context, investigating three particular types of barriers, their occurrence and frequency in the project study area in Limerick city. These include:

- Technological barriers: connectivity, upgrading, obsolesce, and e-waste generation.
- Financial barriers: costs, expense of deployment and maintenance, lack of benefits for investors, and lack of access to micro-loans.
- Social barriers: lack of awareness, absence of a sense of responsibility, privacy concerns, inability to address smart technologies, and dependency.

This is a formative piece of research, taking place early in the project implementation timeline and before our participant panel is established. The information has been gathered from diverse stakeholders in the SMARTLAB ecosystem as outlined in **WP1-D1: Plan for Stakeholders Engagement and SMART Journeys Including SMARTLAB Calendar of Events,** bringing together viewpoints from community, academia, government, and business. Its core finding is a list of barriers across the three pillars, including poor network coverage, lack of return on investment, and lack of awareness of the potential of smart technologies and services. These barriers are analysed in light of EU research into the topic. The Deliverable finds that there are commonalities between barriers reported and those identified by EU research, but that there are also barriers identified which seem specific to the Irish/Limerick context. This topic will be explored further with project participants and will feed directly into future Deliverables including **WP5-D3 Final report on impacts to the buildings, the occupants, the smart energy system, and the future for smart building technology** (M24).

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1 Introduction

SMARTLAB is exploring the lived reality of Irish building users and their buildings, in order to investigate the potential of enhanced smart-readiness in buildings and the potential market for the deployment of smart technologies and services. One of the core objectives of the project is to explore the possible application of the European Union (EU) Smart Readiness Indicator (SRI) in Ireland, exploring the opportunities that could arise from the adoption of this Framework. Measures such as the SRI are being put in place to promote smart building investment because smart buildings can enhance energy efficiency and comfort for occupants. As part of the preparation for implementation of the SRI, the EU Commission has implemented research projects to explore its potential, and part of that research has involved identifying common barriers associated with improving the smartness of buildings. Accordingly, the SMARTLAB project has made a similar exploration in the Limerick context, investigating three particular types of barriers – technological, financial, and social – and their occurrence and frequency in the project study area in Limerick city.

This is a formative piece of research, taking place early in the project implementation timeline and before our participant panel is established. The information has been gathered from diverse stakeholders in the SMARTLAB ecosystem as outlined in **WP1-D1: Plan for Stakeholders Engagement and SMART Journeys Including SMARTLAB Calendar of Events,** bringing together viewpoints from community, academia, government, and business. Its core finding is a list of barriers across the three pillars, including poor network coverage, lack of return on investment, and lack of awareness of the potential of smart technologies and services. These barriers are analysed in light of EU research into the topic. The Deliverable finds that there are commonalities between barriers reported and those identified by EU research, but that there are also barriers identified which seem specific to the Irish/Limerick context. This topic will be explored further with project participants and will feed directly into future Deliverables including **WP5-D3 Final report on impacts to the buildings, the occupants, the smart energy system, and the future for smart building technology** (M24).

At application stage, a number of barriers were identified by project partners. Two highlighted in the project bid documents were (i) the architecture of networks and (ii) the inequality of access to internet connectivity (i.e., the digital divide). This proved prescient, as both these barriers were identified by respondents to this research.

The objective (WP1-O3) of this deliverable is to provide an initial survey of current barriers to deployment of smart technologies and services in buildings in Ireland, and in particular in the Limerick context. Information on barriers has been gathered via online survey among targeted stakeholders, and this methodology is discussed in Section 2. Section 3 outlines the general findings by category, and Section 4 analyses those findings. Conclusions and recommendations are presented in Section 5.

