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### Report on requirements for the re-design of interfaces

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## EXECUTIVE SUMMARY

Built on and inspired by existing knowledge, we have conceptualised a model in which two different user types (occupants and facility managers) are positioned to the building and its climate and regulatory systems. Thus, a feedback loop and interaction take place among all actors involved. The users, as well as the building itself, have a level of agency and control over the building climate and provide feedback to each other through their actions and behaviour. Following the model, several research questions were defined. These deliverable answers one of them: What are the requirements for an interface that supports control and feedback for facility managers and building dwellers?

We have conducted user research over several months to define requirements for the interfaces that will support the interaction between users and the building. Interviews have yielded user data that have enabled us to define an early set of user need statements and two user personas. A workshop during the consortium meeting on 17 November 2022 was held to inform and gather feedback on these results.

The user need statements and personas defined in this project phase will serve as a basis for design cycles in which we will design and test interfaces within the B4Blabs. Results from this iterative approach will further finetune and shape these requirements as we go. Therefore, the requirements presented in this deliverable should be regarded as a 'living document' rather than a 'set in stone' record.



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# 1 METHOD

In this chapter, we present our approach to exploring the needs of the different types of users and their context. Starting with an exploratory review which led to a conceptual framework, we conducted several interviews to define the first set of user needs and requirements.

## 1.1 Exploratory phase & conceptual framing

In this project's first phase, we set out to familiarise ourselves with the project context. As part of the exploration, we approached an external building management systems expert from our extended network. We invited him to tell us about his work's context and challenges. In an online meeting, we discussed several areas of 'tension', like conflicting user preferences, individual degrees of freedom, peer pressure and the ethics of behaviour change. During this period, we also gathered insights from our everyday lives regarding climate interfaces in work environments through notes and photographs of things that caught our attention.

A preliminary literature review on the subject primed us for a discussion about our project's relevant stakeholders and scope and a grounded definition of the most important terms and challenges involved. The discussion and conceptual model defined six design/research questions. The results were conceptualised in a visual model (see 2.1 Conceptual framing).

- 1) **What are the requirements for an interface that supports control and feedback between facility managers and dwellers?**
- 2) What is the (desired) behaviour of dwellers, facility managers and the bms? What are relevant degrees of freedom and control?
- 3) How does transparency of such an interface influence experience or behaviour?
- 4) How can feedback to dwellers and facility managers be presented in a user-accessible way?
- 5) How can different modalities of feedback be used?
- 6) What is the information needs of facility managers, dwellers and the building management system?

*The first question (bold) will be covered by this deliverable, while the others remain relevant for future work.*

## 1.2 User research

### 1.2.1 User interviews

We used the following months to find and conduct interviews with our target users: facility managers and *dwellers* (sometimes referred to as 'occupants') to gain insights into user needs and answer the research questions. The interviewees were recruited from our own work environment at the HAN University of Applied Sciences. The interviews were semi-structured in nature.

After a brief introduction of the project, the goal of the interview was explained. The interview was explained to gather low-hanging-fruit as to how people experience their everyday lives working in the building regarding climate and related behaviour. Interviewees were encouraged to share about their current day. The interviewer then asked how this differentiates from or is typical for other days. To focus the conversation further, a physical template of the conceptual model was used on the table. The interviewer would then paste, and position written post-it notes with excerpts from the conversation on the template. Afterwards, the notes were discussed with the interviewee to gain a shared understanding of what had been said while the interviewee was invited to change, add, or explain certain items.

## 1.2.2 Consortium workshop

We organized a workshop during the B4B consortium meeting on 17 November 2022. This workshop aimed to inform the project partners of our findings while gathering additional requirement insights from an expert-minded group of participants. During this 2-hour workshop, roleplay, and a fishbone diagram (Coccia, 2018) were used to quickly delve into the interaction between the user and the building/system.

### Introduction

After an quick debrief of task 3.4 and our work package with some inspiring examples featuring novel use and mismatches of window/blinds interfaces, we introduced the participants to our persona of a dweller.

### Actors & roleplay

From this story, we introduced several sample actors to work with. These actors, inspired by Actor-Network Theory (Latour, 2017), are (interface) elements that have a level of agency and/or provide user interaction, such as external automated blinds, a thermostat on the wall, or an air-conditioning unit mounted in the ceiling. We divided the actors among willing participants, setting them up for a role play exercise meant to discuss and relate the persona with. One of the workshop facilitators played the persona entering the room, while the participants would act on behalf of their designated actor.

