

Tallinn University of Technology / Estonian Academy of Arts
Design & Technology Futures Masters Programme

BUILDING CONNECTED URBAN COMMUNITIES AND GREENSPACES: A DISTRIBUTED SERVICE SYSTEM DESIGN

Hajusa teenusesüsteemi disain: ühendatud linnakogukondade ja
rohealade arendamine

Master Thesis

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Tallinn, 2021



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Thesis Task

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Thesis topic:

English Building connected urban communities and greenspaces: a distributed service system design

Estonian Hajusa teenusesüsteemi disain: ühendatud linnakogukondade ja rohealade arendamine

Thesis main objectives:

1. Understand, synthesize and analyze the system that surrounds urban waste (with a focus on bio waste), in urban environments and in particular in the City of Tallinn, Estonia;
2. Explore the possibilities for intervention with the aim of turning waste into local resources;
3. Develop and design a service system that connects possibilities with concrete actions by providing tools, knowledge and support.

Thesis tasks and time schedule:

No	Task description	Deadline
1	Field research and analysis of opportunities for intervention	14 / 01 / 2021
2	Concept design	10 / 05 / 2021
3	Thesis finalization	24 / 05 / 2021

Language: English

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Abstract

This thesis explores the systematic issue of urban waste and focuses on the biodegradable waste stream. After understanding waste as a cultural and social construction, where goods lose value and become waste at the individual's hands, one of the goals of this thesis was set on shifting this narrative and exploring the possibilities for repurposing organic materials, transforming them into valuable resources.

A human centered approach was chosen to understand the responsibilities and burdens placed on city dwellers when it comes to collecting, sorting and recycling waste practices. With social innovation and a capability approach as a framework, I explored how citizens could be engaged to participate in the local sustainable development of their communities, affecting the wider urban context. I took into account the collective ways of living and the levels of participation and collaboration the current municipal centralised system enables, where individuals behave mostly individually, lacking connections with others, but still sharing common spaces. I found opportunities for services to support taking collective action by creating enabling ecosystems in their own shared spaces.

The design concept I propose is a service system that fits in the current urban ecosystem, offering an alternative vision where biodegradable waste is understood as a valuable organic material that can be repurposed on site. Thanks to the support and touchpoints provided by the service, urban communities are enabled to become more connected and social due to the creation of shared gardens and greenspaces but also empowered to take control and collaborative action, composting their own organic resources into fertilizer that can be used to enhance those spaces.

The thesis is in English and contains 111 pages of text, 11 chapters, 31 figures.

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1. Introduction

Considering how climate change has become such a serious and burning matter, it appears it has become crucial to rethink some of the practices that have resulted in the world as we see it and experience it today. The vast environmental impact of the anthropocene² is not taken seriously enough by decision-makers, businesses and citizens. Governments around the world have to legislate accordingly, stimulating sustainable behaviours, especially in the growing urban environments.

Thinking about the everyday activities and practices performed consciously or unconsciously, I have become more aware about consumption habits and consequently, particularly interested in the generation and disposal of waste. How materials and goods are produced, commercialized and thrown away, becoming waste, sometimes without much care or thought. I came to the understanding that waste is a social construction that emerges as a consequence of modern society and the responsibility for its impact falls on everyone in their own level of influence.

The aim of the research was to understand this systemic issue and acknowledge the interactions among the diverse stakeholders and actors. The role of the individuals in systemic change has been of my particular interest, in a system that places the large burden of separating and recycling at the end of the chain. However, when considering waste disposal practices, it appears that individuals are not aware and detached from this responsibility, the “out of sight, out of mind” mindset seems to be generally the rule. This led me to research about the management of waste, mostly invisible or unknown to city dwellers, who hardly are aware of what happens to what they dispose of. Here, as an individual I was

² Anthropocene understood as the period during which human activity has been the dominant influence on climate and the environment.

personally inspired by the eye-opening thought that “there is no away, when we throw anything away”, it has to go somewhere...

After analyzing the possibilities to address the complex array of issues I found around waste and its management, I decided to focus on the organic material waste stream, commonly known as biodegradable waste or bio waste. This is one of the most critical issues in the current municipal waste management systems because when not collected separately and disposed of in the mixed municipal waste it ends up either in incineration plants (which is accounted for a resource loss) or in landfills, where it decomposes, creating greenhouse gases that negatively affect our environment. It presents a clear opportunity for recovery and reintroduction to the system as a valuable resource with different technologies, in different scales.

As a designer, I feel urged for the opportunity design has, to take up a role that seems to be increasingly crucial in these times, with possibilities to improve and transform products, services and entire systems. In my thesis research, I approach these practices and behaviors that are deeply connected to established systems that seem to be extremely hard to shake and even more to change. I understood that to change narratives and behaviours towards waste, a holistic approach was needed, to fit the current ecosystem but that would also answer to people’s motivations and needs.

The main objective of this Master Thesis is to develop a design concept that works to facilitate an alternative vision where organic waste becomes a fully valuable raw material and encourages people to participate in the sustainable development of the city of Tallinn. I wonder and speculate on the role of design as an enabler of that process of “regaining” waste, by considering it a valuable resource that needs better management, more awareness and consistent legislations for a sustainable future.

2. Methodology and Framework

In the following subchapters, I will introduce and describe the framework and methodology that have shaped my thesis work. By understanding that people act within their context and the systems that are set in place, it was important to get ahold of a larger picture of the problem, the waste ecosystem, to then go more specific into particular issues and opportunities for intervention. For this purpose, I combined the Systems Thinking methods with a Systems Oriented Design approach, referring as well to the role of design in systemic change.

I decided to take on a human centered design approach as well, regarding the practices and the issues around urban biodegradable waste in urban contexts, with the purpose of researching and ultimately developing a solution that would work to fulfill people's needs but would also align with their desires, goals and beliefs. Ultimately, the systemics approach has been:

- connected with social innovation, leading me to wonder about the role of individuals and how to engage them in participating in the urban sustainable development of cities and in particular of their communities;
- and also directly linked with distributed systems, which aim to tackle the issues generated by centralized systems, such as the current municipal waste management.

2.1. Systems Thinking / Systems Oriented Design

During the initial explorations and readings of my research, I understood that the issue of urban waste could be described as a wicked design problem. As design theorist and university professor Horst Rittel argued already back in the 1960s, when he defined wicked problems as "a class of social system problems which are ill-formulated... where there are many clients and decision makers with

conflicting values and where the ramifications in the whole system are thoroughly confusing” (Churchman, 1967, B141–142).

The topic's high level of complexity and its network of issues and relationships, led me to rely on a systemic approach, where I found the tools and the methodology to help me get started. Through the research process, the relevance of systemic thinking as an organizing element became quite clear, considering it “provides us the necessary context and focus for design activity” (Nelson & Stolterman, 2012, p. 90–91) and in the case of urban waste, helps creating a wider understanding of its complexity.

As a methodology, to create a clear and deeper understanding of any system, especially if it is a complex one like urban waste, designers have the task of choosing which perspective from which to approach the situation and start building the knowledge from there.

Therefore, to complement the systemics approach proposed by Nelson and Stolterman and taking into account the complexity of the issues around urban waste results from the interconnectedness of relationships, actions, issues and values, I referred to design researcher and professor Birger Sevaldson’s work on System Oriented Design. His approach uses a system perspective, where designers work with **problematiques**, suggesting how to react and solve complex problems in innovative ways, acting towards complexity in a proactive manner. This means creating a holistic understanding of all the factors surrounding those wicked issues and synthesizing economic, cultural, social, ecological and political factors.

2.1.1. The Role of Design in Systemic Change

Understanding the interconnectedness of relationships between different stakeholders, user groups, products and services also meant acknowledging that as a result of my design interventions, those elements of the system might be

affected in different ways. The emergence of these so-called wicked problems and the rising involvement of design as a key player responsible for addressing large-scale systemic problems, led me to think how design can have an enabling role in systemic change when it comes to urban waste.

I researched and reflected about the role of design as a discipline can be an enabler of change. This role is discussed amongst the emergence of large scale problems, how in that context “design can play a role in generating elements of change that have the potential to trigger larger systemic changes, for instance, by scaling-up local initiatives, thus working from a lower scale—a community or a small institution” (Morelli, Götzen & Simeone, 2021).

This led me to acknowledge the importance of how design alternates between different scales, thinking for example, both at a system-wide level and from the user’s perspective. And this user-centered nature of the design process seems to me the most interesting way to address a collective and individual issue, with the possibility of engaging problem owners to generate new ideas.

2.2. Social Innovation

The framework for my thesis work has been based on the idea of the possible new social practices that can emerge of meeting social needs and the development of communities in a better, more sustainable way than the existing solutions when it comes to the system around urban waste.

In this case, I referred to the work by Ezio Manzini on Design for Social Innovation and in particular his book “Design, When Everybody Designs”, where he argues that social innovation relates to “the way in which people generate social forms” and its solutions are based on those new social forms, generate unprecedented economic models and deal with all the kinds of social change towards sustainability.

Manzini also discusses the role of design experts in triggering and supporting meaningful social and cultural changes, arguing that social innovation starts with the premise of people taking active co-creating roles, working along with designers as enablers in the generation of new social forms. This is why I chose this approach as the framework behind my thesis work, acknowledging its focus on emerging forms of collaboration, capable of reducing the environmental impact, regenerate common goods and reinforce the social fabric.

2.2.1. Capability Approach

In that line of thinking about social innovation, I refer to the capability approach as a theoretical framework that focuses on the idea of people being able to achieve their own well being thanks to their own capabilities. This normative approach was introduced by Ezio Manzini to the field of design by recognizing people and their capabilities (their knowledge, time, interests, motivation and energy) and understanding them as possible service co-producers, in opposition to people being served to fulfill their problems. In this approach, people can become active subjects, contributing with their resources to their own well being and to the production and delivery of services.

Considering that the capabilities approach and the notions behind the theory of social innovation support each other, they became the basis ground for approaching my research work and especially important when shaping the design solution.

2.3. Design Research

The development of this thesis work can be described through the Constructive Design Research (Bang, Krogh, Ludvigsen & Markussen, 2012). Inspired by the authors' approach of Design Research as a means for the construction of knowledge, through the construction of products, systems, spaces or media, I

apply their model to my thesis work to better describe the non-linear process carried out and provide it with a frame to facilitate the explanation of the actual research work (Figure 2.1). They refer to standard (scientific) ways and terms to describe the process: motivation, hypothesis, research question, experiments...

As the authors state in their conference paper: "hypothesizing is seen as an ongoing process", which is continuously revisited thanks to the experiments that have been conducted and "in close articulation with the research question". In this work, the experimental activities have also been placed at the core and they served to reframe and rethink the research question and the possibilities for intervention.

There are many models that help visualize and organize the different steps of the design process when it comes to the human centered design methodology. During the course of this Masters Programme we have referred mostly to the Double Diamond Design Process diagram developed by the British Design Council³. Since for the development of this thesis, this method has been used in combination of the systemic design approach, I have decided to describe the work, dividing it into 3 main stages, using as a reference the Design Thinking Process diagram (Figure 2.2) developed by IDEO described in their free publication "The Field Guide to Human-Centered Design" (IDEO, 2015, p.11-13):

In the first part (inspiration), where I was set to explore, research, interview, survey, observe and open up the possibilities. As I "diverged" to create an understanding of the problem, I internalized and made explicit the existing information about the topic. For this, I developed the following activities:

3 Bell, J. (2019) "The Double Diamond: A universally accepted depiction of the design process". British Design Council. <https://www.designcouncil.org.uk/news-opinion/double-diamond-universally-accepted-depiction-design-process>

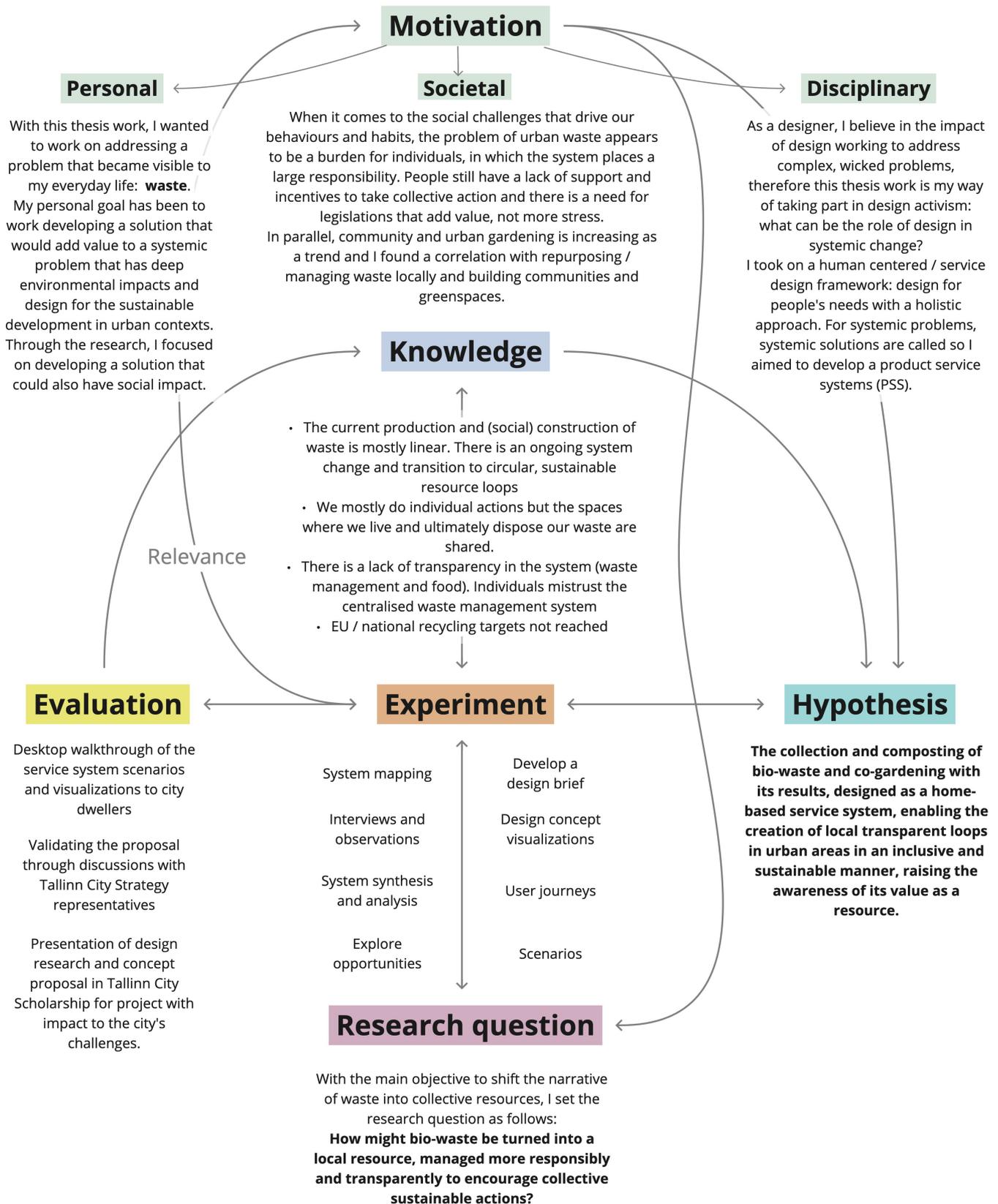


Figure 2.1. Author's thesis overview explained through the Constructive Design Research Model by Bang, Krogh, Ludvigsen and Markussen (2012).

- visually mapped the ecosystem of urban waste and its context (the social, economic, cultural, and technological aspects around the system), mapping out what is known and what is assumed;
- conducted interviews with several stakeholders (urban dwellers, representatives from public and private sector, sustainability and biology specialists);
- made observations of waste disposal practices in urban households and waste houses

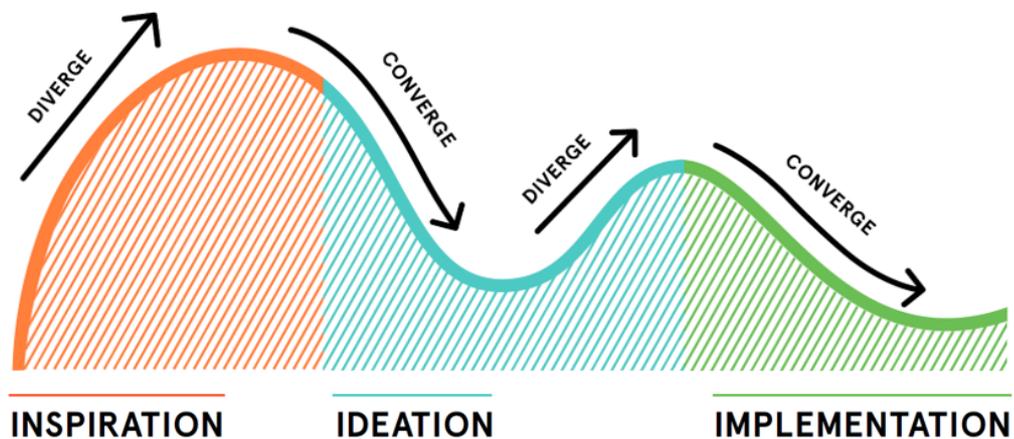


Figure 2.2. Design Thinking Process diagram (IDEO, 2015).

While analyzing the insights from the research, I moved on to the second stage of the process (ideation), that meant synthesizing what was found and “converging” all the findings, narrowing down the possibilities that would help set the direction in which to develop the work further. It was also here that I defined the framing of the problem (a way how to look at the problem from a design point of view) and set goals for the work, understanding the interconnected issues and relations. The frame provided the lens needed to develop a thesis hypothesis and make decisions regarding the connections, interactions and issues found around the system. These became the scaffolds that helped make creative leaps to develop

a design brief, a set of principles that would help shape the design concept in the next stage.

In the third and final part of the work (implementation), I explored and converged the ideas in terms of a design proposal. I develop and designed a service system concept that connects possibilities with concrete actions by providing tools, knowledge and support. In this stage, I made visualizations, user journeys, personas, scenarios, that would help understand how this concept would fit into the current system.

3. The Urban Waste Landscape

3.1. Desktop Research / Literature Review

In the initial stages of the research, I mostly focused on getting acquainted with the field of waste management, the existing recycling strategies, frameworks, and case studies. I set particular interest in understanding the role of design in such field, in the context of design for sustainable change.

