

The background of the entire page is a complex, abstract pattern of thin, wavy lines. These lines are primarily green, with some purple and blue lines interspersed, creating a sense of movement and depth. The lines are tangled and overlapping, resembling a microscopic view of a material or a complex network.

# Entangled Intelligence

*Design for Interaction  
Master's Thesis  
Timon Adriaanssen*



# Entangled Intelligence

AI-collaborations for  
more-than-human-centred  
approaches to community-based  
climate adaptation

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## abstract

Climate change is happening. As mitigation efforts can no longer stop climate change, adaptation is needed to ensure climate resiliency. National regulations and policies often fail to meet the specific contexts of the local scales, and thus, communities need to render themselves capable of adapting through *Community-Based Climate Adaptation* (CBA) projects. *Artificial Intelligence* (AI) is seen as a powerful technology with much potential for aiding communities in their adaptation goals, but how this collaboration is to be designed is still unclear. This project uses a *More-than-Human-Centred* (MtHC) design approach, as well as the *CreaTures* framework and the *Augmented Collective Intelligence* framework, to explore the collaboration between urban communities and AI technology. This exploration is done to assess how AI systems can enhance the capabilities of communities, and how residents can be motivated to adopt MtHC approaches in their adaptation measures. The process, stakeholders, and challenges of CBA projects, as well as opportunities for AI-based interventions, are explored through literature research, expert interviews and a thematic analysis. Following this, design concepts are explored in collaboration with an expert panel, prototypes of further developed iterations are tested, and a final concept is created. The final concept, called Entangled Intelligence, is tested both with a participant group and the expert panel, in order to retrieve insights on the research questions. The project and its limitations are discussed, and a set of characteristics of AI that support MtHC approaches to CBA is presented.

## glossary

**Community-Based Climate Adaptation (CBA):** A bottom-up approach and strength-based approach to building climate resilient environments on a local level (Kirkby et al., 2015).

**Community:** A group of people who are affected by issues in civil society and operate together to tackle these issues (Hsu et al., 2022).

**Resident:** A person who lives or has their home in a place (Cambridge dictionary, 2024).

**Artificial Intelligence (AI):** An umbrella term for a set of technologies that perform a variety of advanced functions and which is often associated with adaptivity. Artificial Intelligence has been explained as “*the study of how to make computers do things at which, at the moment, people are better*” (Rich, 1985).

**More-than-Human-Centered (MtHC):** A design approach that aims to manage, present, and negotiate many different relations in parallel, with no one species at the singular focal point (Giaccardi & Redström, 2020).

**Noticing:** To become aware of something and treat it as worthy of recognition, recognising the interconnections between social, political, cultural, and environmental systems (Bessai et al., 2024).

**Entanglement:** The interdependence and coexistence of multiple species in their processes, systems, rhythms, and activities (Pollastri et al., 2021).

## foreword

*“Artificial Intelligence, community-based climate adaptation, more-than-human-centred design... So what’s your project about exactly?”* That’s the question I’ve been asked on many occasions throughout the past seven months, and to be fair, I wasn’t certain for a long time myself. All I knew was that I didn’t agree with how most of our (AI) technologies are implemented, that I wanted to rekindle our connection to nature, and that the MtHC design approach aligned well with my vision for design. But, as would become clear from the numerous times my coaches told me to narrow down my scope, either by saying it to my face or by highlighting the twenty keywords I had apparently used in a paragraph of about six sentences, *“trying to save the world”* starts by understanding how you can contribute in the smallest, most concrete way possible. This project, if anything, shows my efforts and struggles to condense my widespread interests into a concrete, and meaningful contribution. It has been a journey, and a tough one at that. Nonetheless, I’ve made it through and I’m proud to present the results, and my journey, in this thesis.

## acknowledgements

This project, and its result, would not have been here without the help and support of a lot of amazing people. First of all, a huge thank you to my supervisors Dave Murray-Rust and Roy Bendor for finding the balance between on one hand pushing me to explore further, to solidify my scope and to strengthen my design decisions, and on the other hand pulling me back when I dove into the wrong rabbit hole or overwhelmed myself with unrealistic plans and unnecessary stress. Secondly, a big thanks to Bulent Ozel for offering guidance from a different perspective and sharing his technical expertise. Thirdly, another big thanks to all the experts and participants that have helped me to further develop my research and concepts. Discussing and evaluating with you has always brought an immense burst of positive energy to the project, and your comments and questions have offered me many important insights and realisations. To StudioLab, a big thanks for the chance to work at a desk surrounded by people interested and excited about the many facets of design. Mahan, Timothy, Aadjan, Alessandro, Sophie, and all the others, thank you for your input, your energy, and your understanding of the master thesis struggles, they’ve been of immense support.

To nature, thank you for being an eternal form of inspiration and offering moments of rest and connection. To ChatGPT, thank you for offering room to bounce ideas when I didn’t want to disturb anyone else. To all the baristas, thank you for comforting my mornings with amazing coffee.

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# section 1

# Introduction

This section presents the broader context in which this project is conducted. An overview of the design and research objectives is given, with two main research questions. The scope is presented, as well as the external supervisor: Lucidminds. Finally, a structure of the thesis is presented, and the reflections on AI are introduced.

# 1.1

## background and context

The effects of climate change are on the rise, and the consequences of climate change will be felt globally by communities of all shapes and forms for generations to come. As the effects of climate change intensify, urban communities will face higher temperatures, more occurrences of extreme weather events, and a loss of resources. While mitigation measures are needed to limit the effects of climate change, those measures will not stop climate change completely (Kirkby et al., 2017). Furthermore, those measures will not solve the underlying drivers that make communities vulnerable to the effects of climate change and thus, adaptation measures are needed to ensure climate-resilient environments (Ayers & Forsyth, 2010; Mfitumukiza et al., 2020).

When national regulations and politics fail to meet the contexts and challenges of specific neighbourhoods, urban communities need to initiate community-based climate adaptation (CBA) projects to render themselves resilient to the developing effects of climate change. Through local knowledge and participation, groups enable themselves to initiate projects which the individuals of these groups would not be able to undertake on their own, resulting in more impact on the community's climate resilience (Kirkby et al., 2017). Coming from a public point of initiation, CBA projects can support communities' local needs and challenges at the core of the adaptation (Ayers & Forsyth, 2010; Mfitumukiza et al., 2020).

Artificial Intelligence (AI) is a powerful technology that shows potential for aiding in community-based climate adaptation processes (Hsu et al., 2020). The modelling powers of AI technology offer a range of capabilities to its users, including identification of vulnerable areas, simulation and future scenarios, to assessing risks and opportunities for adaptation projects (Jain et al., 2023).

This project uses a More-than-Human-Centred design approach to explore the relationship between residents,

AI systems, and nature within these CBA processes. By acknowledging the agency of natural species, and understanding the entanglements and interdependencies between humans and nonhumans, the MtHC design approach advocates for measures that benefit all creatures, instead of only humans (Tarcan et al., 2022). Many CBA projects involve reshaping or expanding the local ecosystem within a neighbourhood through greening practices and urban gardening. To do this in a MtHC manner, the act of noticing in the context of urban gardening is seen as an important activity for becoming aware of the liveliness of the neighbourhood's ecosystem, and to take the natural species that surround us into consideration (Poikolainen Rosén et al., 2022).

Apart from the MtHC design approach, two frameworks have influenced this project; the CreaTures framework and the Augmented Collective Intelligence framework. The CreaTures framework describes 25 pathways for working toward socio-social futures, as well as nine dimensions for evaluating how creative practices can support sustainable transitions (CreaTures, n.d.). The Augmented Collective Intelligence framework describes how AI systems can interact with groups of residents to enhance their "collective intelligence" and decision-making within CBA projects (Lucidminds, n.d.).

## 1.2 research and design objectives

This project explores two aspects of AI collaborations in the context of CBA projects. On the one hand, AI systems are seen as powerful tools to enhance the knowledge and capabilities of urban communities in the complex process of CBA. This project explores how AI systems can fit within communities to support them in initiating adaptation measures. On the other hand, the project explores how AI systems can motivate urban communities to change their relationship to nature, and to adopt a MtHC approach to the CBA process. The research and design objectives of this project will be represented by the final concept and a recommended set of characteristics for AI systems that support MtHC approaches to CBA projects.

## 1.3 research questions

Connected to the research and design objectives of this project, the research questions are:

- *What opportunities exist for implementing AI systems to enhance residents' capabilities in CBA projects?*
- *How can AI systems motivate residents to adopt More-than-Human-Centred approaches to CBA projects?*

## 1.4 scope and limitations

The scope of this research has focused on the collaborations between urban communities and AI systems in the context of climate adaptation and how these collaborations can shape the relationship between residents and their local nature.

It's important to note that, apart from one expert being positioned in New Zealand, and the international sources of the literature research, this research has solely been conducted in urban environments in the Netherlands. Similarly, the final evaluation has only been tested with one neighbourhood in Amsterdam. The insights retrieved from the evaluations are based on the moment of evaluation, and no long-term studies to conduct lasting impact have been done. To make more substantial claims, more evaluations with different participants over a longer period of time would be necessary.

## 1.5 Lucidminds

Lucidminds is an impact solutions studio that uses complex system design and analysis to address the interrelated challenges of climate change and social inequalities (Lucidminds, n.d.). Moving beyond critical discourse and focusing on practical action, Lucidminds aims to work towards regenerative futures. Through a systems approach, they balance economic growth with environmental and social impact when building their ventures. Their Augmented Collective Intelligence framework (further elaborated on in the Grounding section), has been used in this project to assess human-AI interactions.

## 1.6 structure of thesis

The structure of this thesis follows the process of the design project. In the *section 2: Grounding*, an understanding of the context is described through literature research, and expert interviews. A thematic analysis shows the exploration of CBA projects, as well as the challenges and opportunities for integrating AI systems in these processes. Two models of the CBA process are presented, with themes that resulted from discussions with the experts and findings from the literature.

*Section 3: Methodology* presents the theoretical frameworks that have shaped this design project. The MtHC design approach is elaborated on to illustrate the designer's stance towards this project and the concepts of Entanglement and Noticing are explored. Additionally, the CreaTures framework and the Augmented Collective Intelligence framework are presented to show how these frameworks have influenced the project.

Following the insights from section 2: Grounding and the theoretical frameworks from section 3: Methodology, *section 4: Exploring* uses the overview of the CBA process and the identified themes as starting points for developing concepts focused on collaborations between urban communities and AI systems. Three initial concepts are developed that focus on different aspects of CBA projects and collaborations with AI systems. To discuss the concepts, storyboards are created and used in Expert interviews. Following the findings, another concept is developed and presented.

Using the findings from the evaluated concepts in section 4: Exploring, *section 5: Materialising* presents two iterations that have been developed into prototypes and tested in order to work towards the final concept. Findings are discussed and conclusions are made.

Following the two concept iterations in the previous section, *section 6: Final Design* presents the final concept, the prototype that has been developed, and the final evaluation. For the final

evaluation, the test plan and context are presented, as well the data analysis and results. Again, the findings are discussed and conclusions are presented.

Finally, *section 7: Concluding* looks back on the project as a whole and discusses possible limitations. The project's research questions are answered and Characteristics of MtHC-AI are described. To end, a personal reflection highlighting the development of the designer throughout the project is presented.

\* As an addition to the thesis, and in keeping with the ever developing processes and methodologies of design projects, reflections on the designer's collaboration with AI systems are scattered throughout the report. These reflections are meant as bits of extra information, exploring how working with AI has influenced the project, but the thesis can be understood without reading these reflections.



# 1.AI

## introduction to reflections

Due to the recent explosion of AI systems and tools becoming accessible to everyone across the web, there are a lot of noticeable changes in the design process. These powerful artificial agents have the potential to reshape how designers conduct many activities in their process, from transcribing interviews and performing data analysis to ideating and brainstorming through generative AI technologies. Because of this, I believe it to be important to be mindful of how I'm applying these tools in my project, and how they affect my practice. This is done with short reflections that are scattered throughout the report, and are based on the respective activities in the chapter the reflections are written in. With these reflections, I hope to maintain a critical stance towards these new tools, and how they influence my design process.

### **ChatGPT-4's answer when asked how it can assist industrial designers in their research and design processes:**

*I can significantly enhance the research and design processes for industrial designers by providing instant access to a vast repository of information, including the latest trends, materials, technologies, and sustainability practices. Furthermore, I can generate innovative design ideas and conceptual sketches to kickstart the creative process. Additionally, I can automate the analysis of user feedback and market data to ensure that designs are not only innovative but also aligned with user needs and market trends. This holistic support helps designers streamline their workflow, make informed decisions, and innovate more effectively.*

- (OpenAI, 2024)

# 1.AI

## thesis structuring

ChatGPT-4 has been used as a collaborator in structuring this thesis (OpenAI, 2024). This has been helpful as there was a lot of complexity surrounding this design project, and it was a challenge to decide how to tell a coherent story. Thus, in search of some assistance, ChatGPT-4 was given an overview of the topics I intended to discuss and was asked to provide a structure to explain my thoughts and the relevant topics. The structure that was provided by ChatGPT-4 was by no means perfect; some suggestions were more fitting for an academic research paper than for a design thesis, and it didn't understand how all the topics related to each other. Nonetheless, it was a convenient tool for discovering for myself how I wanted to tell the story, and it gave helpful advice on how to explain certain topics and chapters in the thesis. By being able to bounce ideas around, and through identifying where suggestions from the artificial agent miss the mark, discovering how to tell the story became concrete within my own head, which was still in the middle of all the complexity.

### **Prompt that was sent to ChatGPT-4:**

*Hi, I'm writing a design thesis and would like some advice on the structure for my Introduction, Literature Research, and Methodology sections. The paper is about exploring the interactions between citizens and AI for community-based climate adaptation. I am exploring this through Speculative Design, with a More-than-Human Centred approach, and I'm using the Eco-Social change concept from the CreaTures framework. Can you suggest a structure?*



# section 2

## Grounding

This section presents how the context was understood through literature research and expert interviews. Following this, the findings from the conducted literature research and expert interviews on the complexities of CBA projects are presented, as well as opportunities and challenges for implementing AI technologies in these projects. Two *CBA process models* are presented to describe the different phases and stakeholders that exist within these processes. A set of themes that arose through the expert interviews and have been cross-referenced with literature research explain the challenges of CBA projects as well as possibilities for AI technologies.

To conclude, a conclusion of the section presents how this research of the context has influenced design explorations.

## 2.1 expert interviews & literature research

In addition to the theoretical frameworks, research into the context of CBA and challenges and opportunities for AI has been conducted. The process and challenges of CBA projects have been explored through five semi-structured interviews with diverse experts in climate adaptation and collaborative transformation processes. Semi-structured interviews fit well with the explorative aspect of these interviews as it allowed diving into different subjects while remaining focused on the context of CBA (Adeoye-Olatunde & Olenik, 2021). The expert interviews explored CBA projects from diverse perspectives to identify challenges and opportunities for implementing AI systems. The experts interviewed were as follows:

### Questions guiding the semi-structured interviews

- In what ways can communities work on climate adaptation at a local level?
- In what ways is this already happening?
- What do communities need to strengthen their adaptation capabilities?
  - Partners, technology, financial support, etc.
- What does [expert's organisation] do to strengthen communities in their adaptation capabilities?
- What does the process of climate adaptation look like at a communal level?
- Who are the relevant stakeholders in local climate adaptation initiatives?
- What metaphor would you use to describe current climate adaptation at a local level?
- What metaphor would you use to describe what possible collaboration with artificial intelligence for climate adaptation would look like?

### An overview of the experts interviews:

- *Project manager climate adaptation*
- *Citizen who initiated & collaborated on a CBA project*
- *Employee at a collective redesign and regreening corporation*
- *Speculative designer with experience in AI and climate change contexts*
- *Engagement specialist working in participatory development processes.*

## thematic analysis

Thematic analysis is a research method that allows researchers to identify meaning across datasets by identifying and grouping insights into clusters, or themes, of shared experiences and meanings (Braun, 2012). To ensure a thorough understanding of the data, the six-phase approach to thematic analysis as described by Braun was used: familiarising yourself with the data, generating codes, searching for themes, reviewing those themes, defining them, and finally writing the report (2012). A thematic analysis of the expert interviews was conducted and cross-referenced with findings from the literature to present the current state of CBA projects and opportunities for AI interventions (see App. C). As part of the analysis, an overview of the different phases within CBA projects was created. The identified phases and themes were used to communicate the research findings and as starting points for exploring interventions and design directions.



## 2.AI thematic analysis

As this research explores collaborations with AI, it has also explored collaborations with AI as a designer in the research process. This was also done during the thematic analysis. After conducting the analysis manually, Miro Assist and ChatGPT-4 were used to analyse the semi-structured interviews. It has been an interesting exercise to use these tools to perform the analysis, and it has shown me how my analysis may have leaned towards specific parts of the context. For instance, in my initially identified themes, I noticed there was a larger emphasis on the community aspect of the CBA projects. While this is not wrong, the AI findings have helped me to realise again how big the network of stakeholders around the community is; many of which are essential to the success of these projects (or even initiators). Something I did miss in the analysis of the AI tools is the storytelling aspect of CBA projects, which has been discussed quite heavily in my interviews. While it could be said that storytelling is taken into account for findings such as “community engagement” and “network and collaboration”, I believe this is one aspect of the interviews that the tools have missed out on. Additionally, it became clear to me that the AI tools didn’t understand my focus on the process behind CBA projects, as they also named findings such as “Importance of Water in Urban Areas.” Again, not a wrong finding, but it may be less important for my study. This could of course be improved by specifying to the AI system what type of insights you’re interested in, although this would need to be balanced properly with the explorative goal/aspects of conducting a thematic analysis.

I think it’s important that I’ve used the AI analysis tools after my own manual thematic analysis. Using the tools in this way can be an interesting check on whether or not I’ve conducted a thorough analysis. Conducting the TA only with AI systems would have been a quick fix and could have resulted in the loss of important insights.

## 2.2 findings from thematic analysis

As part of the CBA context exploration, I created a model that represents the different phases and stakeholders in the process. While it is understood that CBA processes can vary greatly depending on the initiator, size and focus of the project, similarities are visible in most CBA projects. I designed two models, existing of the same phases and stakeholders. The difference is that one model is a linear representation of a singular CBA project (see fig. 1, p. 26), and the other one is a circular (loop-based) representation that shows the CBA process as an iterative process of projects continuing to build on each other (see fig. 2, p. 29).

Designing these models has helped me to test my understanding of CBA projects and the models have been used as starting points for design explorations. Furthermore, the models have been used throughout the project to position my designs within the process of CBA.

## cba model: linear

The linear model (see fig. 1), based on the expert interviews and findings from literature, describes the five phases of CBA projects and places the three types of stakeholders within the context of CBA. The vertical position of the different stakeholders is representative of power structures that exist within this context, with communities initiating projects from a local, bottom-up initiative, or the municipality making adaptation plans from a top-down position. The 3rd parties include a wide range of stakeholders, and can differ depending on the phase of the CBA project. Additionally, they are positioned within the five phases to illustrate that communication and collaboration with them only happens within the process of CBA (while the community and municipality may come in contact with each other outside adaptation projects).

Considering the five phases of CBA projects, it's important to note that the transition between the phases is never as clear or solid as one might think from the model. Using a gradient, the ambiguity of the process and the transitions between the respective phases are highlighted. The distinction of phases is in this case simply a way to define what the different steps are in the process, how these steps look like, and where design interventions could be positioned in the process. Additionally, it should be mentioned that the phases can happen multiple times throughout the project, meaning not every project will follow this exact order of phases. For instance, the design and planning phase might lead to new stakeholders being needed, initiating another phase of stakeholder engagement.

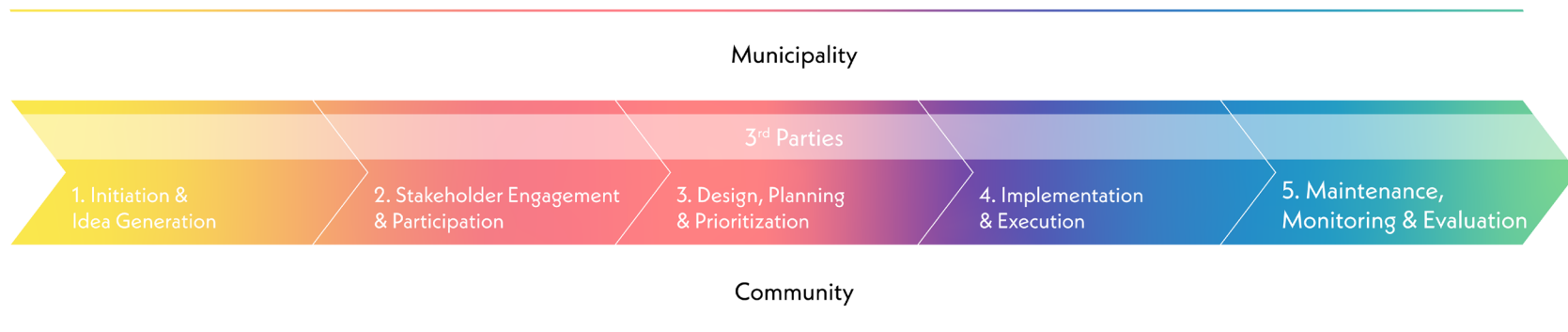


fig. 1: linear model of the CBA process



## cba model: circular

Whereas the linear model provides an overview of the process of a specific CBA project, the circular model (see fig. 2) illustrates how a sustainable collaboration between different stakeholders will result in a continuous practice of adaptation, with new projects initiated from the evaluations of earlier projects. This is strengthened by Kirkby et al. (2017), who state that more than a project, CBA is a socio-political landscape in which adaptation measures are conducted in line with the needs and priorities of those who will be affected the most. As these needs and priorities are ever developing, so will CBA projects continue to unfold over time if sustainable collaborations are in place. For this, strong agreements during a project are necessary, and communities need to be strengthened through several means to ensure that they can carry out future projects.