### Fishbone

Inspired by the role play, we then defined a commonly agreed problem: the occupant is left in the dark on how to act/improve their climate comfort. From this, we used a fishbone diagram to facilitate a discussion revealing underlying symptoms and causes within 5 predefined categories for guidance.

### Recap & reflection

Lastly, we used the now completed fishbone diagram to define interface requirements. Finally, we presented our own defined user need statements to compare results and illicit feedback.

## 1.3 Personas, User Need Statements and Requirements

With the user research completed, we consolidated our insights into more practical tools suitable for the design process. Personas (Guo et al., 2011) are abstract representations of user (arche)types that remind you of whom you are designing for if backed by research data. But since they are always abstractions, they should never be fully relied on to make design decisions. As Pruitt and Grudin (2003) mention, “Personas used alone can aid design, but they can be more powerful if used to complement, not replace, a full range of quantitative and qualitative methods. They can amplify the effectiveness of other methods.”

Likewise, User Need Statements are another tool that can be used in the ideation phase of design. User Need Statements try to capture a perspective from the user with an actionable goal in mind. User Need statements define *the goal* rather than *how* it should be achieved, as this is dealt with during ideation (Gibbons, 2019).

Finally, based on all previous insights, we defined a set of requirements (see 3.1). Note that this is work that will evolve in future work.

## 1.4 Future work

Future work involves working with TNO in our work package to develop, distribute and organise cultural probes and co-creation workshops among participants in the B4B partner buildings. In contrast with the previously held interviews, this will yield bottom-up knowledge from users that is more latent and will complement and refine our preliminary set of requirements. From here on out, the preliminary requirements, user need statements, and the two personas form the starting point for designing interfaces in the coming months. However, we will continue learning about the users and their context through our iterative approach. This means we might change, substitute, or remove user needs.

## 2 RESULTS

This chapter collects the conducted research findings and forms the basis for the requirements presented in chapter 3 Conclusion.

### 2.1 Conceptual framing and context

Brains4Buildings as a project explores the opportunities that new technologies create for smarter, more efficient building management. The goal of work package 3.4 specifically is to create interfaces that support control and feedback between the building (management system) and its users. Since the facility managers and the resident or office workers could be considered building users, we call the latter group dwellers. This allows us to define and discuss the goals and needs of each user group more accurately. Dwellers routinely use the building for work, teaching, or other intents.

We think that interfaces that enable users to understand and control their environment and impact their comfort daily should be usable, useful, and accessible for all human and non-human actors that reside in the building's context.

We created the following model to illustrate the different actors and their relationships and levels of freedom and control between each other. While the model doesn't encapsulate the entire complex and dynamic context of building management, it helps us focus on specific relationships, actions and goals.

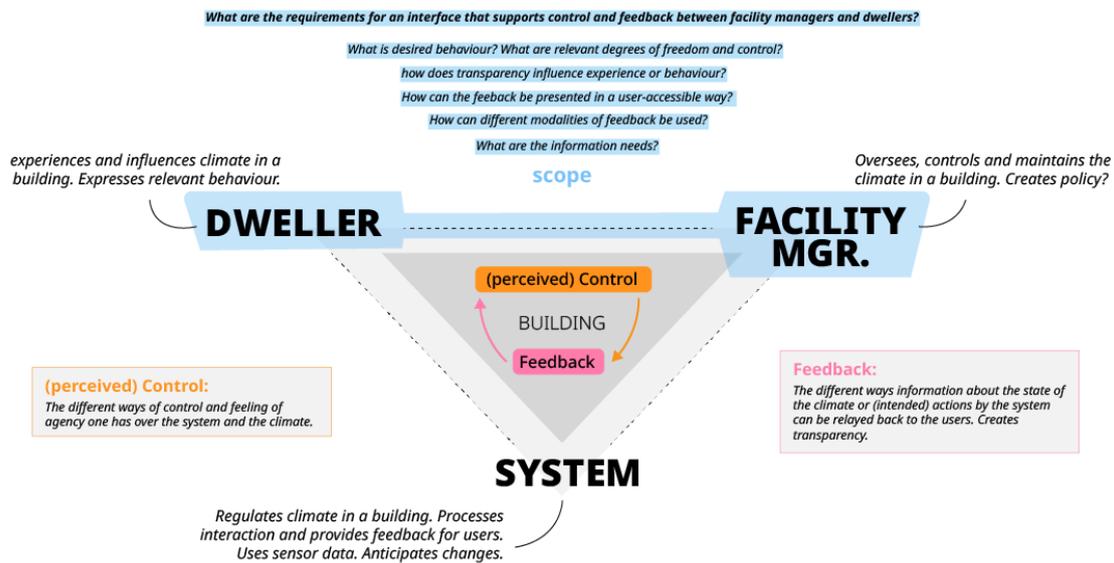


Figure 1 An early version of a stakeholder map showing the control/feedback loop and different relations between users and the system. Note that the term 'dweller' refers to the more commonly used term 'occupant'. However, at the time, we felt 'dweller' was a more appropriate term, as it was associated with a more personal relationship one might have with the building.

