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CURE+

CENTRES FOR URBAN RESOURCES, REUSE AND REMANUFACTURE

Baseline study

City of Tartu, Estonia

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Lists of Abbreviations

CDW	Construction and Demolition Waste
CE	Circular Economy
CEAP	Circular Economy Action Plan
CURE+	Centres for Urban Resources, Reuse, and Remanufacture
EU	European Union
EPR	Extended Producer Responsibility
EUKI	European Climate Initiative
EU WFD	European Union Waste Framework Directive
URC	Urban Resource Centre
WPP	Waste Prevention Plan
WMP	Waste Management Plan

1. Introduction

1.1. City of Tartu

Tartu is the second largest city in Estonia, with a population of 98,306 inhabitants as of December 2023. It is considered as the intellectual capital of Estonia since a quarter of the population are students. Furthermore, the University of Tartu, which is the country's oldest and most prestigious university is located in this city. The area of the city of Tartu is 153.21 km^2, with 11 remaining settlement villages in the territory namely Ilmatsalu, Märja, Haage, Kandiküla, Kardla, Pihva, Rahinge, Rõhu, Tähtvere, Tüki and Vorbuse. The city of Tartu is divided into 17 districts: 12 on the right bank of Emajõgi (Supilinna, Tähtvere, Veeriku, Maarjamõisa, Tammelinna, Ränilinna, Vaksali, Kesklinna, Karlova, Variku, Ropka and Ropka industrial districts) and five on the left bank (Raadi-Kruusamäe, Ülejõe, Jaamamõisa, Annelinna and Ihaste districts). The former Tähtvere municipality was merged with the city of Tartu in 2017 (Tartu City Government, 2018).

In the last decade, an average of 343,793 ton/year of waste was collected from the territories of Tartu and the former Tähtvere. The waste collected from the territory of the former Tähtvere municipality accounted for an average of 17% of the collected waste during this period. The amount of collected waste has remained unchanged since 2014. The majority of the collected waste (approximately 91%) comes from companies while the rest (9% on average) is collected from households. The biggest share of collected waste was the Construction and Demolition Waste (CDW), accounting for 57% of collected waste and was estimated to be a total of 1 million tons in weight. The majority of CDW was collected from the city of Tartu, which has a relatively well-developed waste management system, with designated sites for depositing CDW as soil fillers.

1.2 EUKI Funding

CDW is the most significant waste stream in the European Union (EU) in terms of mass. Around 340 million tons of CDW were generated between 2010-2018 in the EU (EEA, 2020). Therefore, the EU Circular Economy (CE) Action Plan (EC, 2015) has identified CDW as a priority waste stream. The European Waste Framework Directive (WFD) sets a 70% recovery target for CDW by 2020. Most member states achieved the target on time. However, the recovery rate was mainly based on backfilling or downcycling, which hampers the implementation of CE objectives (Galvez-Martos et al., 2018). Currently, most material streams arising from demolition and renovation works are unavailable for reuse or upcycling activities (EEA, 2020). Thus, the recovery potential of CDW in the EU is still under-exploited, with current CDW streams unsuitable for reuse or closed-loop recycling (EEA, 2020).

The CURE+ project, also known as Centre for Urban Resources, Reuse, and Remanufacture, aims to support the CE Action Plan by promoting and designing urban CE practices to track, trace, reduce, reuse, repair, remanufacture, and upcycle household-related CDW. This will be done by learning from the best practices elsewhere and mapping the current waste

management practices in four participating European cities, namely Riga (Latvia), Tartu (Estonia), Kavala (Greece), and Barcelona (Spain), to develop locally tailored solutions for each city. Developing tailored-made solutions requires working with local stakeholders from cities/municipalities, private businesses, and universities while putting citizens at the forefront of this initiative. This involves engaging local stakeholders in waste prevention, upcycling wastes, and decreasing reliance on virgin raw materials. Local authorities play a crucial role in climate change mitigation through the development and execution of CE policies at the local level. Therefore, they must be provided with the necessary knowledge and tools to promote and evaluate such initiatives effectively.