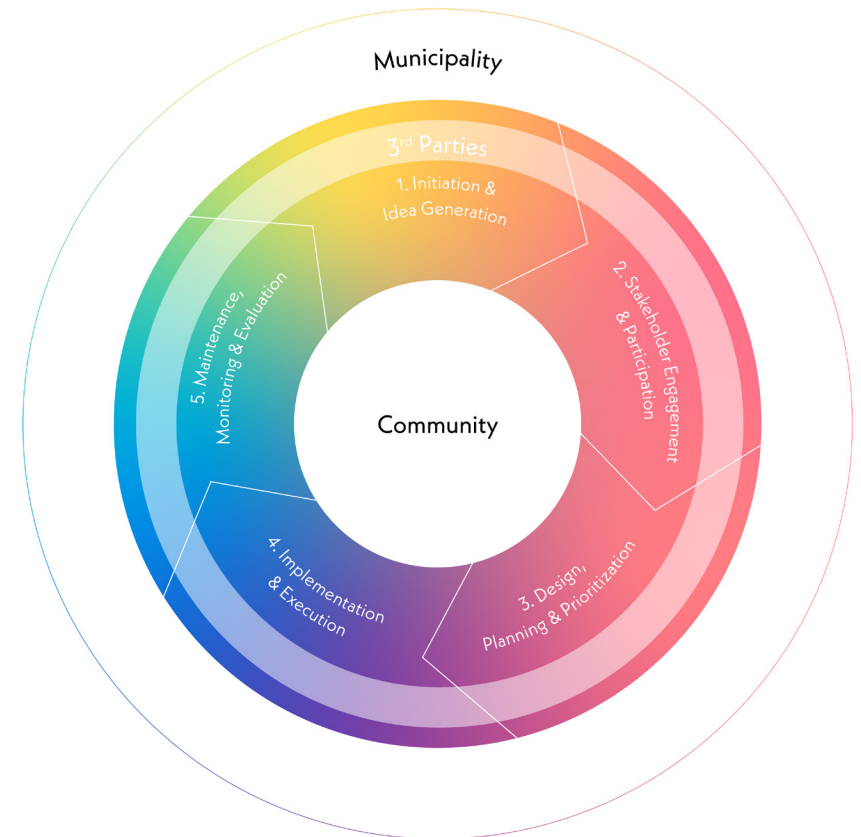


fig. 2: circular model of the CBA process

## phase 1: initiation & idea generation

The Initiation of CBA projects can happen in many ways and the stakeholder that initiates the project greatly influences how the first phase looks like. From a top-down initiative, the municipality can initiate projects to develop neighbourhoods in line with national goals for sustainability. A common challenge for municipalities is how they can gain insights into a neighbourhood's needs and goals, which often results in wrongfully positioning plans in the community.

From a bottom-up initiative, residents or communities can aspire to redesign their neighbourhood, for instance, if they wish to regreen their grey, stone-heavy streets. While there are a lot of systems present that can aid bottom-up initiatives, residents and communities are quite often unaware of these support systems.

Alternatively, some corporations operate between the municipality and the neighbourhoods, and they too can initiate CBA projects. In this case, however, they are approached by one of the other two stakeholders who are requesting guidance in shaping/initiating these projects.

## phase 2: stakeholder engagement & participation

When a project is initiated, a fundamental focus is to generate engagement and attachment to the project on different scales, from residents who will act as volunteers, to companies that bring in their expertise, and institutional stakeholders who will agree on and possibly subsidise the CBA measurements. Without the engagement of these three stakeholders, CBA projects are bound to fail in the short or long term.

During phase 2, it's important to get a solid understanding of the community's needs and goals, as connecting climate adaptations to local wants will bolster participation from volunteers, which is essential to the long-term operation of CBA projects. At the same time, governmental plans need to

be taken into account to make sure adaptations don't clash with nationally envisioned developments.

It's important to highlight that attracting participation from stakeholders and community members is one of the most important activities in CBA projects and should happen continuously to ensure long-term adaptation practices. Thus, while it is presented in this model as a separate phase and extra attention should be spent on this activity right after initiating a project, the activity needs to be extended throughout and even after the project.

## phase 3: design, planning & prioritisation

After the relevant stakeholders are engaged with the project and the stakeholder needs are defined, the design and planning phase can begin. During this phase, stakeholders work together to design an adaptation plan, including resources, a timeline for the implementation, and a division of roles.

This is a phase in which many forms of expertise need to come together. Finding ways to have the right experts around the drawing table greatly influences the efficiency and effectiveness of this phase, compressing what might take weeks into a couple of well-spent afternoons.

This is an important phase for the community to understand what will happen to their neighbourhood, but it's also a phase in which they might feel at a loss for agency due to a lack of expertise. Structuring this phase in a way that ensures knowledge, and ownership of the project, is shared with the residents has large implications on the following phases and how much engagement and participation there is from volunteers.

## phase 4: implementation & execution

Phase 4 is where the plans are set in action and the designed adaptation strategy is being realised. This is a very hands-on phase in which a lot of stakeholders are needed in a collaborative effort. However, this is also the phase in which the hard work from the previous phases is finally physicalised and recognised by the general public. The implementation of a CBA process can also have a non-physical form, for instance, community education on climate-related issues.

As with the earlier phases, engaging the neighbourhood as much as possible ensures that they will be able to sustain the adaptation strategy in the following phase and the future of their community in general.

## phase 5: maintenance, monitoring & evaluation

To ensure the long-term success of a CBA project, maintenance will be necessary to keep the adaptation tools/strategies functional. For this, concrete rules and agreements are needed to ensure that all stakeholders know who is responsible for what. Teaching the community how to conduct continuous maintenance makes it easy to keep the project on level, but the municipality or other stakeholders may need to conduct occasional maintenance as well.

Additionally, monitoring and evaluation are needed to assess the effectiveness of the adaptation strategy and to correct strategies according to developments in national policies and adaptation knowledge. This is an important part of the CBA project, as it ensures that the adaptation strategy remains up to par, and lessons can be drawn from the project to initiate new projects.

## emerging themes

The themes presented below are derived from the thematic analysis of the semi-structured expert interviews and have been cross-referenced with literature. Seven themes emerged from the analysis, which have been divided into two categories; *CBA Requirements* and *Design-Inspiring Themes*. This division arose as the interviews not only discussed the current state, challenges and requirements of CBA projects but also opportunities for implementing AI systems and enhancing the capabilities of communities.

The first category, the CBA Requirements, describes bottlenecks that need to be taken into account in CBA projects: without considering these aspects of CBA, the projects will not reach sustainable execution. The themes are *Interdisciplinary Teams & Knowledge Sharing*, *Project Ownership & Attachment*, *Soft Values & Local Needs*, and *Working Beyond Execution*.

The second three themes, under the category Design-Inspiring Themes, include opportunities and AI-based interventions for enhancing communities' agency within CBA projects. The themes are *Storytelling & Visualisation*, *Bridging (Nonhuman) Perspectives*, and *AI should Support Humans, not Replace Them*. In the following section, the themes are elaborated on with quotes from the semi-structured interviews and references from the literature.

## cba requirements

### interdisciplinary teams & knowledge sharing

CBA projects require diverse expertise and activities, which means there are a lot of different stakeholders needed. Collaborating with the right stakeholders at the right time is essential for the success of a project, but it can be difficult to reach the necessary stakeholders. As mentioned by E2 *“resident initiatives, industry, and government are three worlds that are afraid of each other, but if they work together, things will fly.”* and E4 *“yes, if those large housing associations and municipalities are a bit easier to put together [...] That would help a lot.”* McNamara and Buggy (2016) note that many authors highlighted the need for cohesion, linkages and partnerships between stakeholders, especially local governments, to actively support communities (McNamara and Buggy, 2016).

Getting the right people around the table can accelerate a project, greatly enhancing its efficiency and effectiveness. Interdisciplinary, face-to-face communication can resolve issues and challenges in hours that might otherwise take weeks due to compartmentalization. E2 spoke about how the collective of CBA-initiating residents she was part of became a *“Swam intervention. Together we knew much more than just one person. So the process actually accelerated.”*

Additionally, communities need access to the necessary knowledge and information to strengthen their position and capacity for initiating adaptation projects. From practical information such as regulations and possibilities for subsidies to knowledge on adaptation measures and processes. E1 mentioned that a common problem among community initiatives is *“progressing from the talking and drawing phase towards financing, realising, and management.”* Through knowledge sharing, communities' capabilities for initiating CBA projects from a local, bottom-up position can greatly

be enhanced. As Kirkby et al. (2017) write, knowledge and technology need to be brought from top-down positions to support bottom-up adaptive capacities for communities. McNamara & Buggy also point out that many authors state the need for intersectoral knowledge sharing, including academics, practitioners and municipalities (McNamara & Buggy, 2016).

Furthermore E1 states that communities often face trouble from a lack of transparency on the municipality's side. *“Is the municipality saying they don't want to put a tree there because they are going to create more parking spaces there in ten years' time, as a resident you don't know.”* This struggle is highlighted by E4, who mentioned that cooperatives also struggle to understand grants and funding from the municipality.

### project ownership & attachment

When initiated by residents, CBA projects are often driven by one or two individuals who feel very strongly about their neighbourhood and its environment. This is a bottleneck to CBA projects, as E1 mentions *“If those people drop out, [...], then such a project comes to a standstill. Because no one feels responsible for the neighbourhood anymore.”* Raising the community's ownership of and attachment to a project will ensure long-term execution. Kirkby et al. (2017) state that CBA projects become a success through continuous participation of local people throughout the project and that all the relevant stakeholders need to be represented appropriately. This includes other stakeholders, institutional and industry, as well, and clear agreements on who does what needs to be made for a successful collaboration within these complex projects.

Next to ownership, attachment to the project is essential, especially among the residents who work voluntarily. E2 describes CBA projects as *“Intense, intensive too and all voluntary, right? So, you had to do all that work yourself, in addition to*

*your normal stuff.*" E5 adds on to this by mentioning people's attachment to the project comes from their attachment to the place, which is created through *"patterns and habits in people's life."* Additionally, they stress that the municipality needs to carefully consider this attachment to place to engage the locals in the project instead of disrupting them. Ayers & Forsyth (2009) named technological training and support, accompanied by a raised awareness of climate change, as essential to building attachment among the community, which consequently ensures a sustainable operation of the adaptation measure.

### soft values & local needs

A core characteristic of successful CBA projects is that they are connected to communities' soft values and local needs. E1 explains that residents often *"initiate adaptation projects from a good heart or good convictions, and not because they're engineers and understand how everything works."* E1 also stressed the fact that these soft values (e.g. *"feeling better in a green neighbourhood"*) are difficult to translate to many stakeholders and are often the first values that get ignored when budgeting project executions.

Additionally, there are often other concerns or issues within a neighbourhood and CBA projects do not happen in a vacuum. As E1 explains *"These are all very concrete things that people in a neighbourhood encounter, if you want to successfully implement climate adaptation, other things must also be taken into account."* Notably, taking on other goals and desires within a community can motivate neighbourhoods to work on climate adaptation. According to Ayers & Forsyth (2009) and Kirkby et al. (2017), successful CBA strategies are created through participatory processes in which the cultural norms of the community and local development concerns that make people vulnerable are positioned at the centre of the strategy.

### working beyond execution

A common blindspot in CBA projects is the phase after implementation and execution when continuous maintenance and monitoring are needed to ensure the project lives on. E1 mentioned it as a commonly noticed problem *"What I encounter in my work is, 'the next step, management and maintenance.' This is often overlooked by neighbourhoods and communities."* Clear agreements need to be made about who is responsible for what, and how the project will be carried on to ensure sustainable, long-term impact. And, according to E1, this needs to happen early on in the process, as they explain that *"It actually always comes down to very good agreements with each other from the start."* Municipalities and other stakeholders also need to be careful with the agreements they make, as E4 stresses that *"it also depends on the client, because if they promise a lot and ultimately do nothing, of course, that doesn't help you much either."*

As became clear from the literature, there are many other reasons outside of community awareness and organisational support why CBA projects are not extended sustainably. McNamara & Buggy list unsuccessful participatory activities, technical barriers as well as economic viability and missing financial or other benefits for the volunteers (McNamara & Buggy, 2016).



## design-inspiring themes

### storytelling & visualisations

Storytelling and visualisations can greatly bolster the shared motivation between stakeholders to work on CBA projects. Storytelling, as a tool, can connect different perspectives and forms of knowledge, as well as strengthen attachment to projects. E1 mentioned the importance of *“responding to people’s feelings. So, ‘you also want a neighbourhood full of beautiful birds and nice trees, right?’”* This belief is shared by E2, who mentioned the response of the municipality to their stories for change. *“They read that story and immediately thought something like ‘Yes, this force from below, it is very great, it’s very strong.’”*

According to E1, storytelling can form a bridge between the necessity of climate adaptation and people’s lives and personal needs, as they state *“People turn off when you start talking about numbers. If you say, ‘yes you have to do this because of climate change, 1.5 degrees of warming in the world.’ That doesn’t work.”*

Visualisations, on the other hand, can be a great tool for helping people realise what the opportunities for their neighbourhood are. From visualising future scenarios to helping with identifying rooms for adaptation, there’s a lot of potential for visualisations to motivate communities and other stakeholders to get into action. Pérez-Soba et al. (2018), state that future visioning can aid with stimulating dialogue, building consensus and long-term planning. P1 shares this claim by stating *“For example, if you have a completely petrified neighbourhood, it could also help to generate impressions of what it could be like.”*

### bridging (nonhuman) perspectives

Different people think in different ways and connect to their environment differently as well. Understanding this difference, and being able to communicate these different perspectives and forms of knowledge will be necessary to ensure effective collaboration among stakeholders. E5 mentions important aspects of her process as *“taking these steps together with the technical expertise and understandings and the local expertise, we weave them together.”* E5 further explains the importance of weaving those types of knowledge together by highlighting that

*“the other side of it is public legitimacy. You can make the best technical plan in the world, but you need to understand how it can account for the different ways people value the land.”*

Additionally, there is a lack of nonhuman perspectives and ecological mindsets among many human stakeholders, and there’s a belief that adopting this nonhuman thinking will be needed to adopt more sustainable lifestyles. This is believed by E3 as well, as they state

*“I think if we can start to expand people’s sense of self from individualised, discrete units [...] and start to see ourselves as in flux and flow with a wider ecology. That, I think, will start to change the way that we see things and other organisms and the environment and even ourselves and our own bodies.”*

E5 mentions *“stewardship and valuing the land”* in relation to a project in Aotearoa New Zealand in which the Maori relationship to place resulted in the Wanganui river obtaining legal personhood under the Te Awa Tupua Act, which has had immense effects on the river’s well-being and protection (Kramm, 2020).

## AI should support humans, not replace them

AI technology has shown to have much potential in supporting climate adaptation processes as it enables the development of innovative strategies that are fit for the complexity and multifacetedness of climate change challenges (Jain et al., 2023). As Jain et al. (2023) state, AI technology can greatly influence CBA projects by assisting with data analysis, identification of risks and opportunities, and development of adaptation measures. Similarly, Hsu et al. (2022) showed how communities can use AI to collect data and take action from an evidence-based approach.

However, there are also challenges concerning the integration of AI technology in CBA projects; on one hand ethical and social issues, and, on the other hand, issues related to technology and data management (Jain et al., 2023; Sirmacek & Vinuesa, 2022). While many stakeholders - government officials, cooperatives, etc. - see potential in using AI technology for climate adaptation, many lack the proper understanding of how this technology can be implemented, and what the impacts of the system can be on the social ecosystem (Popelka et al., 2023, p. 8). According to Hsu et al. (2022) and Alavi et al. (2019), AI systems need to continuously adapt to the changing social landscape in which communities interact with the system and to take into account the diverging values of the citizens over a prolonged period.

AI systems' role in CBA projects can be very tricky, as it can either greatly enhance a project, or cause residents to feel controlled or overtaken by the system. Jones & Rahman (2007, p.28, as cited by Kirkby et al., 2017) state that the residents are the ones who should be making choices in CBA projects, and not have these choices imposed on them from outside.

There's a lot of perceived potential in AI's abilities to advise people or to collaboratively carry the project with communities. E1 mentions potential for AI systems to reduce burn-outs among the initiators by *"taking over some of the responsibilities, offering structure and guiding collaborations."* E1 continues by stating that, while AI systems cannot build the emotional connections that engage people with the project, it can *"support someone else with all kinds of tips and learning."* P5 mentioned a similar role for AI systems, by stating

*"That should be done by humans and by standing and being with the place and knowing the place [...] because it's about possibilities for the future that can then be taken by the people to investigate together. And so it's a way of stimulating imaginations and possibilities. And it's a tool for the people in their relationship to place rather than doing a job for them."*

AI systems have the potential to aid CBA projects along many of the previously mentioned themes, from identifying opportunities for adaptation to helping different stakeholders to communicate. In this sense, this theme represents the possibilities for this project, but also highlights that the role of the AI system, as well as how it is introduced and by whom it is used, will notably affect the impact of the system on the social ecosystem of CBA projects and the projects' results. This is well summarised by E5, who wonders

*"What is appropriate for AI to do? Where is it exciting? Where is it genuinely resonant and stimulating rather than that it brings a sense of unease to the process. Because, for me, that also disrupts this idea of public legitimacy. If you bring unease to the process and, even if it's a very effective tool, if it delegitimizes the process, it will lead to less sustainable outcomes, and that might not be immediately apparent."*

## 2.3 conclusion

The expert interviews and literature research have expanded on the processes and complexities of CBA projects. Through creating the models, it has become clear what the five main phases are that these projects go through, and how different stakeholders relate to each other and the process. The CBA Requirements themes have highlighted the many challenges that communities and other stakeholders may run into. The amount of needed participation from diverse stakeholders has shown that CBA projects are ultimately a challenge of communication and collaboration, with problems arising from different forms of understanding and relating to a place. Strong agreements need to be made, especially with the municipality, early on in the project, to ensure the community and other stakeholders know how the process looks like and what responsibilities they have. For communities, knowledge sharing and technological support are among the most important necessities for increasing their agency and capabilities. Additionally, as many members of the community work on these adaptation measures on a voluntary basis, it's important that they see their needs, answers and their values embedded within the project.

Apart from the complexities of CBA projects, opportunities for implementing AI systems within these projects have been explored. While literature research has shown many potential functions for AI systems, including risk and opportunity analysis, simulation, and data analysis, the themes that emerged from the data highlight other aspects of AI systems. Reverting back to the statement that CBA projects are a challenge of communication and collaboration, these interviews have shown AI systems can assist these projects through storytelling and visualisations, by bridging perspectives between different stakeholders, and by helping to carry the load for communities.

As will become clear in the following section which highlights the methodology that has been used in this project, the potential for AI systems to help us reconsider our relationship with nature is explored through this project. The Design-Inspiring themes are closely connected to this exploration, as connections are made through storytelling, bridging perspectives, and helping humans instead of replacing them. The CBA Requirements themes, however, highlight the complexity that already exists within this context. As communities already face enough challenges as is, it's important that the AI system continues to strengthen their position, their agency, and their capabilities. This balancing act of helping residents within the context and raising awareness on aspects of CBA projects that are currently not considered will be elaborated on in the rest of the report.



# section 3

## Methodology

This section presents the theoretical frameworks that have influenced the design and research activities. The *More-than-Human-Centred* design approach describes how we need to “decentre” the human in our design process to make room for nonhumans to share centre stage. Additionally, *Entanglement* and the act of *Noticing* are highlighted as important concepts for motivating MthC approaches. Furthermore, the *CreaTures* framework and the *ACI Framework* are presented.

## 3.1 more-than-human-centred design

The More-than-human-centred design approach rejects human exceptionalism. Instead, it acknowledges that human society exists within a complex ecosystem of nonhuman actors, including technology, animals and the environment (see fig. 3) (Giaccardi et al., 2024). In doing so, MtHC design moves away from traditional concerns of human-centred design - users, products, and functionality - and instead turns towards ecologies, entanglements, and relations (Yoo et al., 2023). More importantly, in the context of the sustainability issue and climate change, MtHC design aims to detach human well-being from capitalist gains and instead hopes to reconnect humans to their ecosystems (Yigitcanlar et al., 2019).