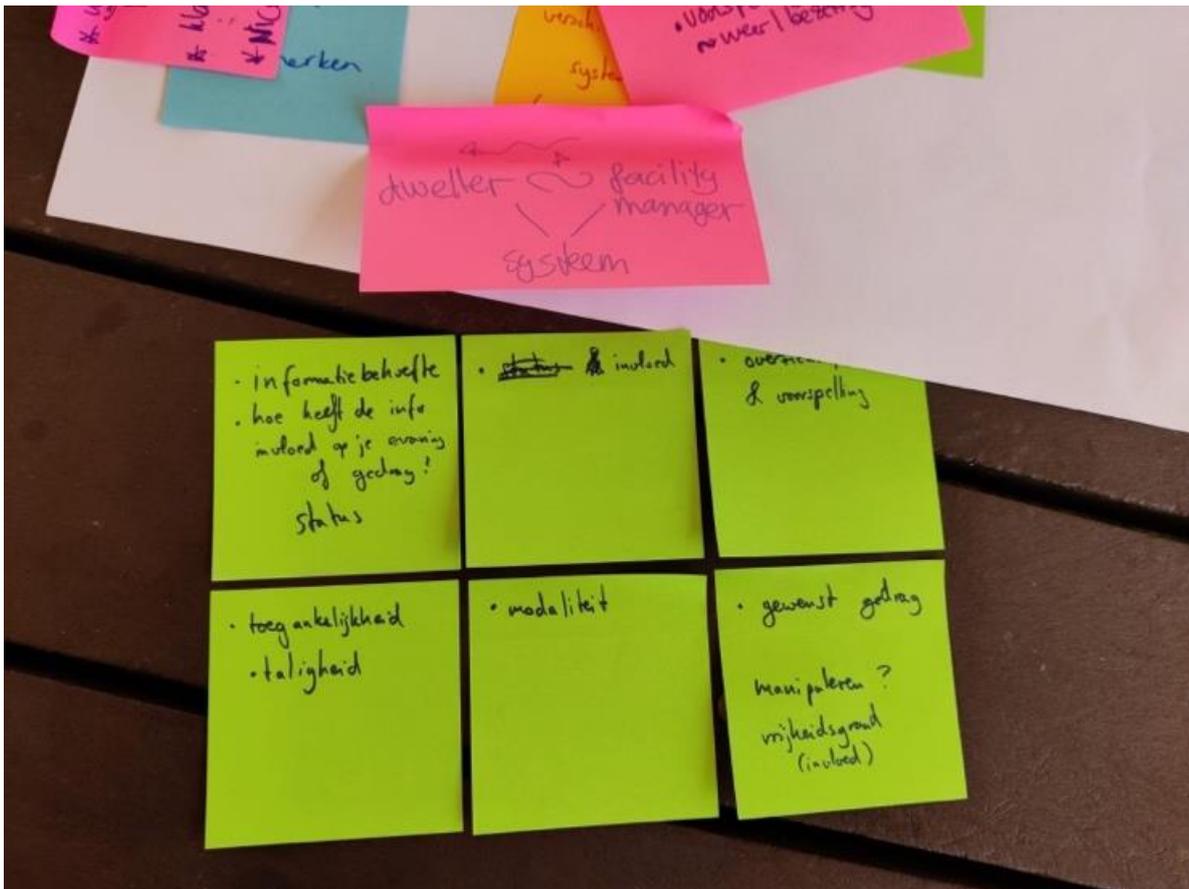


Figure 2 Brainstorm/associative mapping of relevant dimensions and users

## 2.2 Personas

The following personas reflect exploratory insights from interviews with different types of building users – in this case, a facility manager, and an office worker.

### 2.2.1 Persona Sam – office dweller in higher education

**Sam** is a researcher working at a higher education institute. For their work, they perform fieldwork (both on-site and off-campus), but a significant part of their work takes place at their desk, in front of a large screen. Here, they analyse results, write reports and plan future meetings.