3.1.1. Waste and Circular Economy

Attempting to develop an understanding of the current sustainable approaches towards the generation and management of waste, I came across the Waste Hierarchy Scheme (Figure 3.1), which places the elements of the European Waste Policy (European Commission, 2020) into a hierarchy of the possibilities in which the resources that make up waste are extracted as much as possible, aiming to contribute to the circular economy.

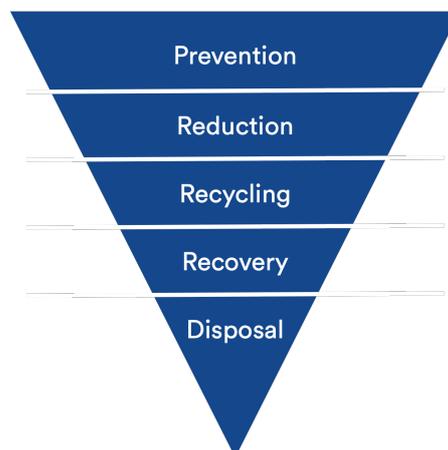


Figure 3.1. EU Waste Framework Directive, Waste Hierarchy (European Commission, 2020), author's simplified interpretation.

In 2015, the EU already started its path towards this transition, by introducing its first circular economy action plan, which included concrete actions in relation to products, services and systems life cycles. And one area of focus was waste

management and a revised legislative proposal on waste. Then in 2019, a more ambitious plan was introduced with the European Green Deal with the goal of reaching climate neutrality in 2050, aimed to promote growth by transitioning to a modern, resource-efficient and competitive economy (European Commission, 2019).

In my own process of understanding what regulates and dictates the management of waste in urban environments, I referred to the different legislations that shape the role waste has on the development of circular economies. Nevertheless, despite institutional and governmental initiatives, action plans and strategies, I still felt that the stress and burden placed on users in the management of the resources at the end of the mostly linear cycles.

3.1.2. Waste Recycling / A Human-Centered Design Problem

Articles and research papers that refer to the (unsustainable) management of waste are uncountable, the issue definitely raises the interest of media, citizens, companies, NGOs and international entities. Several articles and research papers, currently oppose the culturally installed idea that places recycling as the primary and elemental way to deal with waste, manifesting its faults and flaws. In this subchapter, I introduce and reflect upon the ideas from two articles published in early 2020 by Don Norman⁴, one of the developers of human-centered design (HCD)⁵, where he critically declares that “recycling violates every principle of HCD” and is “the wrong solution to the problem of waste”.

⁴ Don Norman is a professor and director of the Design Lab at University of California San Diego, cofounder of the Nielsen Norman group and a former executive at Apple and HP. The articles mentioned: “*Why is recycling so difficult?*” (2020) and “*Recycling is the wrong answer to the problem of waste?*” (2020). Fast Company.
<https://www.fastcompany.com/90452707/im-an-expert-on-complex-design-systems-even-i-cant-figure-out-recycling>
<https://www.fastcompany.com/90463116/waste-is-an-enormous-problem-but-recycling-is-the-wrong-solution>

⁵ Human-Centered Design (HCD), coined initially as user-centered design, is used to describe an approach to design based on the needs, capabilities and desires of people, of the users.

Norman presents a critical overview of recycling from his own point of view, which is tinted by the HCD approach. HCD's purpose is to make people's lives better and more enjoyable, with principles such as: "focus on the people", "solve the underlying problem, not the symptoms" and "everything is part of a system: design for the system". He reflects on how and why recycling goes wrong by not focusing on people and he bluntly argues that "everything about recycling lacks any attempt to make it understandable and easy for people to obey the proper rules". He also places the blame on business culture, having consumers forced to take responsibility for managing their waste.

Several of the issues he exposes looking at waste from a user's point of view correspond also to the results of the interviews and surveys I conducted. He states how problematic recycling results for users when there is a lack of national systems for it to be based on: "The confusion caused by inconsistent standards means that people do not understand what is possible and, as a result, violate the rules. So either they don't recycle at all or they recycle incorrectly, causing entire truckloads of material to be discarded because they're contaminated". He offers the idea of recycling a smaller set of materials, which might end up with a higher compliance rate and an overall increase in recycling.

When he refers to the system that is put in place, he describes it as hard to change and states that "the system is not designed to solve the problem, the system is the problem, where recycling is only one small part of the entire system". He refuses to only place the blame upon designers, which he describes as "mid-level layers of authority" and looks at how business culture continues to manufacture, advertise, deliver, package and sell "products that are more than the products".

In this line of thinking, if the problem is the solution, contrary to the popular narrative, the focus should not only be set on recycling but on other strategies like prevention, reduction or reuse.

3.1.3. Cultural Construction of Waste

In this subchapter, I address the current system in place regarding physical production and cultural construction of waste. The system that has been built for societies and within businesses operate is mostly linear, where first there is value in the product and then resources become waste, with their value vanishing at the hands of users and customers.

Figure 3.2. illustrates my understanding of the current ecosystem, where linear flows of material and energy are integrated with the most known circular opportunities of resource recovery. Additionally, I identified the different stages where waste is produced and resources are spent in its transport. It was crucial to recognize the role of business and design as well, right at the start of the cycle, where decisions are made, business models are formed and materials for production are chosen.

One of the tools I used to add another layer of interpretation to this map, is called the ZIP analysis tool (Sevaldson, 2013, p.17-18) in his conference paper "Systems Oriented Design: The emergence and development of a designerly approach to address complexity". The method is proposed as a simple way of identifying opportunities for intervention and innovation in mapping visualizations, as its name (ZIP) stands for Zoom, Innovation, Potential:

- Zoom is used to mark areas that need more research, where to zoom in to.
- Innovation (and / or intervention) is meant for areas where to focus on making something new or finding a solution to a problem in a new way.
- Potential is used where there is an obvious problem that needs improvement.

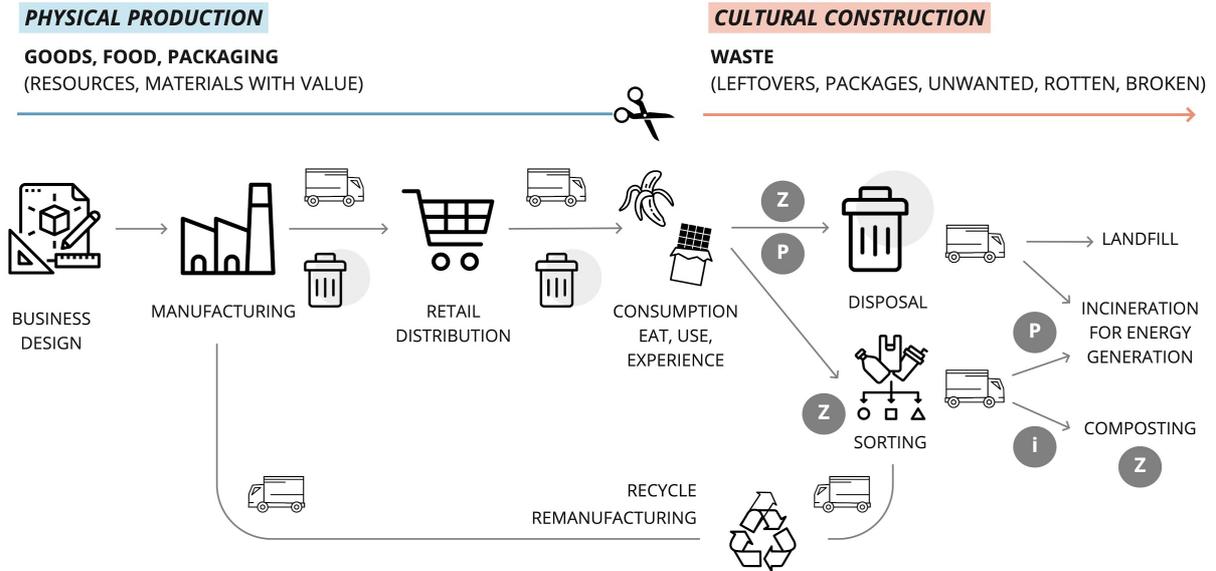


Figure 3.2. Author’s reinterpretation of Walter R. Stahel’s Life Cycle Thinking diagram⁶ to illustrate the linear flow of the current system and the transformation of resources into waste.

Tracing the mostly linear paths of urban waste, I came to the conclusion that waste is generated by the industry, to be bought, consumed, separated and disposed individually by users, in collective spaces, to undergo third party services. In this way, it can be argued that this type of linear systems is predominant in modern societies, with the idea of waste becoming culturally constructed as such. I gathered many interesting insights about waste in the context of post-socialism from an article by Francisco Martínez and Kaia Beilmann, where they address the changes in the management and regulation of waste which they consider “a liminal, hybrid entity”. In their work, they present different approaches to the construction of waste:

- they refer to historian Susan Strasser’s idea of waste created by sorting (which placed the responsibility on all human decisions, when and how waste is constructed);

⁶ Interreg Baltic Sea Region. *Sustainability Guide – Design, Whole System Thinking*. European Union Development Fund. <https://sustainabilityguide.eu/ecodesign/design/>

- the ideas of sociologist Zsuzsa Gille, highlighting the social aspect of waste, arguing it is “not always a free choice to classify something as waste”, opposing that previous statement about sorting that places much emphasis and responsibility on individuals.

Martinez and Beilmann refer to ‘waste regimes’, to describe how institutions determine what resources a society considers valuable, as well as regulating the production and management of waste. In that line of thinking, they also develop the idea of the “Culture of Rubbish”, which they connect to the social implications that introduction of the separate collection of waste for the municipal waste management had in the post-socialist Estonia.

Their ideas about the cultural side of waste helped me reflect on how strong and grounded are the lack of awareness and of transparency in the current system. In the absence of a functioning system of municipal waste collection, people are also confused, which leads to a weak motivation to “work” or to put effort in a system they don’t fully understand or that they mistrust.

3.1.4. The Capability Approach to Urban Waste Practices

To visualize and analyze the level of participation and involvement of individuals in the traditional, centralised, municipal waste management services, I referred to the participant involvement map (Figure 3.3.), an adaptation of the Citizen Involvement Quadrant Map (Manzini, 2015). When considering what urban dwellers are asked to do in practical terms, in the traditional system it is mostly about individual actions. On one hand, in customer’s private apartments and kitchens, we have to be active as individuals, taking decisions on our own (DIY: top left quadrant). On the other hand, when the bins are full it is time to go out and empty them in shared containers, we are served when those resources go out of sight and out of our minds (BEING SERVED: bottom left quadrant).

Participant involvement map: centralized waste management services

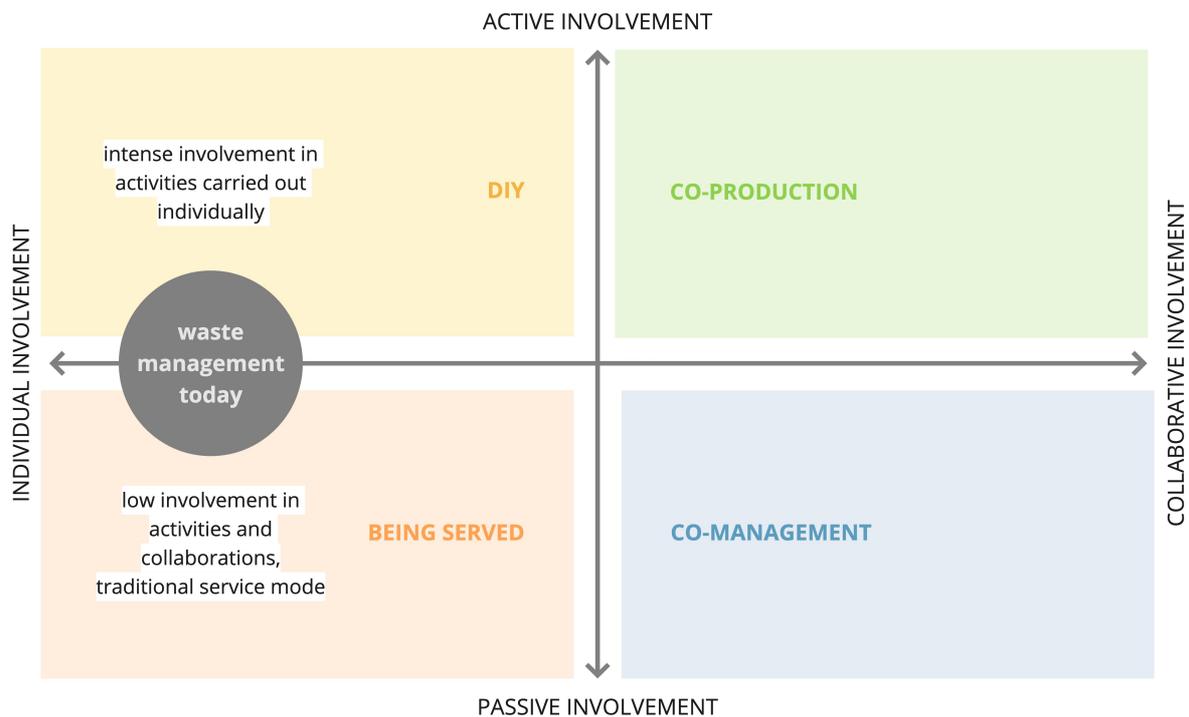


Figure 3.3. Participant involvement map in traditional, centralised, municipal waste management services (Manzini, 2015), adapted by the author.

3.1.5. A Challenge for Design

The main thing resulting from this part of my research was the understanding of the possible role design can take in this complex, sticky, resistant to change problem. By supporting a shift to a circular economy as the preferred answer to the challenges associated with the use and handling of resources (including the disposal of waste), design can help tackle at least some of the barriers for recycling, for example, the confusion about the use of the recycling infrastructure and what materials can be recycled and how. In spite of that, the critique of the waste recycling system from a human centered design point of view by Norman (subchapter 3.1.2.) had a significant influence on the research I conducted afterwards but also the development of my hypothesis and my design concept.

3.2. Urban Waste in Estonia / Field Research

In this subchapter, I present and describe the findings of the further research I conducted on the issues around urban waste in a specific context, the City of Tallinn in Estonia, where I concentrated and focused the research, analysed the local possibilities and ecosystem and developed the further concept exploration scenarios. Additionally, to get ahold of different perspectives towards local urban waste and discuss opportunities for intervention, I conducted interviews with:

- individuals (customers, users, city dwellers);
- municipal waste management companies;
- businesses that use waste as a raw material for manufacturing;
- Tallinn City representatives;
- a circular economy specialist from Stockholm Environmental Institute.

In 2004 the Estonian government introduced the Waste Act in order to regulate relations between “waste producers” (defined as property owners) and waste local operators:

“providing the organisation of waste management requirements for preventing waste generation and the health and environmental hazards arising from waste, including measures for improving the efficiency of the use of natural resources and reducing the adverse impacts of such use...”⁷

Later in 2011, an amendment was approved, this time shifting the primary focus on to providing improved ways for keeping waste from being generated in the first

⁷ Estonian Parliament (Riigikogu), (2004). Waste Act. <https://www.riigiteataja.ee/en/eli/ee/Riigikogu/act/520012015021/consolide>

place (preventing and reducing), followed by preparations for reuse, recycling and other recovery (such as transformation of waste to energy by incineration) – with disposal in landfills as a last option. “Maximum consideration must start to be paid to lifecycle assessment in waste treatment – that is, the principle of making the impact of waste processing minimal for the environment” said Peeter Eek, director of the Ministry of the Environment’s waste department in an interview for ERR news⁸.

The new legislation set a 50% recycling target for paper, glass, metals and plastics and this goal was described as “an attainable challenge”. However, despite the initiatives from the Minister of Environment and diverse municipalities around Estonia in regards to green cities, sustainability, waste and its management, and despite having waste reduction as the main objective, the goal for 2020 to recycle at least 50% of the municipal (household) waste has not been achieved. In the end, only 28% was recycled on average in Estonia that year, according to statistics from Tree of Truth digital platform created by Estonian Government Office.

When it comes to Tallinn, the capital city of Estonia and the biggest with a population of approximately 450.000 people (density: 2800 people/m²), it is found as the district with the highest share of source separated municipal waste in Estonia, with 45% of waste recycled (above the average Estonian recycling rate). The waste generated by citizens corresponds to 40% of the total waste and the other 60% is produced by companies.

3.2.1. The User Perspective / The Role of Individuals in Systems

While continuing my desktop research, I moved on to conduct individual semi-structured interviews with end users, ‘waste makers’ at a personal, individual,

⁸ Rikken, K. (07.07.2011). “Landfill a Last Ditch under Proposed Amendment to Waste Act”. ERR News. <https://news.err.ee/100711/landfill-a-last-ditch-under-proposed-amendment-to-waste-act>

citizen level, which main aim was to help me create an initial comprehension of the matter in question and gather different perspectives. In order to get additional and more quantifiable information, I also created an online survey, to be fulfilled by a larger number of people, around sustainable behaviours and habits, general questions about waste and environmental awareness.

User Interviews

In order to create new understandings of diverse user standpoints and to enrich the problem space, I conducted five interviews with people of diverse ages, genders, backgrounds and cities.

Since I started analyzing my own waste sorting and disposing habits, it was a matter of time until I decided to approach the neighbors from the building in which I reside, therefore I actively engaged some of the neighbors to discuss their habits and issues. As all the waste is disposed of in a shared waste house, that can only be accessed with a key, I mostly observed them as much as I could when we ran into each other there.

After that, I moved on to conduct user interviews with people who I considered represented different profiles in relation to lifestyle, mindset, beliefs and value systems. During the interviews, we went over urban practices around waste, how it is generated, sorted and managed but also I asked my interviewees about their awareness and responsibility in the issue. Our interviews ended with open discussions about the topic, where they brought their own thoughts and issues.

The following are the most relevant insights that I gathered from the interviews:

- “Out of sight, out of mind”: There are different levels of awareness, in general people lack the knowledge of what happens to the waste after disposing of it.

- Most people feel responsible for the disposal, putting effort into the sorting.
- **The need of a supported system that changes the paradigm of waste:** “If you want to change the system, you have to educate the people and create possibilities to make sorting the normal... When I was in school, nobody talked about it. Garbage was garbage”.
- There is a huge amount of interactions with waste happening in the kitchen, either with leftovers, scraps, rotten food or with food packaging.
- People are looking to take purposeful action and for that they often need support (of business, of institutions, of municipalities): “I think it is essential that new government policies be implemented to channel the concerns and the responsibility that each individual has”.