As Nicenboim et al. (2023), state, a “decentering” of the human in our design practice is needed to take a critical perspective and challenge dominant viewpoints and narratives. Decentering does not mean that the human disappears from the focus of design practice. Instead, the focus is broadened, allowing nonhumans to “share” centre stage, and to be understood as active participants in the design process (Forlano, 2016; Giaccardi, 2020, p. 124; Wakkary, 2020, p. 117). Smith et al. (2017) stress the importance of decentering the human as a means to develop technologies and practices that shape environmentally and culturally sensitive cities.



fig. 3: From human-centered towards more-than-human-centered design (Poikolainen Rosén et. al (2022))

## entanglements & eco-social change

As stated by Smith et al. (2017), cities are often described by their technological, cultural, social and political aspects, and the ecological aspects that would show the entanglements within the city are often left aside. As they explain, natural elements within the city are seen as designed spaces or apart from urban space. However, as urban nature becomes increasingly present and important, cities need to be approached as entanglements of humans, technology, and nature (Smith et al., 2017; Pollastri et al., 2021; Bessai et al., 2024). *Eco-social change* is a concept drawn from the CreaTures Framework, which describes a “CreaTurely” approach to the challenges of our times, based on the acknowledgement that there is no ecological without social, and there is no social without ecological (CreaTures framework, n.d.). In other words, they focus explicitly on our interdependence with nature and believe climate and social justice should go hand in hand (CreaTures framework, n.d.).

Pollastri et al. (2021), explore ecology-centred approaches, in which architecture and landscapes of future cities support the coexistence of multiple species in what they call ‘mediated matter.’ According to them, mediated matter is the result of multi-species entanglements based on “processes, systems, rhythms and activities” (Pollastri et al., 2021).



## the act of noticing

Noticing is a commonly discussed concept in the field of More-than-Human-Centred design (see fig. 4). As stated by Bessai et al. (2024), to notice something means to acknowledge something, to treat it as worthy of attention. Poikolainen Rosén et al. (2022) propose it as a method in urban gardening to raise awareness of the mutual interdependence of humans and nonhumans. As they explain, gardening is a powerful practice for pushing MtHC approaches among residents by making them notice positive human experiences concerning the needs of the environment through close interactions with plants and the soil (Poikolainen Rosén et al., 2022). Additionally, they stress the importance of noticing oneself as part of the interdependencies within an ecosystem, as a means to understand one's position within the natural world (Poikolainen Rosén et al., 2022). Similarly, Contesse et al. (2021) show that our perception of non-human agency influences how we understand processes of transformation on multiple (time)scales, and emphasise the long-term trajectory of sustainable change that becomes apparent through non-human worldviews.

Pollastri et al. (2021) explain how design can support the act of noticing by guiding explorations within the environment through representations of nonhuman entities. As they explain, the process of designing our environment should start with immersively engaging ourselves within the ecosystem and its intricacies, to understand the more-than-human aspects of our environment. As they state, this engagement can motivate stakeholders in adaptation measures to design with nature, create new forms of knowledge, give agency to multiple species, and allow us to transition our environment towards MtHC cities.

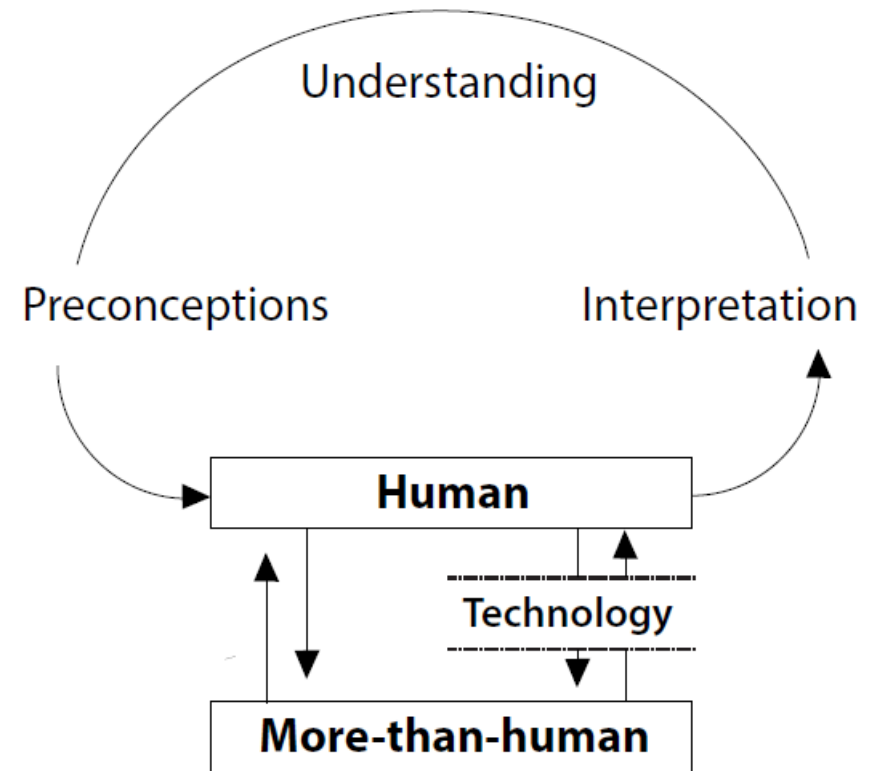


fig. 4: Noticing a more-than-human world  
(Poikolainen Rosén et al. 2022)

## 3.2

# CreaTures framework

As mentioned before, the concept of eco-social change describes how social and ecological justice go together to build resilient systems and communities. Along with the concept of eco-social change, the CreaTures framework project describes 25 creative pathways towards better futures (Vervoort et al., 2024; CreaTures, n.d.). Vervoort et al. state nine dimensions (see fig. 5), divided into three categories, for the evaluation of how art and creative practice can stimulate societal transformation (see Fig. X). As they explain, creative practices can help societal transformation by changing meanings, connections and power. The nine dimensions, as well as the 25 creative pathways, explore different approaches to changing our relationship with nature, and have shaped with what goals and functions the AI systems in this project were designed.

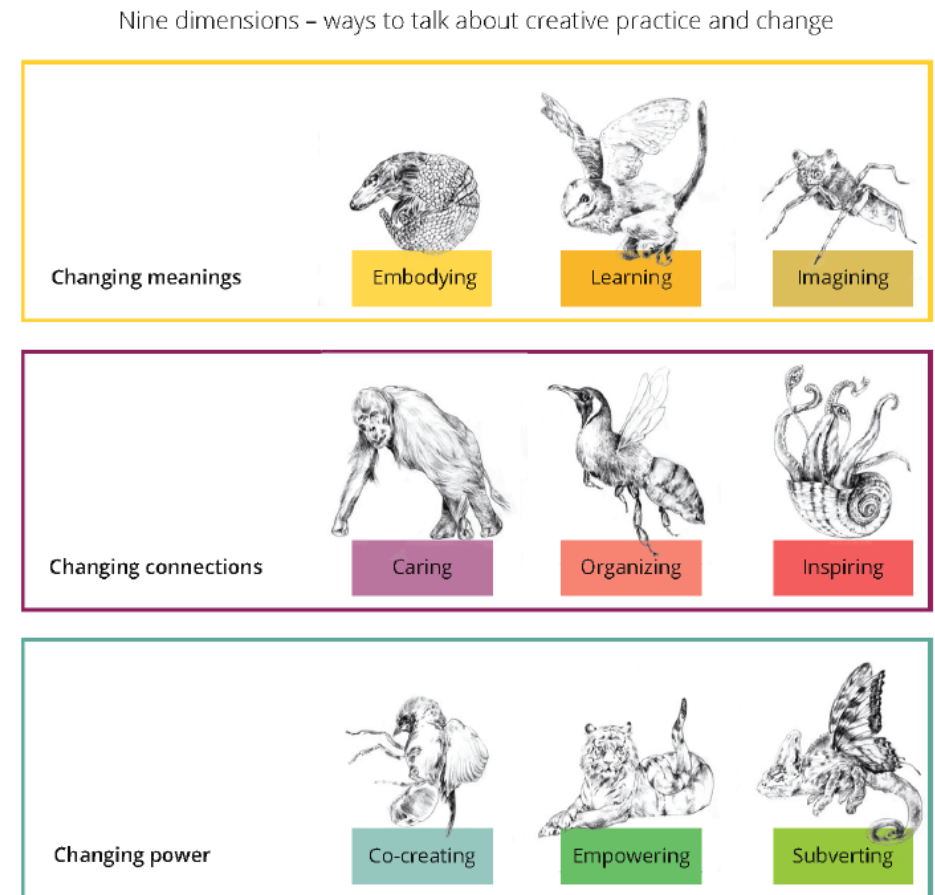


fig. 5: Nine dimensions for evaluating how art and creative practices can stimulate societal transformation (CreaTures framework, n.d.)

## 3.3 Augmented Collective Intelligence framework

The Augmented Collective Intelligence (ACI) framework (see fig. 6) has been developed by Dark Matter Labs and Lucidminds as part of their CivicAI project; a project in which they explored how communities can better respond to the climate crisis in collaboration with AI technologies (Dark Matter Labs & Lucidminds, n.d.). In the ACI framework, they illustrate how different facets and activities from both human and artificial intelligence can interact to enhance the capabilities of groups of people for decision-making in community transition projects. This framework has been used to explore and analyse design concepts based on how AI systems can fit in and support urban communities in initiating adaptation projects.

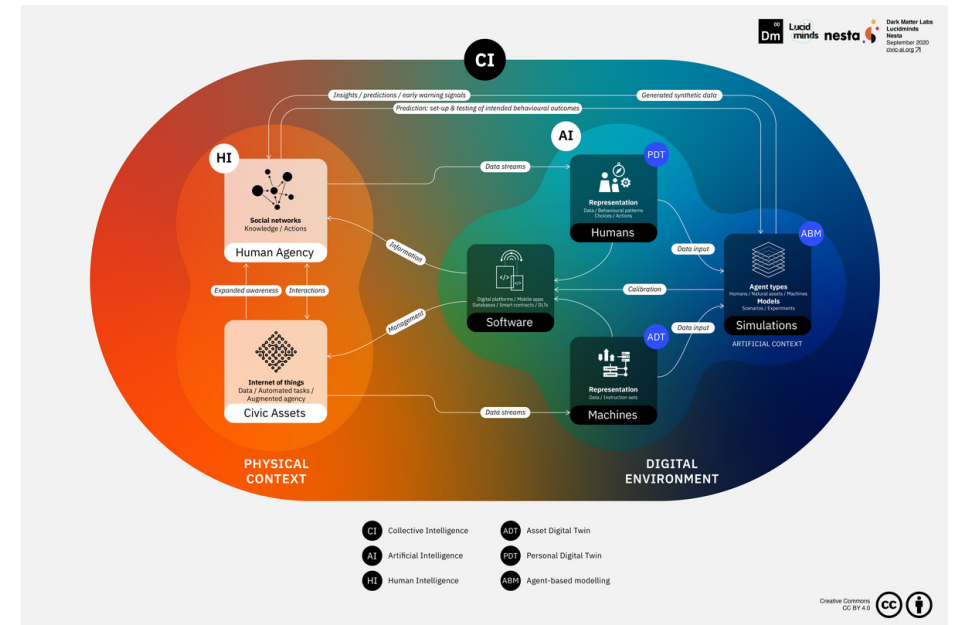


fig. 6: ACI Framework by Dark Matter Labs and Lucidminds (n.d.).

## 3.4 conclusion

The MtHC design approach offers interesting concepts for reconsidering our relationship with nature and technology, highlighting the entanglements and interdependencies that exist within ecosystems. The act of noticing is seen as having much potential for motivating residents to adopt MtHC approaches to their adaptation measure, as it raises awareness and builds connections between humans and natural species. The CreaTures framework, combined with the concept of eco-social change, has highlighted the need to consider both the social, and ecological aspects of communities in CBA projects. The nine dimensions and 25 creative pathways have been used for design inspiration that focus on societal transformations. Lastly, the ACI framework has offered practical inspiration for analysing the interactions and collaborations between residents and AI systems, and how these can enhance the capabilities of communities in CBA projects.

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# section 4

## Exploring

This section presents the design explorations that have been done, using the insights from the Grounding and Methodology sections as starting points and design inspiration. Three initial concepts are presented that have been evaluated with the expert panel. Following this, another concept iteration is presented and reflected upon. The section ends with a conclusion, presenting the main findings from the design explorations, and showing how the concept is further explored in section 5: Materialising.

## 4.1 initial concepts

Starting from the themes that emerged in the Grounding phase, and influenced by the theoretical frameworks, the Exploring phase started. The circular CBA model was used as a means to initiate brainstorming activities in the different phases of the process and allowed the concepts to be positioned within the ecosystem of CBA projects. Similarly, the themes were used to generate design directions that would target specific aspects and challenges of CBA projects. The MtHC design approach, as elaborated on in the Methodology section, directed concepts towards expanding the resident's perception of community to include nonhumans. Additionally, the CreaTures framework and the ACI framework were used for inspiration in the design explorations (CreaTures framework, n.d.; Lucidminds, n.d.). The CreaTures dimensions and pathways inspired ways to reconsider the connections, meaning, and power between the community and the AI technology, other stakeholders, or nature. The ACI framework gave insights into how the communities could be enhanced in their knowledge buildign and decision making through AI technologies.

After extensive brainstorming, three concepts were further developed through sketches and storyboards as a means to elaborate on the designs and make them discussable with the expert panel previously consulted in the Grounding phase. The concept explorations focused on different aspects, challenges, and phases within the CBA process as a way to explore where AI interventions could be interesting and meaningful. The initial concepts are presented in the following section, and an overview of the feedback from the expert panel is shown per concept.



## neighbourhood sensing

The *Neighbourhood Sensing* concept emphasised the moment of integration of AI technology within urban communities. As became clear from the expert interviews, how the communities were introduced to the respective technology had a large impact on how comfortable they were with using it. A wrongful introduction could lead to a perceived loss of agency in the community, which would keep them from using the technology. Thus, for this concept, it was ideated that the technology would be introduced to the community through a participatory activity in which the residents would build their “digital twin” of the neighbourhood by driving a movable camera around.

The movable camera, in which object detection algorithms were embedded, would analyse the neighbourhood while being driven around by the residents. With a screen attached to the device, residents could view what was being picked up by the device live to discuss it in the moment. This way, driving around the neighbourhood would become a participatory activity for the neighbourhood to explore their environment together.

Following the initiation activity, the residents would receive an overview of their neighbourhood. This overview could then help them decide how they wanted to approach their adaptation project.

### The concept focused on the following themes:

1. Interdisciplinary Teams & Knowledge Sharing
2. Project Ownership & Attachment
6. Bridging (Nonhuman) Perspectives
7. AI to Help Humans, not Replace Them

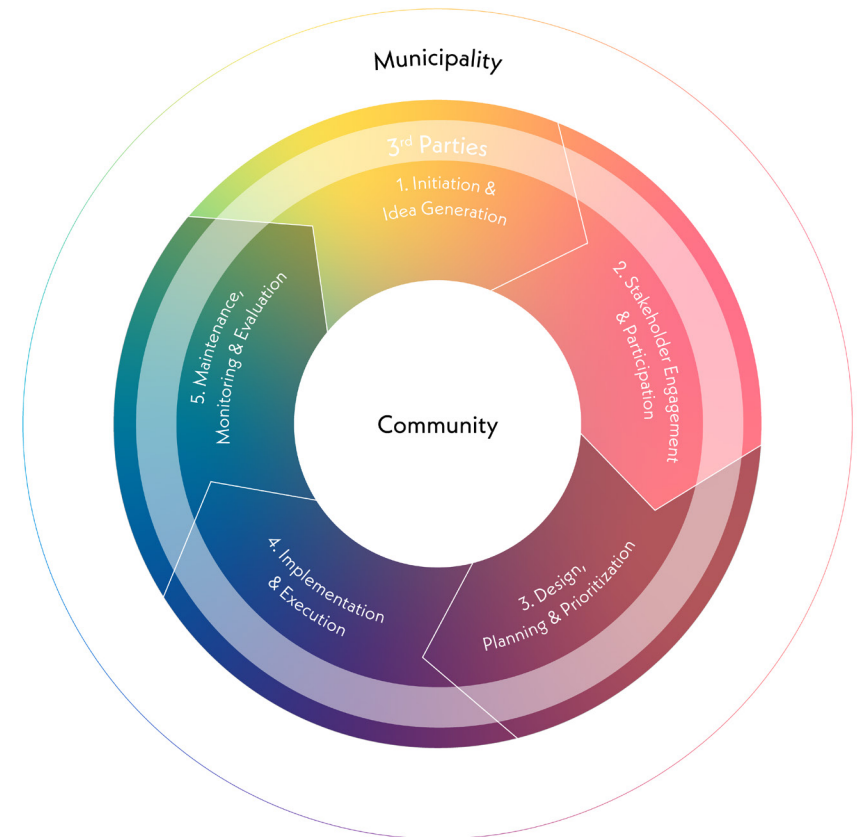
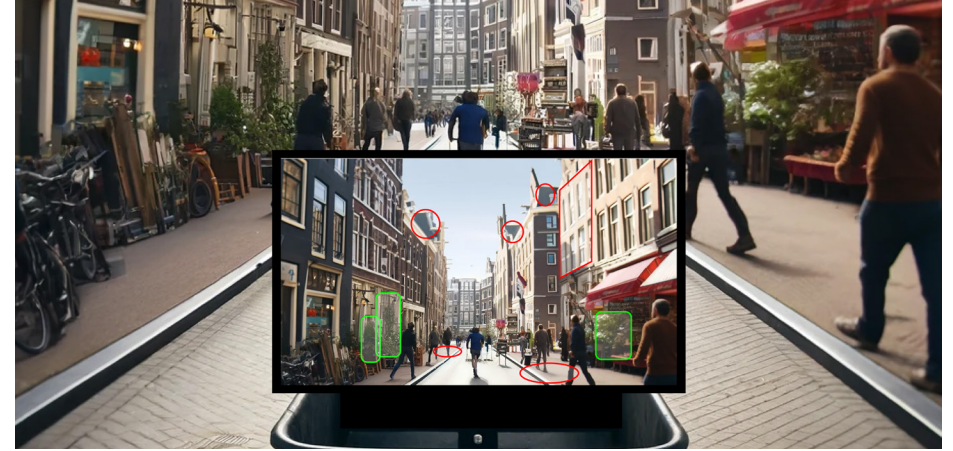


fig. 7: Positioning the concept within the CBA process

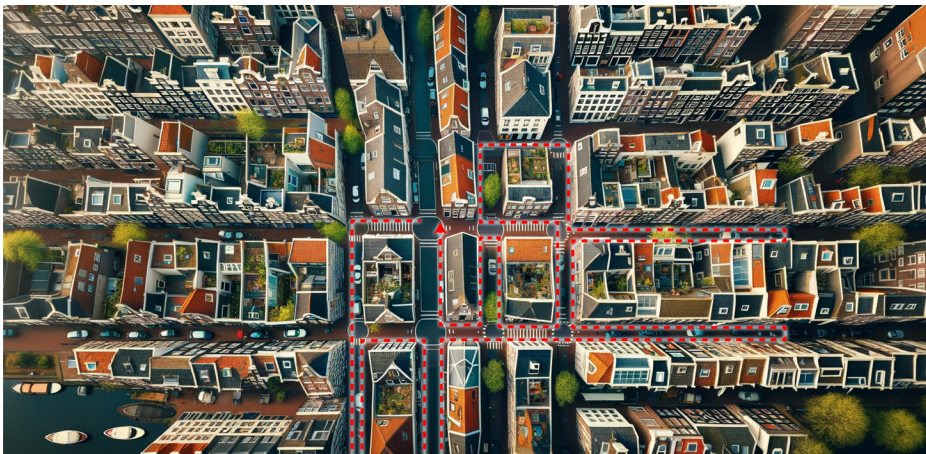
## storyboard



1. Residents drive a camera through their neighbourhood



3. The camera records natural species and room for adaptations



2. They decide what route to take and what to record



4. Residents use the recordings to discuss with stakeholders

## Feedback received

In conversations with the experts, two aspects of the concept were discussed the most; the activity of driving the device around, and the way in which adaptation possibilities and nonhuman entities would be presented to the residents.

Many of the experts mentioned how the physical embodiment allowed the technology to become a participatory tool for the community. The community could use the device to initiate their CBA process and learn about their neighbourhood together with the machine (E7). E5 added on to this, saying that it would be very exciting for the public to go on *“walk and talks with the machine, and notice things around them.”* E2 highlighted the potential for the participatory activity to get *“many stakeholders together and, in doing so, breach a lot of barriers that otherwise hinder CBA processes.”*

In how the system presented the possibilities and nonhuman species, experts saw both potential and danger in its effects on the residents. E5 mentioned that the activity should be a quiet, humble, and reflective exploration of possibilities instead of a presentation of fully fleshed-out ideas. E8 highlighted the need *“to consider - also depending on the adaptation measures - what nonhuman worldviews can be brought in, and why.”* This was also mentioned by E7, who discussed *“different ways of representing nonhuman entities,”* and how this would impact the residents' perceptions and, consequently, their approach to CBA processes.

However, another important point of feedback was that the system was trying to do too much at the same time. Instead, sizing it down to focus on particular issues could make the system more useful and plausible. As one expert mentioned, simply *“raising awareness and showing possibilities is already enough”* (E5). E4 added on to this by mentioning how different people may want different ways to sense their environment, and thus suggested creating an ecology, or set, of tools that could sense the environment in different ways.



## nonhuman perspectives

The *Nonhuman Perspectives* concept was focused on raising the agency of nonhuman entities in the CBA process. By raising the nonhuman agency in adaptation decision-making processes, the intent was to raise the ecological awareness and thinking of residents. With this concept, the goal was to raise the agency and presence of nonhuman entities in the neighbourhood. The concept revolved around residents collecting data about the nonhuman species in their environment, as well as sensors measuring the environment. From this collected data a nonhuman representative, in the form of a conversational agent or digital report, would suggest adaptation measures to improve the situation for the nonhuman species.