Since the Covid crisis, they partly work from home but also value working on-campus to be near colleagues.

They have structured this with fixed work-from-home days and fixed work-at-location days. Sam has happily positioned themselves in a fixed office room and desk in the building, although there are plans to convert all workplaces into shared flex working spaces in the future. This is a development they somewhat dread because they highly value having control over their own working space. They have situated themselves in a comfortable spot next to the heating radiators and with a pleasant view outside. They decorated their immediate surroundings with several personal memorabilia and small plants.





Sam shares their office with several co-workers, who come and go at different moments during the week and day. This makes for a small-scale but dynamic work environment.

Sam is a self-proclaimed *'koukleum'*, someone who feels cold easily. This is also why they value their spot near the radiator. They have several instruments at their disposal to combat the cold. First, some radiators can be manually controlled. These are almost always set to max ("I never realized they had an in-between setting"). But when it is particularly cold, the heating/cooling unit mounted on the ceiling can be turned on, providing direct heat in copious amounts for the room.

Not all of Sam's co-workers share their desire for warmth. Temperature changes usually involve careful discussion and probing to find a common or middle ground. Sometimes, concessions involves letting the heat escape by windows and open doors, causing Sam to use additional scarves/blankets for comfort.

## 2.2.2 Persona Robin – building facility manager

**Robin** has several buildings of a higher education institute under their care. These are large buildings housing hundreds of students and faculty staff daily. Routine janitorial jobs like fixing a broken ceiling light or servicing a coffee machine do not fall under their duties. Instead, they have the project lead over a small team tasked with keeping the central systems and utilities running in all buildings. Among these systems, climate control (heating, air quality, external sunshades, among other things) plays an important part.

Robin has a no-nonsense attitude and is generally grounded – problems that occur during the day do not easily shake them. Their attention is split between making recommendations for the long-term future and keeping the everyday system running in the here and now.

They have several software tools to monitor what is happening in the different buildings under their care. These programs require different authentication and login protocols and are generally slow to access. However, this does not bother Robin much – they take these time-consuming, mundane tasks for granted as it has always been like that. Within each program, Robin feels well at home; they can navigate dazzling menus and navigating options concisely and with relative ease. To make their life easier, the program gives warnings when things are not working as intended. These things need to be 'fixed'.



For the longer term, they rely on usage reports to draft policies for the future. With these ideas, they report directly to the board of directors. This involves plans for disabling heating during vacations/downtimes. Or, for example, during the pandemic, suggestions for saving energy in essentially (but not altogether!) empty buildings. More recently, Robin proposed a plan to lower the radiators' temperature to follow the wishes of his superiors and society to conserve energy in times of scarcity.



Robin has much confidence in how they manage the buildings and the data at their disposal. They are not very empathetic of the impact of their decisions on the dwellers and users of the building; “sometimes”, Robin laughs, “I get a complaint about an office space being too cold – from a group of women upstairs.” Or when a CO2 meter states a threshold value has been reached, they say somewhat frustrated: “but that is not the system’s fault; that is doing fine! It is probably because there are too many people in that room.”

Robin has a clear preference for the more modern parts of the buildings that have more automated and regulated systems in place. The older buildings, which offer a lot more manual controls to students and staff, are of much lower priority to them. This is because Robin’s little control over these places can easily be overridden or undone by human actors opening a window, for example. The older buildings also make it more difficult for Robin to reach the energy and climate goals they set out to achieve. That’s why they feel these older buildings should be modernised and their systems centralised sooner rather than later.

## 2.3 User Need Statements



**DWELLER**

- R&B** Sam, who is a **dweller**, needs to experience fresh air in the room at the start of her day in order to have a pleasant start of the day.
- SI** Sam, who is a **dweller**, needs a way to find common or middle ground with her co-workers in order to change or set the temperature of the room.
- A** Sam, who is a **dweller**, needs to be made aware of the temperature after some time in order to prevent 'slowly being cooked like a frog'.
- SI** Sam, who is a **dweller**, needs an easy way to express discomfort to a facility manager when comfort and climate control is out of reach.
- I&F** Sam, who is a **dweller**, needs a way to be made aware of relative temperature changes in the building in order to make informed decisions regarding where to go and what is reasonable.