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2 Methods

In order to gather the insights and information needed to develop new knowledge around the current understanding of barriers facing those who wish to make their buildings more smart-ready in Ireland, the project team are using a Living Lab approach. This has been outlined and mapped in SMARTLAB Deliverable **WP1-D1: Plan for Stakeholders Engagement and SMART Journeys Including SMARTLAB Calendar of Events.** Accordingly, data was collected through the following stages (**Error! Reference source not found.**):
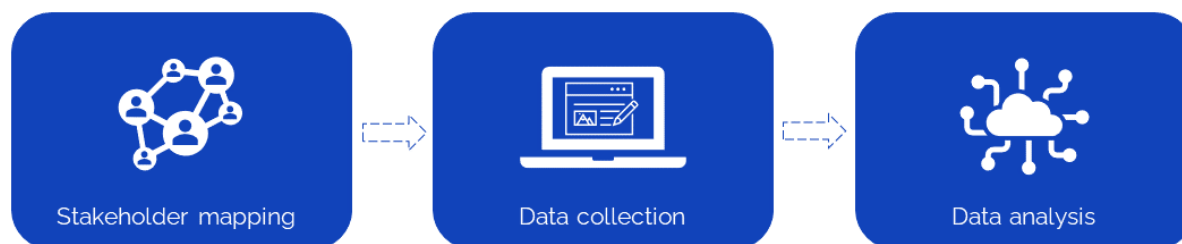

Figure 1. Stages of data collection.

(i)   Stakeholder mapping: A selection of prospective participants were identified from key stakeholders within the SMARTLAB ecosystem as outlined in WP1-D1. In order to be considered, participants had to represent at least one of the sectors that are part of the SMARTLAB ecosystem (academia, business, government, and civil society). Project partners .and civil society stakeholders were invited to contribute.

(ii)   Data collection: this stage was carried out through a Qualtrics survey that was shared with stakeholders (see Annex A). The survey was tightly focused, and collected only relevant data on participant sectors, and the different barriers they identified.

(iii)   Data analysis: once the surveys were complete, the SMARTLAB team categorised the different barriers into technical, financial, and social categories, drawing on the work of the SmartBuilt4EU project (see Annex 2). Then a content analysis was conducted with NVivo software, to identify patterns in responses and analyse context.

The results of this deliverable are presented and discussed in the following sections (3 and 4) outlining the data that was gathered and producing a list of potential barriers organized by category (technical, financial, and social).

3 Findings

As a result of this study, a number of factors have been identified as possible barriers to developing the smart readiness of Irish buildings, categorised in relation to technical, financial, and social barriers. This information was gathered through contributions from seven participants, made up of smart technology specialists and representatives from SMARTLAB ecosystem sectors including academia, business, government, and society. In total, seven respondents were asked a series of open-ended questions which required text input and reflection, and so word-cloud analysis was used to examine and group responses. Word-cloud analysis is useful for identifying commonalities across responses and for visually representing the comparative incidence of different terms within responses.

3.1 Technological barriers

The words that appeared most often in participant contributions were *building, dependent, energy, services* and others shown in Figure 2 below.

Figure 2. Most mentioned words related to technical barriers.

When using the word "building," the most prominent word in the above word-cloud, respondents were primarily discussing antiquated systems that are unfit for smart retrofit, even in newer buildings. In addition, smart-readiness of buildings also *depends* on the *materials* that are built and relies on the available *connectivity services*, which is a limitation based on poor network coverage in the building's location. In terms of the *devices* that can enhance smartness in buildings, an issue was identified in a number of responses that pointed to problems being in control of devices, as well as some ethical concerns regarding e-waste generation after devices are used and discarded.

Regarding the technical barriers related to building materials and conditions, one participant mentioned:

> *"Building materials may also make it more difficult to upgrade to smart buildings i.e., it may make it more difficult to automate (e.g., communal heating) or for radio waves to penetrate building environments" - Participant 4.*

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This concern has been analysed in **WP3-D1: Review of the SRI and other appropriate systems for measuring the 'smartness' of a building and requirements for data monitoring and DIY toolkits as a result**, which observes that building owners of older building stock will need particular consideration when adapting the new SRI framework so that SRI technical solutions can be appropriately applied.

3.2 Financial barriers

A number of phrases predominate within responses related to identifying financial barriers to smart readiness (e.g., cost, and smart) as seen in Figure 3. The word *cost* in responses often refers to either the cost of particular smart technologies, which can be expensive, or to the cost of deployment and services that are required to keep those smart technologies working. The word *cost* was also connected to a concern about the tangible benefits of acquiring smart technologies, indicating that education will be a key component of any smart-readiness development plan. The word *smart* is mentioned in connection with a concern around the limited willingness of investors to install smart tech, as well as the availability of smart devices for individual consumers, indicating that the smart sensor supply chain is still primarily focused on larger scale business.