The nonhuman representative would not take human concerns into account. This was deemed unnecessary as human stakeholders already have more agency in these processes, and this way the nonhuman agency would be elevated to match their human counterparts. Since the nonhuman representative could only suggest measures to the residents or other stakeholders, there was still a lot of power in the hands of the human stakeholders. The experience was mainly meant to push people to reconsider how they see and treat their environment.

### The concept focused on the following themes:

1. Interdisciplinary Teams & Knowledge Sharing
4. Work Beyond Execution
6. Bridging (Nonhuman) Perspectives

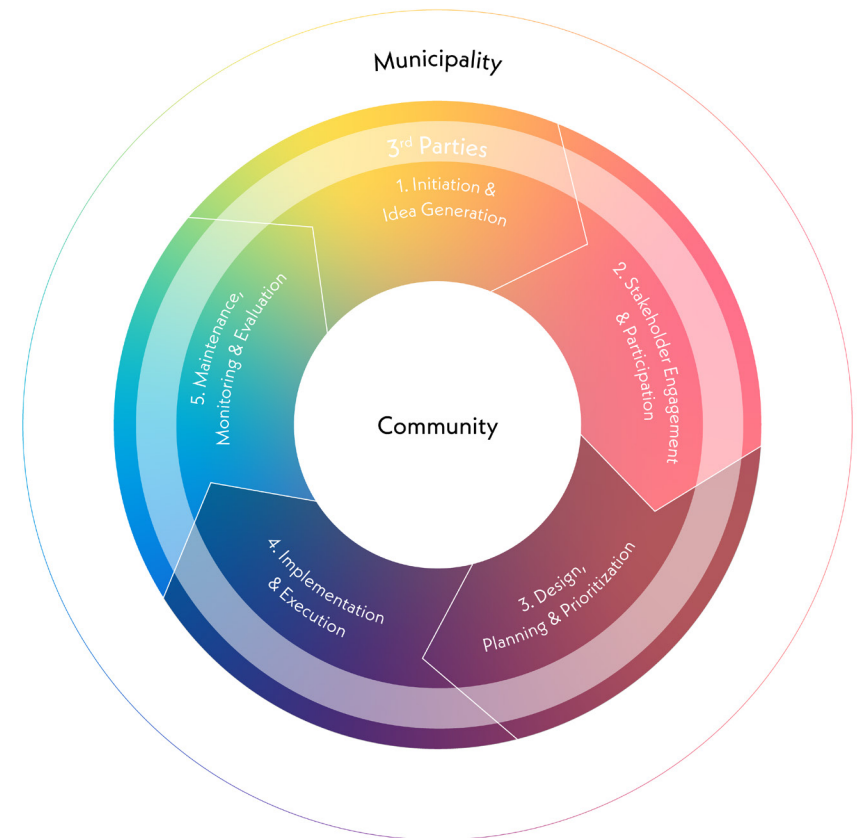
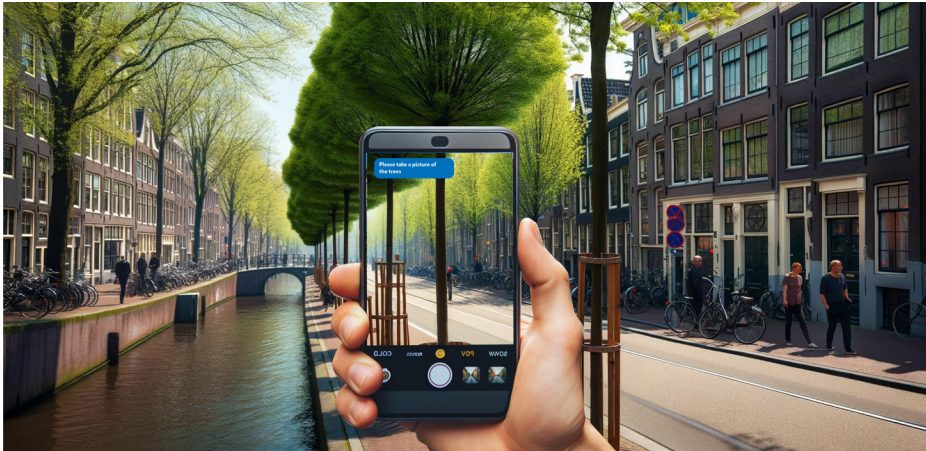


fig. 8: Positioning the concept within the CBA process

## storyboard



1. Citizens record information about the natural species



2. Additionally, sensors monitor the environment continuously



3. Residents receive a report on the state of the natural species



4. The adaptation plans account for the natural species

This concept initiated a lot of discussions about data and knowledge. On one hand, multiple experts, again, saw the benefit of raising awareness among residents of the nonhuman species that surround them (E7). Additionally, through the raised agency of nonhuman species and by solidifying their position using data to influence policymaking, neighbourhoods could be redesigned to better account for the needs of nonhumans (E4, E6).

However, other experts noted that the concept could go beyond simply presenting nonhuman species through data. This was strengthened by the question of what the incentive was for residents to go out and collect the data (E7). Instead, they mentioned the need to bring in the nonhumans and to design activities that strengthen the connection between human and nonhuman stakeholders (E8).

Finally, in the conversations, the discussion arose about whether a digital agent should represent a single nonhuman species, or consider the neighbourhood as an ecological entity (E4). This would greatly influence the adaptation measures suggested by the agent, but would also affect how the residents perceived the nonhumans around them (E7).



## future neighbourhoods

The third concept, Future Neighbourhoods, intended to use conversational agents and generative AI to enhance the agency of individual residents by interviewing them and speculating with them about the future of their neighbourhood before presenting the different visions at a collective project meeting. This concept was designed around the following common problem in CBA processes: when initiating CBA projects from a top-down position, municipalities often lack the time or resources to interview the residents of a neighbourhood thoroughly. Because of this, residents can feel like they're left out of the conversation concerning their environment. To counter this, the idea for a conversational agent that would interview residents individually before a collective meeting arose. The CreaTures framework (n.d.) describes how working to inclusion and creating new frames can help to change power among stakeholders and focus on co-creating. The ACI framework describes how simulations can generate synthetic data that open up discussions and inform public decision-making.

This interview would allow the system to investigate what different needs and wants are for the development of a neighbourhood. Additionally, through generative AI, the residents could speculate together with the agent about how they saw the future of their neighbourhood.

Following these interviews, the digital agent could analyse the different visions for the neighbourhood, and present these at the collective stakeholder meeting. This way, the different futures of the neighbourhood could be used as discussion tools, showing similarities and tensions between the different visions.

### The concept focused on the following themes:

2. Stakeholder Engagement & Participation
3. Soft Values & Local Needs
5. Storytelling & Visualisations
7. AI should Support Humans, not Replace Them

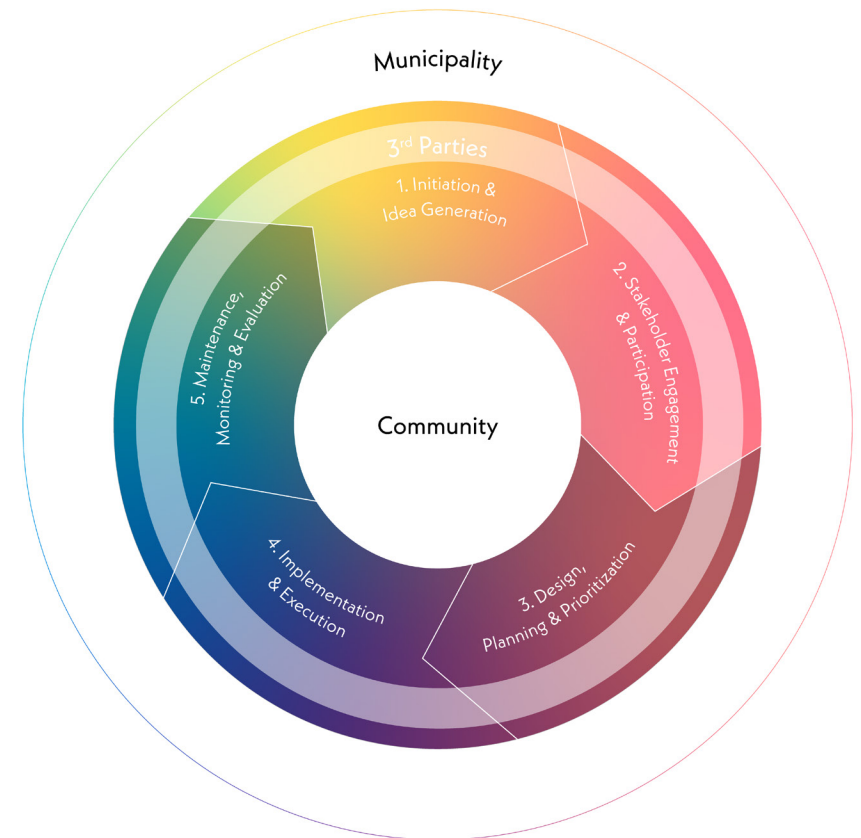


fig. 9: Positioning the concept within the CBA process

## storyboard



1. Residents are interviewed about their vision for the future of their neighbourhood



2. The system collects and analyses the different visions



3. The system presents the different visions at the stakeholder meeting, and facilitates discussion about the possibilities



4. Finally, the system helps the stakeholders to create a plan to work towards the shared vision for the future



## Feedback received

Discussions that arose during the conversations with experts were again mainly twofold. On one hand, experts saw a lot of potential in making residents more aware of the agency and power they hold in these projects. On the other hand, experts had varying views on the use of the different future visions. Concerning the resident's level of agency, experts mentioned how these future visions could work as arguments for defending their needs and desires, as E6 highlighted that residents often have more agency than they think. E4 speculated that the digital agent could become a liaison for the community by fitting their ideas and visions within the legal frameworks of the municipality.

For the views on future visions, experts saw a lot of potential for presenting tensions between future visions as a way to guide discussions in the stakeholder meetings. They mentioned that the visions should work as a way to raise awareness of the differences and similarities between stakeholders, instead of aiming to end up with a singular vision that represented the plan (E7). A concern, however, among the experts was the difficulties for residents to understand the difference between a seducing visualisation and a feasible, thought-through design (E5).

## 4.AI sketching & storyboards

OpenAI's Dall-E (through the ChatGPT-4 interface) was used to generate visuals for the concept pictures and storyboards. In generating the visuals, questions regarding what can be considered a design sketch arose. On one hand, the speed and ease of use that is offered by working with these image generation tools fit well with the concept of sketching as a means to quickly jot down ideas in a visual way. Instead of ambiguous, difficult to understand concept drawings, it became easy to sketch not only the design artefact but also the context in which the design would be used. On the other hand, the relatively high-quality of the storyboards generated different insights and feedback during the expert evaluations, and it became clear that there was a lot of information in the picture that I hadn't thought about. While the parts I hadn't considered came with insights I may not have retrieved from hand-made sketches, I apparently fell into the same trap as was speculated by one of the experts on the Future Neighbourhoods concept; a seducing visualisation had portrayed itself as a feasible, thought-through design. In evaluating the concepts, and the storyboards that were used to discuss them, it became clear to me I had appreciated the high-quality output without carefully considering each aspect of the pictures generated.

As the activity and result of sketching with GenAI systems seem to misalign, it should be approached with caution and a sense of criticality towards the output. A middle way may be found in using GenAI systems that offer outputs that resemble human sketches made with pencil.

## 4.2 concept iteration

Following the insights from evaluating the initial concepts, a new concept was developed that was focused on exploring the neighbourhood as an ecological system. Pushing residents to become aware of the ecology and interdependency of their local ecosystem was seen as a potential way for pushing MtHC approaches to the adaptation measure. Thus, an activity in which they became aware of the ecological connections in their neighbourhood could serve as a valuable part of the initiation of CBA projects. For this, the Ecological Imaginations with GenAI concept was conceived.

## ecological imaginations

This concept revolved around considering a neighbourhood as a living, ecological entity. In the context of a 3D-rendering of a neighbourhood, citizens could explore their environment. The system would start the analysis of the neighbourhood by identifying the nonhuman species that were present. Based on this, it would visualise where ecological connections were made (e.g. fields of trees and shrubbery), and where in the neighbourhood there were barriers to the ecological health of the neighbourhood (e.g. streets and stone walls). In communicating with the residents, the system would create new frames of thinking about the opportunities to activate communities, as described in the CreaTures framework (n.d.). Additionally, due to the ecological focus, it gave accountability to more-than-humans, and invited residents to collaborate with living materials (CreaTures framework, n.d.). Considering the ACI framework, the digital interface could be seen as a digital twin of the neighbourhood that offered insights and prediction to support human agency (Lucidminds, n.d.).

Following this initial analysis, citizens could explore how they could enhance the ecological health of their neighbourhood. When being asked to do so, the system would identify opportunities for replacing barriers with ways to build connections. For instance, it would suggest removing certain parking spots to connect two fields together. When exploring opportunities presented by the system, citizens would get a photo of the current barrier and a visualisation of the potential measure created with generative AI. Furthermore, the system would provide information on what plants should be planted, and what kind of activities were necessary for realising the adaptation measure.

## storyboard



1. Residents receive a 3D model of their neighbourhood, simulated as a living entity through breathing movement



3. Based on the identified plants and their surroundings, the system shows where there are ecological connections



2. The system identifies what plants are present in the area



4. Following this, the system identifies barriers to the ecological connections in the neighbourhood





5. After the analysis, the system proceeds to offer advice on where there is room for adaptation measures



7. Additionally, the system offers advice on what plants would be best to plant in the neighbourhood



6. The system shows a how the improved situation could look like



8. To conclude, residents can download a report on how to realise the adaptation measure

## Feedback received

While the concept had some interesting ideas, it ran into the same problem as the Neighbourhood Sensing concept as it was trying to solve too many issues at the same time. Focusing on one or two of the functions as provided by this system would already be enough to be an interesting design tool. Furthermore, the large-scale ambience of the 3D-rendering interface felt unfitting for the local scale on which communities normally operate when initiating CBA projects. A smaller, more intimate, and humble tool would be better suited for this concept as it would avoid overwhelming the residents and instead raise their perceived sense of agency. Additionally, exploring the ecological connections in an outside context would allow residents to build stronger connections with nature than if they were sitting behind a computer inside, which could better motivate them to adopt MtHC approaches to the CBA projects.

## 4.3 conclusion

The four concepts presented in this section show interesting aspects of AI collaborations in the context of CBA, and have started the exploration of how AI can help us reconsider our relationship to nature. Designing the AI system to be humble in its functioning and presentation will offer residents the time and opportunity to sit with their context, and understand the possibilities without immediate solutions and plans being pushed on them. In general, it was considered that highlighting opportunities and tensions for the development of adaptation measures was more meaningful than simply offering solutions. This would turn the AI system into a tool for exploration and discussion, while leaving the responsibilities and decisions in the hands of the community.

Considering the CreaTures framework, it becomes clear from the concept explorations that engaging residents in the process of understanding the natural world changes both their connections to the ecosystem and their power within the CBA process. By collaborating with living materials, working from a particular place and offering accountability to more-than-humans, residents can discover the agency and interdependency of nature (CreaTures framework, n.d.). Additionally, by solidifying the data about these natural species, the AI system strengthens the residents in bridging worldviews and engaging with governing bodies through communication and collaboration.

For the ACI framework, these explorations have shown how AI systems, by identifying opportunities and simulating possibilities, can enhance the knowledge and decision-making capabilities of residents. Furthermore, in exploring and solidifying the natural species through data, the local ecosystem becomes a civic asset that supports the decision-making process and raises the agency of nonhumans in these processes (Lucidminds, n.d.).

Finally, understanding the connections between different species as explored in the Ecological Imaginations concept was seen as promising for helping people uncover the natural world and its complexities. In this regard, an important aspect of this discovery is designing the AI system to help residents build connections with nature instead of distracting them from nature. These insights are further explored in the following section, which highlights the Materialising phase of this project, concepting, prototyping and evaluating that has developed into the final concept.





# section 5

## Materialising

Following the concept explorations and the insights that were presented in section 4: Exploring, the project moved towards a design concept in which residents would, in collaboration with an AI system, explore their local climate and ecosystem in order to decide how to redesign their neighbourhood from the status quo.

This section presents two iterations of concepting, prototyping and analysis, with findings that lead up to the final design concept.

## 5.1 community planting coach

To put more emphasis on the connection between residents and their local ecosystem, the project moved away from 3D-rendering. Instead, the collaboration with the AI system was designed to happen outside, in the context of the resident's neighbourhood. Similarly to the concepts described in the Exploring section, this concept focused on the early stages of the CBA process. More specifically, the concept was designed for residents that were initiating a greening project within their neighbourhood, but who were unsure what plants they should place. This was chosen as an accessible context for this device, as it avoided many bureaucratic issues and the need for large-scale organisation. Additionally, it fits the community-aspect, as it is often done by multiple neighbours together after one of them decides it can improve the street's ambience and aesthetic. Through these decisions, the *Community Planting Coach* came into existence. The Community Planting Coach would aid residents in deciding what crops to plant by guiding them through the process of understanding their local climate and ecosystem.

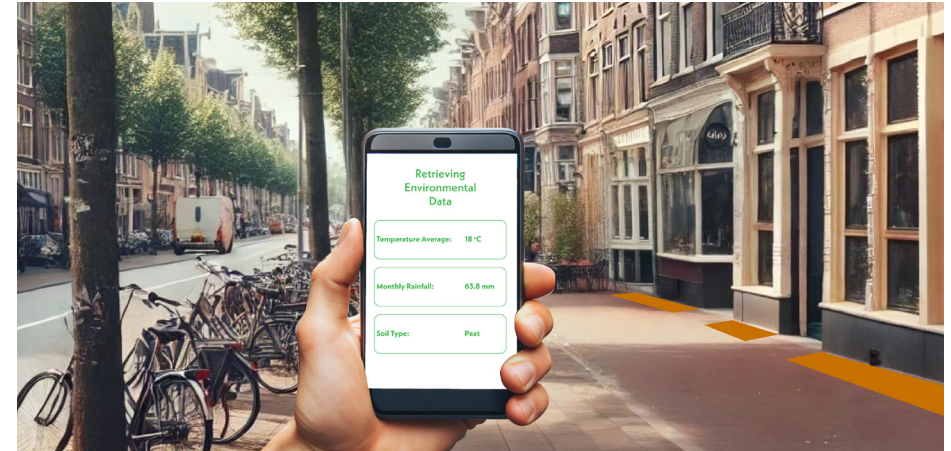
To push MtHC approaches to adaptation measures among the residents, nonhuman needs and desires were brought in as topics of consideration. Instead of only tending to the desires of the residents, how could the conversational agent take nonhumans into account as well? And, more importantly, could the agent motivate residents to do the same? To push these considerations among residents, they were tasked to go out and explore their neighbourhood. In doing so, the AI system would guide them to notice the different species that were present in their ecosystem, creating new frames for thinking and pushing MtHC approaches, as well as offering accountability to more-than-humans as described in the CreaTures framework (n.d.).