User Survey

Continuing the field research, I created an online survey, which was based on the previous interviews experiences as a reference but also mixed quantitative with qualitative questions. The survey was filled by 30 people. The demographics were mixed gender, aged from 20 to 60 years old and mostly living in private or shared apartments.

When asked about their waste sorting practices, the main barriers mentioned were that:

- it is confusing, the guidelines are unclear,
- it is time consuming,
- it lacks feedback,
- people lack of personal dedicated space for it,

- people lack the knowledge or time
- people lack motivation and it is also not mandatory.

The whereabouts of the waste after disposal was unknown for almost half of this group (47%) while the rest was divided into landfill burning (also called “city dump”), more sorting and separating and recycling (only chosen by 11%).

Regarding their own personal role in this systematic issue, when I asked “Where do you think your responsibility towards waste starts and ends?”, for half of the people surveyed, simply put “it starts when we buy things and ends when we dispose/sort them”. Today, throwing the waste away definitely marks the point where the individual responsibility is thought to end, with more or less effort and dedication to how we do it, and after that, it is somebody else’s business: “Putting everything to the right place and let the trash companies in charge deal with it”. A few answers referred generally to “my decisions” or “on each other’s conscience: we are all responsible for it”.

One of the main problems regarding waste is the mistrust in the system, about what is happening with the waste after the sorting, where users are not sure if the effort they put in is worth it or not: “I have a big distrust that it is actually going to get sorted by the municipality / waste management company”. One of the most elaborate and thought through answers referred to individual’s responsibility in a larger system:

“It’s a paradox – It is necessary to change people’s mindsets on this topic towards environmentalism, but a single person’s perfect sorting is pointless if the total system is not properly functioning (e.g. greenwashing, where focus is not on the actual results but on creating a feeling of sustainability to customers)”.

The last part of the survey addressed overall sustainable practices and environmental awareness. The largest percentage of people think they could do more, despite their current behaviours or the actions they already take. Despite the awareness as consumers of the waste we create, it is not easy to avoid consumption of plastic packaged goods altogether, either because of lack of options, lack of time and effort put into finding more sustainable (zero waste) alternatives. There is an overall interest and motivation to get more informed but more importantly, to start putting the existing knowledge into practice: "I know more than I do". Lastly, most of the people from the surveyed group are not aware of city campaigns, guidelines or initiatives.

One of the main themes that came out from the interviews and survey were the barriers for sorting, I found there are more barriers than incentives for citizens to recycle properly and separate resources accordingly. The other themes were responsibility, awareness and action: individual actions are mostly shaped by different levels of awareness and personal interests and motivations. Moreover, the time invested in an untrusted and flawed system is not considered totally worth it.

3.2.2. The Business of Waste in Estonia / Expert Interviews

Having the opportunity to discuss with professionals that work in the business field of waste has been extremely valuable to my research. In the interviews, I aimed to understand their viewpoints, by discussing what is being done, what are their needs and what are the possibilities for the future.

Municipal Waste Management

Firstly, I was introduced to Rainer Pesti, Marketing and Communications Manager at Ragn-Sells AS, a Swedish 140-year-old company, known as one of Scandinavia's largest recycling and materials businesses. To support their vision for the future, which includes the goal for 2030 to become climate neutral, they

are working on projects that aim to capture more CO2 than produced, leading a transformation from linear to circular models.

The company's business in Estonia stands out as the last market in which they deal with household waste since in the rest of Scandinavia their main focus at the moment is to manage industrial leftovers. The collection of household waste and its subsequent recyclability are often considered grey areas, where usually there are transparency issues and this represents a conflict with Ragn-Sells values. They are still working hard and developing new solutions and services for dealing with waste, considering it as a resource.

We discussed the barriers for recycling and sorting in Estonia and he argued this following several important points to consider:

1. The sorting system in Estonia should be simple to understand but instead, it is confusing, people lack of knowledge about recycling and depending on where you live.
2. There are no taxes on household waste in Estonia, which could be used as a financial instrument to motivate people to sort waste but most importantly as a tool to make a statement for society that "mixed waste is a waste of resources".
3. The system should uniform, the same all around Estonia. Considering the same amount of containers everywhere, same language, same icons, same colors wherever you go, even in small rural areas.
4. There is no feedback or supervision of what people are doing in the current system.

We discussed how the biggest motivation for people to sort is internal, people would like to give their share on this issue and help as much as they can. However, currently only 30% of the household waste is being recycled and, according to

him, nothing has changed in the last 10 years. The financial side is a strong motivation but “the system should be user friendly and dead-easy for customers”.

Waste as a Manufacturing Material

After that, I was referred to Kadi Liimand, Production Manager at Neular (Plastrex Europe Ltd), an Estonian company that manufactures extruded plastic profiles from recycled plastic waste. Neular mostly imports an ‘agglomerate’ of recycled plastic from Germany, which consists of mixed domestic waste, but it is sold as material, not as waste and its cost is 25% of the total price per ton of virgin plastic. The reason for importing is mainly because the quality of the mixed recycled material stays higher than in Estonia. She claims that “municipalities don’t sort enough because the selling price of the recycled materials is not high enough to cover the sorting costs”, which results in mixed or dirty material that is not suitable for manufacturing.

Since the content of the material received is different every time, they go through it, sort it and study it, in order to make their own “recipes”, melting the plastic at temperatures needed for extrusion. The final look of the parts shows its main feature: being made out of mixed recycled plastic and they also recycle their own leftovers into back as raw material as well.

When we discussed the availability of the recycled plastic coming from Estonia, she mentioned they would buy locally, but “the government needs to better regulate the sorting”. She is positive that people in Estonia are becoming more conscious about the environment and green thinking is getting more and more mainstream but it takes time for people to get used to thinking in new ways.

3.3. Waste to Resources / Research Conclusion

During my research, I have been after the following questions:

What is considered or constructed as waste?

When, how and why waste becomes waste?

In Figure 3.4, I visualize the main insights gathered from the first part of the research. I understood that waste is constructed as a modern cultural understanding of our current consumer, throw away culture and it is also part of a systematic issue that among others, holds a strong weight on citizens' individual responsibilities. Waste is not seen as a resource enough for tools, infrastructure and incentives to be put in place, in order to facilitate and regulate proper sorting of all the materials of which citizens dispose of. Additionally, the management today is flawed in several ways: it is expensive, centralised, not efficient enough and requires additional transport and resources (energy and manpower).



Figure 3.4: Research main insights about urban waste.

The following questions have remained unanswered from the research:

How not to construct waste at all, considering that waste is culturally constructed? Considering the prevention of waste as such, what are the opportunities and strategies that could work?

Taking into account the EU's Waste Hierarchy (Figure 1), the main focus for an intervention should be put on waste prevention. Therefore, there are opportunities in reducing or avoiding waste generation, which in this case means that waste never becomes waste as such. The idea of 'waste into resources' goes together with the local management of waste in urban residential communities, in order to avoid the additional transport and resources for handling, separating and transforming needed. This is why I decided to conduct additional research on decentralized, distributed systems (see Subchapter 4.2).

I defined the following research question for the next steps of the thesis work:

How might waste be turned into local resources,
managed more responsibly and transparently,
to encourage collective sustainable actions?

4. Ecosystem Analysis / Management and Possibilities of Biodegradable Resources

During the analysis of the system and in the search of clear opportunities for intervention, I set my focus on the possibilities around the management of bio waste, considering it is one of the most critical issues in the present municipal waste management system in Tallinn (Cleantech for Est, 2018).

For the purposes of this thesis work, I consider biodegradable as the organic materials capable of being decomposed by bacteria or other living organisms. Taking into account that ecosystems recycle materials indefinitely in circular loops, biodegradable materials present a clear opportunity for recovery and reintroduction to the system as a valuable resource, but currently its correct separation is mostly connected to individuals knowledge and motivation and the possibility of managing it locally not approached as a communal service / task.

In the following chapter, I present an analysis of the current situation of the biodegradable waste stream, starting from understanding the current regulations for its management in the context of Estonia, that are also dictated by the EU legislations. With the insights gathered from an interview with a representative of the City of Tallinn, I moved on to conduct research and map the possibilities of bio waste management. I created a scenario to help me visualize a context where bio waste would be culturally considered as a resource and with those insights, I conducted additional research about urban composting, community gardening, distributed decentralised systems and how all of those connect to the social life in urban communities.

4.1. Bio Waste and Politics / Strategies and Initiatives

Improving the waste management has been identified as a crucial challenge to promote greener and more circular cities and the issue is definitely in the agenda of the European Union, the Republic of Estonia and the City of Tallinn, with a variety of (sometimes overlapping) short and long term plans, strategies and initiatives. To name a few and its main objectives:

- EU's Green Deal: its goal is to make Europe the first climate neutral continent, making a transition to a circular economy, efficient use of resources, restore the biodiversity and cut pollution (European Commission, 2019).
- Estonian Climate Neutrality for 2050: the long term goal is to move to a low-carbon economy, gradually transforming the economic and energy system into a more resource-efficient, productive and environmentally friendly one and reducing the greenhouse gas emissions (Estonian Ministry of Environment, 2019).
- Estonian Environmental Strategy 2030: this national plan has multiple long term goals that aim to preserve the natural environment. In particular, the reduction of waste, the sustainable use of resources and the preservation of the natural diversity and landscapes. (Estonian Ministry of Environment, 2007)
- Estonian Circular Economy Strategy / Action Plan: a commitment to develop a circular economy document and action plan by the end of 2021, which aims to map the current situation, develop indicators while involving stakeholders (Estonian Ministry of Environment, 2018)
- Estonian National Waste Management Plan 2014–2020 (now 2022): developed by the Estonian Ministry of Environment, the main strategic goal

of the plan is to implement the principle of the waste hierarchy (that places waste prevention as the top priority). The validity of the plan was extended until the end of 2022 because the goals were not achieved, the strategy will be reviewed and next steps will be set (Tallinn City Strategy, 2019).

- Tallinn Development and Strategy Plans for 2021+ (now Tallinn Development Plan 2035): from its six main strategic objectives, the most relevant to this work is the N^o4, the Green Turn, that aims for Tallinn to become a climate neutral city and adapt to climate change, where there is favorable soil for the “green revolution”, where initiatives in different spheres are promoted (technological, process, organizational or societal). When it comes to the city’s environment, natural biodiversity protection and richer urban landscapes are the main aims. Additionally, the City is working in the transition towards a circular economy, lifecycles of products and services are to be reviewed to promote resource efficiency, in particular there is a focus in waste, aimed to be separately collected in an environmental and consumer-friendly way.

In recent years, the issues and problematiqués around municipal waste in Estonia, specifically about its sorting and recycling, have brought interest, criticism and even a bit of scandal. However, the strategies developed are inefficient when it comes to tackling its reduction and promoting positive action. It is known that Estonia has not succeeded in reaching EU targets when it comes to recycling at least 50% of its municipal waste (Statistics Estonia, n.d.) and organic waste is one of the key waste streams that if sorted and managed separately from mixed municipal waste would help to achieve these goals.

A recent study from the Stockholm Environmental Institute Tallinn (Moora et al. 2020), claims that the separate collection from households is not sufficiently organized and needs to be improved. It also mentions the specific figures of the

City of Tallinn when it comes to bio waste: the goal for 2020 of biodegradable waste not to exceed 20% of total mixed municipal waste weight was not achieved and it resulted in the 32%. From that, 73% corresponded to kitchen food waste. More than 50.000 tons of bio waste are generated yearly (from those, 40.000 tons are kitchen waste). The average Estonian household generates around 130 kg of bio waste per year (2.5 kg in a week). And lastly, approximately 8.000 tons of kitchen waste are collected separately in one year in Tallinn. These numbers provide an overview the considerable amounts of bio waste generated and the scale of what a possible intervention could mean when it comes to the urban context, using a case study the City of Tallinn.

Several main members of the Estonian Government discuss about the current and possible strategies around bio waste. Minister of the Environment of Estonia, Rain Epler, argued about “the obligation to collect more and more bio waste at the source where the waste is generated, while there is a growing need to recycle it” (Environmental Investment Centre, 2020). Additionally, Kaupo Heinma, Deputy Secretary General of the same ministry, declared that “biodegradable waste treatment centres are already in place or under construction in several counties, where certified high-quality compost or digestate is produced” and added about the specificity of bio waste being “that its recycling should occur as close as possible to the place where it is generated”.

I delved into researching the specifics of the management of bio waste in Estonia, particularly in Tallinn and for that, I conducted desktop research and an interview with a representative from Tallinn City Strategy Department.

4.1.1. Tallinn City Strategy Interview

To get a deeper understanding of the political perspective on the status of urban bio waste and its issues, I conducted an interview with a representative from Tallinn City Strategy. The main aim was to get to know what are the city’s current

and future plans regarding the waste management system. I wondered about their action plans towards transitioning into a circular economy and the sustainable development of Tallinn and opened up the topic of a holistic, wider approach when it comes to the bio waste stream, to validate the initial ideas gathered through my research.

We went over a general overview of the regulations that take place today in the city. When it comes to biodegradable waste, all registered properties with at least 10 units must obtain a container to separately collect this waste stream. For properties with less flats / units, this waste stream must be turned into compost or brought to the nearest biodegradable waste container.

I learnt that Tallinn is taking part in a Circular Economy program by the Organisation of Economic Co-operation and Development (OECD) where the current status of the City is being assessed in order to develop an action plan. While the Strategy department is waiting for those results, they have already set the target for 2022 to recycle 100% of the biodegradable waste, which is and will continue to be centrally collected and taken to the outskirts of Tallinn for the development of high quality composting that is sold on the spot.

In the near future where the bio waste collection is planned to be enlarged, there are also plans to implement regulations for containers to be available in properties with at least 5 units (currently the minimum is 10 units). In comparison to the mixed waste containers, biodegradable waste containers shall be:

- reduced in price (so that it is equivalent to 50% of the mixed waste);
- emptied more often;
- proportionally larger in size.

When we discussed the possibilities about the localized management of bio waste, the main barriers presented were:

- how hard is to reach agreements between neighbors and the buildings union associations,
- how it might be hard to control or regulate (with the current centralized collection, the ones who transport "may give feedback to the clients")
- how motivation might be lost overtime, since after some time, people might not want to take care of the management anymore.

4.1.2. Ongoing Discussions / Upcoming New Regulations

As global awareness of the climate crisis and the effects on the natural environment of the unsustainable development of the current systems, more and more programs, initiatives, services, solutions, regulations are continuously emerging. There has been special attention put to a reduction of waste generation with new waste recycling programs and requirements for the processing and management of waste. These regulations are aimed at creating change at the local and global level.

When it comes to the European Union, circular economy and waste policies are increasingly addressing bio waste as a key waste stream. One case in particular is the Waste Framework Directive (whose Waste Hierarchy I referred to in subchapter 3.1.1., Figure 3), which has introduced in 2020 a revision with new requirements for bio waste separation. By the end of 2023, "bio waste must either be separated and recycled at source or collected separately and not mixed with other types of waste (European Environment Agency, 2020).

Additionally, new targets have been set with high expectations for the recycling (65% for 2035), preparation for reuse and mandatory separate collection of municipal waste. It also addresses the low monitoring rates of food waste, supporting UN Sustainable Development Goals 12.2 ("the sustainable

management and efficient use of natural resources”) and 12.3 (to reduce food waste in half) both expected to be achieved by 2030 (United Nations, 2015).

In the context of Estonia, during the development of this thesis work, several articles have brought the topic of municipal waste to the public agenda and most of them referred particularly to the bio waste stream (as well as a strong focus on plastics and packaging waste).

The following are a few article titles which I believe opened up the conversation for the general public, from criticism and the difficulties to reach targets to upcoming waste management action plans aimed to provide a certain degree of transparency to the current systems:

- “Recycling has not become more common over past decade” (ERR News, 01.11.2020)
- “Bio-waste must be better identified, EU fines may follow if not” (ERR News, 17.03.2021)
- “Avoiding waste sorting no longer an option” (ERR News, 10.05.2021)
- “Estonia planning national real-time waste management monitoring system” (ERR News, 10.05.2021)

In general, there is an increase in the awareness of the importance of waste management and recycling, the theme has become highly topical and considerably mainstream. When it comes to the new Waste Law about to be introduced, it still places a large responsibility on the individuals (or what the legislations call ‘waste generators’). The new sorting regulations introduce a lifecycle of waste that “will begin with the individual, who has generated the waste, sorting it by type and handing it over to waste managers” to increase the re-usability of resources and save energy and workforce at later stages.

Separating bio waste at this stage is important as it is expected to improve the quality of the rest of the mixed municipal waste.

Even though I believe a new definition of mixed waste is highly needed and relevant, the stress and burden of recycling still results on the individual level, relying on people's diligence and decisions. This regulation reflects how the societies understand and widely accept how things are, where individuals are literally considered to be generating waste and not really acknowledge as the ones dealing with the consequences of what was already designed and produced as waste. The cultural construction of waste, in the terms of this regulations, also means that individuals are not left with much options, there are no other scenarios provided where they could act differently.

4.2. Bio Waste Management

The large amounts of biodegradable waste that are not collected separately (either to be collected centrally or to be composted on site) end up in the mixed municipal waste and are transported to be incinerated or buried in landfills and this is, indeed, a waste of resources (Figure 4.1). These materials are not fulfilling their full potential and generating a series of environmental damages.

When it comes to waste incineration, there are opposed points of view. On one hand, there are several initiatives for banning incineration as a method for waste management and many papers that criticize it (Recupero, 2019), claiming that burning materials is not recycling, it means destroying resources. On the other hand, some countries use this type of waste management technology, like Sweden, with state of the art Waste-to-Energy incineration plants, that claim to be carbon dioxide free (Saarimaa, 2019) and generate electricity and heat from municipal waste.