Figure 3. Most mentioned words for financial barriers.

As mentioned above, smart technology costs may be a significant barrier according to participants. As one participant wrote:

> *"The cost of applying meaningful innovative technologies (technology that can make a significant impact on the operational expenses of buildings) is often too high, and the benefits aren't always obvious." – Participant 1.*

Another commented on the lack of financial return on investment in installing smart technology:

> *"The majority of buildings are investor owned and the willingness to install smart tech is limited - they do not see a financial benefit in installing these devices." – Participant 2.*

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3.3 Social barriers

Responses on social and behavioural barriers identified by respondents were mostly associated with a *lack of awareness* about what advantages smart technologies can provide to benefit buildings regardless of building type (Figure 4). According to the responses, this lack of awareness may be due to the lack of time or resources to learn more. It is clear that the demand for smart solutions is being suppressed by this lack of public awareness.

Figure 4.Most mentioned words for social barriers.

The most highlighted social barrier is linked to the lack of awareness about what smart technologies are and how they can benefit buildings occupants and owners.

> *"Certainly, people's awareness affects the installation of energy-saving new technologies. It is necessary to disseminate information about the use of new technologies and conduct information sessions to convey information to people on the use of new technologies." – Participant 7*

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4 Identified barriers and the SMARTLAB research agenda

This section considers the findings of the survey as outlined in Section 3 and provides a brief analysis in light of existing evidence. It sets out the research agenda of the SMARTLAB project which will be informed by the results of this Deliverable.

4.1 SMARTLAB technological barriers

The following Table 1 shows a summary of the technological barriers identified.

Table 1. SMARTLAB technological barriers.

Technological barriers	
	• Poor connectivity due to geographical location and building materials. • Obsolete building systems that make smart upgrading difficult. • Risk of ending up with obsolete devices over time. • Ethical concerns regarding e-waste generation

The technological barriers observed by this study's respondents are fundamentally connected to the challenge of transforming both existing building infrastructure and current data communications networks in Ireland. The work involved in making Irish buildings smarter is very clearly set out in these responses. Furthermore, analysis on this topic by SMARTLAB partners has already flagged a number of the concerns highlighted by participants. The barriers identified in this section are directly related to those found in **WP2-D1: Review of Available LPWAN networks,** which discusses the different kinds of wide area networks that are most feasible for the SMARTLAB project:

From a risk perspective one of the largest risks facing the data collection function within SMARTLAB is the prevalence of 'black spots' across buildings. This would lead to a loss of visibility of our devices and the data they are streaming. At scale, black spots would ultimately negate the projects viability. Therefore, a capacity to mitigate and resolve blackspots is of primary importance to the success of the project. It is also one of the primary mitigations that would need to be put in place nationally for any SRI deployment (p. 14).
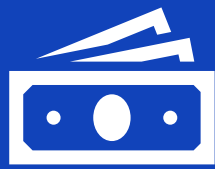
The risk that devices could become obsolete is also connected to other technological challenges identified by SMARTLAB partners. In **WP3-D1 Review of the SRI**, an assessment of the value of installing smart heating systems identified similar issues:

Smart heating services are costly and depend on the ability of the owners building to adapt to new systems i.e., whether the building has a heating system that is ready for adaptation of smart services, or the ability of the owner to invest in a new system. Furthermore, these smart systems are not DIY friendly, and will often require installation from an accredited professional (p. 15).

4.2 SMARTLAB financial barriers.

Table 2 shows the financial barriers that were identified by respondents.

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Table 2. SMARTLAB financial barriers.

Financial barriers
• Costs of obtaining appropriate smart technologies. • Expense of deployment and maintenance of smart technologies. • Unclear benefit for investors to install smart technologies. • Risky investment for business. • Lack of access to micro-loans to invest in smart technologies