The CURE+ project is funded by the European Climate Initiative (EUKI). EUKI is an initiative launched in 2017 by the German Federal Ministry for Economic Affairs and Climate Action to improve collaboration among the member states on climate action. EUKI supports organizations within the EU to implement plans related to contributing to the expansion of renewable energy, improving energy efficiency, and reducing CO_2 emissions. Furthermore, EUKI-funded projects aim “to strengthen technological advances and political dialogue, social justice in climate action as well as climate education and sustainable economy” (EUKI, 2017).

1.3 Problem Statement and justification for selecting Tartu city

The EU's transition to a CE will reduce the pressure on natural resources while creating sustainable growth and jobs (EMF, 2015). Achieving the EU's 2050 climate neutrality targets is also a prerequisite. In order to contribute to this goal, the CURE+ will specifically address the following issues:

- Lack of knowledge of current CDW flows, their composition, and their characteristics to identify them as recoverable; in each partner city, there is a lack of reliable and available data and classification systems;
- Different understanding and varied accounting systems of EU-member states for waste recovery operations; as a result, there is a lack of comparable (baseline) data on how much of CDW is currently recovered, and it is difficult to measure improvements over time;
- A habit of giving preference to raw materials over secondary materials (originated from waste) for two reasons: 1. They are cheaper, and 2. Warranties and standards assure their quality, giving consumers and companies a limited incentive to use recovered materials;
- Lack of knowledge and resources to rethink value chains and business models, product design, and the overall economic systems to achieve the lowest environmental impact; and
- Communicating and promoting long-term benefits from implementing circular actions in the building sector.

In sum, a common understanding, exchange, transfer of knowledge, and capacity building are crucial for the CURE+ partner municipalities to achieve the EU climate goals.

The city of Tartu is a focused city in this project for two reasons. Firstly, CDW makes up more than half of the waste collected (more than 150,000 tons of CDW annually) in Tartu city and these wastes, such as wood, have high recycling potential which is currently unrealized since the majority of the CDW is mainly used as soil fill in construction works. The learning from this project in terms of implementing an Urban Resource Centre (URC) as an innovative solution for managing CDW, can be adopted and tailored to the city of Tartu. Secondly, Tartu has a high interest to enhance widespread recycling and valorization of CDW as part of their CE roadmap. Hence, other city partners in the project both can learn and provide learnings to Tartu to achieve their CE goals.

1.4 Aim of Article

The aims of this report are to: (1) highlight the unique aspects of Tartu, including its CDW management approaches, legal and policy frameworks, city visions and strategies, innovative practices, and enablers and barriers for CDW management; and (2) provide recommendations on how to organize a URC as an innovative approach for CDW management using the baseline insights obtained from relevant reports and stakeholder interviews in the city of Tartu.

1.5 Article Roadmap

The sections of this report are structured as follows. Chapter 1 introduces the city of Tartu, the funding body behind this project, the problem statement, and justifications for selecting this city, followed by the aim of this article. Chapter 2 presents the sources of information in this article, which include interviews and reports. Chapter 3 provides an overview of the CDW management practices based on national and local level policies and regulations and CDW stream analysis. Chapter 4 discusses the current city vision and strategies, innovative practices and experiments, and the barriers and enablers to more circular CDW management. Chapter 5 recommends how a URC, as an innovative experiment, can be organized to better manage CDWs in Tartu.

2. Methodology

The data were collected using a mix of reports, interviews, and a workshop. The reports include national and city documents on the State Waste Plan, CE Plan of Estonia and Tartu City Waste Management Plan (WMP). These reports were written in Estonian and were translated into English. The interviews, which were conducted in June 2023, consist of different sets of stakeholders with their profiles summarized in Table 1. All interviews were conducted in person and were recorded via MS Teams. The transcripts of interviews were generated using the same platform and were analyzed by coding relevant answers to the themes of this report. The information obtained from the reports and interviews were validated and were supplemented through a workshop held among city stakeholders in Barcelona in October 2023. The representatives of Tartu city were also included in Table 1 as part of the sources of information in this report.

Table 1 Profile of the interviewees.

Interviewees	Type of stakeholders	Profile
1	Private	Representative of a family-owned company, which was previously a waste management and recycling company and is now a Circular company
2	Private	Co-founder of a repair workshop
3	Public	Member of Parliament
4	Private	Works for an exchange platform (for second-hand materials)
5	Academic	Lecturer at the Tallinn Technical University
6	Public	Head of an environmental service department (responsible for waste management)
7	Private	Construction project manager
8	Private	Member of Wo(Men's) Shed Association
9	Public	Project assistant at City Government of Tartu
10	Public	Project manager at City Government of Tartu

3. Construction and Demolition Waste Management practices

This section identifies the different policies and regulation frameworks in the city of Tartu and Estonia in general, followed by the CDW stream analysis.