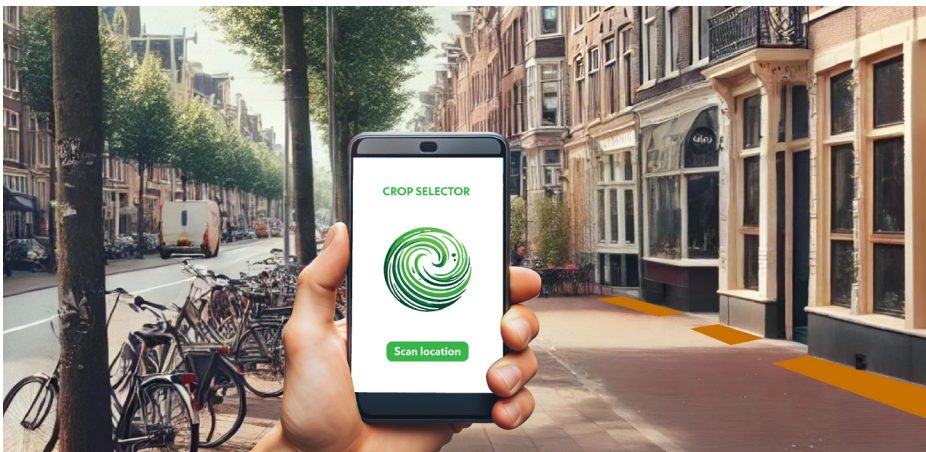
## storyboard



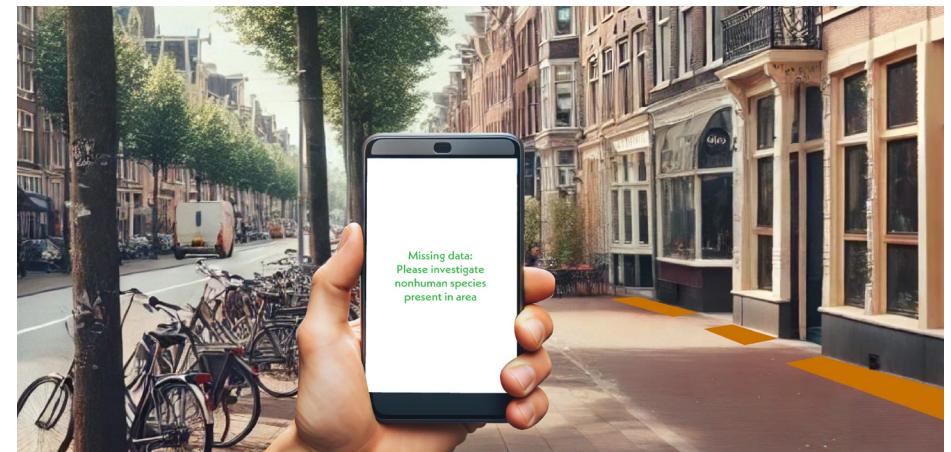
1. Residents use Entangled Intelligence to explore their local ecosystem



3. The system notifies the residents that the first node has been added to the ecosystem, as is also visible on the Map of Entanglement

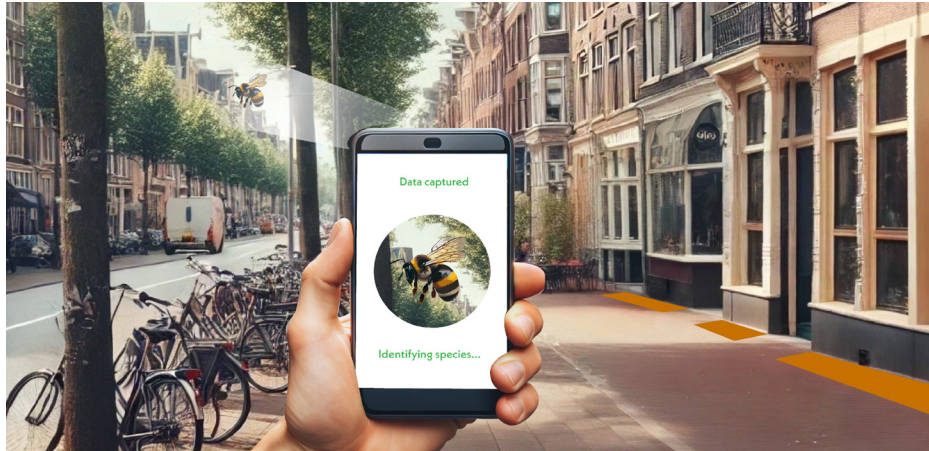


2. Residents enter their location and the system collects data on trees present in the area

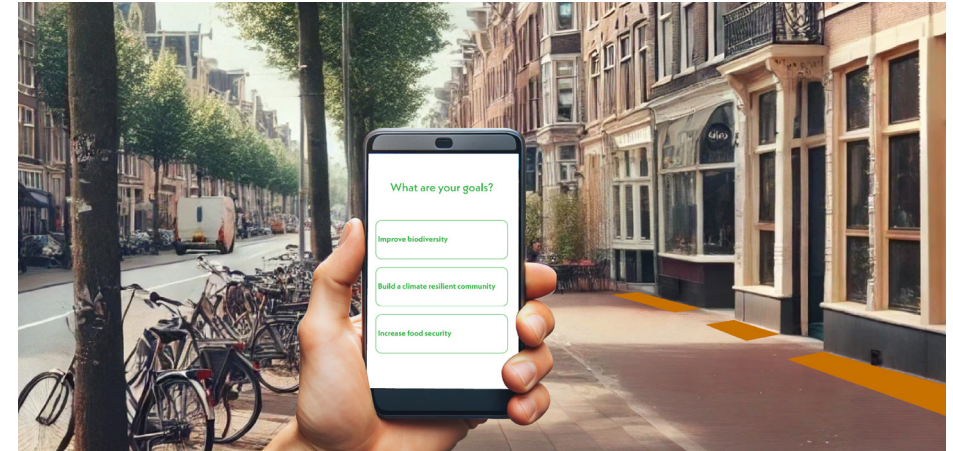


4. Clicking on the node expands it, offering the resident a poetic description of the species

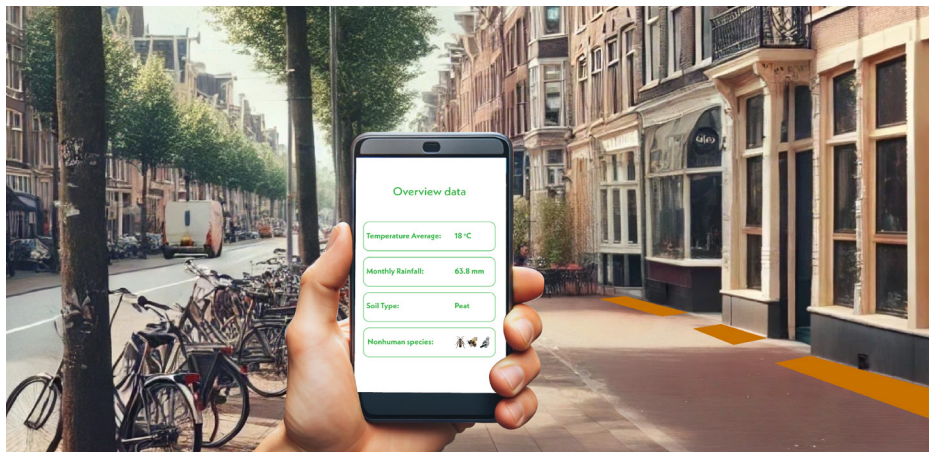




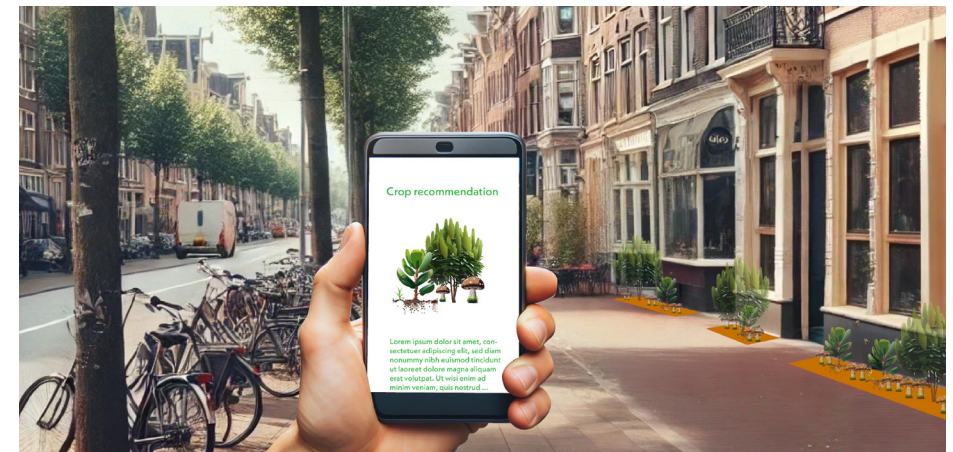
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3. The system notifies the residents that the first node has been added to the ecosystem, as is also visible on the Map of Entanglement



2. Residents enter their location and the system collects data on trees present in the area



4. Clicking on the node expands it, offering the resident a poetic description of the species

## creating the prototype

Following the concept and storyboard, a prototype was made to test the idea. To get a better understanding of how residents would experience interacting with the Community Planting Coach, an interaction flow was created on Figma (see fig. 10). Through interacting with the Figma prototype, residents would walk through the process of understanding their local climate and ecosystem together with the agent. As Figma prototypes do not allow access to the phone's camera, the investigation was performed by presenting residents a list of

trees, plants, and insects, and asking them to push the buttons of the species they saw. As the prototype could not actually retrieve data and lead recommendations responsively, the experience of the system retrieving data or recommendations was created by informing the user what the system was doing combined with a loading animation. Again, it was about testing the experience of the interaction, instead of presenting residents with a fully operating system, which is why Figma was chosen as prototyping software.

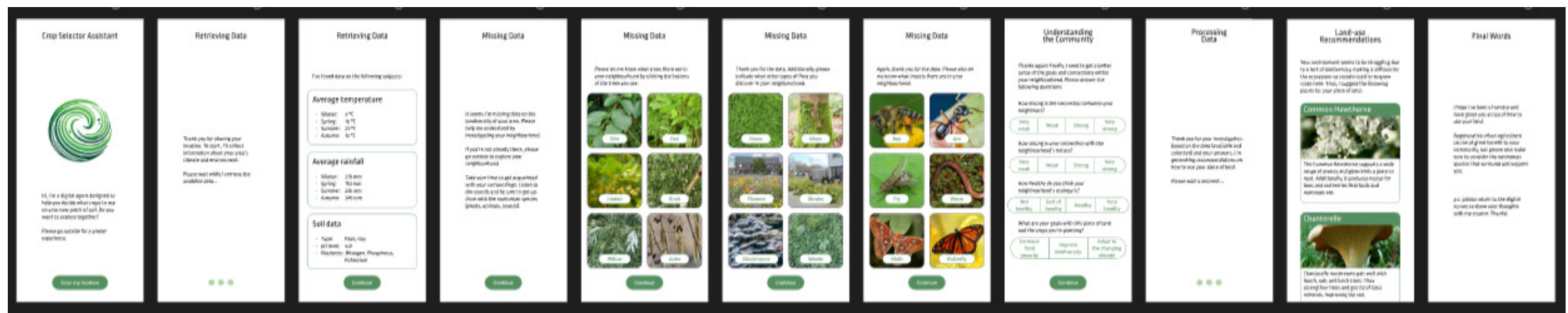


fig. 10: Overview of interaction flow from the Figma prototype



## testing and analysis

To test the concept, the digital prototype was shared among six young adults (mainly students) in Delft and Rotterdam. Using a digital survey, test participants were given a short introduction to the project, received a link to the prototype, and finally were asked some questions to evaluate their experience.

Following the introduction, participants gained access to the Figma prototype and were asked to test the prototype outside, as they needed to investigate their neighbourhood's ecosystem (see fig. I1 and fig. I2).

After the test, a survey (see App. D) was used to gain a better understanding of their experience. As the test was conducted without the researcher present, and the test was mainly used to further develop the concept, participants were asked to share their experiences and opinions on multiple aspects of the interaction. The results from the survey were analysed for further development of the concept.



*fig. I1: Participant starting the interaction with the Community Planting Coach*



*fig. I2: Participant looking for insects as part of the ecosystem exploration*

## results

In total, six participants took part in the evaluation, most of whom were students in Delft. In general, they mentioned that the interaction had helped them to connect with their local ecosystem, as P2 mentioned *“I liked the idea of engaging with my surroundings to understand what is better for the ecosystem.”* Furthermore, P5 stated that *“I like the activity. It forced me to get out and through the medium of a screen it made me look outside.”* and P6 mentioned how the system helped as *“It uses the digital to connect you with the physical surroundings.”*

Generating data for the system was seen as a useful part of the process, as P1 mentioned *“I don’t mind generating data in this case, I understand it’s for my own good and it’s helpful for me. Also the information asked didn’t feel private.”* However, in terms of identifying the species around them, reactions were doubtful, as many participants struggled in recognizing certain species. P1 expressed their struggle by stating *“I felt a bit discouraged when I had to recognize the trees, I don’t really know many trees so it was hard to recognize them only based on the picture of the leaves, I would have needed some help there.”* (see fig. 13).

Similarly, P5 mentioned *“When I was inputting data for generation I kept thinking if I am putting the right data, for example I did not see the worms in the area today but usually I do see them. So, I wasn’t sure if I was supposed to record that as well.”* (see fig. 13).

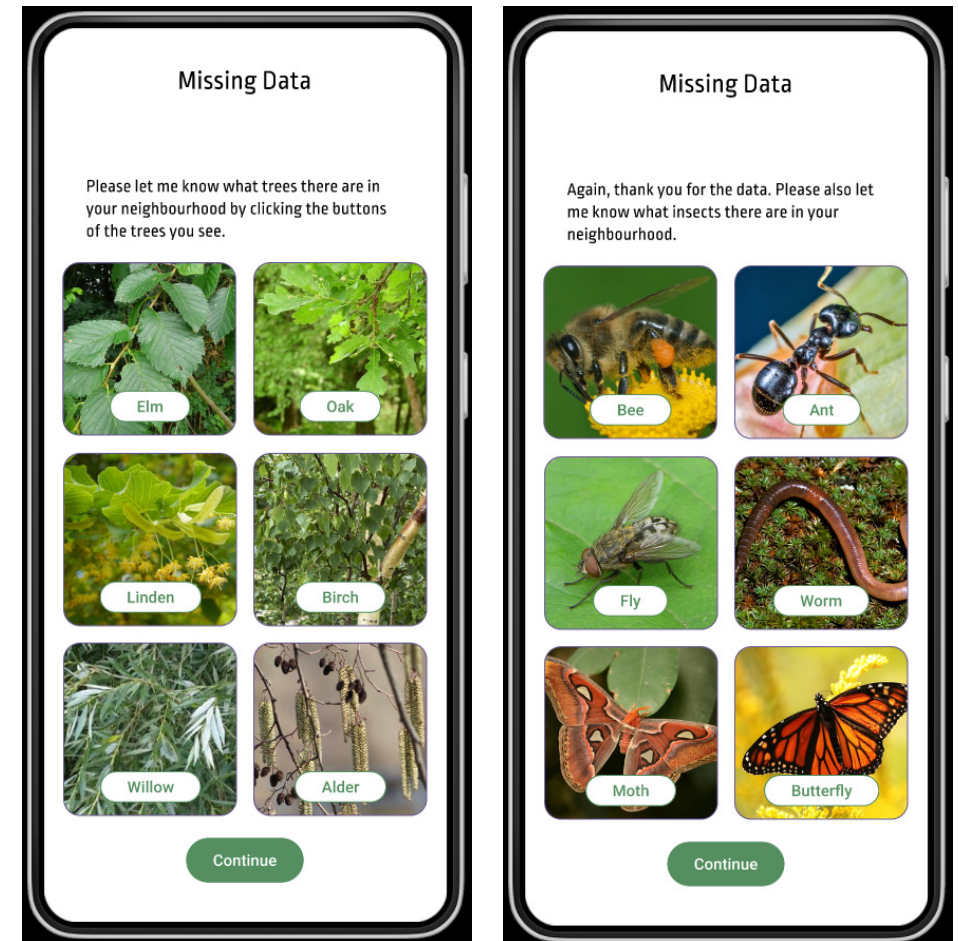


fig. 13: Participants expressing difficulties in recognising trees (left) and finding insects (right) using the Figma prototype



The questions asked by the system regarding their goals for the neighbourhood received diverse responses, as P1 mentioned *“They make sense but it wasn’t clear what they are used for, for some of them I thought they would be useful to give me personalised suggestions afterwards but others felt a bit unrelated.”* P5, however, stated *“It made me sad that there is no community in my neighbourhood. The nature in my neighbourhood made me feel like “oh I can do something so useful just by this.”* (see fig. 14).

Finally, considering the recommendations they received, participants responded positively, as P1 stated *“I imagine that choosing what to plant would be the most challenging part, this is a nice way to lower the effort by also increasing my impact.”* and P2, who mentioned *“Maybe it can also suggest some places where i can find these species, or, some people have already signed up to share their plants for people to improve the biodiversity in other neighbourhoods. That is how the community can empower each other maybe.”* (see fig. 14).

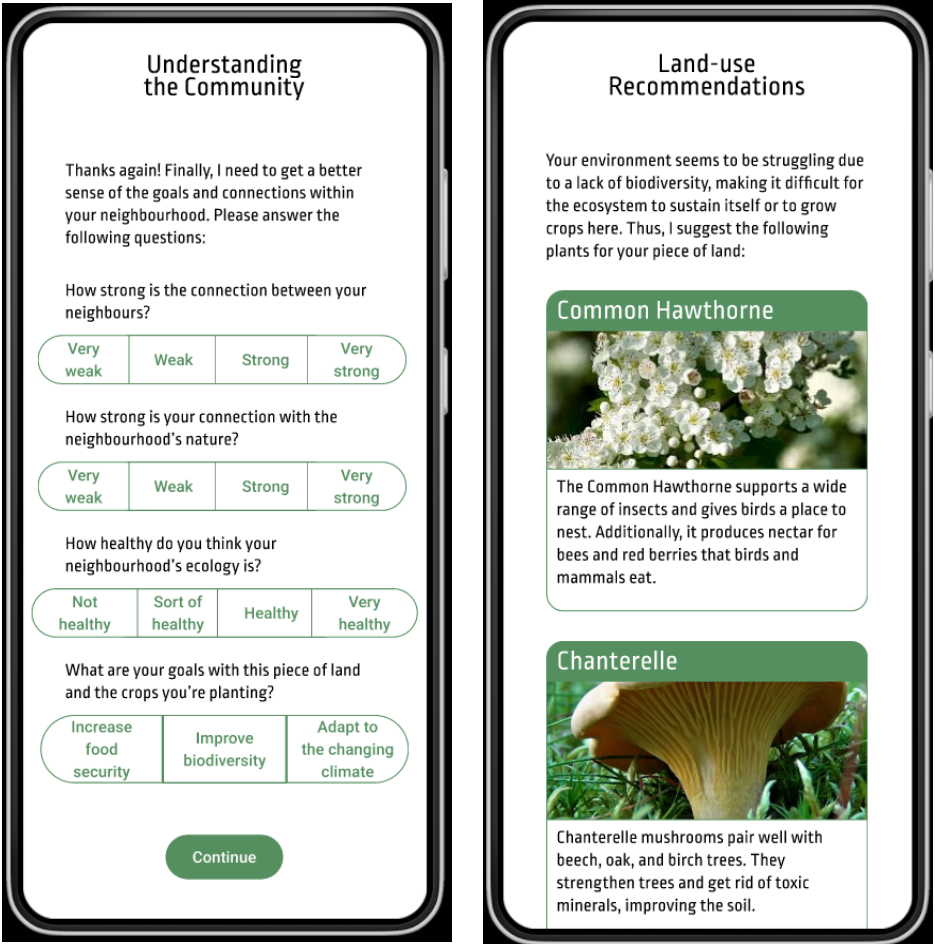


fig. 14: Participants responding to the questions about the community (left) and to the recommended species (right)



## reflection for further development

It became clear from the feedback that the activity of investigating the neighbourhood made most participants more aware of their surroundings and the different plant and insect species that inhabit their neighbourhood. However, multiple participants mentioned experiencing difficulties in identifying the species surrounding them, and they were unsure how to solve this issue during the test. This is not a surprising struggle, as the Figma prototype was unable to match the complexity of actual ecosystems. The six trees that were presented to the participants were chosen based on the most common trees in the Netherlands, but there are many more trees the participants could have had in their neighbourhood. The same goes for the other plant and insect species they were asked to identify. For further iterations, working with a working camera and species-determination software would most likely solve this struggle, and would thus be needed to further explore the participants' experience of investigating the neighbourhood.

The questions concerning the participants' connections with their neighbours and the nature in their environment made multiple participants question how they relate to their place. The results from this aspect of the test are most likely limited from the participants being students, as they are less likely to have a strong sense of community within the neighbourhood due to their short-term stay (in studenthouses). Nonetheless, the interaction made them question how they related to their neighbours and their environment, and motivated some of them to see how this connection could be improved.

Participants responded positively to the recommendations and were excited for continuing the initiative. Some of them mentioned how this could work in a closely connected community, and others mentioned the existing ecosystem and how it could benefit from the new recommendations. However, participants expressed concerns about missing information on knowing how to plant species, and where to get the seeds. More importantly, it seemed as if their considerations did not go beyond the recommendations they were offered. Thus, motivating residents to think critically about what their ecosystem needed became a goal for the following iteration.

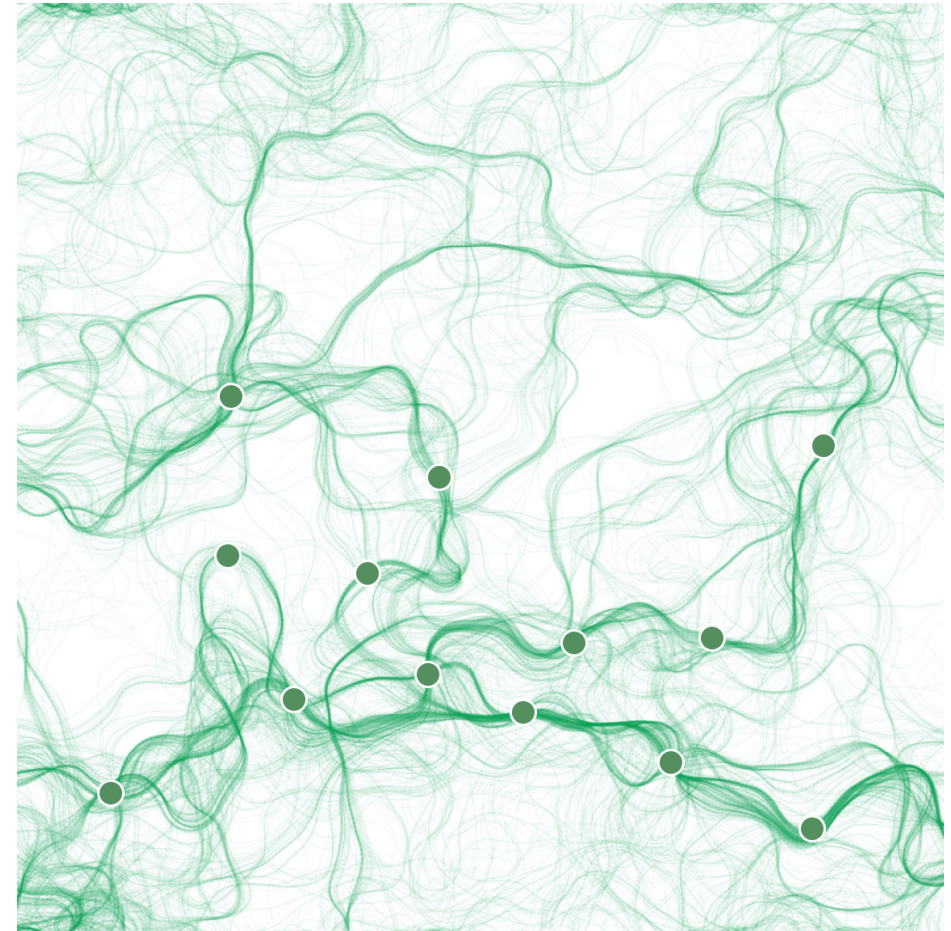
## 5.2 community entanglement coach

Following the testing and analysis of the Community Planting Coach concept, multiple aspects of the concept were redesigned to focus more on motivating residents to consider nonhuman species and their needs when initiating adaptation measures. For this, it was estimated that understanding the local ecosystem from a relational way, meaning how different species were connected to each other, would convey a sense of interdependency among residents. Additionally, the descriptions of the plant species would be more artistic, describing the lifeworld and experience of the plants, insects and animals. For this, the Map of Entanglement was designed, as is explained in the following section.