**FACILITY MANAGER**

- I&F** **R&B** Robin, who is a **facility manager**, needs to see all variables currently influencing the buildings climate in order to evaluate if everything is on track information climate routines.
- I&F** Robin, who is a **facility manager**, needs an easy way to triangulate different layers of data in order to get a sense of a 'complete picture'.
- I&F** Robin, who is a **facility manager**, needs detailed reports of resource usage in order to come up with strategic plans and policies for building management information
- A** **A&C** Robin, who is a **facility manager**, needs to be made aware of urgent matters that need immediate attention/fixing in order to keep the whole system running properly.
- A** **SI** **I&F** Robin, who is a **facility manager**, needs input from dwellers in order to create a personalized, pleasant atmosphere for everyone in the building.
- A&C** Robin, who is a **facility manager**, needs to handle different systems, hardware and programs in order to deal with all the different buildings and their specific facilities.

## 2.4 Consortium workshop takeaways user needs

The key findings from the consortium workshop on the 17 November are:

- **The tone of voice:** Simplicity is less about simple and more about speaking the person's language that needs to be informed.
- **Technology cost** vs Productivity: People don't want to walk again and again to the window to open the blind when it goes down automatically.
- **Cognitive load:** Just push a button when you are cold, and then the system will do something.
- **Responsibility:** the user must feel responsible about the situation in their room. Not only the building owner is responsible.
- **Visibility:** needing to be informed about what a person can do and signal to the user that there is an option available.
- **Understanding:** Mental models of users are interesting: people make up their own stories, which are not necessary the real model.

## 3 CONCLUSIONS

This exploratory research has led to the first list of requirements that can be used as a starting point for the re-design of interfaces for dwellers and facility managers in collaboration with our partners. One important yet unsurprising finding is that context- and user-dependent makes a climate control interface usable and useful. Dwellers have highly individualistic needs and approaches when it comes to the indoor climate. However, we also see patterns between different dwellers that can be utilised to provide an interface that works for many dweller “archetypes”. Just like dwellers, buildings and their facilities are highly variable and complex. Building systems provide largely different levels of control and agency given to dwellers and facility managers or “taken over” by the system itself.

When designing an interface for this eco-system of the building (system), dweller and facility manager, we need to incorporate each actor’s different needs and goals. To achieve this, we will need to continuously learn more about these needs and goals by iteratively creating, building, and evaluating potential user interfaces with users in their use context.

### 3.1 Requirements

The following list of requirements forms a “living” document. This means that, through prototyping, design and evaluation activities, the requirements can and likely will be continuously changed and improved upon whenever new insights about the user, their needs and context come to light.

#### Occupant

**What are the requirements for an interface that supports control and feedback between facility managers and dwellers?**

- The interface facilitates the occupant’s climate routines.
- The interface provides clear and useful feedback to the occupant while avoiding information overload.
- Feedback should be relevant to the occupant’s context and available climate system. It can include the status of the climate, options available to reach the occupant’s comfort or climate goals and advice on energy efficiency and well-being.
- The interface is accessible and easy to learn and use.
- The interface allows occupants to express discomfort when climate-related issues arise that are out of the occupant’s control.
- The interface could mediate decisions to meet various occupant climate/comfort needs.

#### Data

- The interface collects relevant data through interactions with the occupant, which is used to inform facility managers on the system’s current state and occupants’ comfort.
- The interface considers privacy concerns and limits data collection from occupants according to the GDPR (General Data Protection Regulation).

#### Facility manager

- The interface must make the facility manager aware of urgent matters that need attention or fixing to keep the system running properly.
- The interface provides a way to triangulate and connect different sets and layers of data and systems for the facility manager to get a sense of the “complete picture”.
- The interface signals to the facility manager when dwellers are uncomfortable or raise climate-related issues.
- The interface provides detailed resource usage reports to support facility managers in creating strategic planning and building management policies.



## REFERENCES

- Pruitt, J., & Grudin, J. (2003, June). Personas: practice and theory. In Proceedings of the 2003 conference on Designing for user experiences (pp. 1-15).
- Ishikawa, K. (1986). Guide to quality control. Quality Resources.
- Gibbons, S. (2019, 24 March). *User Need Statements: The 'Define' Stage in Design Thinking*. Nielsen-Norman Group. <https://www.nngroup.com/articles/user-need-statements/>
- Latour, B. (2007). Reassembling the social: An introduction to actor-network-theory. Oup Oxford.
- Coccia, M. (2018). The Fishbone diagram to identify, systematize and analyze the sources of general purpose Technologies. *Journal of Social and Administrative Sciences*, 4(4), 291-303.
- Guo, F. Y., Shamdasani, S., & Randall, B. (2011, July). Creating effective personas for product design: insights from a case study. In International Conference on Internationalization, Design and Global Development (pp. 37-46). Springer, Berlin, Heidelberg.