ORGANIC MATERIAL CYCLES

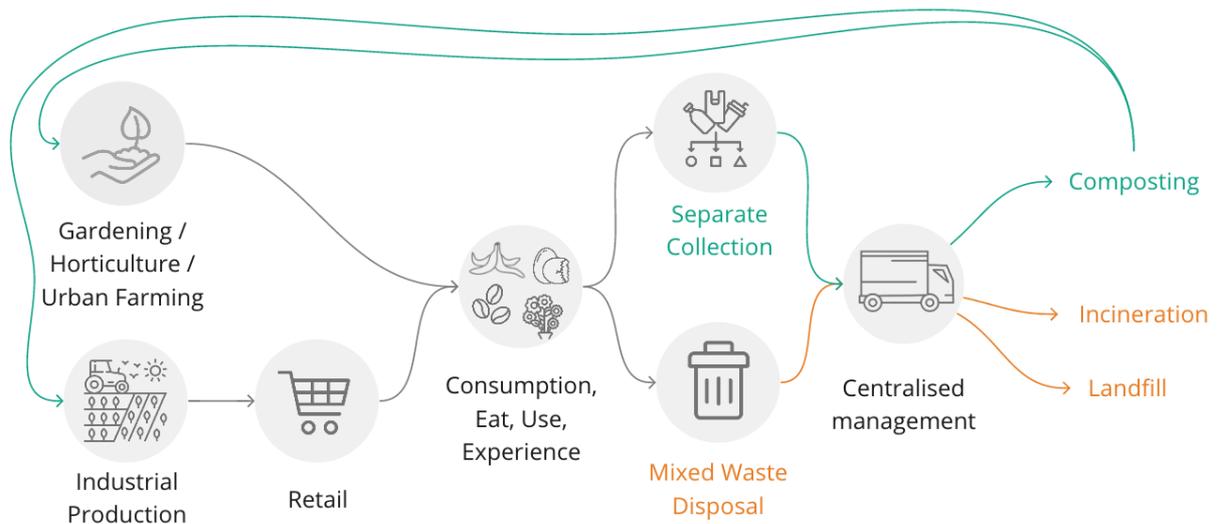


Figure 4.1. Organic Material Cycles, by the author.

Landfilling, on the contrary, is generally considered to be a generator of massive environmental damages and in the case of bio waste ending up in buried, these are organic materials (resources) that decompose, generating carbon dioxide and methane (a pollutant worse than carbon dioxide), greenhouse gases that are released in the process.

Better managed, these resources can be fully recycled and reused, helping reduce their environmental impact. The biological Waste-to-Energy possibilities for processing bio waste, including different composting techniques, can also contribute to enriching soil, feed people when used as fertilizer for growing food and also generate green energy (biogas). In this sense, bio waste can indeed be understood and considered a commodity, a product that can be sold or bought, and in this way, it does not become waste but continues to be a resource along the way.

After analysing the key findings regarding the urban management of bio waste, I understood that the separated collection in Estonian urban residential buildings is not heavily promoted, sufficiently organized or well regulated. Considering that currently it accounts for a large part of the centrally collected municipal mixed

waste that is transported for incineration or landfilling, there are opportunities for creating services (public and / or private) to better manage these resources, in a more environmentally sustainable and cost effective manner. This is why in the next subchapter, I conducted further research about urban composting and its local, social and environmental impacts.

4.2.1. Urban Composting

In the process of finding opportunities and possibilities for communities to regain their biodegradable waste as local resources, I conducted additional research regarding urban composting.

Composting is described as “the process of creating the ideal conditions for the rapid decomposition of organic materials”⁹. In these conditions, microorganisms such as bacteria or fungi thrive to consume and digest these decomposing resources, that might start as vegetables, fruit scraps or any other type of food waste (not considering animal products) to become a nutrient-rich material called **compost**, which resembles soil in its aspect and in its smell.

The benefits of composting are extensive. It is described as a soil-based carbon capture solution, it improves soil texture when added and mixed into, it loosens hard heavy soils, helping generate better growth of roots but it also can help retain water and nutrients. As a source of nutrients and minerals, it helps reduce diseases and provides aeration for plants roots, becoming essential for its growth and health. It can be used for amending soil of different qualities, for growing flowers, vegetables or any other type of plant, potted or not, for lawns, trees and shrubs.

Organic waste is generated all year round and composting can be done continuously as well, even though, depending on climate, “decomposition will slow

⁹ New York City Compost Project. "Outdoor Composting Guide". <https://www1.nyc.gov/assets/dsny/site/our-work/reduce-reuse-recycle/community-composting>

down over the winter". Materials can still be added and mixed into what is called the compost pile and once there is higher temperatures, decomposition speeds up again. Nevertheless, there are specific composting techniques that can serve different types of climate, making the collection and composting near where it is generated, available for everyone.

Today, it is done in different scales with different levels of participation and involvement:

- in large communal facilities (which could be community gardens);
- in small scale private households, because of the availability of space and often the lack of a bio waste specific container close by;
- In private flats in urban apartment buildings, mostly moved by individual motivation and, but not exclusively, to the access to balconies.

To analyze and visualize these examples in terms of participation and involvement, I referred once again to the Manzini's Participant Involvement Map (Figure 4.2).

One of the main by-products generated from the composting process is organic fertilizer, which is mainly used for enriching the soil for farming and horticulture. As it is known, in urban contexts, the land is scarce. Particularly in apartment building flats, the application for this byproduct is not directly proportional to the amounts of bio waste generated all year round.

During my research, I found that the interest in urban composting is rising, it is becoming a global trend that engages different stakeholders and promotes a general awareness on the importance of separately collecting bio waste to return it of its value, to turn into resources.

Participant involvement map: urban composting cases

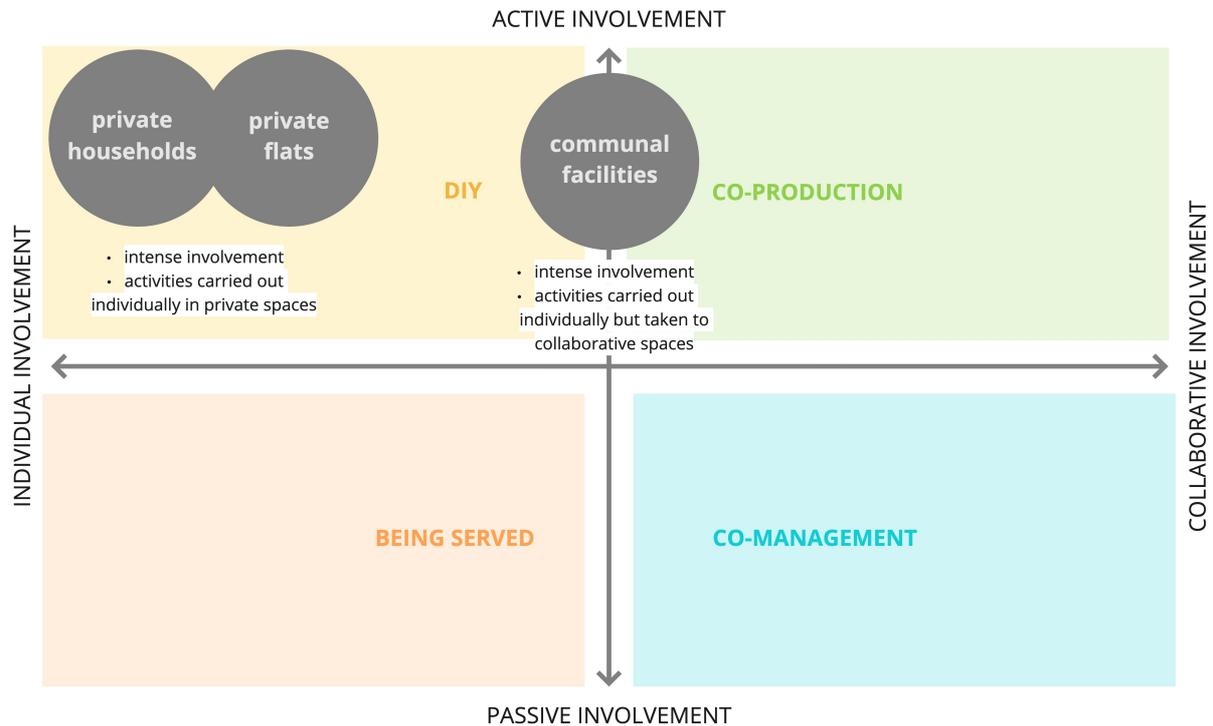


Figure 4.2. Urban composting cases – Participant Involvement Map (Manzini, 2015), adapted by the author.

Here among the multiple case studies I found I will highlight the case of my hometown, the City of Buenos Aires, Argentina. More than 3 million people live in this urban metropolis and according to the Ministry of Public Space and Urban Hygiene, around 600 tons of bio waste are “revalued” in the Composting Centers (Figure 4.3) to be reintroduced as compost for the maintenance and care of urban parks and greenspaces. The objectives of these centers include:

- reduce the amount of bio waste that ends up in the mixed municipal waste;
- generate compost to be used as fertilizer and enhancement of soil;
- and create “greenspaces”, places of promotion and environmental awareness.



Figure 4.3. Composting Center in the City of Buenos Aires (Buenos Aires Ciudad, 2021)

The main benefits I found for urban community composting are its flexibility, since it adapts to different scales and its efficiency in becoming an alternative or a complement to the centralized municipal waste systems.

The interest in urban composting is on the rise and one example of this is in the context of Estonia, is the City of Tartu (Tolmoff, 2021), as part of a larger environmental project, aim to reduce the share of bio waste that ends up in the mixed municipal waste and promote the reuse of bio waste by distributing 600 composters for free for three years to anybody interested and willing to participate. According to the press release, the Government of Tartu promotes the importance of home composting, because it reduces the need for transporting it from one place to another, reducing costs and environmental impact of the transport. The project was launched in May 2021, and few hours after, due to the unexpected high interest of the citizens, the official website of the City crashed (Raavik, 2021).

4.2.2. Possibilities for Bio Waste Management

One key part of the bio waste research has been understanding the trends that surround it and the global context that affects the future of this waste stream. For

that, I developed a map (Figure 4.4) to help me summarize and visualize a scenario with the main global trends affecting waste generation and urban lifestyles in the close future. I took into account general trends like the growing urbanization and rise of global population, the idea of new sustainable lifestyles and how the 2020's virus pandemic has affected urban lifestyles as well, with people working and eating from home, affecting also the generation of residential organic waste. The global challenge of reducing greenhouse emissions is highly topical, affecting all the aspects of our lives, where the increased consciousness is helping open up the debates about renewable energy, the reduction of food waste, the phasing out of landfilling and circular economy models.

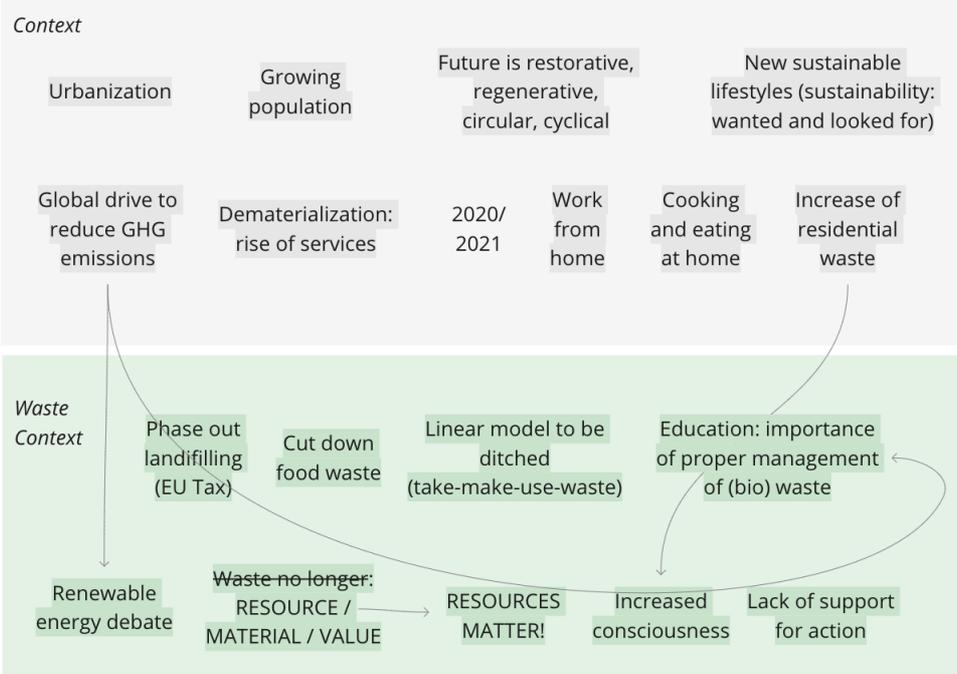


Figure 4.4. Close Future Scenario Context Map, by the author.

Developing scenarios can help create a vision of the future. “Scenarios are tools, devices to trigger the individual and collective knowledge, skills, imagination and culture of people towards the future” (Pärn, 2020). This tool helped me think about the future of waste, explore and research possibilities and assumptions and shape the basis for future thinking and action. I visualized this insights in the map from Figure 4.5.

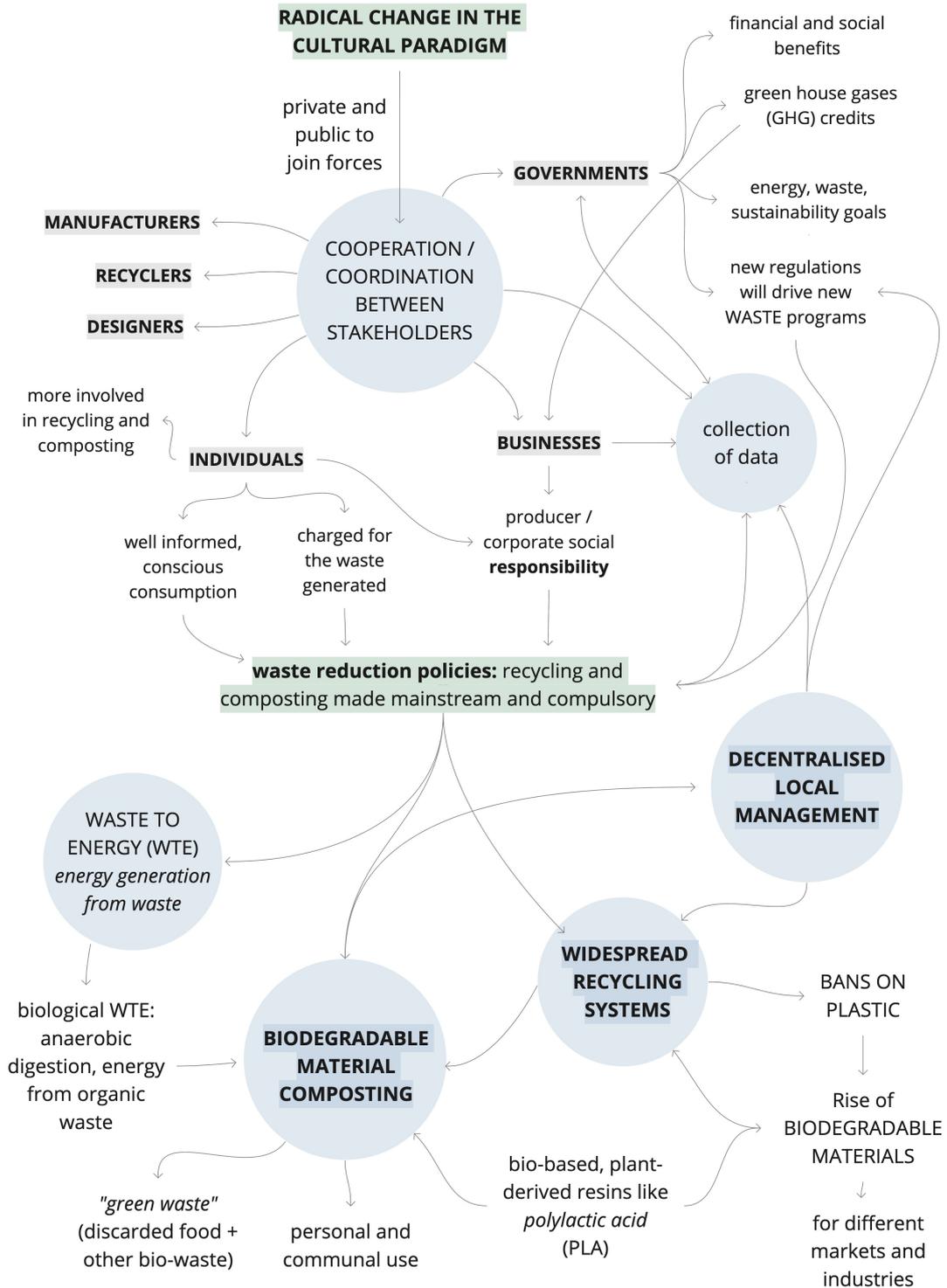


Figure 4.5. Future of Bio Waste Scenario Map, by the author.

The starting point was a new cultural paradigm in relation to waste and its narratives which would influence all areas of society. As a result of waste considered as a valuable resource and circularity becoming the norm, new political regulations shall be introduced, impacting the coordination and

cooperation between stakeholders. I explored how new regulations could impact individuals, businesses and governments, where responsibilities are shared and data is more transparently collected. In this scenario, recycling and composting become mainstream at different levels, especially with the rise of biodegradable materials for the use of different industries (and as a replacement of other non recyclable materials). Decentralised management systems emerge, making it possible to collect data at a local level. Considering the role that the local management of waste in a decentralised manner can have in the larger waste system, I conducted additional research of its possibilities, looking at case studies and the benefits provided for citizens, municipalities and the environment.

4.3. Distributed & Decentralized Local Loops

My initial research led me to understand that the centralised municipal waste management lacks transparency, is not efficient enough and requires additional transport and resources (energy and manpower) to move resources far from where they were generated. In parallel, new decentralized models of co-management are emerging, where local communities are becoming empowered and gaining control over their resources, what I understood as a new approach to an old model that has been mostly predominant in rural areas that are far away and have to manage on their own.

Local closed loops can be achieved with communal composting in urban areas. The biological process of composting presents a clear opportunity for decentralization because it adapts easily to different scales of operation, considering that few simple basic parameters enable the action of microorganisms in the decomposition process and the necessary conditions. People need to have the necessary knowledge to ensure an efficient and safe process that results in good quality compost and it all starts in the quality of their bio waste separation. After that, the composting process requires management

and additional organizational efforts when it comes to approaching it as a communal task.