Apart from that, the step-based approach to exploring the resident's local climate and ecosystem remained the same.

### Map of Entanglement

*The Map of Entanglement (see fig. 15) is a visual representation of the recommended species and how they relate to each other and the ecosystem as it is already present. On the map, nodes are presented that expand when pressed to offer information on different species and their function/connections in the ecosystem. The lines in between the nodes represent connections between different species. The residents obtain this map at the end of the collaborative investigation, and can discover how the recommended species would fit in the ecosystem.*



*fig. 15: Map of Entanglement with nodes and connections representing the ecosystem in a relational way*

Expanding a node would reveal a nonhuman species, i.e. plants, insects or animals, and some information about that species. Instead of providing practical information, a poetic text highlighting the species' function and experience within the ecosystem was given by the AI system (see fig. 16). This way, residents would be encouraged to consider the species from their point of view, and would become more aware of the different responsibilities and roles species may have within the ecosystem.

Additionally, by hinting at companion species, the poems highlighted the interdependence between species. This way, residents could be motivated to think critically about their ecosystem and continue their exploration.

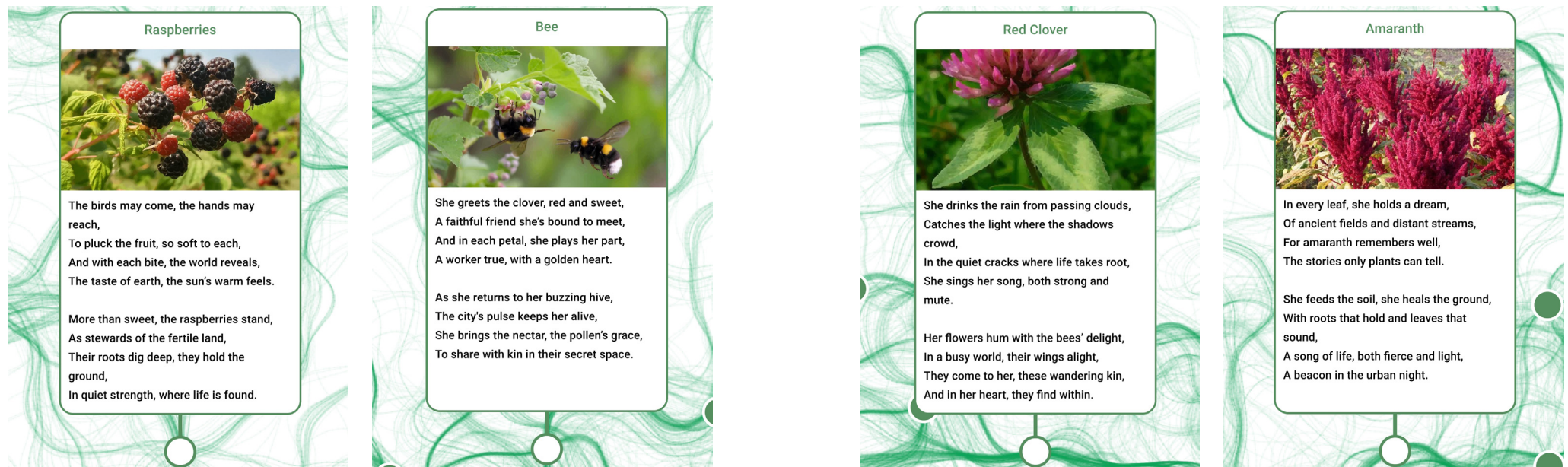


fig. 16: Poetic descriptions of natural species within the ecosystem



## creating the prototype

Considering how the Figma prototype failed to match the complexity of participants' ecosystem, it was needed to create a prototype that would allow participants to use their camera for generating data. To create the prototype, OpenAI's software and models were used to create a GPT-based prototype.

As mentioned before, the step-based approach to discovering the resident's location remained the same, but OpenAI's data allowed the prototype to be properly functioning and responsive to the participant's location and input. The GPT prototype was able to scan the resident's environmental data after they put in their location. Furthermore, it was able to analyse plant and insect species based on the description a user entered, either through text or from a picture taken by the resident. The GPT model also understood native plant species for location, and combined with all the data collected and retrieved by the resident, the system could generate recommendations that would fit the resident's ecosystem.

However, the text-based interface was unfit to show the relationality of different species that would hopefully push ecological thinking among residents. Thus, it was decided that the GPT prototype would link the users to a Figma prototype in which they would perceive the recommended plants.

## 5.AI prototyping with gpt

### A double-edged sword

As a designer with limited coding skills, I was amazed by the power of GPT-based prototypes. Having made an overview of all the data and technology that would be necessary to create this prototype, I was hesitant of my abilities to turn this into a functioning prototype. As an experiment, I decided to create my own GPT, and I was struck by the power it gave me to create responsive interactions and systems. Through an iterative process, I started to understand how I could shape my own GPT – its form of communication, the process it led users through, and the knowledge it had. The GPT model seemed able to do anything I needed it to do, with very limited expert knowledge from my side.

There was, however, also a negative side to the well-oiled machine that my GPT tried to be. The interaction with the system became overwhelmingly positive, and it reduced my critical stance towards the interaction and purpose of the prototype. The device becomes too charismatic too quickly, making me content with the system I had before me. GPT-prototypes, while promising high fidelity prototypes with low fidelity effort, should be approached with a certain sense of criticality during the creation and exploration, as they will otherwise steer designers in directions that fit the model, instead of the concept.



## insights from prototype

In analysing the prototype with my academic supervisors, it became clear that the GPT-process (see fig. 17) of understanding the local climate and biodiversity didn't connect well with the Figma-based Map of Entanglement presented to the residents at the end of the interaction. Additionally, the process felt too broad and complex, and it was discussed whether it was necessary for the residents to receive detailed data on their local climate. The Map of Entanglement was considered an interesting way to visualise the ecosystem, but it was deemed that it should be put more at the centre of the interaction. While discussing this prototype, it became clear that another iteration was needed before the final evaluation would take place, removing all parts of the concept that felt unfitting or unnecessary. The final design of this project, together with the prototype and evaluation, is discussed in the following section.



fig. 17: Exploring the prototype in-context

## 5.3 conclusion

In materialising and evaluating the final design concept iterations it became clear that there's potential for AI systems to support residents in CBA projects and simultaneously encourage them to reconsider their relationship with nature through a guided exploration of the local ecosystem. To motivate MtHC approaches to CBA projects, a level of ambiguity and open-endedness encourage critical thinking from residents. Additionally, by being transparent about what information is available to the system, it can motivate residents to build knowledge together, acting as a humble collaborator in processing data and offering advice.

Considering the creative pathways from the CreaTures framework, it seems these concepts advocate for eco-social change and MtHC approaches by creating new frames of thinking and embedding mutual care within the adaptation initiative (CreaTures framework, n.d.). Furthermore, the CreaTures framework highlights working from a particular place as an important measure for connecting with that place and building from the status quo.

As visible in the ACI framework, the interaction between the resident and the AI system can be described as a constant dialogue of data streams and generated synthetic data to retrieve insights about the ecosystem.

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# section 6

## Final Design

This section presents the an overview of the final concept, the prototype, and the final evaluation with participants and experts. Using the insights from all the previous sections, this design concept demonstrates all the knowledge generated before, and uses that to eventually answer the research question through the final evaluation.

## 6.1 entangled intelligence

Entangled Intelligence is an AI system designed to help residents explore their local ecosystem. This is an activity that would happen early on in the adaptation process, as a way to get familiar with the environment, and to motivate residents to take the current ecosystem into account for their regreening initiative. The broader process of exploring the local climate as explained in the Materialising section has been left aside, with only the exploration of the local ecosystem remaining. Furthermore, the system no longer directly presents residents with recommendations at the end of the exploration. Instead, the focus lies on understanding the state of the environment, with connections between different species highlighted. Instead of providing answers to the residents on how to move on with their regreening initiative, Entangled Intelligence challenges them to consider what is needed for a healthy ecosystem, and how they can take the species that are present already into account when initiating their adaptation projects. This way, the concept creates accountability for more-than-humans and new frames for thinking, and motivate residents to collaborate with living materials (CreaTures framework, n.d.).

To do this, the Map of Entanglement and the chatbot interaction have been merged to support a collaborative exploration between the resident and the AI system.

The interaction starts with residents entering their location, and Entangled Intelligence collecting data on what trees are in the area. The first node appears in the Map of Entanglement, and residents can expand it to learn more about what species of tree is close to them. From this, residents work together with the AI system to explore their ecosystem by offering pictures and/or descriptions of the natural species they see. The system analyses the data, and shows the results of their input on the Map of Entanglement. Through AI-generated, poetic descriptions of the species and connections between different species, the system highlights how the discovered species function within

the resident's local ecosystem. By mapping the biodiversity of the neighbourhood collaboratively, the ecosystem turns into a civic asset, as described in the ACI framework, that can help residents communicate the status quo of their environment with other stakeholders (Lucidminds, n.d.).

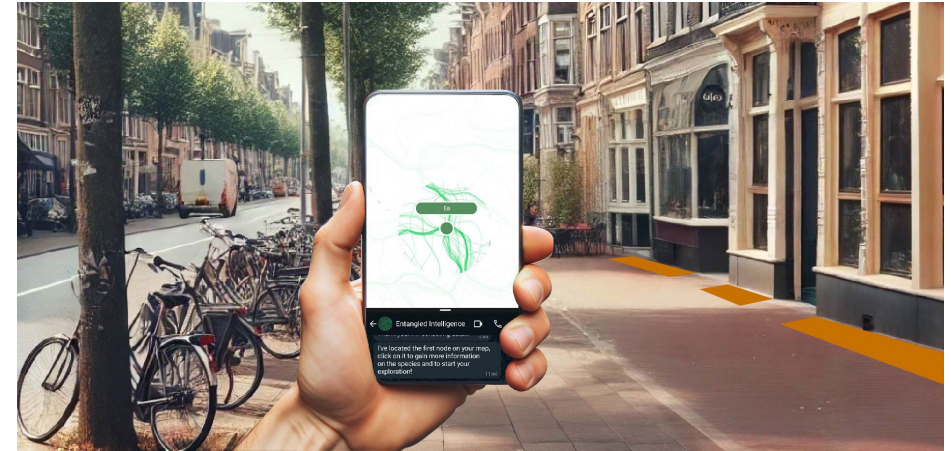
Multiple residents can work collectively on a Map of Entanglement of their neighbourhood to build a cohesive overview of their neighbourhood. Depending on the size of their regreening initiative, they might decide to split up and discover different parts of the area, only to discover how different species in the neighbourhood connect to form one bigger ecosystem.



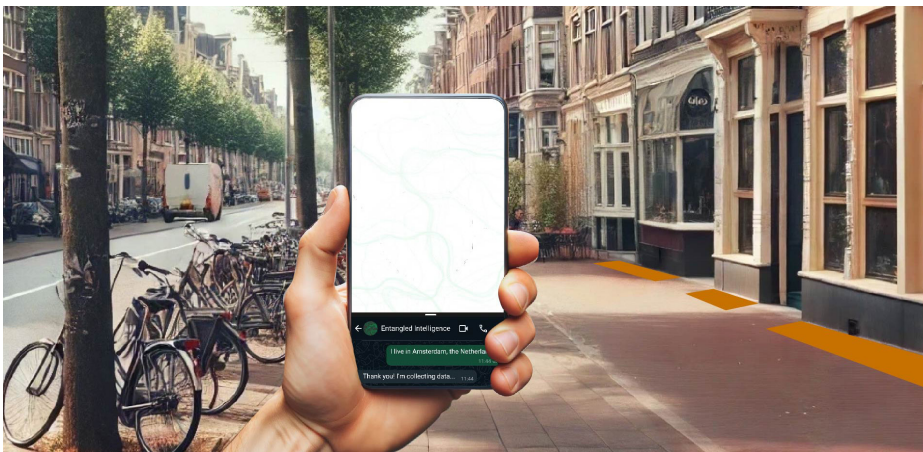
## 6.2 storyboard



1. Residents use Entangled Intelligence to explore their local ecosystem



3. The system notifies the residents that the first node has been added to the ecosystem, as is also visible on the Map of Entanglement

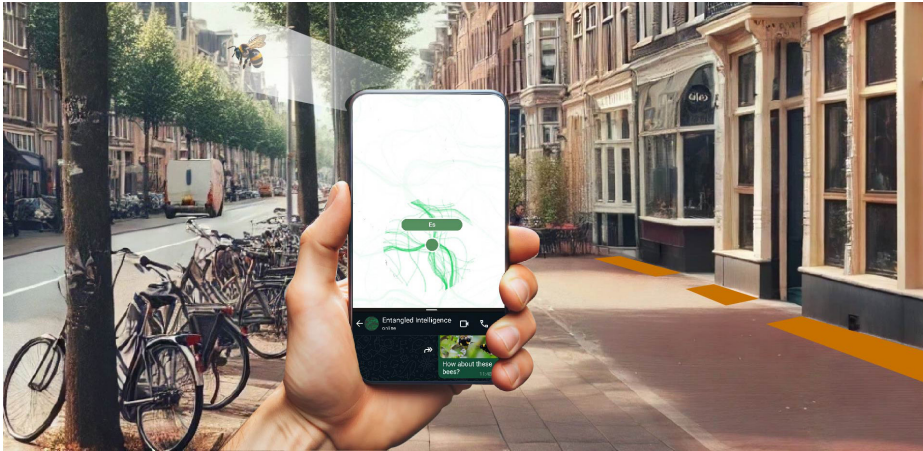


2. Residents enter their location and the system collects data on trees present in the area

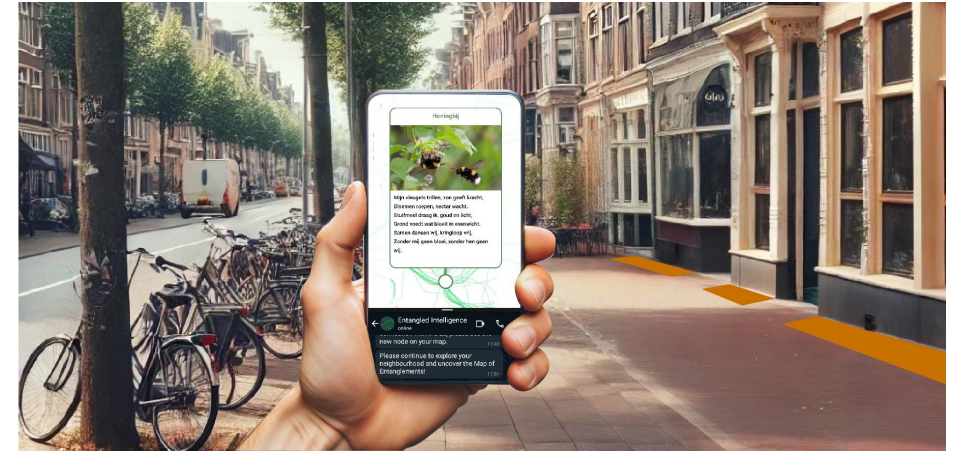


4. Clicking on the node expands it, offering the resident a poetic description of the species





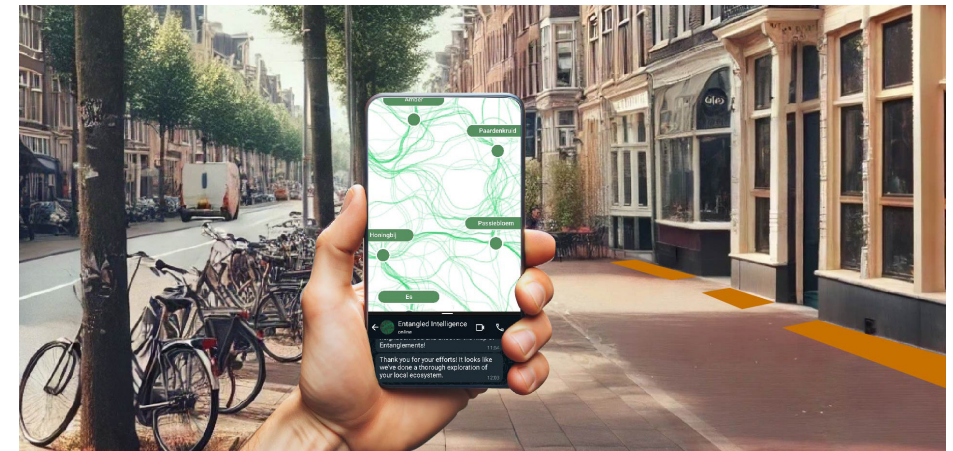
5. Being asked to explore further, residents investigate their neighbourhood by describing and taking pictures of species



7. Again, residents can expand the nodes to receive information on the newly discovered species



6. Analysing the data, the system notifies the residents about connections between different species



8. Together, the residents and the system collaborate to build the Map of Entanglement, discovering the local ecosystem

## 6.3 prototype

Considering the needed control over the interaction between the resident and the prototype for the final evaluation, it was decided that the evaluation would be done using the *Wizard-of-Oz* technique. As explained by Maulsby et al. (1993), Wizard-of-Oz prototypes simulate a system's intelligence and interaction, while actually being operated by a human “*Wizard*.” The prototype was created using the designer's phone, which was able to run Figma, presenting the Map of Entanglement, and WhatsApp, presented as a chatbot interface, simultaneously (see fig. 18).

To prepare for the final evaluation, the ecosystem of the test context was explored, in order to understand what species were present in the residents' ecosystem. This was done in a similar manner as the residents would have done through my concept, as I used ChatGPT-4 to identify what species there were based on pictures I offered and the information that I was taking these pictures in Amsterdam. This would allow the wizard to hide and reveal the species as the test participants explored their neighbourhood. The WhatsApp interface would simulate the experience of talking with a chatbot, while in reality the wizard would receive the messages and update the Figma map accordingly. A script for responding to the expected messages from participants was created, and furthermore the wizard would improvise messages based on how a chatbot would respond.

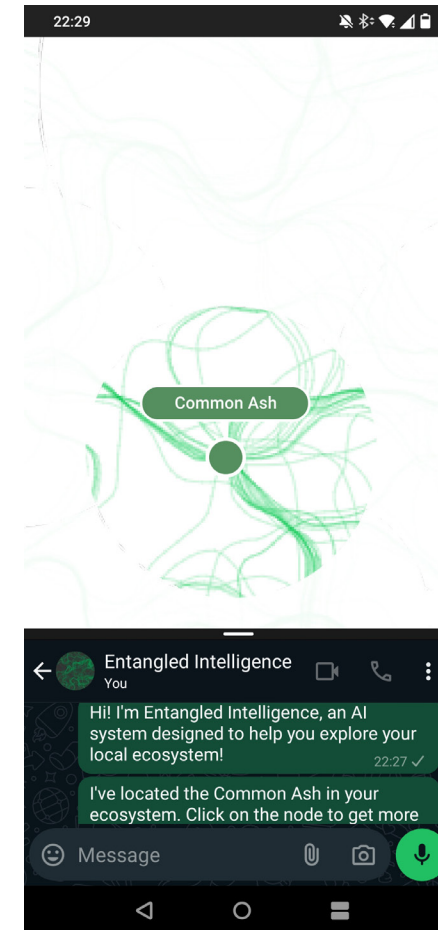


fig. 18: Screenshot of prototype with the Map of Entanglement (Figma) on top, and the chatbot interface (WhatsApp) at the bottom

## 6.4

### test plan and context

The final concept was evaluated in two ways: discussions with the expert panel consulted earlier in the project, and individual evaluations with five neighbours that were at the start of a regreening initiative, and in. By demonstrating the concept to the expert panel, I could explore the concept within the broader scope of CBA projects, and where experts saw potential for the concept to influence these processes. Evaluating with the participants in-context helped me to explore what thoughts arose from interacting with the device, and what the effects could be on residents' approach to regreening initiatives. The main goal of this final evaluation was to explore the second research question of this project, which is: *How can AI systems motivate residents to adopt More-than-Human-Centred approaches to CBA projects?*

### expert evaluation

In the expert evaluations, the concept was presented to them through the storyboard and a demonstration of the prototype. Similarly to the previous expert evaluations, semi-structured interviews were held to discuss different aspects of the concept and its perceived influence on CBA projects. The interviews revolved around the following questions:

- Where do you see potential for this concept in the process of CBA projects?
- How do you think this concept can influence communities' approach to CBA projects?