3.1 Policy and Regulation Frameworks

1. Waste Act 3 (RTI 2004, 9, 52)

Estonia's primary legal framework for waste management is the Waste Act, enacted in 2004. It establishes guidelines for various waste types and processing methods. This Act, along with its subsequent amendments with the latest as of 2015 and its related subordinate regulations, form the basis for waste management rules in the country. Regarding specific rules for CDW, the Waste Act mandates that 70% of CDW waste must be reused annually from 2020, though it does not assign the responsibility for achieving this target to local governments (Bio by Deloitte, 2015). The Waste Act § 1363 specifically pertains to CDW, excluding natural substances such as stones and soil, and hazardous substances containing stones and soil, prepared for reuse, recycling, and other forms of recovery, including backfilling, instead of other substances.

2. The Environment Charge Act (RT I 2005, 67, 512)

The Environment Charge Act describes the conditions under which landfill operators should pay landfill tax to the state for receiving waste in the landfill. Specific legislation for CDW management does not exist under the Environment Charge Act; however, detailed guidelines for CDW management are clearly defined in waste management regulations at the municipal level. Consequently, CDW’s regulation falls under the jurisdiction of individual municipalities, following the mandatory provisions outlined in their local government waste management rules, as stipulated in the Waste Act, Article 71 (Bio by Deloitte, 2015).

3. National Waste Management Plan

Estonia is currently implementing the National Waste Management Plan (WMP) 2023-2028, which is an extension of the National WMP 2014-2020. The National WMP 2014-2020 includes a chapter on developing the National Waste Prevention Plan (WPP), as well as a specific focus on promoting and intensifying support for investments and financing to companies engaged in waste recycling to enhance their performance and treatment capacity to contribute to achieving both recovery/recycling targets for municipal solid waste and CDW. Estonia aims to reduce landfilling as much as possible and recover the highest possible share of CDW. CDW is considered a priority waste stream in the WPP section within Estonia's WMP (Bio by Deloitte, 2015).

The National WMP 2023-2028 has several objectives that aim to support the transition to a CE, focusing on sustainable use of resources, in line with the European Green Deal and other relevant climate goals (Ministry of Environment, 2023). This plan also emphasizes the importance of achieving waste reduction targets, specifically for municipal and packaging

waste, and the need to adapt and respond to global challenges such as energy crises and achieving energy independence. Specifically, the objectives of the NWMP 2023-2028 are related to (1) Sustainable conscious production and consumption, (2) Enhancing safe material circulation, (3) Addressing and reducing the impacts of waste management, (4) Waste prevention, (5) Encouraging reuse, repair, and renovation, (6) Supporting a user-friendly, efficient, transparent, and innovative waste management system that follows the waste hierarchy and creates new value from waste materials, (7) Implementation of the waste hierarchy, (8) Transition to a circular economy, (9) Facilitating separate waste collection, (10) Ensuring environmentally and human health-safe waste management through effective supervision and regulatory compliance, (11) Digitalization of the waste management sector to support the implementation of waste hierarchy and efficient supervision systems, and (12) Collaboration and alignment with European Union and national regulations, as well as considering global developments that may affect waste management goals.

4. Demolition permit

This policy is implemented at the state (not local) level. If there is a demolition project, a permit for demolition must be applied. The permit's requirements include a description of the kind of waste and the materials, the amount of waste, and the journey of the waste (Personal interview, June 2023).

5. Tartu city policies

The role of local government is significant in monitoring the separate collection of waste at the source and ensuring its proper handling. According to the Waste Act, the local government is responsible for supervising the compliance with waste management regulations within its administrative territory. Waste management regulations must specify the requirements for handling CDWs not covered by organized waste collection. Therefore, waste management regulations should outline how CDW should be collected and handled, including which types of waste should be collected separately. The local government must ensure that these requirements are fulfilled. The local government unit organizes waste collection separately, to enable their preparation for reuse, recycling, or other forms of recovery to the greatest extent possible. In addition to organizing separate waste collection, the local government unit must also designate a waste management location or locations for waste covered by organized waste collection.