Inspiring Cases

While researching about communal, local and decentralised composting , I came across multiple very inspiring case studies and pilots that had different scales, with diverse impacts and reach. From those, I would like to highlight two projects:

- The “Revitaliza” Project in the Pontevedra Province in Spain (Zero Waste Europe, 2019), from the Zero Waste Europe programme, a region that has transformed from an expensive centralised system (that resulted in more than 90% of bio waste being incinerated or landfilled far from where it was generated) to a comprehensive and community-based system. They propose a combination of individual home composting, community composting and small scale composting facilities but also have raised awareness of the population through the training of ‘compost masters’ and the regular collection of data of the composting quality and the volumes generated;
- “The Decisive Project” (Decisive, 2017), which aims to analyze and demonstrate options for decentralised bio waste management systems in Catalonia, Spain and in Lyon, France. Its circular approach to “change the urban metabolism”, promotes the local management of bio waste, generating value for urban farming resulting in closed organic loops in urban and peri urban areas. The decentralised management scheme uses micro-scale solutions for “the creation of a regenerative circular economy based on bio-waste management”. The social side of this project is important as well, they work to increase citizens’ involvement and participation and also to create new local jobs.

In these case studies, I recognized several benefits and values provided by the decentralized composting and the creation of local loops:

- lower collection needs;
- higher quality of sorted bio-waste because of citizens increase in awareness and involvement;
- higher transparency;
- adaptability of the solutions to the communities' needs;
- positive effects for the communities by creating collective synergies;
- new job positions related to circular economy and sustainable development of urban areas;
- data generation.

The compost produced by households or small communities (like apartment buildings) could be used at the small scale level, resulting in an example of a local closed loops. But after analysing the case studies and the application of these programs, a main question still remained unanswered which was the lack of local application of the resources generated with the decentralised composting. No service was provided particularly to apartment building communities to provide that connection to the use of organic fertilizers as raw materials to enrich the soil of their surroundings and garden on top of it. Even though it appears quite straightforward, finding applications for these resources in an urban context still presents opportunities for the creation of supporting services.

This connection between composting on a communal scale with the opportunities to apply those by products into community gardening, led me to wonder about the possibilities to supporting those (individual or collective) activities, especially to give solutions for urban apartment buildings dwellers,

enabling those who do not have private gardens (or their own balconies) to participate in the urban composting and gardening. I wondered why these communal solutions are not generally mainstream, to take a material that is not waste, repurpose it and use it on site.

4.4. Community Gardening

Getting additional information and a closer look into community gardening and how they could work in the context of urban communities seemed to be relevant at this stage, one final step that would help put the bio waste puzzle together and in the process, engage city dwellers into improving their lifestyles, their relationships with their peers and their surroundings.

As a direct local application for compost, urban community gardening is usually connected to sustainable lifestyles and associated with deep environmental awareness. These are spaces for recreation, social cohesion and education (Veen, 2015), helping to create a sense of place and enabling social community building. Because community gardens are known to be initiators of just that – a sense of community.

As part of the recent rise in the environmental awareness of government institutions in Estonia, there are multiple activities and green initiatives that the city of Tallinn supports and offers grants for, including the development of community and school gardens, the improvement of green spaces or the purchase of communal garden composters, gardening tools or infrastructure, among others.

In recent years, due to the interest and initiative of several active city dwellers, multiple new community gardens have been created around cities and towns of Estonia. When it comes to Tallinn (Tallinna Keskkonna ja Kommunaalamet, 2020), there are already several community gardens distributed across the city in

different neighborhoods, where growing vegetables goes hand in hand with building a sense of community.

The activity of cultivating edible plants in urban contexts is promoted as part of a greener way of living and promoted for everyone, those with or without experience in gardening, regardless of their age, and cultural background. In Estonia, there is a social movement called “Söödav Linn”, in English “Edible City”, very active in social media, that promotes and shares news about community gardening activities (in public ones and also in schools), where participants share tips and advice, take part in online and physical workshops and trainings and generally share their passion over gardening and sustainable urban lifestyles.

The City of Tartu came again to my attention during my research when I discovered that the land dedicated to community gardens was expanded to up to five hectares (ERR News, 03.03.2021) due to the high interest of city dwellers to “book” their own piece of land. The motivation to take part in such activities is high but I still wondered about the nature of these spaces, where people come together to grow their own food in a shared piece of land, but still (relatively) far from where they live. Here I wondered about the opportunity to use those unused spaces in people’s urban residences surroundings and turn them into their own private shared gardens.

I moved on to research and reflect about the opportunities I found for collective action and how it connects to the previous findings about the possibilities of repurposing bio waste with urban composting and gardening in communities.

4.4.1. Connected Communities

In the Estonian Human Development Report, Asko Lõhmus argues that “joint action... plays a direct role in shaping a cohesive cultural space. Recent decades have seen the emergence of social actions in nature that promote public goods have their roots in the tradition of communal work in Estonian village culture”

(Lõhmus, 2020). I became aware of several movements that work on activating positive, social and environmental change. One in particular, now spread globally and originated in Estonia is “Teeme Ära” (translated to English as “Let’s do it”), that started as a campaign to activate civic society to take action and collectively clean up the country’s garbage or litter. Now, this organization has spread not only in location but in objectives: one of their main focus today is set on reducing food waste (Teeme Ära, n.d.), for that they collectively build composters for households.

Teeme Ära has a wider reach that covers entire cities, countries and regions. In a smaller scale, Estonians hold another cultural practice called “talgud”, events that Teeme Ära also promotes as “talgupäev” (translated to English as communal work day). In these events, community members get together to work, build, spend their time helping others or simply cleaning up their surroundings (Figure 4.6).



Figure 4.6. Teeme Ära (Let’s do it) 2018. Photography credits: Anna Aurelia Minev / ERR News.

When it comes to waste collection, these movements that promote engaging people to work and spend time together with their communities appear to oppose to the feeling created by the current waste management services in urban apartment buildings, where people are mostly left alone, to collect in their own households and to drop their collected waste in the shared containers or

houses (which in some cases are private to the properties and allocate the containers). These are environments that are mostly focused on individual actions.

Building communities in that way is pretty much connected to placemaking. In that sense, I refer to the ideas of Marc Augé's in his work "Non-Places, Introduction to an Anthropology of Supermodernity" (Augé, 1992), where he describes non-places as spaces where people do not meet, spaces that do not have common references for people, where people act mostly individually and tend to feel anonymous and lonely.

There are still opportunities for community members to meet, collaborate and spend time together. Acting collectively can help change those narratives that surround waste collection and disposal, but also be connected to other activities that indeed promote positive and proactive conversations and collaborations and between community members, opening and strengthening the social ties. This led me to reflect on the possibilities of more social and connected communities where people are encouraged to take part and do things differently when it comes to managing their resources, but doing it together.

4.5. System Synthesis / Possibilities for Intervention

After the research done regarding the analysis of the waste system and with a particular focus on bio waste, taking into account the current state of the issue, its stakeholders, the regulations, the individual practices, the trends, the future possibilities, I created a visual map (Figure 4.7) to summarize the main insights and findings, to which I also integrated the specific themes introduced along the way, such as urban composting and community gardening.

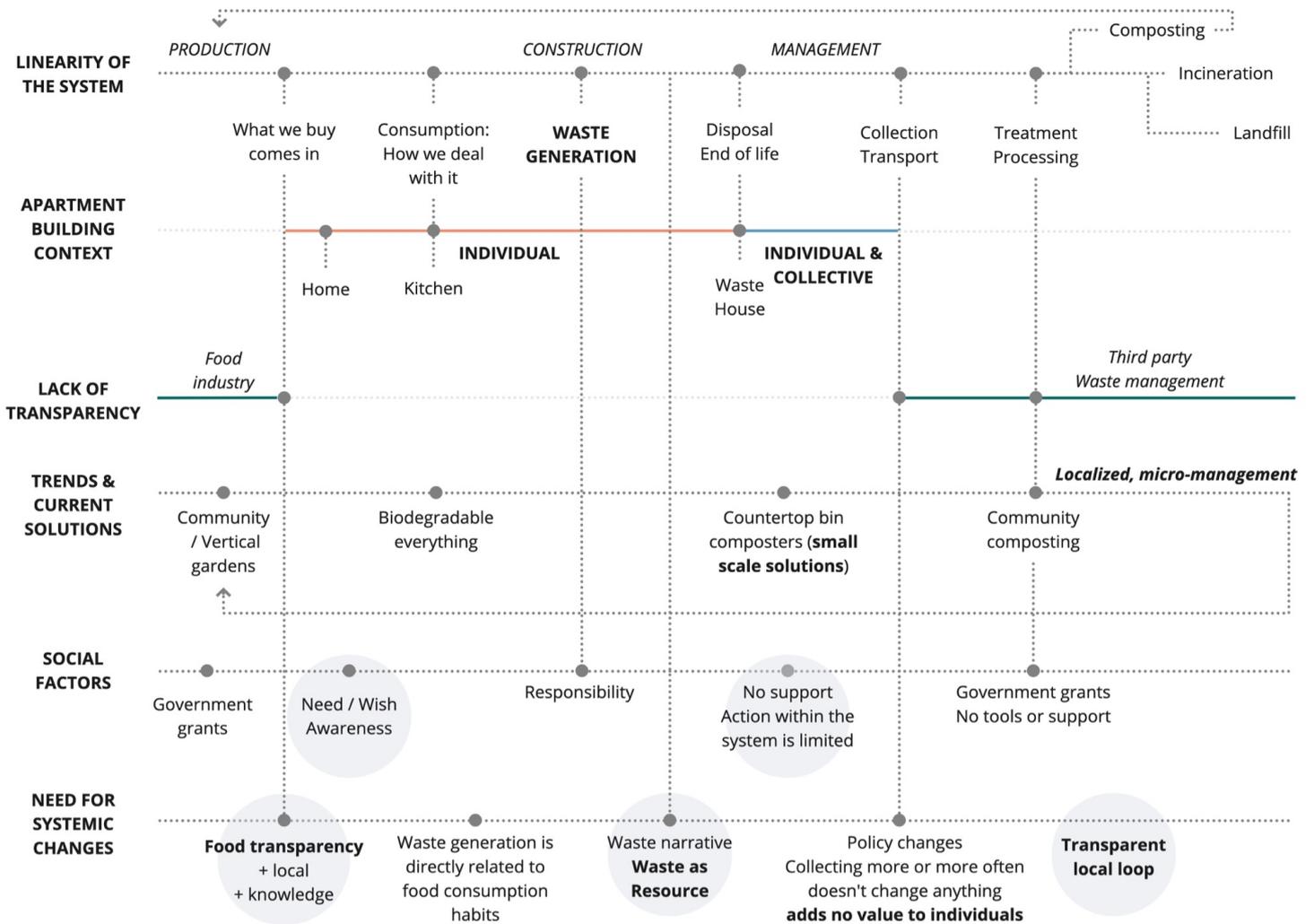


Figure 4.7. System Synthesis and Main Research Findings Map, by the author.

Considering a cultural paradigm shift where urban bio waste becomes and is considered a collective resource for communities, and new policies, tools and incentives could be introduced to nudge city dwellers to regain their waste (and therefore transform them into valuable raw materials). The current trends of community gardening and urban composting support the localized micro management of resources in communities. Especially in the context of apartment building communities, these issues and opportunities could be combined into a comprehensive and holistic solution that might start with the collection of bio

waste, improve citizens awareness of its value, but also support activities that connect neighbors together socially and environmentally.

I defined my thesis hypothesis as follows:

The collection and composting of bio waste
and co-gardening with its results,
designed as a home-based service system,
enables the creation of local transparent loops in urban areas
in an inclusive and sustainable manner,
raising the awareness of its value as a resource.

5. Design Brief / Resource Management and Community Making

5.1. Concept Design Approach

Visualizing possible design approaches to the hypothesis mentioned before, I decided to address the development of a Product Service System (PSS) concept, where the diverse touchpoints are combined with the information needed to promote and implement new actions. New types of incentives could be given for citizens that take action, which raises the need to evaluate what could be put in place fitting in the current system and what new legislation would be needed.

5.2. Design Principles

With the goal of transforming the idea of waste into a valuable resource, the design concept will be shaped on the following principles:

- Localized
- Motivating
- Enabling
- Consistent
- Efficient
- Understandable
- Supported (help available if needed)
- Social / Collaborative

- Circular / Positive Impact
- Distributed (decentralized)
- Scalable

Considering urban apartment building as the context in which the service system would take place, the following are the opening questions for the exploration of ideas and development of the concept:

- How to change the mindset about bio waste and transform it into valuable resources that communities can repurpose on site?
- How to provide enough of a purpose and a motivation to regain these resources locally?
- How to support individuals to take action (individually and collectively) while connecting with their peers, creating and building more connected communities?
- Following Manzini's participant involvement map criteria (Figure 5), how to propose a new vision for the management of bio waste that would have individuals (participants, users, customers) more actively and collaboratively involved?

The main focus during the development of the concept was to provide the WHY (the reason to "dispose" organic waste in a different way), support the HOW (by giving the tools and the way how to manage them) but also educate on the WHAT (when people are aware of what happens with their waste, they will be more interested into getting it right).

6. Root: A Service System Design Concept

Root is a supportive service system for urban apartment building dwellers that aims to transform organic waste into local resources for community gardening. With distribution and decentralisation at its core, the service proposes an alternative to traditional centralised waste management systems which gives community members a purpose, awareness, control and also supports their collective ways of living, by helping them create stronger bonds with their neighbors.

The service promotes the separate collection of bio waste and takes care of its local management and composting. A closed loop is created by giving these materials a local purpose, linked to urban gardening, which has great social and environmental benefits, promoting positive connections between people and between people and the environment. Gardening on top of soil fertilized with their own bio waste allows communities to grow fresh food and other plants right next to their homes, which not only enhances their surroundings and the environment but also the social relations amongst neighbors.

With the premise of shifting the narrative around waste, the service provides the support and tools needed for city dwellers to engage in community activities that result from that first step in which they separate and collect the organic (compostable) materials generated in their households. These materials get repurposed and are used for shared gardening activities and in this way they become community resources, not waste.

The main functionalities enabled by the service are:

- the collection of the community's organic materials;

- the local management and processing of those organic materials into valuable collective resources by the service provider;
- the creation of urban gardens, which engage community members into collectively planning and deciding what to grow during each season, doing those maintenance tasks and lastly, harvesting or just enjoying of diverse varieties of plants (herbs, flowers, fruits and vegetables);
- the expert support needed for taking care of those gardening units during the different stages;
- the social education of younger generations of the cultural norms of shared spaces and activities but also about the natural cycles and systems behind the food that reaches our tables in urban environments;
- the possibility to take part in the community as a member in an active or rather passive way, according to their available resources (time, knowledge or interest);
- and as a consequence of all what has been stated above, the construction and building of close knitted and engaged urban communities, which are fostered by the participation in shared gardening activities, workshops and trainings organized by the service and other social spontaneous gatherings or planned events amongst community members;

6.1. Service Components

The service is based on a set of digital and physical touchpoints that work together, complemented with the support from experts and specialists, to locally manage and process the bio waste and contribute to the maintenance of the community gardening and social activities.

The service system is made up of:

- a digital platform as a centralized database that connects the communities with the service;
- a set of proposed physical products:
 - Individual Caddies for bio waste collection;
 - a Collection and Composting Communal Hub (CCCH);
 - infrastructure, tools and materials that support urban gardening;
 - complementary outdoor furniture to support socialization;
- a physical information Notice Board;
- the management and composting of organic materials;
- and expert support in urban gardening.

The different components of the service system will be described in the following subchapters. The general interactions of the elements of the service are visualized in the scheme System Components Scheme (Figure 6.1).

Service System Components

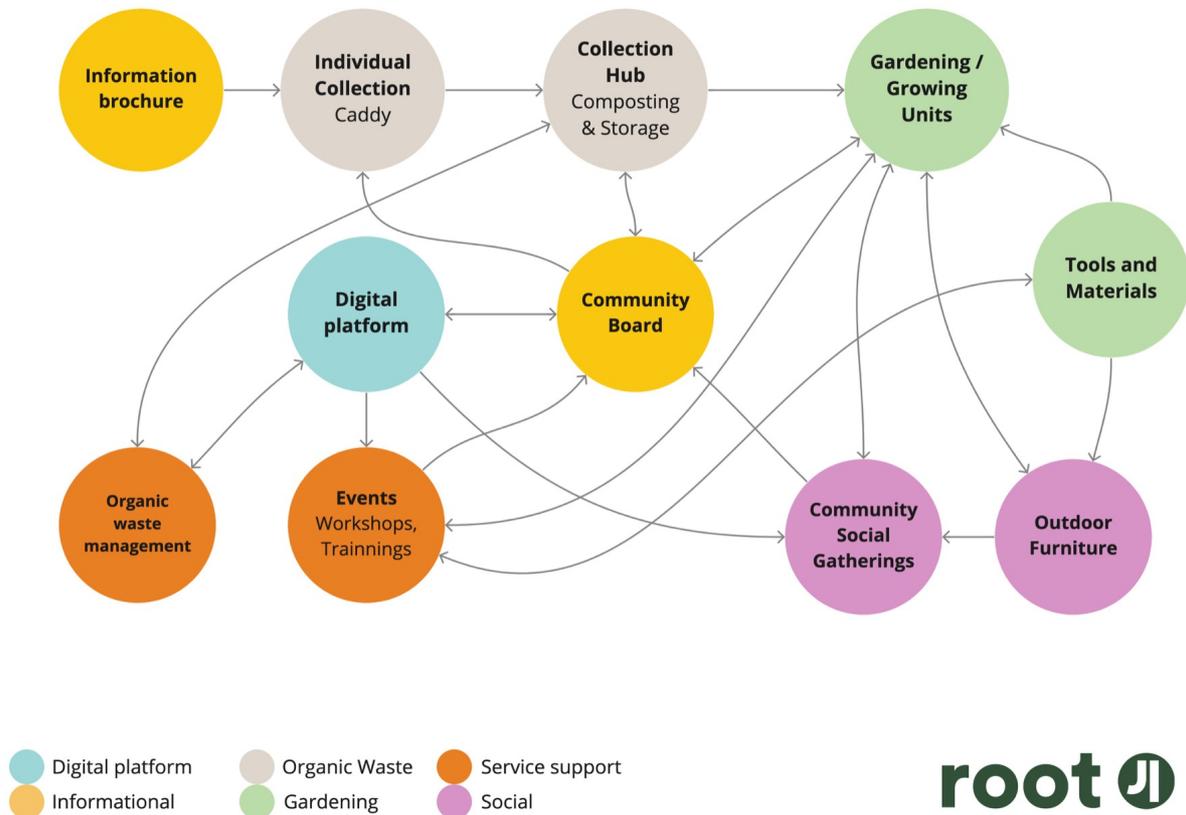


Figure 6.1. Service system components scheme.