### participant evaluation

For the final evaluation, a neighbourhood in Amsterdam was approached. At the time of the evaluation, they were in the starting phases of their regreening initiative, which lined up well with the positioning of my design concept within the CBA process. Additionally, as they were starting a regreening project, their concerns and goals for the CBA project made them an interesting test case for evaluating how the concept would impact their plans for the initiative.

The evaluation was performed with five neighbours, individually, and lasted 45 minutes to an hour. The evaluation consisted of three parts; a small introduction, interaction with the prototype, and a post-test interview. The test focused on making the citizens more familiar with the urban nature that is currently present in their square, as a way to expand their sense of community to include nonhuman species. As all the participants were Dutch, the interviews and interaction with the prototype were conducted in Dutch as well.



## participant context



fig. 19: Square as the centre of the neighbourhood

The group of participants is from a neighbourhood in Amsterdam that is centred around a small square (see fig. 19). Some of the neighbours have started the initiative to regreen the square, and the project is at the starting point of the initiative. They've come up with three potential regreening initiatives (see fig. 20), and have created a form to collect ideas from the other neighbours. The three initiatives are conceptual plans for the square, with no specific plants chosen yet.

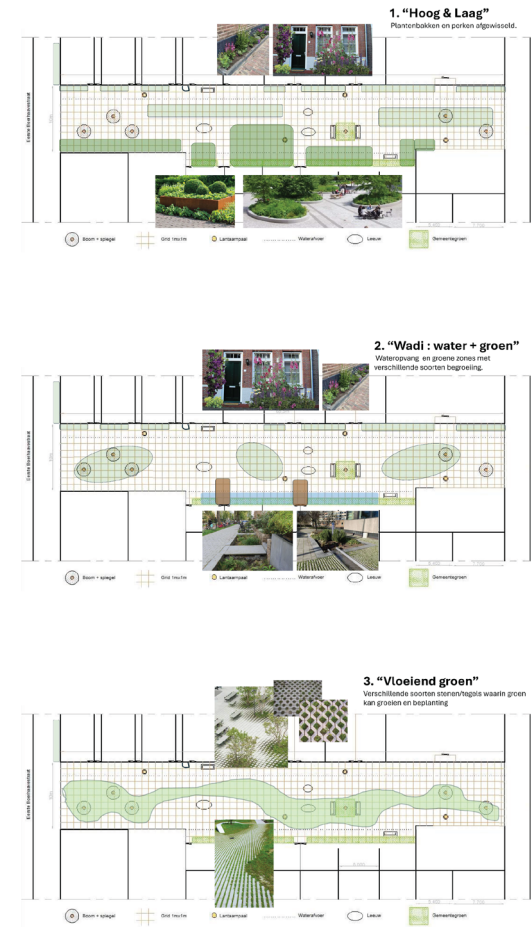


fig. 20: Schematic plans for the neighbourhood as designed by initiators of the regreening proposal

## introduction conversation

Before starting the prototype interaction, I gave the participant a short introduction to the project (framing the concept using the ACI framework) and the setup of the evaluation. The participants received the consent forms and got the chance to ask some questions before starting the test. Additionally, the participants were asked some questions about their stance towards the regreening initiative. This was meant to get an idea of how they perceive nature in their neighbourhood before interacting with the concept. The questions asked were:

- What is your stance towards nature in your environment?
- What do you find important about the regreening initiative?

## prototype interaction

Following the introduction, participants received the prototype and were asked to go through the interaction. The interaction took place outside, and the participants interacted with a Figma and WhatsApp interface on a phone. The designer was acting as the Wizard in the interaction, simulating the conversational agent that creates the Entanglement map as the citizens explore the neighbourhood. As the whole square was too large to effectively allow the Wizard to understand where the participants were exploring, a part of the square was chosen for the evaluation (see fig. 21). In preparing the evaluation, it also became clear that this small patch of nature was already complex enough, consisting of about twelve different plants and multiple insects, and would thus be a perfect scope for the evaluation. Other nonhumans, such as birds, cats, and fungi were kept outside of the scope of this evaluation, as it was deemed that asking participants to explore plants and insects would already give them the experience of uncovering the liveliness of the ecosystem.

## post-interaction interview

*Following the interaction, a semi-structured interview was conducted to gain insights into the participant's experiences and thoughts. The semi-structured approach allowed the participants to speak freely, while the prepared questions ensured that the relevant topics were discussed. The questions asked were as follows:*

- *What did you notice while interacting with the prototype?*
- *What did you think when seeing the connections between different species?*
- *What is your stance towards nature in your environment?*
- *How has your approach/stance towards the regreening initiative been influenced by this interaction?*
- *Could you please draw another plan for the regreening initiative?*



*fig. 21: Specified context for the participant evaluation (tree with the beech hedge)*

## 6.5 data analysis

Several forms of data were collected during the evaluations. (see App. E) From the participant evaluations, transcriptions were created from the pre- and post-interaction interviews. Additionally, by asking the participants to think out-loud while interacting with the prototype, their remarks throughout the interaction had also been recorded and transcribed. Furthermore, the participants' interaction with the chatbot had been stored, as well as their discovered Map of Entanglement, and finally the drawing they made for the new regreening initiative. For the expert evaluations, the semi-structured interviews were transcribed.

To explore if certain aspects of the AI system had motivated residents to adopt MtHC approaches to their regreening initiative, it was needed to assess if a change in their relation to nature was present. For this, their answers to the question "what is your stance towards nature in your environment?" before and after the test were compared. Additionally, the new plans they drew for the regreening initiative, combined with their descriptions of why they were making certain decisions, were analysed to further examine their stance towards nature.

After this initial analysis of the AI system's impact, the transcriptions from both the participants and the experts were analysed on how different aspects of the AI collaboration had motivated residents (or could motivate, according to experts) to adopt MtHC approaches to the regreening initiative. For this, the transcripts from participants were analysed based on the post-interaction interview questions as mentioned in the participant evaluation plan, exploring if the comments and considerations they made in regards to the regreening initiative were aligning with MtHC concerns.

## 6.6 results

This section offers an overview of the results from the participant and expert evaluations, starting with the perceived change in participants' stance towards nature. Following this, aspects of the AI collaboration are discussed, and how these have motivated residents to adopt MtHC approaches to the regreening initiative. Additionally to the quotes from participants and experts, both the created Map of Entanglement and screenshots of the chats between participants and the system have been translated to English for readability. And to give a better overview of the chats between the participants and Entangled Intelligence, the chatbot interface is sometimes shown without the Map of Entanglement interface. Before looking into the results, a small guide on how to read the quotes: the "E" represents an expert's comment, with the "P" showing insights from the participants (followed by a number in both cases to identify specific experts or participants).



participant's stance  
towards nature

	pre-test	post-test
P1	Thinks there's not much nature in the city and little biodiversity, "I'm not a biologist"	Aware of functions and connections in ecosystem, doubtful about removing weeds
P2	Nature in area not very special, but quite nice. Enjoys having some nature around	Wants to let nature take its course and designs from the current ecosystem
P3	"Nature is an accessory" "It's a bonus if it also helps nature"	New understanding of importance and connections of certain species
P4	Would like more nature in the city, and thinks it could be wilder	Takes current ecosystem into account when designing, understands connections
P5	Likes having nature around, but already content with the amount of nature in the area	Understands functions and connections in ecosystem, designs from current ecosystem

aspects of the ai collaboration

Following the perceived change in participants' relation to nature, this section offers an overview of how different aspects of the AI collaboration have influenced the CBA project, as perceived among participants and as speculated on by experts.

communication with the chatbot

A main component of the interaction has been the communication between the residents and the AI system, and how this has influenced the exploration of the local ecosystem. Different participants interacted with the chatbot in different ways. Some mainly offered pictures, while others asked questions to the system or even went into discussions as they didn't agree with species identified by the system. P2 conducted the most comprehensive exploration of their ecosystem, offering pictures of seven species in total, and responding excitedly whenever the system identified a new species. Being prompted by the system to explore, P2 mentioned *"When I looked more precisely, I noticed there were way more species than I originally thought."*

The most elaborate discussion between a participant and the chatbot happened during the evaluation with P3, who didn't believe the Common Ash was a Common Ash. They questioned the system numerous times, taking pictures of the tree and asking if it couldn't be an Acacia tree (see fig. 22). Here, the system made arguments that it could potentially be an Acacia tree, but according to the data available (as well as the pictures taken by P3), it still assessed the tree as being a Common Ash.

In general, P3 often asked questions concerning the pictures she took, asking *"Is this a weed?"* when taking a picture of Horsetweed, and responded with a laugh when receiving *"According to humans, yes"* as an answer from the AI system (see fig. 22).



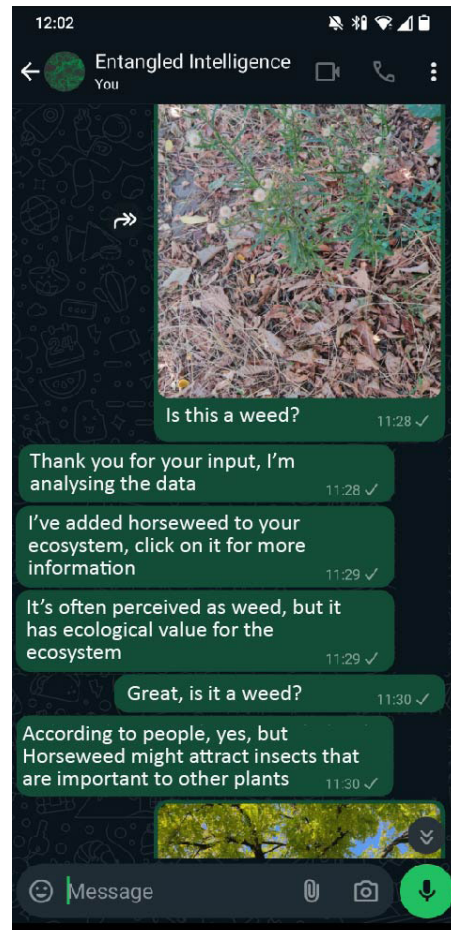
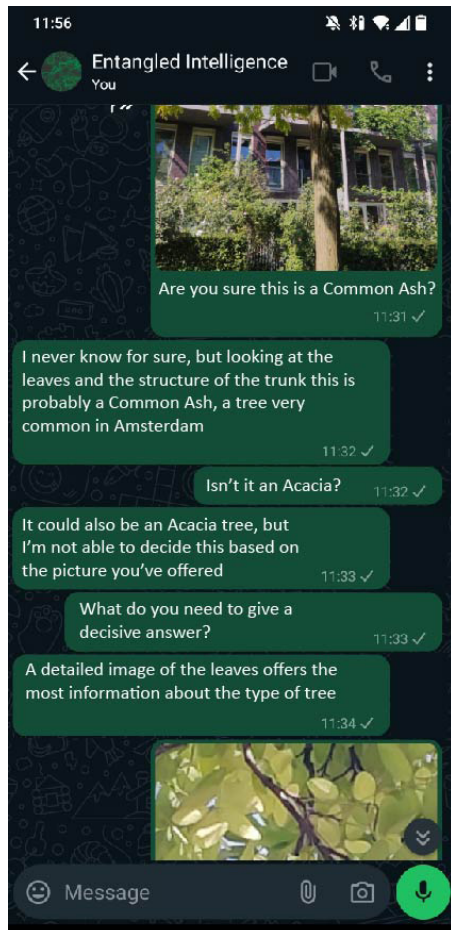


fig. 22: P3 questioning the validity of the identified species (left) and discussing if a certain plant was a weed (right)



fig. 23: The system identifying 'hidden' species

Multiple participants experienced difficulties in taking pictures of insects during the exploration, which resulted in different interactions with the system. P2 and P3 expressed amazement that the system was able to detect an insect in a picture of which they weren't sure that the insect was still there, as P3 states *"sometimes the system sees things we don't."* P5, on the other hand, mentioned that the insect got away before they could take a picture, and instead gave a description to the system of the insect they saw. Luckily, the system was able to process their description, and added the species to their ecosystem (see fig. 23).

## description of species

The description of species played another big part in guiding the exploration, as multiple participants mentioned how the different poems motivated them to continue their exploration. E5 expressed how *“using narrative instead of science to describe species”* made the experience accessible and motivating to a lot of different residents. Similarly, E3 expressed how *“a layer of abstraction can help people understand the functionality and experience of different species within the ecosystem.”* E1, 2 and 5 speculated how the educational, in-context activity would make people reconsider urban nature, as E2 states *“I think a lot of people see nature as this sort of static, background thing. And guiding them to explore can really push people to see that it lives, also in the city!”* Apart from the educational aspect, E1 and E2 mentioned the power of the concept lies in *“the connection it helped people build with the natural world.”*

P2 and P4 both mentioned how the poetic descriptions of species engaged them to continue exploring their environment, but also mentioned that they sometimes lacked some information (see fig. 24). As P2 stated *“the description gave me a feeling for the species, and made me connect more with them, but it didn’t help me to understand if it would assist the biodiversity of the ecosystem.”* and P4, who mentioned *“I enjoy the poems as offered by the system, but I lack some practical information that will help me to continue the initiative.”*

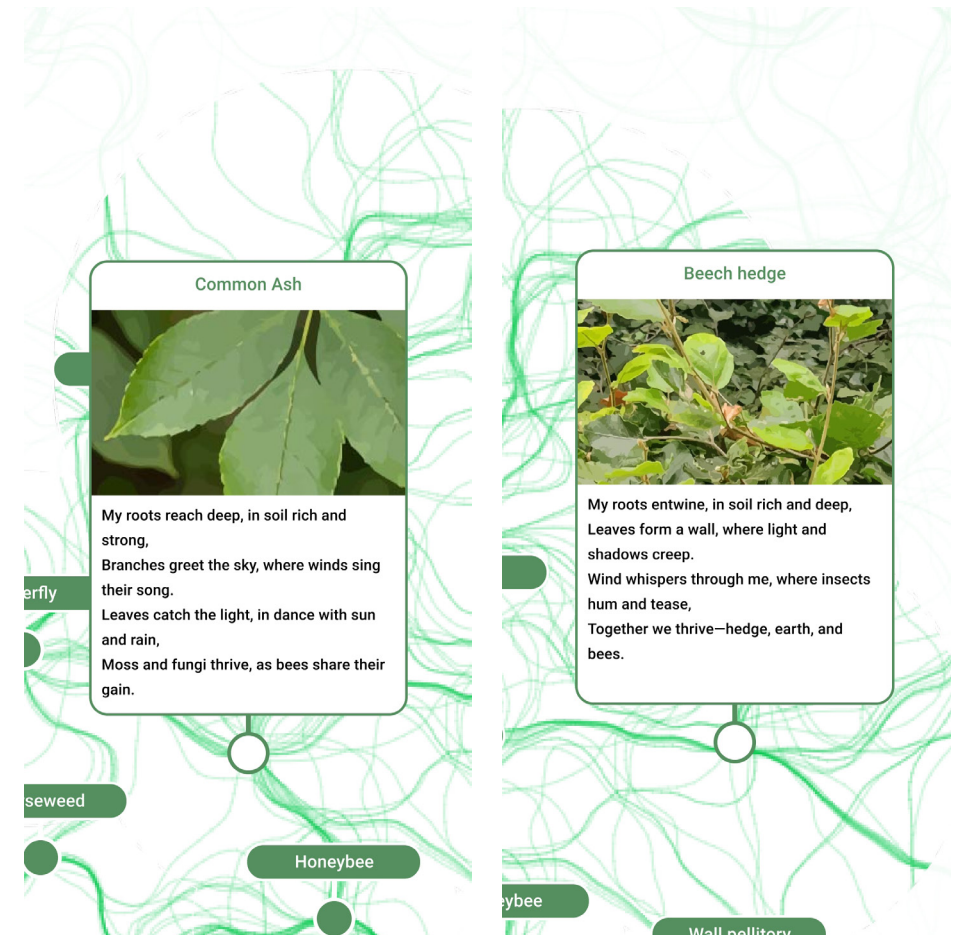


fig. 24: Overview of two expanded nodes offering information to participants in a poetic way



## Map of Entanglement

The connections within the ecosystem, as presented through the Map of Entanglement, influenced participants differently. The ambiguity and lack of explanation made participants read the visualisation in different ways, although many figured out that the lines between nodes were referring to connections as they progressed in the exploration. This is expressed by P2 as well, who read it as a geographical map at first, but later mentioned *“It’s nice that you can see it is a sort of ecosystem, with connections between the different species. And to find out how the weeds connect positively to the ecosystem as well.”* Similarly, P3 mentioned *“After a while, the environment starts to get populated, and you see the ecosystem.”* P3 added on to this that she noticed the chatbot kept the discovered species in mind when it responded to their questions.

Other participants mentioned they still lacked information on the ecosystem, as P1 stated *“I could see the connections, but I didn’t understand yet how they were connected.”* P4 added on to this, by stating that *“It would be nice to see visually on the map how different species have different connections to each other.”* (see fig. 25)

According to E1 and E2, the Map of Entanglement could motivate residents to continue their exploration of the ecosystem, by discovering new or missing connections between species. Moreover, they mentioned how the relationships between the species would make residents more aware of the interdependencies that exist within these ecosystems, a belief that was also shared by E5. Finally, E1 and E4 mentioned that they believed the relational visualisation would change the resident’s perspective of the natural system as hierarchical to one of interdependence and connection.

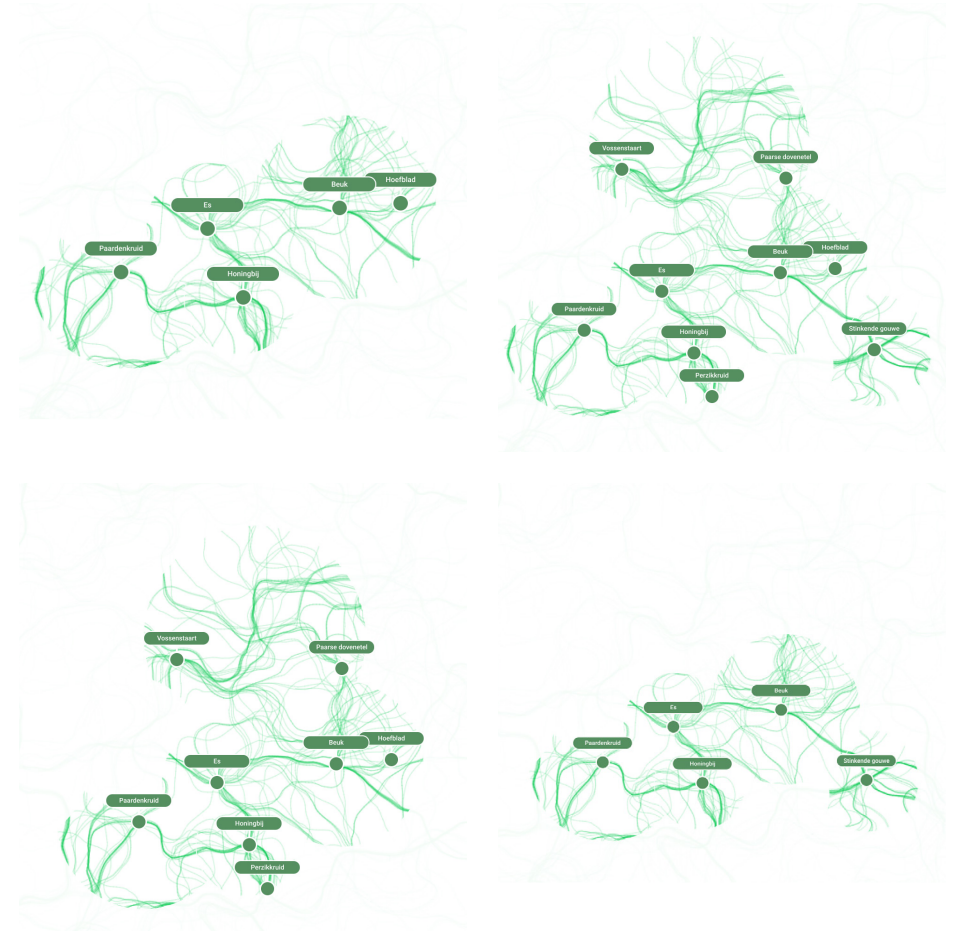


fig. 25: Map of Entanglement as created by P1 (top-left), P2 (top-right), P4 (bottom-left) and P5 (bottom-right)

## Map of Entanglement as lasting output

Following the collaborative exploration, the Map of Entanglement also acted as a lasting output of the interaction. During the post-interaction interview, many participants consulted the created Map of Entanglement while drawing their plans for the greening initiative. As an example, P4 mentioned *“those connections right? If there’s a possibility for mushrooms you want to give those room as well. And the Purple Deadnettle I saw will attract bees.”* P3 specifically mentioned their new stance on weeds in the area, and the role those species played in the ecosystem to attract insects. Additionally, they mentioned *“The system told me I need the Beech Hedge to protect the insects and small plants, so I will plant more of those.”* (see fig. 26).