6. “Polluter pays” principle

In accordance with the "polluter pays" principle (Ministry of Environment 2007; Tartu City Government, n.d.), the primary waste holder bears the costs associated with waste management. In cases provided by law, this is the producer or person who has had the waste in their possession. One of the outcomes of the "polluter pays" principle is producer responsibility. Furthermore, Extended Producer Responsibility (EPR) has been enacted to collect waste from problematic products. Under EPR, producers which are defined as the company who made the product, are required to ensure the collection, reuse, or disposal of

waste generated from products they release on the market, even if the ownership is by somebody else. Producers can transfer this responsibility to producer associations (Tartu City Government, n.d.).

3.2 CDW Stream Analysis

The CDW stream analysis includes the (1) processes involved in the collection, separation, recycling, and disposal of CDWs, (2) types of wastes that are generated and where CE practices can be implemented, and (3) different stakeholders involved in the process and CE implementation.

Managing CDWs at the individual or household level

As an individual, if you have CDW, the following steps need to be followed (Tartu City Government, n.d.; Personal communication, June 2023):

1. **Segregate Your Waste:** At construction site, separate the waste by type. This includes hazardous waste, wood, packaging, metals, inert waste (stones, plaster, concrete, gypsum, etc.), plastics, and other mixed waste.
2. **Use Designated Containers:** Place waste in the designated containers for each waste type. If the waste is too large or heavy for a container, set it aside in a designated area within the construction site.
3. **Manage Hazardous Waste:** Special care should be taken with hazardous waste. Pouring liquid hazardous waste, such as paints, varnishes, solvents, adhesives, etc., into hazardous construction waste collection containers is prohibited. Unusable paints, varnishes, solvents, adhesives, and other residues must be stored in sealed original packaging until handed over and placed in a securely closed, lockable container.
4. **Reuse and Recycle:** Try to reuse clean wood waste or hand it over to produce wood chips. Other recyclable materials should also be placed in a designated area within the construction site for later reuse.
5. **Handover to Waste Handler:** If on-site waste segregation is not feasible or cost-effective, the waste can be handed over to a waste handler for sorting.
6. **Prevent Environmental Contamination:** Measures should be taken to prevent the spread of dust and construction waste during construction, such as placing it in collection containers, loading it onto waste trucks, and transporting it.
7. **Dispose of Contaminated Soil:** If the soil is contaminated, it must be handed over to a waste handler with appropriate authorization.
8. **Pay for Waste Management:** Remember the "polluter pays" principle. As the primary waste holder, you are responsible for the costs associated with waste management.
9. **Transportation:** Bulky and construction waste can be transported in an open waste truck, ensuring that waste does not end up in the environment during transport.

10. **Disposal at Waste Stations:** For a fee, it is possible to take CDW to designated waste stations, including the Aardlapalu (a village in Estonia) transshipment station.

CDW management at the construction site for companies

This section discusses the obligation of waste holders and the collection and separation of wastes at construction sites. According to the Tartu City Council (2021), the waste holder is obliged at their construction site to:

1. Collect construction waste separately by type;
2. Prepare a level, hard-surfaced base for placing collection containers at the construction site;
3. Ensure that separate, marked collection containers for different types of waste are available at the construction site;
4. Collect large construction waste that cannot be placed in a collection container due to its weight or volume in a designated area within the construction site;
5. Place recyclable construction waste in a collection container or a designated area within the construction site for later reuse;
6. Reuse clean wood waste or hand it over to produce wood chips;
7. Prevent the spread of dust and construction waste during construction, placement in collection containers, loading onto waste trucks, and transport; and
8. Inform their employees of the requirements of this regulation.

In terms of the segregation, CDW must be segregated by type into hazardous waste, wood, packaging, metals, inert waste (stones, plaster, concrete, gypsum, etc.), plastics, and other mixed waste (Tartu City Council, 2021). If a separate collection of construction waste is not feasible at the construction site or proves to be economically inefficient, construction waste can be handed over to a waste handler for sorting. When segregating construction waste on-site is not feasible or cost-effective, it can be transferred to a waste handler who will undertake the sorting process.

To ensure the continued effectiveness of separate CDW collection, efforts should concentrate on enhancing the promotion of this practice and implementing stricter oversight measures, such as mandating documentation for the management of CDW (Tartu City Government, n.d).