6.1.1. Digital Platform

Most of the components of the service system are tangible and the main interactions among community members and between them and the service experts will happen physically. However, Root relies on its digital platform as a central element, on a functional, informational and organizational level.

The following paragraphs describe the interactions happening in Root's digital platform during the different stages of the service. These interactions are mapped in the scheme presented in Figure 6.2, where I visualize the data inputs and outputs of the service digital platform front-end and back-end.

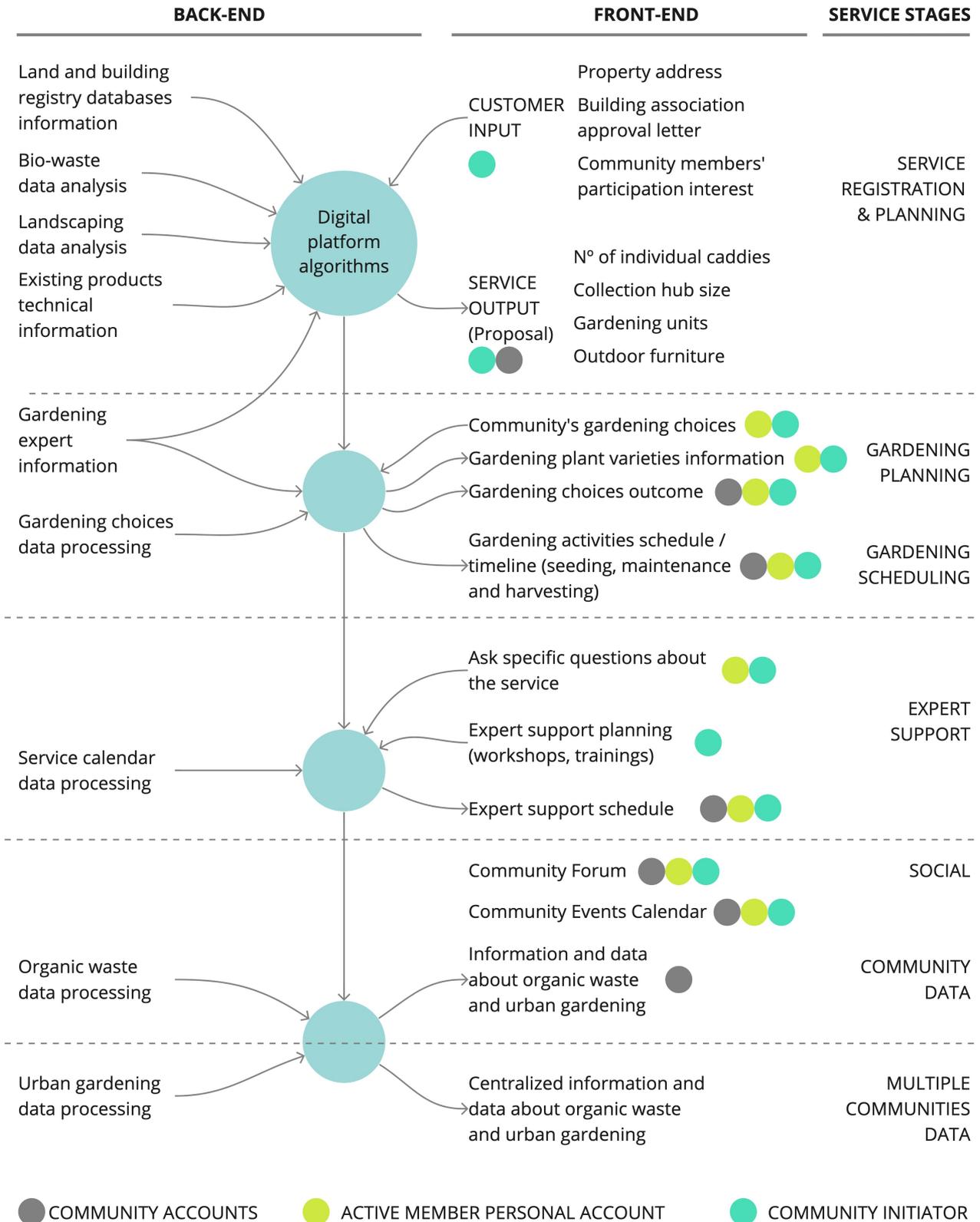


Figure 6.2. Service digital platform data scheme mapping.

The platform’s landing page (Figure 6.3) is designed to quickly describe the service and what it enables, engaging visitors to turn into prospective customers by speaking to their needs. The interest in participating in such initiative is then shared among communities by their interested and active members.



Figure 6.3. Digital platform – Landing page.

SERVICE REGISTRATION & PLANNING

The platform illustrates and presents the different steps required for communities to get started: evaluating their needs and interests, meeting experts on site to validate the proposal for physical touchpoints, reviewing, approval and agreement.

During the initial onboarding stage, one active member of the community (who becomes ‘the community initiator’), registers the building in the digital platform, by submitting a digitally signed letter of approval from the building association head. The platform’s algorithms will analyze the information about the property’s location, unit count, orientation, surface area, among other details thanks to its

connection public data registries, from where it is able to retrieve that data. In Estonia and particularly in the City of Tallinn (Tallinna Linnaplaneerimine, n.d.), there are several open and public databases related to buildings and households properties and their use of land. Some examples include the E-land Register (Registrite ja Infosüsteemide Keskus, Estonia, n.d.) or the Building Register and Development Roadmap (Ehitisregister ja arenduste teekaart, Estonia, n.d.).

During the registration phase, community initiators provide information of their community's participation interest, an input needed to calculate the scale of the proposal regarding gardening activities (taking into account how many people want to participate). The analysis of this data is combined with information about bio waste average generation, depending on the unit count and with gardening and landscaping expert data. The platform's algorithm will offer and present different intervention proposals according to the characteristics of each property, which shall include:

- the number of Individual Caddies and the Collection and Composting Communal Hub (CCCH) size, both calculated according to the number of apartment units in the building;
- a set of gardening units with its tools, calculated according to the space available combined with the interested participants;
- complementary outdoor furniture for socializing.

GARDENING PLANNING / SCHEDULING

The digital platform contains gardening expert information based on the principles of *permaculture* (Laker, 2010), a holistic approach to gardening (and also agriculture) that aims to create harmonious integration with the landscape in the most sustainable way. It has some technical features for how to do so, using design to create more natural, biodiverse zoning and planning resulting in systems that allow plants to set seed, get interplanted with other varieties for pest control

and make the best use of the resources with minimal input (Permaculture Visions, n.d).

Active members of the communities are able to choose what they want to grow in the community garden and the platform presents a set of options from different varieties of plants (flowers, herbs, fruits, vegetables or others), so that a users can create a balanced mix. These collective choices of plant varieties are combined and processed to reveal the outcome for the preliminary gardening units plant distribution (Figure 6.4), which also includes recommendations from the platform to improve the diversity of the garden.

The processing of this data also creates the planning and scheduling of the different gardening activities to happen in each community, whether it is the planning for seeding plants, watering, maintenance or harvesting.

EXPERT SUPPORT

Community members are able to use the platform to ask specific questions about the service, either organic waste collection or gardening activities and get the service provider experts' feedback. Community initiators can also schedule and plan expert visits, trainings and workshops to engage the community in learning about managing the composting process or improving their gardening skills. These events are reflected in the community's events calendar and news section from the users' personal accounts.

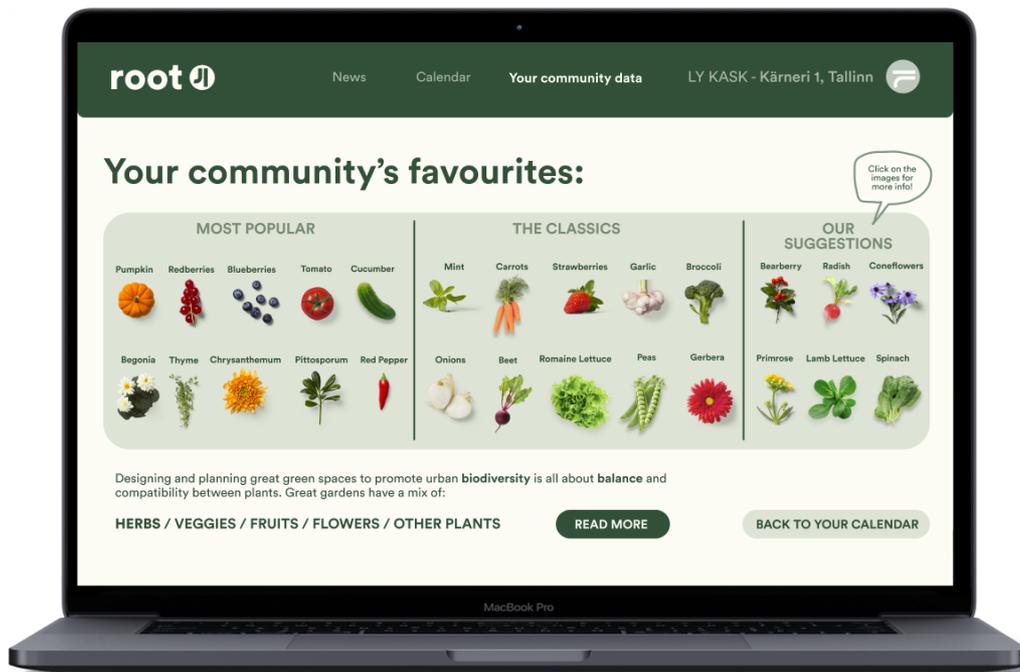


Figure 6.4. Digital platform – Gardening choices outcome.

PERSONAL AND COMMUNITY ACCOUNTS

Community members can access their own personal accounts which enables users to:

- make their informed gardening choices with the access to the platform's supporting information about permaculture, plant varieties and timelines (Figure 6.4);
- check the outcome of what the community has chosen;
- ask questions about the service;
- check the news about their community (the information regarding the particular activities about the service are also available physically in the community's Notice Board, placed at the building's entrance);
- propose and plan social gatherings and activities;

- review their community account data, mostly related to statistics about bio waste collection but also about their garden.

COMMUNITY FORUM

The digital platform's Community Forum provides members the opportunity to connect with other communities in the distributed network across their city and other cities as well (Figure 6.5). It is meant for all communities to come together, share knowledge, advice and experiences (where service provider experts can participate too). A digital space that provides the possibility of real life encounters, where people can meet and organize open yard days.

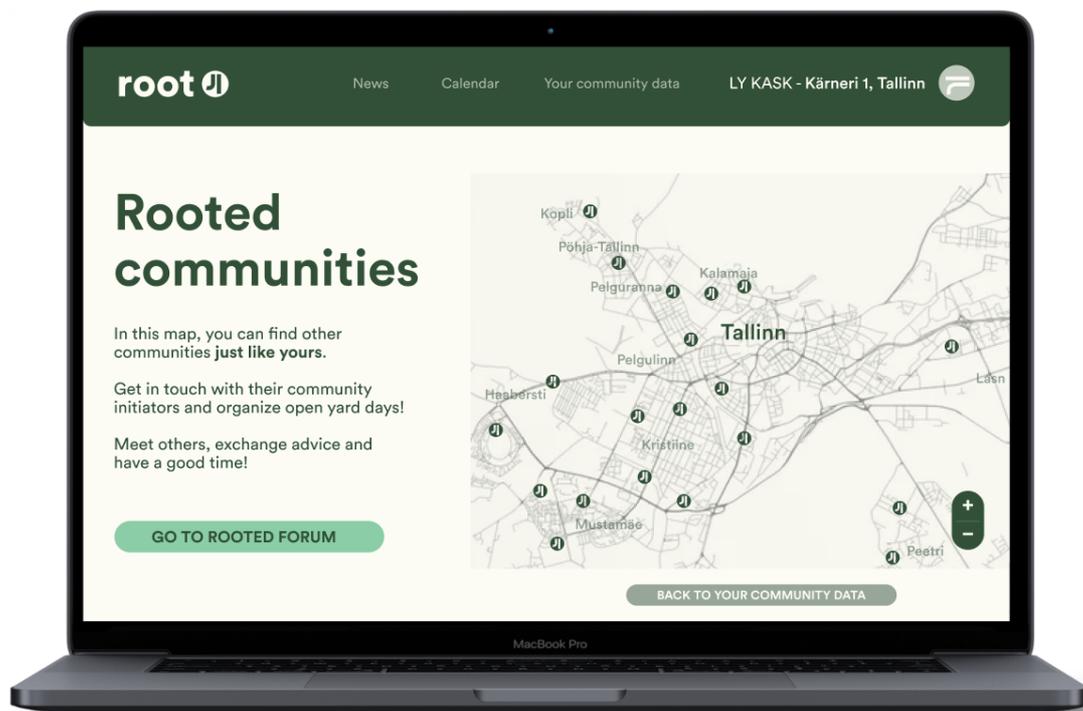


Figure 6.5. Digital platform – Rooted communities map and access to Community Forum.

DATA COLLECTION / DISTRIBUTED COMMUNITIES

The digital platform enables the service to work as a scalable, centralised ecosystem by gathering data about the amounts of organic waste collected and composted in each building (Figure 6.6) along with the specifics of each community's gardening interventions.

The distributed service data of multiple communities can be combined, analysed, presented publicly as statistics for municipal governments. This ultimately enables main stakeholders (governments and waste management companies) to adjust their actions, plans and legislations to better fit the demands of their citizens.

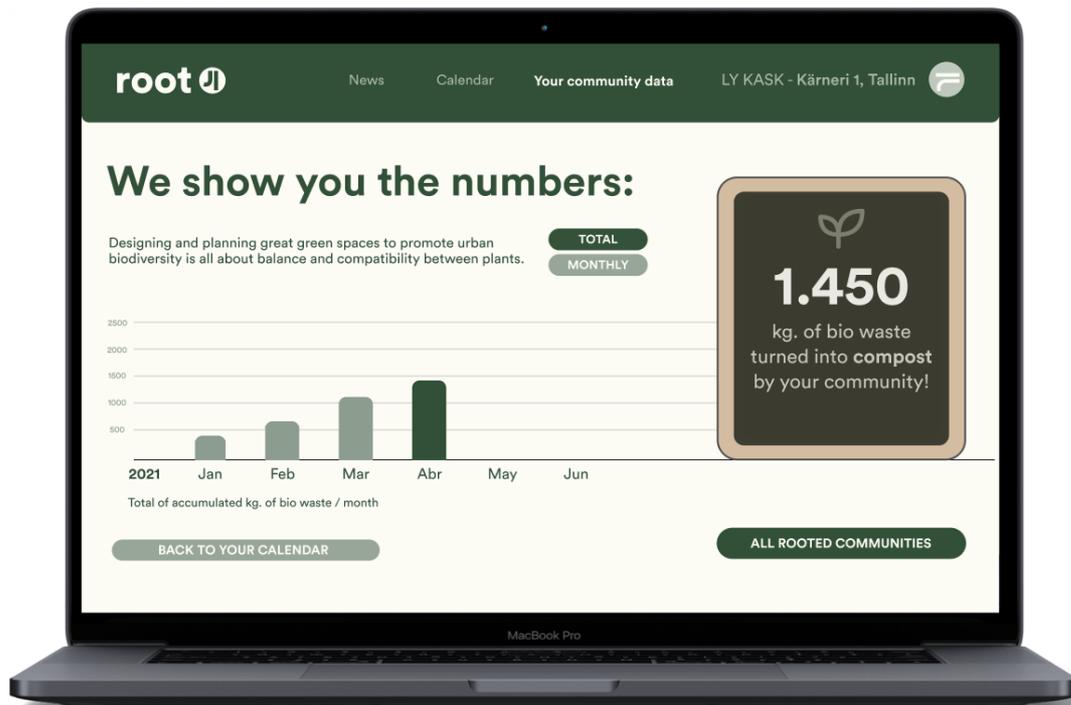


Figure 6.6. Digital platform – Bio waste collection and composting community data.

6.1.2. Physical Touchpoints

One of the main aims of the service is to provide an alternative option that changes the way things are happening in the current centralised waste management system but while developing the concept, I realized that this did not mean redesigning the necessary touchpoints to make it happen. There are currently a vast variety of existing products that are designed for and support:

- **Waste disposal:** collect and dispose of any type of waste (and bio waste in particular);

- **Composting:** different techniques and scales to compost biodegradable resources;
- **Gardening:** grow fresh herbs, fruits, vegetables, flowers and other plants under the principles of permaculture;
- **Socializing:** outdoor furniture that would support the time spent outdoors, individually or with others, either sitting, relaxing, eating, etc.

Most of these products, however, are not available or provided to customers in a context where they can be used in connection to one another and also collectively in urban communities.

Root's service system approach has been to choose a set of those products which fit into the service's needs and values and put them together, providing them along with the support needed to **plan** which, how many and where to place them in the community's property space, to **manage** them (composting or take care of garden).

ORGANIC MATERIAL COLLECTION

Biodegradable waste is considered a valuable material and a resource for the gardening activities it supports. The collection starts in each household, in each kitchen, by each community member. This is why the Individual Collection Caddies (ICC) are proposed for each apartment unit to collect their organic waste.

Fitting the values promoted by the service, ICC main features are that they have to be long lasting, made of sustainable materials, easy and convenient to use, sized accordingly to fit in a kitchen counter or under kitchen sink, have a handle and a lid to close it and hold up to approximately 4.5 / 5 litres in volume, which means that each community member will empty it, on average, once a week (Figure 6.7).



Figure 6.7. Individual Collection Caddy, illustration by the author.

Initially, ICC could be optional, considering that some apartments already might have a dedicated caddy or bin where to collect bio waste separately. Nevertheless, community members receive a Composting Information Brochure with the simple guidelines on what to include and what to avoid (Figure 6.8).



Figure 6.8. Composting Information Brochure, illustration by the author.

COMPOSTING

One of the first interventions of the service in the community is setting up a Collection and Composting Communal Hub (CCCH), sized according to the amount of apartment units per building. Placed in the building's property, it allows

for local management of the materials and avoids the need of transporting it to centralised facilities.