The lasting output offered by the interaction was also perceived by experts as having a lot of potential. According to EI, the exploration and the Map of Entanglement could *“motivate an enthusiastic municipal worker or neighbourhood to advocate for designing the initiative from the status quo, instead of from the standardised feasibility of the municipality’s vision on greening.”* Similarly, E3 and E5 both mentioned the leverage the activity of mapping the environment brings to the residents when talking to different stakeholders, as *“professionals love maps.”*

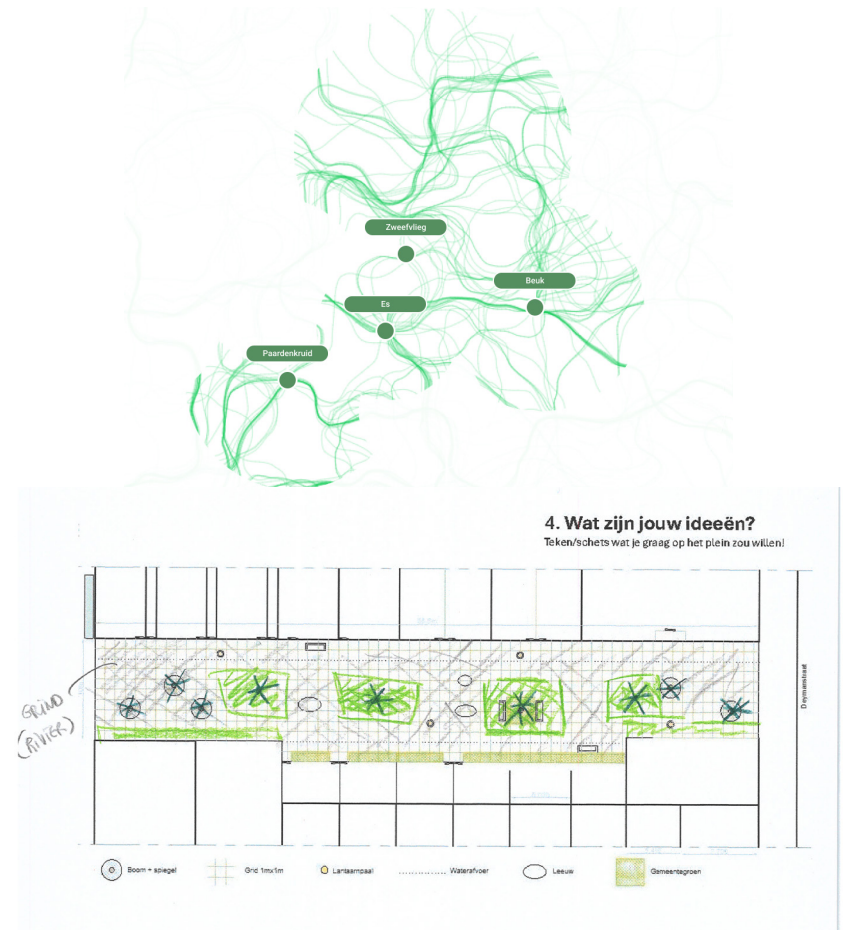


fig. 26: Explored Map of Entanglement and drawing for greening initiative of P3



## 6.7

# synthesis of insights

Looking at the results of the participant and expert evaluation, it becomes clear that Entangled Intelligence has the potential to influence residents in their stance towards nature and their approach to adaptation initiatives. For the participants' stance towards nature, I realised residents both perceive nature as a whole, and as the different types of species. Through the evaluation, the participants' stance towards certain species differed more than to others, and this was mainly depending on the association residents have about types of plants, insects, etc. In general, by showing the intricate workings of an ecosystem, and the different roles and connections species have, participants changed their perception of nature from static, background species to dynamic, lively parts of their environment.

Looking at the participants' newly-drawn plans for the regreening initiative, it's noticeable how they took the current ecosystem into account when coming up with new plants and designs for the square. Surprisingly, some participants decided to take a step back, instead of planning a lot of new ideas, and said that all they had to do was let nature run its course. When asked why they made this decision they mentioned their new awareness of the liveliness within the ecosystem and the level of biodiversity already present in their area. This was a clear sign of their new stance towards nature in their area, as they increased the agency they gave to species that were originally seen as static, or even "accessory."

## 6.8

# discussion and limitations

While the final evaluation generated valuable insights, both from the participants and from the experts, it's important to consider what may have influenced the results. First of all, for the expert interviews, their ideas and comments should be seen as informed speculations on how this concept would influence the community and CBA processes, as they didn't actually experience interacting with the concept. To ensure that claims weren't made solely based on their input, all their comments have been cross-referenced with experiences and quotes from participants.

For the participant evaluations, simulating the prototype through the Wizard of Oz technique both came with positive and negative side-effects. First of all, due to the setup of the prototype, it was not possible to evaluate the concept with multiple participants exploring their neighbourhood simultaneously. While the participants and experts speculated about how this exploration could be done together as a community, it remains to be seen how exactly this would influence the collaboration with the AI system and the impact of the exploration on the residents.

For the chatbot interface, pretending to be the AI system allowed the evaluation to develop into unexpected interactions without the prototype stopping to function. None of the participants mentioned that they realised they were speaking to the designer directly, and thus the experience can be seen as successfully simulated. For the Map of Entanglement however, the Wizard of Oz prototyping resulted in some limitations of the exploration, as the exploration relied on the species that had been discovered previously by the designer, and no new nodes could be created in real-time. As an example, birds were not part of the exploration, but PI mentioned how they were mainly interested in the experience of birds in the ecosystem.

Other times, some improvisation on the chatbot's side helped to smooth the interaction, for instance when P3 was discussing with the system about whether or not the identified Common Ash was an Acacia tree. Because changing the Figma interface would be too much work, the participant was convinced by the chatbot that it was most likely a Common Ash, while I discovered later that it was in fact an Acacia tree and I had messed up in my preparation.

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# section 7

## Concluding

This chapter looks back on the research and design processes of this project to discuss what has limited or influenced the findings of this project and what are the final conclusions that can be taken. The research questions of this project are answered and, finally, a set of characteristics that support MtHC approaches to CBA is presented.

## 7.1 insights

This project has explored the potential for AI interventions in CBA projects to enhance the capabilities of urban communities and change the relationship of residents with the nature in their area. Through its research phase, design explorations, and the final evaluation, this project has aimed to answer the following research questions:

- *What opportunities exist for implementing AI systems to enhance residents' capabilities in CBA projects?*
- *How can AI systems motivate residents to adopt More-than-Human-Centred approaches to CBA projects?*

This section provides an overview of the insights this project has retrieved in relation to these questions, discusses the limitations of the project, and ends with a recommended set of characteristics of AI systems that motivate MTHC approaches to CBA projects.

### when to use AI in cba

Section 2: Grounding has presented the general process of CBA projects as existing of five phases. The phases consist of different activities within the adaptation process, and require different collaborations and efforts from the community, the municipality and other stakeholders. Likewise, the implementation of AI systems within the different phases will have to be designed differently, as AI technologies can offer support with different activities and collaborations.

The thematic analysis as presented in section 2: Grounding shows that CBA projects require Interdisciplinary Teams and Knowledge Sharing, Project Ownership and Attachment, Soft Values and Local Needs, and Working Beyond Execution. These four themes show different challenges that communities, and other stakeholders, run into when initiating or collaborating on adaptation measures.

Considering Interdisciplinary Teams and Knowledge Sharing, residents lack knowledge on many aspects of CBA projects. From municipal bylaws to understanding ecological concerns for their neighbourhood's ecosystem, CBA projects are complex processes with many forms of expertise required. Aiding residents by offering them this knowledge in an accessible way or connecting them to the right stakeholder can assist residents in initiating their projects.

For Project Ownership and Attachment, it became clear that residents need to feel connected to the initiative, as most of them will collaborate on it voluntarily. In this theme, the implementation of AI systems can act as a double-edged sword. On the one hand, the computational powers of AI system offer residents the information and skills to progress with their projects without constantly having to rely on other stakeholders. On the other hand, residents can be overwhelmed by the output of AI systems and through this they can lose a sense of agency.

For Soft Values and Local Needs, it's important to consider that CBA projects do not happen within a vacuum, and that there are other issues in the neighbourhood.

The Working Beyond Execution theme presents a common barrier for single CBA projects turning into continuous a continuous system of adaptation. The fifth phase as described in the CBA process model, called Maintenance, Monitoring and Evaluation, is oftend overlooked by communities and other stakeholders alike. Because of this, the adaptations don't reach sustainable operation. There's much potential for AI systems to support residents in this phase through monitoring and evaluations.



## what the use of AI may yield

Considering the phases and challenges of CBA projects as described in the previous section, CBA projects are complex processes of communication, collaboration, and execution. Looking at the literature, AI systems can aid communities through vulnerability assessments, risk identification and opportunity simulations (Jain et al., 2023). Furthermore, AI systems can support CBA projects from a community perspective by building local knowledge and gathering evidence to support decision-making (Hsu et al., 2022).

Looking at the thematic analysis, additional to the CBA requirements three design-inspiring themes emerged, these being Storytelling and Visualisations, Bridging (Nonhuman) Perspectives, and AI should Support Humans, not Replace Them. These themes highlighted opportunities and concerns for implementing AI-based interventions, exploring a more intimate and guiding form of AI-collaborations with the residents. AI-based interventions can enhance the knowledge, skills and agency of residents to initiate these types of processes. The design explorations in this project have shown that AI systems can enhance communities through knowledge sharing, accessible engagement and participation, and by supporting learning and noticing processes.

## what not to do

While there are many benefits gained from implementing AI technologies, AI systems can also augment the complexity of these projects, and caution is needed when implementing these systems within the community. As power structures exist (or are perceived) between the initiatives of residents and the position of municipalities and corporations, the implementation of AI systems should avoid exacerbating these structures. Introducing an AI system to a community should not make them feel overruled, forced to collect data and follow technological solutionism.

Similarly, while one of the emerged themes focused on connecting different perspectives between stakeholders, the use of AI systems should not justify the absence of certain stakeholders at the discussion table. The representation of communities' needs and values is not the same as the community being present.

## what worked best

As this project focused mainly on the community of residents, their interaction with AI systems and their relationship to local nature, the project was positioned in the first two phases of the CBA projects. In these phases, AI implementations focused on increasing knowledge and building awareness among residents, to support their decision-making throughout the adaptation measures. In exploring the collaborations, it became clear that residents benefit most from AI systems that allow them to connect with their environment, and explore it on their own account. CBA projects are complex processes, and giving residents the time to sit with the issues and grapple their complexities allows them to get informed without being overwhelmed. Being transparent about what data was available to the system helped residents to understand how the system could help them, instead of overrule them and encourage technological determinacy.

Additionally, highlighting a multitude of possibilities, as well as tensions and similarities between concerns or stakeholders meant that the AI interventions could facilitate discussions among stakeholders. In the end, the decisions within CBA projects have to be made by humans, and the AI systems should support them in doing so.

As became clear from the design concepts in section 4: Exploring, the evaluations in section 5: Materialising, and the final evaluation in section 6: Final Design, there's potential for AI systems to motivate residents to adopt MtHC approaches within their adaptation projects. A common response to the MtHC design approach is "but what about the humans?" A response that highlights the concern that we will lose focus on our human users when we suddenly have to share the focal point with nonhuman species. This project combines the findings from the Grounding section on how AI systems can enhance communities with the MtHC design approach to explore how attention to natural species can happen without

unnecessarily burdening residents with extra concerns in these projects. Instead, by connecting them to their natural environment, and in solidifying this connection within a lasting output, the collaborative exploration can help residents to tune in to the needs of their ecosystem, and pay attention the different species. Using the CreaTures framework and the ACI framework, this project shows how building new connections and changing power between different actors can enhance the accountability for more-than-humans and can create new frames of thinking for residents. In solidifying the explorations of the natural species in the neighbourhood through mapping practices, AI systems ensure that the residents' newly adopted MtHC approaches can also be communicated with other stakeholders.

To conclude this project similarly to how Entangled Intelligence has poetically motivated residents to approach their ecosystem from a MtHC way, here's a poem by *ChatGPT 4o*, in response to the findings from this section, about AI's role within the context of CBA projects:

*"AI whispers to the city streets,  
connecting hands where knowledge meets,  
It sows the seeds of change with care,  
a guide for nature, ever fair,  
In tangled webs of thought and green,  
it helps the unseen to be seen,  
Not to replace, but to enhance,  
the dance of humans, tech, and plants,  
With wisdom shared and stories spun,  
All of life become as one."*

## 7.2 limitations

An important limitation of this project has been the sole input of a very small group of experts and participants. The context of the final participant evaluation has been a single, relatively wealthy neighbourhood in Amsterdam. Most of the participants were aware of the importance of climate adaptation before starting the evaluation, and some even worked in the city planning industry. Considering the expert panel, there were two interviewees that were not stationed in the Netherlands, but even those lived in what would be considered Western countries (the United Kingdom and New Zealand). These participant and expert groups show the extremely narrow scope of the evaluations performed in this research. While the expert group (as well as the literature research conducted) did offer a broader understanding of CBA projects, it remains to be seen how different neighbourhoods and communities would react to the AI collaboration. Additionally, the evaluations only assessed the participants' reaction to the concept and impacted approach to CBA projects at the moment of evaluation. While there was a noticeable change in their stance towards nature at the moment and participants seemed to approach the initiative through MtHC approaches, it remains unknown whether these ideals would be held as the project developed, and as residents had to communicate with other stakeholders.

Furthermore, considering the five phases of the CBA process as described in the Grounding section of this report, the design explorations have only focused on a narrow part of the process, as all were positioned within the first two phases (initiation & idea generation, and stakeholder engagement & participation). Similarly, apart from the views shared by the expert panel, the project has only focused on collaborations between residents and the AI system, with no other stakeholders involved. While this makes sense as the project has focused on enhancing communities through interacting with AI, the multi-stakeholder challenges of CBA processes mean there's much left to explore

and evaluate within this context.

Finally, while AI-collaborations have been at the core of this design project, it's important to consider whether similar results could be reached without the use of this technology. To compare, noticing is a common activity in MtHC design projects that focus on public space, and these are often guided through printed templates. Similarly, working with a biologist or ecologist could be a helpful activity for residents that are trying to learn more about their environment. However, the final evaluation showed that the educational and guiding aspects of the chatbot had a clear effect on how much participants explored their neighbourhood, and the growing accessibility of AI systems makes this collaboration an easy step towards MtHC approaches in these challenging projects.

## 7.3 M̐HC guidelines for AI in cba provide guidance, not solutions

Noticing the natural species and thinking critically about their function and connections within the ecosystem has been shown as important activities that motivate residents to approach the initiative in a M̐HC way. AI systems enhance residents' experience of noticing their ecosystem through identification of species and narratives of nonhuman experiences. In this activity, a balance needs to be found between offering them the information needed to further explore, and engaging them in the process of critical thinking about the different species and the ecosystem. Offering them no information whatsoever may leave residents at a loss of motivation to put in the effort, while giving them all the information immediately will stop them from further considering the natural species.

### offer a voice to the voiceless

While running the risk of interpreting the needs of nonhumans from a human perspective, translating the experiences of natural species to residents can build connections between humans and their environment. This is a fine balance to walk, as earlier mentioned in the insights (see section 7.1), it was mentioned that using AI systems to represent certain stakeholders' values and needs is not the same as those stakeholders actually being granted a seat at the discussion table. Eventually, the goal is to make people understand and connect with nonhuman species' way of communicating and being. In aiming for this goal, bringing in the currently unheard voices of those species can be a useful step towards (re)connecting residents to the natural world. In doing so, the agency and accountability of nonhumans can be raised, pushing residents and other stakeholders to consider how they can build communities that are beneficial for the ecosystem as a whole.

## be humble and transparent

To residents that are unfamiliar with technology, the computational power of AI systems can be overwhelming. To ensure that there's no loss in the perceived sense of agency among communities, AI systems need to offer residents room to explore possibilities and sit with the complexities they're dealing with. By identifying opportunities or simulating possibilities in an accessible way, AI systems can create new frames for thinking and raise awareness among residents without the loss of critical thinking as caused by a charismatic visual.

To support this, showing transparency about what knowledge is available to the system increases the collaborative aspect of the interaction and avoids pushing technological determinism among stakeholders. M̐HC approaches to CBA require residents to slow down, and connect with their environment. In this activity, AI systems should act as a humble collaborator, building knowledge and connections together with the residents.

### create M̐HC communication

Due to the large number of stakeholders in the CBA process and the power structures that exist between them, it's not enough to only motivate residents to adopt M̐HC approaches to the adaptation measure. To raise the impact of the M̐HC approach, as well as the power and agency of the residents, a lasting output is needed that embodies the M̐HC approach as adopted by the residents. For this, it's important to consider what type of output will engage what stakeholders, and how residents can be strengthened to communicate the M̐HC approach to others.



## 7.AI on working with AI

As becomes clear from the numerous reflections on working with AI that are written throughout this thesis, AI systems are capable of handling a diverse range of tasks in the design and research process. In this project alone, AI systems have collaborated with thesis writing, thematic analysis, storyboard development, and the creation and application of prototypes. In some of these tasks, such as the structuring of the thesis or the process of conducting a thematic analysis, the AI system simply was used as a way to bounce ideas or check biases. In other tasks, such as generating visuals for the storyboards and prototyping a functional chatbot with object recognition software, the AI system immensely enhanced the output I was able to create within my skills and/or timeframe. In all examples, collaborating with an AI system sped up the process and offered me the content needed to further develop my concepts and project in general.

However, the sped up process was often based on assumptions made by the AI system that I only became mindful of when receiving feedback during evaluations, from experts reacting to certain aspects of the visuals in my storyboards, to participants disagreeing with the species identified by the system in the final evaluation. In these moments, I realised the high-quality output of the AI systems I collaborated with had stopped me from thinking critically about the content I received. Comparing this to other tasks performed by AI systems of which I had a higher expertise, such as thesis structuring or thematic analysis, I often used the output from these systems as a mirror to check my own assumptions, or to bounce ideas and reflect on my own thoughts. This shows how we regard AI systems and their capabilities. We attribute a form of authority to it, especially when we believe our own knowledge on the topic is less than the knowledge of the AI system, and this can influence our decision-making in these processes.

Considering this difference in reaction to the AI system's output based on my respective expertise, it feels as if collaborating with AI systems makes the Jack of all trades feel like they have mastered everything. In reality, however, the Jack has just discovered a magic box of which it doesn't fully understand the contents and they decided to run with it. If we are going to use these powerful technologies in our process (which we will), I would like to offer similar advice as I've done in the main story of this thesis. AI systems are powerful tools with much potential for enhancing the process and output of researchers and designers, but only if we use it with caution. We may never fully understand how exactly these systems think, so let's not blindly follow their output. Instead, let's use these systems to explore possibilities, highlight tensions and similarities, and bridge worldviews, as I believe the true power of Artificial Intelligence lies in helping us understand how WE think.

## 7.4

### personal reflection

This project has suffered from two major struggles, indecisiveness and the self-imposed pressure to finish cum laude. This struggle was caused by multiple things, and has influenced the project in multiple ways as well. To start, the boundaries of the context in which I was working were too ambiguous and too open for far too long. This stopped the project from diving deep into a certain topic or aspect of the CBA process, the adaptation measure, and consequently the design of the AI collaboration. Additionally, there was a lack of clarity on whether the project was speculative or practical, which made it difficult to fully commit to certain goals for the project. Because of these issues, the exploring phase was tough and didn't seem to lead to anything useful or interesting for way too long. Analysing what interested me about the different contexts, and being forced to narrow down my scope repeatedly by my coaches helped me to finally discover how my design could contribute in the context. In the end, the project became less speculative than I had initially hoped. Nonetheless, the project has allowed me to explore my interests within the context, and I believe approaching the context of CBA projects through a MtHC way has resulted in interesting insights and a final concept I'm proud of.

Apart from being indecisive about what direction to go in, I also often had unrealistic expectations for what I could achieve within the timeframe of the project. This was another reason why the project got delayed multiple times, together with the lack of narrowing down and creating boundaries. The unrealistic plans often resulted from high expectations of what should be done within the timeframe of the project, which blocked me from considering critically how long each activity would take. While I believe I've made developments in this area, I think it's something I need to continue being mindful about. These two ambiguities were combined with a level of self-imposed pressure to put down the perfect project, the crown achievement of my

academic career, which blocked the design process from being allowed to fail (which is of course a very important aspect of design processes).

At a certain point, nearing the edge of completely overwhelming myself with my own expectations for the project, I realised I had to let go of those pressures in order to give myself room as a designer and as a person to breathe. I took a much needed break, and decided that I'd focus more on the design process instead of the end result. This was a struggle, and took quite some effort sometimes, but it helped me to open up the project and focus on what I was enjoying and where it was leading me. This was an important decision and it has had a major impact on my design process and output following the break, and I will continue to work on it.

Considering this was my first (big) project on the topics of AI and climate change, I think I've done quite well in finding my scope, even though it took me quite some time to get here. It feels as if this project has been an introduction for myself to understand where I'd want to position myself in this context as a designer. Knowing what I know now, I believe I'm ready for more projects in this context and of this scale, whether by working in a team or by exploring on my own.

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## appendix

For the appendix, use this link:  
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## video

To see a video demonstrating the final concept, use this link:  
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