Waste that is not suitable for reuse at the source should be disposed of in a container specified for that type of waste, situated either on the same property or in designated community collection bins for that particular waste type. Alternatively, it can be transported to a designated waste station or collection point. In addition, other recyclable materials like plastics, metals, glass, packaging, wood, textiles, problematic products, and hazardous

waste, which are not collected on the property, must be transported to a waste station or a specific collection point or given to an authorized individual for proper handling.

Types of Waste Generated

The different types of CDWs that are generated include door and window frames, metals, bricks, inert waste (stones, aggregates, plaster, gypsum, concretes), glass, hazardous waste (such as asbestos, varnishes, solvents, adhesives, etc.), and mixed waste. Based on interviews and reports (Tartu City Council 2021; Personal communications, June 2023), Figure 1 summarizes the different types of waste and the circular activities that are currently done with these CDWs. Four main circular activities can be identified – downcycling, reuse, recycling, and upcycling. A large part of CDWs was reused as soil fill and in road construction. A smaller proportion was used for other purposes, such as wood waste for heating pellets and glass waste for insulation material production. The generation of metal waste in CDW amounted to 348,000 tons. Most of this waste is recycled, but it is done outside Estonia. CDWs that cannot be reused, downcycled, and recycled are incinerated. There are two pathways for incinerated CDWs: (1) disposal to landfill and (2) ashes are upcycled by a company-based in Estonia with high investment on research and development. These ashes are turned into paints, floorings and floor carpets among others.

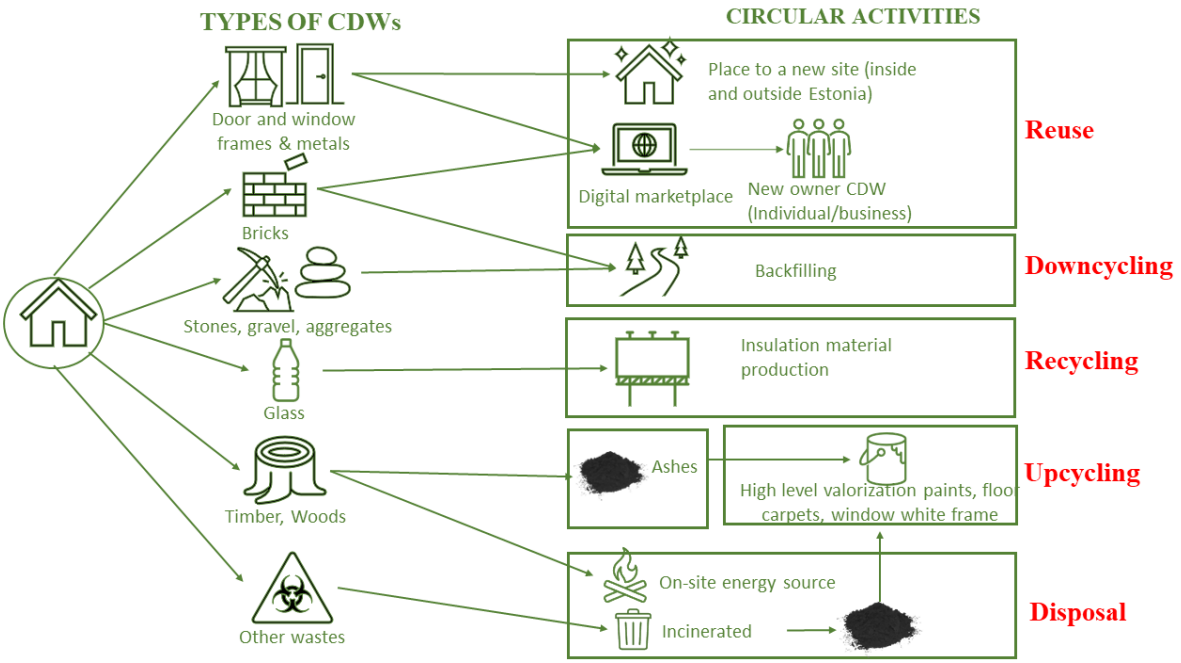

Figure 1 The different types of CDWs, including the circular activities for each waste stream (Sources: Interviews, 2023 and Reports)

4. Towards more circular CDW management

4.1 Current city vision and strategies (initiatives/programs)

A. European level strategies

At the European level, Tartu is part of the European Union's 100 Climate Neutral and Smart European Cities in 2030 (Euro Cities, 2022). This initiative enables cities to speed up climate action, with an ambitious goal of achieving climate neutrality by 2030, while at the same time learning from other cities. In alignment with the European WFD, the goal at the national level is to recover at least 70% CDW, which has been achieved by 80-90% (Bio by Deloitte, 2015). Recovery means reuse, recycling, and other form of material recovery.