The financial concerns flagged by respondents as barriers can be segmented into three sub-categories: the cost of acquiring smart technologies, the lack of funding or loans to support access to smart technologies, and the lack of investment pathways for the smart technology market. A suite of responses will be required to address these interlinked barriers, and the SMARTLAB project will work to develop policy recommendations which can support such responses. It is anticipated that the cost of smart technologies will continue to drop, and SMARTLAB will allow participants to circumvent this issue by providing sensors free of charge. The investment barriers highlighted are a clear indication that a study of potential markets for smart services will be important within the SMARTLAB timeline, as reflected in Objective **WP4-O5 Demonstrate the potential for non-energy services as a result of smarter buildings**. The opportunity for a micro-loan or funding scheme for smart technology installation may be of interest to SEAI, potentially involving an additional focus on smart technology to already existing retrofit supports through their various funding schemes. The policy development aspect of the SMARTLAB project's work will carry this analysis forward through its Policy Fora, beginning in M12 (**WP1-D1: Plan for Stakeholders Engagement and SMART Journeys Including SMARTLAB Calendar of Events)**.

4.3 SMARTLAB social barriers

Lastly, the social barriers that were mentioned by respondents are listed in the Table 3.

Table 3. SMARTLAB social barriers.

Social barriers
• Lack of awareness of smart technology and its potential. • Absence of a sense of responsibility to act. • Privacy concerns. • Inability to address concerns around smart services. • Dependency on services that are not in the user's control.

The barriers identified in the "social" category of the survey relate to current behaviour, attitudes and to the perceptions of such behaviour held by survey respondents. There was a clear preponderance of evidence that people lack an awareness of the potential of smart technology, which we hope to address directly on the ground in Limerick. By using a Living Lab approach and working with project participants to track and measure the impact of installed smart technologies in the buildings they use, we will be able to identify the changes among a significant study group who become familiar with smart technology through personal experience.

The privacy concerns flagged in the responses will be directly addressed in the later stages of SMARTLAB when the project partners will explore frameworks for data ethics

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and data sharing among participants (T6.1). Associated concerns around the lack of individual control of smart technologies are reflective of wider problems in current technology markets and services models which are built on profiting from data harvesting and high levels of competition for user data from a concentrated number of tech companies. A focus within SMARTLAB on the potential of DIY toolkits and co-design approaches to policy development will help to mitigate against these concerns. These approaches are identified in Objectives **WP6-O2: Policy recommendations to enable wider deployment of smart systems/programmes in Ireland,** and **WP6-O3: Policy recommendations on improving city-scale infrastructure to enable uptake of smart technologies and services across Ireland.**

Finally, it is notable that many of the barriers reported in this Limerick study can be mapped to those identified by the SmartBuilt4EU project, an EU-level project to develop a Strategic Research Agenda to support the further uptake of smart buildings in Europe (see appendix B for full index of SmartBuilt4EU barriers). For example, the SmartBuilt4EU project also identified a technical barrier of poor connectivity due to building materials and/or obsolete building systems as a link to weak adaptability of buildings. Their study highlights the financial costs, deployment, and maintenance of smart technologies as economic concerns for end-users, occupants, and private investors and owners. Social barriers around data privacy and lack of control over smart technology were also identified by the SmartBuilt4EU project. They also had a fourth category of "value chain" barriers which related to (i) concerns around lock-in effects around the future of smart solutions, and (ii) the challenges of implementing co-design processes with end users. In our study, the first value chain barrier, which refers to the need for ongoing updates and upgrades, is mappable onto a number of barriers identified within our technical category, particularly in relation to local infrastructure and the smart technologies. Interestingly, the second value chain concern, around the challenges of implementing co-design processes, was not flagged by our stakeholders. This may be explained by the SMARTLAB living lab approach, which is designed to address this concern and which was made known to interviewees of this study as part of their participation. It should also be noted that our study identified some barriers not captured in the SmartBuilt4EU research, such as the risk of ending up with obsolete devices and e-waste generation (technical barrier), smart technology as a risky investment for business, the absence of microloans (financial barrier), and a lack of awareness around smart technologies and their benefits (social barrier). This indicates that there are valuable localised insights which should be further explored by the SMARTLAB project, and which may provide useful context to any national approach to the adoption of the SRI.

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5 Conclusions

SMARTLAB project partners identified technical, financial, and social barriers to improving the smart-readiness of buildings in Limerick. In general, the barriers identified are similar to those identified in other EU research, with particular barriers such as ending up with obsolete devices, e-waste generation, risky investment for business, absence of microloans, and lack of awareness around smart technologies and their benefits.