The CCCH consist of 3 main unit, visualized in Figure 6.9., from left to right:

- 1. meant for neighbors to drop the separately collected materials;
- 2. where the composting happens;
- 3. to store the compost ready to be used for gardening when needed.



Figure 6.9. Collection and Composting Communal Hub, illustration by the author.

COMMUNITY GARDENING

The organic fertilizer generated by the composting of the resources collected is then employed to enhance the soil used for the gardening activities that take place in the community’s surroundings.

Taking into account the building’s characteristics, unused areas and the amount of community members interested in participating in the gardening, the service makes a proposal of the possible infrastructure, tools and materials that will support those activities.

These touchpoints are thought as diverse existing gardening solutions which could include vertical units, greenhouses, vertical walls, raised beds and cold

frames, etc (some examples in Figure 6.10). They shall be made of long lasting and sustainable materials.



Figure 6.10. Examples of gardening units. 1. Urban Garden Pyramids in Madrid, Spain, photograph by the author. 2. Photograph by Rawpixel (freepik.com) 3."Plants in a raised bed garden" by Alabama Extension (CCO 1.0)

SOCIALIZING

Enabling social interactions between neighbors and promoting connections between people of different ages and interests is one of the service’s main objectives. For that, the service proposal shall include complementary infrastructure that would support socializing and those events and gatherings that might result from the shared time spent gardening and growing food together as communities in their own surroundings.

The possibilities for those touchpoints include modular additions to gardening units (seatings attached to garden beds, benches held between planters or tables and shelves held on the side of elevated garden beds) and also outdoor benches and tables (examples of existing solutions are shown in Figure 6.11).



Figure 6.11. Examples of socializing units. 1. Outdoor bench in Tartu, Estonia, photography by the author. 2. Outdoor Furniture in Entre Ríos, Argentina, photography by the author

6.1.3. Physical Information

As a physical connection with the community and as a way to make digital data about the service tangible, Root provides Notice Boards to be placed in the building's entrance hallway, making the information available for community members of all ages.

The Notice Boards are designed with different sections areas for different purposes, which I illustrated in Figure 6.12. The larger space at the top of the board works as a blank canvas in which community members are enabled to share news, comments, advice, questions or event invites amongst themselves.

The bottom area follows a traffic light inspired system. On the left, the green area works as a communication tool for the service that allows sharing and reviewing updated information about the activities carried out. The Notice Boards can be easily updated to provide weekly data about the gardening tasks and schedules, providing the minimum and necessary information that they need to know, exactly when they need to know it. It is also a good way to make tangible the information about the different plants' status and also to share activities planned for the community such as expert visits, trainings or workshops. On the bottom right, yellow and red areas are meant for providing feedback to community

members about composting and also for giving notice about what needs care, attention or watering in the garden.

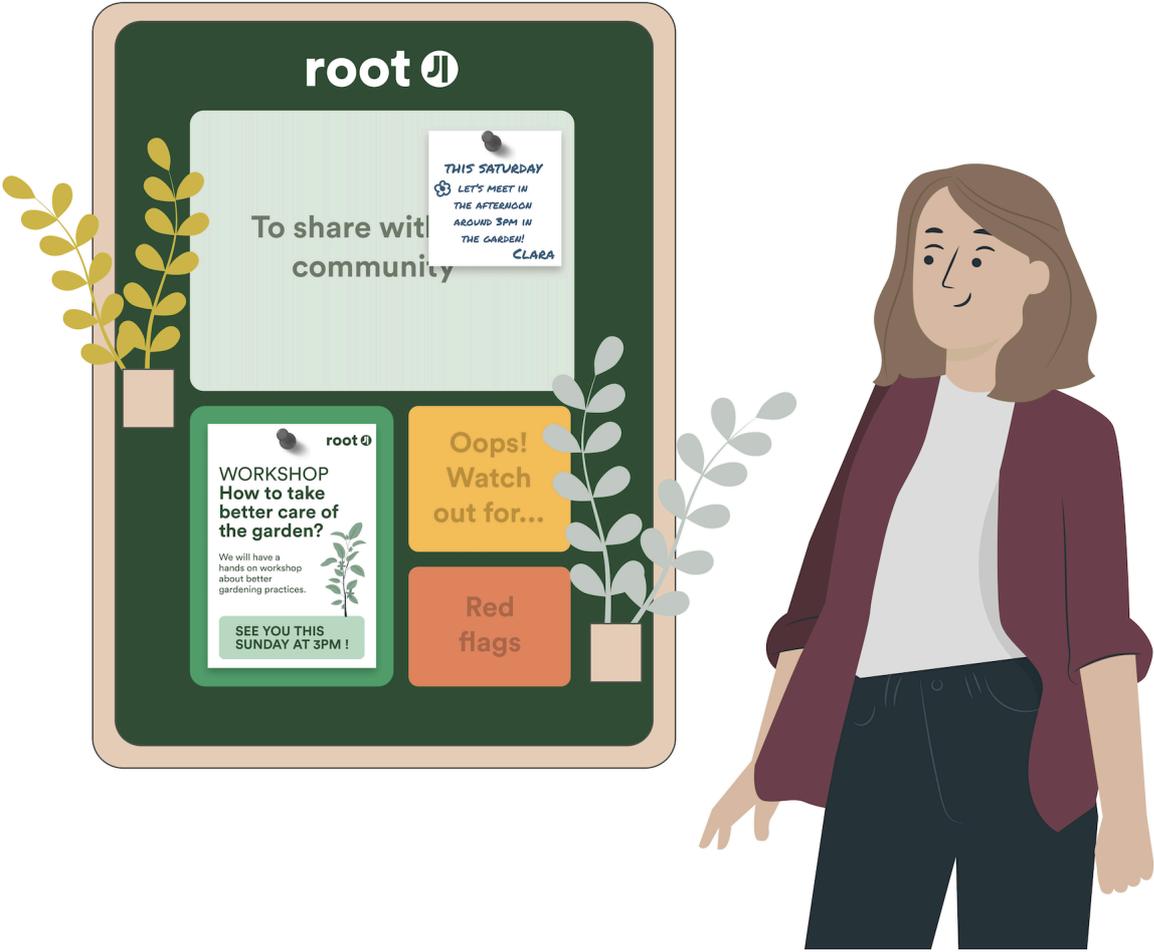


Figure 6.12. Root’s Notice Board

6.1.4. Organic Waste Management: Local Composting On-site

The collection of the organic materials is a constant input during the year, which creates the need of constant handling. The management of the resources and the composting process is done initially by the service provider experts since handling these materials in this scale requires expertise, temperature measuring and work, among other specifics of the composting process. As time goes by, community members are encouraged to take part of this process, get the knowledge and the necessary information so that they can take over and manage

it by themselves (Figure 6.13 illustrates the Collection and Composting Hub scenario where Community Initiator meets service expert).



Figure 6.13. Collection and Composting Hub scenario.

The data collected by the service is available in the digital platform, providing transparent and accessible information so that community members could understand the scale of resources they would need to manage.

To have an overview of the amounts that I am referring to, I took as a case study an apartment building of 40 units. As I found during my research, an average household generates 2.5 kg of bio waste per week (generally emptied in the communal hub once a week), which for 40 units would mean 100 kg.

Since generally waste containers are measured by volume, I found that a bin of 240 liters full of organic waste has an estimated to weight of 100kg (Environmental Protection Agency, n.d.). Additionally, I learnt that organic waste reduces to almost half of its volume during the composting process (Breitenbeck & Schellinger, 2013), which provided me with a basic understanding of the volume-weight ratio for my calculations.

The organic resources would be moved every week from the collection unit to the composting unit, where during the process they would reduce to half of its volume, generating 120 litres of compost. I referred to a compost calculation tool (Field Compost Ltd., n.d.). According to this tool, for a garden bed sized 1,20 x 1,20 x 0,30H (Mts) 432 litres of compost are required, which means that on average the organic resources generated in the course of 3,5 weeks could serve one garden bed ($432 \text{ lts} / 120 \text{ lts} = 3,58$). In total, counting 52 weeks per year, the total amount of bio waste in this case study would be 6240 litres ($120 \text{ lts} \times 52 = 6240 \text{ lts}$). Taking the requirements of 1 sample garden bed, it would mean 14 units could be filled over the course of a year ($6240 \text{ lts} / 432 \text{ lts} = 14,44$). Nevertheless, the service proposal would include different possibilities and sizes of gardening units, but I used this calculation as a basis to continued to develop the concept.

6.1.5. Gardening Support

In the community gardens created with the support of Root, the activities, tasks, and results are shared amongst community members. The digital platform also provides the help, support and knowledge necessary when it comes to the organization and scheduling of the activities.

These urban gardens start with the idea of having communities use their own bio waste to fertilize their shared land, where together they grow fresh produce, herbs and flowers, creating better social bonds and enriching our surroundings. And this is where the main difference between Root urban gardens and traditional urban community gardens relies, in the latter people are responsible for their own garden bed, their own space and what they grow on a shared land.

Some of those community members might not have the knowledge or expertise to go on with those activities but also not the tools to properly manage them in a collective way. This is where the service comes in. Root's digital platform data and the information made tangible in the physical Notice Boards, provide that expert

knowledge that city dwellers need for those gardening tasks to run smoothly. Moreover, the service provider experts play an important part with their support, visits, trainings and workshops that help educate people on the maintenance of these collective greenspaces (illustrated in Figure 6.14).



Figure 6.14. Gardening workshop scenario.

The service uses the notice boards as a tool for physically communicating with the community members, by giving them constructive feedback, sharing news and updates about their garden and also raising red flags when there are things to take care of.

6.2. Rooted Communities

To better understand the community members and their participation regarding the service, I developed three types of service user profiles: Community Initiators, Active and Passive Community Members.

Rooted Communities

- Community Initiator
- Active Community Member
- Passive Community Member



● Tarmo, 67

● Hardo, 42

● ● Ly, 31

● Dora, 71

Values / Motives

Head of apartment association. Not really into changing things, content with as-is. Believes back in the days things were simpler regarding waste.

Wants to teach his son how food is grown and enjoy gardening as a shared activity, especially on the weekends. Keen on having his family eat healthy.

Grew up with a big yard full of apples, potatoes and other veggies. Wants to have a garden without giving up city life. Eats organic food bought from markets.

Would enjoy meeting neighbors and contributing to the community as a way to stay active and busy. Used to enjoy gardening. Knows that local food is best for her health.

Frustrations

Wants a simple system where everybody can follow rules, without wasting money.

Would like to have a garden to but can't afford a home.

Spends time separating waste without knowing if it was worth it.

Spends most of her free time alone and it's not easy to socialize with neighbors.

Resources



Figure 6.15. Members of Rooted Communities – Persona Profiles

Every community is different but I wanted to represent the main groups to be found: young people, couples, families with kids and seniors. In order to create better understanding their roles, their motivations and their resources, I created

customers' persona profiles (Figure 6.15). For these user profiles I developed user journey maps that helped design the interactions with the service in the different stages. (see Appendices 1 and 2). The user journeys will be described in more detail in the Subchapter 6.3.

6.2.1. Service Flexibility / Participation and Collaboration

To visualize and analyze the level of participation and involvement of Root service users in comparison to traditional municipal waste management services and existing urban composting solutions, I again referred to the participant involvement map (Manzini, 2015), and created Figure 6.16. combining what is proposed by Root with the analysis from Figures 3.3 and 4.2.

Participant involvement map: Root

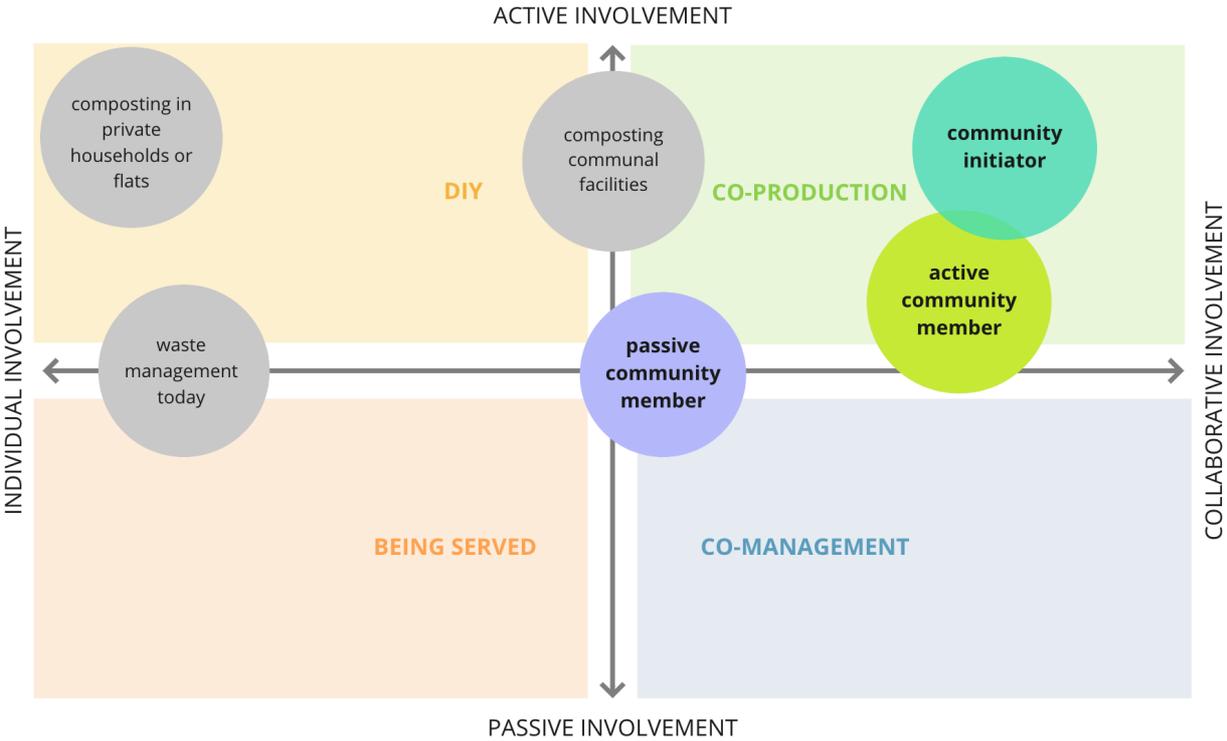


Figure 6.16. Root's service participant involvement map.

As analyzed previously, currently the solutions for apartment buildings are mostly working on an individual basis, where customers are left on their own, acting

individually and being served. Root proposes a new approach that aims for people to be more active and more collaborative. For those communities of people that live together, the level of interest and resources for participation and involvement of users might still differ. This led me to develop a service flexible enough to provide possibilities provided for all, despite how active or passive they would like to be.

Active community members and community initiators are indeed more active when it comes to their organic waste and are engaged in those activities done collaboratively. Some members of the communities might still prefer to keep a more passive involvement, due to lack of time or interest. Those individual actions all of them carry individually still have a collective purpose, therefore placing them more to the right side of the map.

An Enabling Ecosystem

The systemics approach used for this work, as mentioned, is linked to the ideas social innovation related to people's capabilities. I considered the participation of individuals and designed to create an enabling ecosystem, to support their capabilities (rather than their problems). In this context, individual actions (more active or rather passive) are defined by people's resources (time available, knowledge, skills, experience, willingness or motivation) and determine the level of collaborative involvement of the communities.

6.3. User Journeys

In this subchapter, I will describe the user journeys, the actions and interactions of community initiators, active and passive members of an urban community with the service system.

6.3.1. Community Initiator

Community Initiators refer to those people who engage their communities into having their building take part of the service. This hypothetical user plays a crucial role for the connection between the service and the community. They are conversation starters, driven by their own personal interests and motivations regarding living sustainable lifestyles. These people are generally informed about the environmental impact of their actions, are interested in gardening and probably have had experience in it. When it comes to their waste practices, they aim to generate the minimum, separating thoroughly their waste but still not being sure whether their efforts were worth it, really looking forward to having more transparent systems.

Besides acting as Community Initiators, these people are indeed Active Community Members, taking part in the collection of organic materials and in the gardening activities. In order to create a general overview which would help describe most of the interactions with the service and its touchpoints, for the user journey mapping, I illustrated them together, showing the actions performed by both. For the purpose of description, I here address them separately.

After sharing the idea of joining the service to their neighbors and building association heads, they get their community's approval to get started. They collect their neighbors' participation interests and available resources for taking part of the activities and become the link between the service and the community. During the initial onboarding stage, community initiators register the building in the service's digital platform and review and define the service proposal.

They help plan together with the service provider expert those green interventions according to their shared property land and decide how and where they will place them in the early onboarding stages. Once the community defines

what are the physical touchpoints to be placed in their property, the service gets launched and the collection of organic resources starts and the service starts composting process. In the mean time, while the gardening units are built, community initiators invite other members to choose what they would like to grow (as shown in Figure 6.4., all members have their say and the decisions are collective).

During the year, community initiators are the ones responsible to organize workshops and trainings with service experts about learning how to compost or how to better take care of garden. As mentioned before, community initiator are indeed active community members, but have specific tasks for taking the initial lead of the community to get the service started.

6.3.2. Active Community Member

All members are invited and engaged to participate actively in the community, it could be participating in the gardening activities and proposing or taking part of events, to get to know each other and socialize. In the different activities that the service enables, they interact with the physical and digital touchpoints and also with other members. Though the digital platform, they are able to learn about gardening and the benefits of permaculture, while making their gardening choices. Every week, as the Notice Board gets updated, they get information about the gardening scheduled activities: mixing compost and soil, seeding, watering, maintenance, harvesting, etc. The outdoor furniture serves as a complement for those community events, where people are encouraged to relax, eat, cook together and just spend time together or alone outside.

6.3.3. Passive Community Member

These are the community members who don't have the free time and / or the willingness to participate in gardening activities but still contribute to it with the separate collection of his home's organic materials. Through the different stages

of the service, they get familiar with the activities and hopefully after the service is up and running, some of those passive members start taking part of the activities and become more active in their communities. However, as it was mentioned before, already collecting correctly their organic resources and placing them in the Communal Hub changes the way they may act or think about waste, since they would know that those resources will be used to grow food and other plants, improving their living surroundings.

6.4. Service Value Creation

The values that the service as a business concept promotes are the idea of being part of a movement of urban change makers, who care for the future and are willing to raise awareness by acting in different ways, making those needed changes to the complex urban systems. It is all about making a positive impact and the creation of new types of urban lifestyles that results in the making and creation of closer and more social communities in shared living environments.