B. National level strategies

B.1 Green Tiger program (Rohetiiger)

Estonia has a Green Tiger program (Rohetiiger), which is an active platform that brings together companies, NGOs, universities, and institutions that believe in green transition. The Green Tiger program focuses on creating industry road maps to describe the transitions that must be made for Estonia in 2040. In terms of CDW, the Green Tiger program launched a construction road map that describes how the construction sector in all the cities can be developed to support the climate ambitions of zero carbon emission (Rohetiiger, 2023). In addition, activities are also done under Rohetiiger. This include the construction round table, which brought together municipalities, construction and waste management companies, and Minister of environment/parliament members, to discuss the needed supports towards transformation to green and zero carbon emission construction sector [Interviewee 1, June 2023].

B.2 Estonia's Circular Economy White Paper 2022

The Circular Economy White Paper 2022 of Estonia has six priority development directions including the strategic choices for each development direction (refer to Table 2). The priority development directions include: (1) Responsible use of resources based on demand, (2) Forward looking and circular business models for companies, (3) Integrating the know-how, expertise, and cooperation between different areas and sectors, (4) Using digital solutions and high quality data to support transition to CE, (5) Coordination of CE at national level including creation of legal and economic environments to support CE, and (6) Establishing an environmentally conscious way of thinking and friendly behaviour.

Table 2 Six (6) development directions that have been agreed upon in Estonia's CE Action Plan including the strategic choices.

PRIORITY DEVELOPMENT DIRECTIONS	STRATEGIC CHOICES
1. Responsible use of resources based on demand, resource use is well thought out and waste generation is kept to a minimum.	1. Preferring environmentally friendly products and services 2. Encouraging the sharing economy 3. Ensuring safe material circulation 4. Using the best possible approach
2. Forward-looking and circular business models for Estonian companies.	1. Increasing the cooperation capacity of supply chains 2. Involving science in the creation of circular economy solutions 3. Encouraging partnerships between companies and companies and research institutions 4. Encouraging cooperation between companies and the state
3. The know-how and expertise, as well as the effective cooperation between different areas and sectors are necessary for implementing CE in Estonia.	1. Ensuring the succession of experts and the necessary know-how 2. Ensuring the possibility of using qualified labour, including foreign labour 3. Encouraging cooperation between fields, including participation in international cooperation networks
4. Working digital solutions have been created to support transition to CE, and high-quality data has been ensured to monitor the situation.	1. Creation of sharing and collaboration platforms 2. The use of qualified labour, including foreign labour 3. Implementation of innovative digital solutions, including those using artificial intelligence
5. The CE is well coordinated at the national level and a legal and economic environment supporting the CE has been created.	1. Modernization of the legal landscape 2. Clearly defining the roles, functions, and adversities of the various parties 3. Establishing the principles of collecting information necessary for organizing and monitoring the circular economy and creating a standard

	4. Creating digital platforms for collecting, analysing and exchanging information
6. An environmentally conscious way of thinking and environmental friendly behaviour have taken root.	1. Increasing environmental awareness of all parties 2. Direction of market parties, including consumer behaviour 3. Implementation of the use of environmental management measures

Source: Estonian CE Action Plan, 2023.

C. City Level (Tartu´s waste management principle)

The first and most important goal of the Tartu´s waste management is to prevent and reduce the generation of waste, including reducing the hazard of waste. The basis for achieving this goal is a greater awareness of resource efficiency in the business sector, the introduction of new technologies in the production process and the formation of the population's awareness and consumption habits, as well as an even distribution of waste prevention initiatives (reuse centers, food banks, repairs, etc.).

The second strategic goal is to recycle waste or otherwise reuse it at the maximum level. Among other things, the development of an optimal waste collection and handling network, an increase in the collection and recycling of biodegradable waste by type, and a continuous awareness raising aimed at recycling and reuse will contribute to the achievement of the goal.