The barriers identified in this deliverable will be considered for planning future SMARTLAB activities and proposing policy recommendations to help to mitigate those barriers in the Irish context, and to achieve the **WP6-O2: Policy recommendations to enable wider deployment of smart systems/programmes in Ireland**, and **WP6-O3: Policy recommendations on improving city-scale infrastructure to enable uptake of smart technologies and services across Ireland**. As the SMARTLAB project focuses on deploying smart technologies and identifying the opportunities that could arise from the adoption of the Smart Readiness Indicator, the implementation of the project will give the project team an opportunity to work with participants gaining direct experience of increased building smartness. It is anticipated that the use of a Living Lab approach to work together with participants using smart technology will provide a rich insight into the potential for smart services and technologies in Irish and EU contexts.

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Annex A: Barriers survey

SMARTLAB is a research project exploring the potential of smart technology to contribute to the energy transition in Irish building stock. As part of this work, we are inviting up to 100 building occupants and owners in Limerick city to install sensors in their buildings. These devices will help to collect energy usage data as well as indoor environmental data such as humidity, temperature, and CO_2. The data will be used to evaluate the smartness of building stock in Limerick and based on that data and participant experiences with the sensors, we will develop policy recommendations for decision-makers at local and national levels.

A core component of the project is an exploration of the barriers to the transformation of our building stock, particularly the transition towards smarter, more energy-efficient buildings. We know that these barriers can be technical, financial, and behavioural. Technical barriers might include the absence of infrastructure for sensor installation or the "broadband gap;" while financial barriers include the cost of installing and maintaining smart devices. We know also that there are challenges for people in using smart devices and in interpreting their own data.

But we are eager to learn more about the reality of challenges facing Limerick building owners and occupants in efforts to make their buildings smarter and more energy efficient. We'd be very grateful if you would be willing to share your insights with us using the short questionnaire below. We'd also be very happy to follow up with you and have a conversation if that would suit.

1. Your name
2. Your email
3. What sector do you represent?
   - Academia
   - Business
   - Government
   - Society
   - Other:
4. In your experience, are there particular TECHNICAL barriers facing Limerick people who wish to make their buildings smarter? e.g., building infrastructure, wireless connectivity. (Response Required)
5. In your experience, are there particular FINANCIAL barriers facing Limerick people who wish to make their buildings smarter? e.g., maintenance costs, or cost of smart devices. (Response Required)
6. In your experience, are there particular PERSONAL OR BEHAVIOURAL barriers facing Limerick people who wish to make their buildings smarter? e.g., discomfort with technology, lack of awareness of smart tech potential. (Response Required)
7. Do you have any other insights on this topic that you would like to share? Please feel free to add them below.
8. Would you be interested in discussing this issue further with the project team?
   - Yes, I'd be happy to discuss this issue further.
   - No, my answers above cover what I have to say.
9. Please click to confirm you agree to us storing your data in accordance with our Research Privacy Notice [SMARTLAB Research Privacy Notice]
   - I agree.
   - I do not agree.

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Thank you very much for your contributions!

If you have any questions about this survey or would like to know more about the project, please contact the SMARTLAB Postdoctoral Researcher -
Miguel.TrejoRangel@ul.ie

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Appendix B. SmartBuilt4EU

The Table 4 below, elaborated by the SmartBuil4EU project, synthesises the main barriers identified to the increased acceptance and adoption of smart building solutions by end users.

Table 4. Overview of main SmartBuilt4Eu barriers (Source: SmartBuilt4EU, 2021, p. 4).

BARRIERS	
TECHNICAL	Weak adaptability of buildings to different end-users`profiles and to their different life phases in the building (e.g. moving in, getting used to the equipment...)
ECONOMIC	Economic concerns for end-user, occupant, private investor and owner: affordability/short term, compared to benefits (medium to long-term)
SOCIAL	Fears related to lack of data privacy and lack of control on smart solutions
SOCIAL	Unknown, different perceptions of comfort for different end-users wrt smart building use
VALUE CHAIN	Lock-in effect: how the smart solutions will evolve in the future, requirements for updates, upgrades
VALUE CHAIN	Difficulties to implemented successful co-design processes with end-users in order to develop more user-centered products

Top barriers according to the Task Force

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