As more and more communities join the service to locally manage their organic resources and use them to collaborate in their shared gardens, the number of people engaged in the movement will increase as well. As a result of this bottom-up approach, of communities that are 'rooting' for new collaborative and more sustainable ways of doing things and managing resources, their local identities strengthen enough to become a bigger social pressure for their municipal and national governments. As a result, new regulations and legislations are expected to appear and be rolled out affecting all the stakeholders that take part in the system.

The main values of the service have been analysed for the main stakeholders: urban communities, the city environments and municipalities.

For urban communities:

- support and tools for collective decision making and co-management of resources and gardening activities.
- decentralised and localised management of bio waste, city dwellers own bio waste circles right next to them in their surroundings;
- gardening has several benefits: being in contact with plants and with soil reduces stress and it is also a great educational tool to teach about the food system and natural cycles of the soil and plants;
- new urban lifestyle by growing your own food and how it enables the access to locally sourced fresh produce;
- higher transparency of knowing where your food came from and where your bio waste is going;
- community making: develop stronger connections, new relations with neighbors and become part of your community through those activities that are done together;
- lower the barrier to get into urban composting and gardening activities that require knowledge, effort, time and financial investment;
- city dwellers get to contribute to enhancing their surroundings by changing significantly their common shared areas, which tend to be generally dull nowadays, providing them with social and environmental meaning and also with more beautiful, biodiverse, greener and richer landscape (the way in which I visualize these communities is illustrated with the moodboard in Appendix 3);
- separating the bio waste with a purpose, creates awareness amongst city dwellers towards other types of waste;

- taking part of collective action towards mitigating the climate change.

For the city environment:

- richer urban landscape and enhanced urban building surroundings, either by repurposing unused spaces or giving meaning to plain grass areas;
- an increased urban biodiversity with the service combinations of herbs, flowers, vegetables and fruits;
- diverting organic waste from incineration or landfill by increasing awareness and its separate collection;
- reducing the emissions of greenhouse gases that result from the decomposition of organic waste in landfills;
- reducing carbon footprint of municipal waste management by avoiding the transport of a specific waste stream;

For municipalities:

- receive statistics and data of urban bio waste generation and its recycling;
- obtain information and data about urban gardens and their characteristics;
- Improving the recycling rates, which helps to reach national and EU targets.

Referring back to the barriers for the decentralisation of bio waste composting discussed during the interview with the representative from the Tallinn City Strategy (Subchapter 4.1.1.), most of them are addressed and tackled:

- Root helps and supports community members to agree, collectively decide and also manage together.
- The service provides the users with feedback, the necessary information in a comprehensive and simple manner, easy to understand and at the right

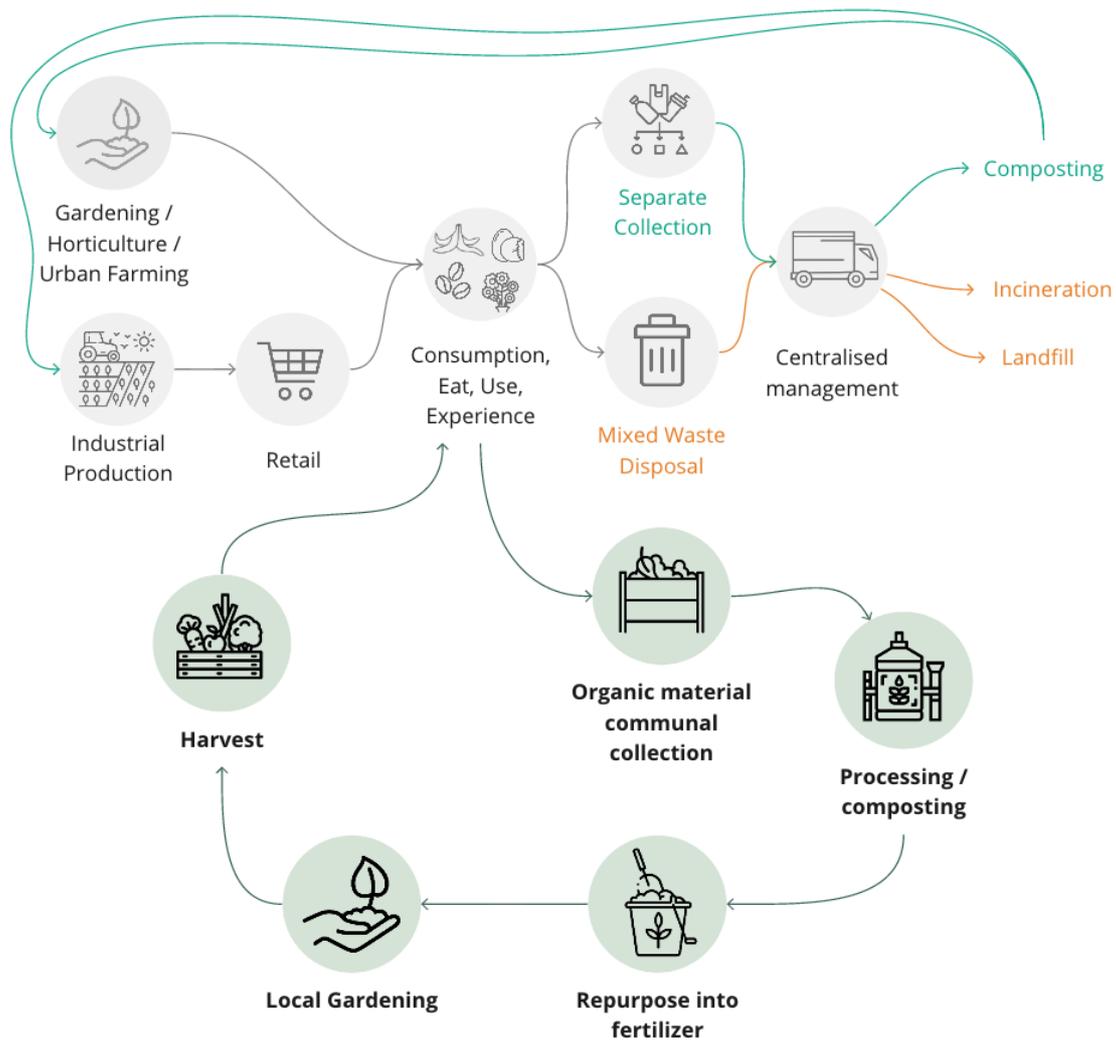
time when needed and engages the community to learn how to take care of the activities on their own.

- With the intervention of this system, community members become engaged with their community in managing and repurposing their resources. The composting, gardening and socializing activities enabled by Root, keep people motivated and empowered with awareness, knowledge, tools and transparency.

6.4.1. Local Closed Loop

In these types of communities, bio waste would not be constructed anymore, it would mean that all the organic materials would actually be considered resources, that they would not lose value and are not lost getting transported somewhere else (Figure 6.17). These closed local loops, require new systems that support the activities needed for co-managing those resources and this is where Root comes to play. New environments are created therefore new interactions between community members emerge.

ORGANIC MATERIAL CYCLES



LOCAL CLOSED LOOP

Figure 6.17: Organic Material Cycles and Local Management Loops, by the author.

6.4.2. Root's Message

Root was chosen as the name of the service system because of its multiple meanings and connotations either as a noun (the part of a plant that attaches it to the ground / the basic source, cause, essential core / cultural origins) and as a verb (to establish firmly and deeply / to enable the development of roots of a plant / to cheer or encourage a person / to discover and bring to light). As its name states, the service is all about growing roots, both social ones related to the creation of bonds between people in a common shared space and the roots that are generated by planting seeds on the soil. The ideas that define the service's

brand will also be communicated in different channels (Figure 6.18 shows two examples). Root is defined by:

- the support and simplicity among the waste management system and urban community composting and gardening;
- its bold and enabling approach to regain resources as communities
- a solution that is both sustainable and circular but also has a social and environmental impact.

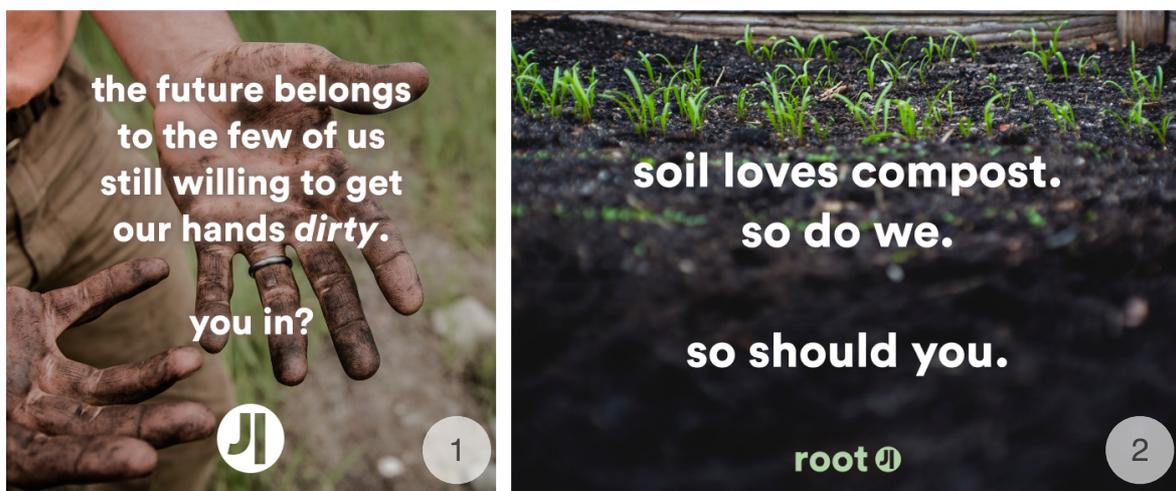


Figure 6.18. Root's brand messaging, logo design by the author.

Photography credits. 1. Orrico, J. (2017), Unsplash. 2. Spiske, M. (2018). Unsplash.

7. Conclusion

During the development of this Master Thesis, I delved into the problematique built around the urban waste landscape, with a focus on the biodegradable stream, analysing this systemic 'wicked' problem from different angles, individual and collective practices, management, business, political legislations and strategies (local and regional), environmental impacts, trends and opportunities.

As discussed, one of the questions I wanted to answer with this work is how to change the social and cultural narratives that consider waste creation and generation only at the individual level, placing the responsibilities and burdens on people. The analysis of the context led me to understand clearly why recycling targets are not reached with the current centralised waste management system, generally mistrusted by individuals due to its lack of transparency, feedback and information, that leads people to get detached from their actions with the 'out of sight, out of mind' mindset, lacking motivation and a reason to act differently.

Nevertheless, with the framework of human centered design, in combination with the Systemics and Social Innovation approach, I conducted research, shaped the analysis and searched for opportunities that would promote collaboration, participation, meaning and community making to guide me towards the development of a solution that would aim to make that change. I understood that when it comes to giving responsibility to people, it should work for them, to fit their needs, their lifestyles, giving them meaning and a reason to do it.

This research work started with the premise of turning waste into local resources, managed responsibly and transparently, encouraging collective sustainable actions. In order to transition to new (local) cycles that close resource loops, a change in mindset is needed, to switch the current way of thinking about waste, reduce burdens and stress and the responsibility without purpose. Even though

there are issues with waste recycling, I realized that addressing it would not be enough, there are multiple possibilities for that already in the market and information is available. However, there are no solutions that puts it together, to help people manage but also to give people the reason why to decide to do so. I researched further into those activities that would give a more social meaning to waste, complement its management and impact city dwellers' lifestyles and how they connect with their communities. The environmental impact and the possibilities of design to enable social change and sustainable solutions shaped the hypothesis and the concept's design brief and guiding principles.

Root is the design concept I developed to answer those initial questions in a comprehensive way and in a holistic manner. As a distributed service system, Root's touchpoints enable communities to properly and collectively collect their organic resources, learning **WHAT** do to with the support and information provided. Resources are turned into compost, used to fertilize their own greenspaces and gardening units, making their surroundings more richer and enhancing these shared spaces into places where community can share and become more connected and social.

Root is all about taking collective decisions and actions, it is about **HOW** the resources are co-managed among community members, with the support of the service, creating transparency, increasing awareness, engaging people to take part in their communities. Taking more meaningful action and making change, does not mean everything has to change. People would not have to change much of how they collect or how they dispose of bio waste today. However, with the introduction of Root, communities would manage their organic resources in a smarter, more inclusive, environmentally friendly manner. Placing biodegradable materials in the Collection and Composting Hubs provided by Root, instead of in the centralised municipal waste management containers (if their properties even

have them), everything changes. **The actions and the people involved might appear the same. But the outcomes and the social mindset are a lot different.**

Root is mostly about purpose, about giving people the reason and motivation to do it, it is about the WHY. Author and motivational speaker John C. Maxwell has shared this idea, when talking about purpose: "Find your WHY and you will find your WAY". This quote fits quite well my personal motivation to develop this thesis work and to find direction in the process. Root is about connection and community making, I believe that this is where it all could start, with community initiators, those people willing to engage and inspire those around them, starting the conversations and work to create and enable those connections with others, creating hopefully more 'rooted' urban communities.

There is still a long way to go for biodegradable waste to be considered a resource. The question remains about the wording, even during this work, can the word 'waste' be changed to resource, particularly when it comes to this material stream? Would that already help all stakeholders to change their mindsets? I hope this thesis helps to open up the discussion and also provides a framework to move on with other ideas. There are still possibilities to locally recover the bio gas generated from the decomposition process and with that, generate integrated systems, where this energy could support the activities enabled by the service and also other needs, like lighting, heating, etc.

When it comes to systematic matters of such large scale, it is hard for people to see the impact of their actions, however I believe it is always better to try, to act, to think differently. Here one closing and very inspiring quote about taking action that resonates well with the values of the design concept but also with my personal ones, shared by one of my dear relatives: **"I do not regret of what I did, but what I did not even tried to do". If we don't act, if we do nothing, there will be no change.**

8. Summary

This thesis work aims to shift the narrative of bio waste and explore the possibilities and alternatives for repurposing these materials to transform them into valuable resources. I analysed this problematique from different levels starting with the idea of waste as a cultural and social construction, where value is lost and resources become waste at the individual's hands. At the functional, more practical level, I analysed the municipal, communal and individual strategies and existing tools needed to support the management of these resources in this transition. Changing what resources mean for people, cannot only start and end with the bio waste as such, to create a change in people's lifestyles it has to provide value, a meaning, a purpose for them to choose to act differently.

The framework used was a combination of the systems oriented design approach combined with a human centered design perspective, with a particular focus on the role of design in systemic change. The systemics approach is linked to social innovation, where I considered the participation of individuals and designed to create an enabling ecosystem, to support their capabilities (rather than their problems). This approach also led me to consider distributed systems to tackle some of the issues generated by current centralised waste management services.

I worked on developing a solution that would integrate the main issues of the problematique with the opportunities found in urban composting and gardening, towards building social bonds between members of urban communities but also improving and making richer living surroundings and greenspaces.

The design concept I created is a comprehensive and holistic solution that has meaning, action, awareness, connection, distribution and decentralization as its core principles. Root is a co-managing service system for urban communities that aims to transform organic waste into local resources for shared gardening. It

provides city dwellers with purpose, control and support to take collective action. Root helps create local and more transparent resource loops inclusively and sustainably, resulting in more engaged, connected and social communities.

Kokkuvõte

Magistritöö eesmärk on nihutada biojäätmete narratiivi ja uurida võimalusi ning alternatiive nende materjalide kasutamiseks väärtusliku ressursina. Ma analüüsisin seda probleemistikku erinevatel tasanditel alustades jäätmete kontseptsioonist kui kultuurilisest ja sotsiaalsest konstruktsioonist, kus väärtus kaotatakse ja ressurs muutub jäätmeks indiviidi käes. Funktsionaalsel, praktilisemal tasemel, ma analüüsisin munitsipaal-, kommunaal- ja individuaalseid strateegiaid ja olemasolevaid tööriistu, mida on vaja selleks, et toetada nende ressursside siirdeprotsessi juhtimiseks. Ressursside tähenduse muutmist inimese jaoks ei saa alustada ja lõppeda vaid biojäätmetest kui sellisest, inimeste eluviisides muutuse loomiseks peab see pakkuma neile väärtust, tähendust ja eesmärki, et otsustada teisiti käitumine.

Süsteemidele orienteeritud disaini lähenemist kombineerisin inimkeskse disaini perspektiiviga, mille täpsem fookus oli disaini rollil süsteemsel muutusel. Süsteemne lähenemine on seotud sotsiaalse innovatsiooniga, kus ma võtsin arvesse indiviidide osalust ja disainisin võimaldavat ökosüsteemi, et toetada nende võimekusi probleemiga toime tulla (mitte probleeme nende eest lahendada). See lähenemine suunas mind arvesse võtma hajussüsteeme, et adresseerida tsentraliseeritud jäätmemajanduse poolt genereeritud probleemataid.

Mu eesmärk oli arendada lahendus, mis integreeritult käsitleks peamisi probleeme võimalustega, mille leidsin linnaaiandusest ja –kompostimisest, looks uusi

sotsiaalseid sidemeid linnakogukondade liikmete vahel, aga arendaks ja rikastaks elukeskkonda ja rohealaseid.

Ma lõin lahenduseks tervikliku ja igakülgse disainikontseptsiooni, mille põhimõtted lähtuvad tähendusest, teostatavusest, teadlikkusest, ühendatusest levikust ja detsentraliseeritusest. Root on koosjuhtimise teenusesüsteem linnakogukondadele, mille eesmärk on muuta orgaanilised jäätmed kohalikele ühisaedadele ressursiks. See pakub linnaelanikele eesmärke, kontrolli ja tuge, et ühiselt tegutseda. Root aitab luua kohalikku ja läbipaistvamat ressursitsüklit kaasavalt ja keskkonnasõbralikult, mille tulemusel on kogukonnad rohkem kaasatud, ühendatud ja seltsivamad.

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¹¹ Photography credits: Rawpixel. Accessed 20.05.2021 https://www.freepik.com/free-photo/glass-greenhouse_2971570.htm#page=1&query=greenhouse&position=0

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¹³ Photography credits: Orrico, J. (2017). Unsplash. https://unsplash.com/photos/ljdxBF_StBk

¹⁴ Photography credits: Spiske, M. (2018), Unsplash. <https://unsplash.com/photos/71uUjlt3cls>

11. Appendices

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