The third strategic goal is to reduce the environmental risk arising from waste, by enhancing, among other things, monitoring and supervision. Fulfilling the requirements for the operation of waste storage facilities and the aftercare of landfills, supporting the collection and transfer of hazardous waste, and enhancing the supervision of compliance with the environmental requirements of waste management will contribute to the achievement of the goal.

4.2 Current Innovative Practices and Experiments

According to the interviews conducted with stakeholders found in Table 1 (June 2023), the main practice in managing households and company CDWs in Tartu is recycling or downcycling using old bricks and concrete as back fillers for roads and floors. The same set of interviews also reveal that there are innovative practices in managing CDW, which are currently undertaken in Tartu city. Each will be discussed as follow.

(1) Exchange platforms

Exchange or digital platforms facilitate the selling of leftover, second-hand goods from one party such as the producer to another party such as the buyer who wants to use the materials.

These exchange platforms can operate either in business to business (B2B) or consumer to consumer (C2C) environment. In terms of B2B, a manufacturer can sell his left over materials while a buyer, who is need of these materials such as shops or businesses, can buy those materials. Interviewee 4, who is operating a B2B platform, facilitate exchange of different kinds of materials, such as furniture, textiles, etc., with textiles and leathers as the most exchanged items. C2C platforms, such as smart swap and Facebook pages, help citizens exchange second hand goods.

(2) Green Points

Green points are drop-off points for collected household wastes in Tartu city. The different types of wastes that are collected by the green points include paper, textile, plastic, glass, and hazardous waste.

(3) Repair shops or basements and repair café (event)

Repair shops empower individuals to fix their valuables and goods that they use at home by providing co-working makerspace and mentors to teach individuals on how to repair and upcycle products. These materials include clothes, home appliances, electronics, bicycles and furniture. There is also a repair café, which is a one-time event that brings people together, with mentors teaching people who have broken things on how to assess the problem, how they could fix their broken items, prevent it from happening again, and to reassess what will happen if they buy another product (Interviewee 2, June 2023).

(4) (Wo)men's[1] Shed Association

The (Wo)men's shed movement is an association that started in Australia in the 1980s which focused on older men finding something meaningful in their life, by building something out of second hand or waste materials while at the same time socializing with each other. This movement spreads throughout Europe including Estonia. The current movement consists of an association of men and women (usually on their 40s, 50s, and 60s) who try to find purpose in their life and do something for the society. The movement in Tartu has cooperation with the City Council, the latter supporting them by providing means or support for building things. Some of the projects that the (Wo)men's shed movement has done for the municipality include bird nests, bird boxes, flower boxes for parks, as well as park benches. Woodshop is something that gathered the type of man and are interested in traditional wood work, reusing, or creating something from scratch. The movement also has collaboration with school, where students have "wood working day" in the facilities of the (Wo)men's shed movement (Interviewee 8, June 2023).

[1] The name Men's shed movement stirs reactions in Estonia due to gender bias in its name. For this report, we named it (Wo)men's shed association since there are also women members in this movement.

(5) Upcycling of materials through high valorization.

Upcycling of materials is another innovative practice in Tartu. However, this could only be concentrated to big companies who have investments in research and development. For instance, a Swedish CE-focused company in Estonia put a lot of time on innovation of critical raw materials. They do a lot of cooperation with scientists and universities. This company has the climate ambitions to find more low footprint products and circular materials. One of their focuses is on extracting critical raw materials from ashes. Estonia produced 600 million tons of ashes that go straight to landfills in the eastern part of the country. Using high-level valorization, the calcium is taken out of the ashes, then the captured CO_2 will be stored in the calcium to produce climate-positive calcium carbonate, which will be used for white paints, white window frames, floor carpets, and other floor materials (Interviewee 1, June 2023).

4.3 Barriers and enablers

Several barriers and enablers were identified from the interviews and reports. Table 3 presents the barriers for a more circular management of CDW in Tartu city. These barriers include factors coming from (1) citizens such as risk perception on use of second hand materials, lack of awareness on the existence of construction leftovers, and non-compliance with rules, (2) government that include unregulated imports of CDW, lack of enforcement on managing CDWs on sites and clear translation of demolition permit from state to local levels, and (3) the markets such as lack of CDW volume for CE activities. Specific examples from the interviews were provided for each barrier.

Table 3 Lists of barriers for a more circular management of CDW in Tartu city.

Barriers	**Examples from interviews**
1. Risk perception and low reputation of using waste (or second-hand items)	- Recycled concretes were tested on the roads (both the bottom and layers), while adhering to all rules and regulations. Results are positive; the road authority accepted the idea that the road can be built from recycled materials, but companies do not want to use these since they find it risky to use second-hand materials, and it might backfire on them via legal means (Interviewee 5).
2. Lack of awareness of people that construction leftovers (second materials) exist.	- Most people are not aware that second-hand or waste materials exist and that they are not dirty. People have different connotations when hearing about leftover materials. Even though not everything is true, some people think of a dumpsite where everything is damaged. However, these materials are often stored in warehouses and are in perfect condition, just like items in a regular shop (Interviewees 2 and 3).

3. Import of CDW is unregulated.	- Construction companies bring new construction material from Estonian markets, to Finland to build houses for Finnish people. In return, the Estonian companies take the waste from Finland to Estonia with the same truck. In a way waste trafficking is happening, not only in Estonia, but also at European level. It is unclear what are the restrictions and demands for these waste, whether these wastes are being used or being dumped. Therefore it needs to be organized with legal support (Interviewee 5).
4. Non-compliance with the rules.	- Construction waste must be collected separately on-site, such as the bricks, stones, hazardous waste, packaging etc. Everything must be collected, and then the builder or the person doing the construction must give this separated and collected waste to a special person who owns the permit (a special permit or waste permit). The main issue is that the construction company does not want to collect wastes separately; they want to put a lot of different construction waste into one big container (Interviewee 6). - CDW, just like household wastes, are thrown into one bin. There is a lack of sorting among citizens (Interviewee 1).
5. Small volume of CDW.	- The volume of waste that can be repaired and reused by citizens are very small (Interviewee 5). - The amount of waste (e.g. CDWs or other special waste stream) is not so big, therefore there is not much to do with it. There would have been a possibility to recycle if there was more some kind of waste (Interviewee 6).
6. Weak government enforcement on managing CDWs on site.	- The way the waste is handled in the construction site is still traditional. The recycling manner on site (visual recycling) is also poor and there is a grey area since there is no rule whether recycling should happen on site or on the landfills (Interviewee 5).
7. The demolition permit is organized on a state level and not on a local level.	- Demolition permit is needed when making a renovation or demolition project. This permit describes the kind of waste produced, how much wastes are generated, and what happen to this waste after demolishing. However, these rules are from state level and not directly on local level, which may require

	special rules. These could include which companies should bring and transport the waste containers (Interviewee 6).

Source: Interviews, June 2023

Table 4 summarizes the lists of enablers for a more circular management of CDW in Tartu city. The majority of these enablers are market and business driven, such as the presence of many start-ups, high level of digitalization, market interests on construction leftovers, presence of certification bodies, green loans provided by banks, recycling opportunities in the landfills, and presence of online market places to sell or exchange materials. Enabler related to the government includes reduction in municipal landfills, which puts pressure to businesses and citizens to enhance recycling of wastes. Other institutional factor is the education provided by university lecturers to management of companies in relation to CDW recycling and management of wastes. Specific examples from interviews are provided for each enabler.

Table 4 The lists of enablers for a more circular management of CDW in Tartu city.

Enablers	**Examples according to interviews**
1. Presence of many start-ups.	- Estonia has a strong start-up community, which is perhaps even stronger/one step ahead than other Baltic countries. (Interviewee 1). The presence of start-up community could be eventually essential in establishing the URC of Tartu.
2. High level of digitalization.	- The level of digitalization in Estonia (including Tartu) is one of the best in the world and the mindset on using digital solutions is already present. There is a need to start designing some circular concepts and services and stuff to have the possibility of being the forerunners in green transition (Interviewees 1 and 3). - There are software for building modular designs of buildings in Estonia (Interviewee 3).
3. There are interests on construction leftovers.	- According to a representative of an online platform (Interviewee 4), the construction leftovers are not yet listed on their site. However, there were discussions with companies in that field, and there seems to be high interest on CDW. If regular buyers can access to these materials, it could work very well. In addition to the talks with construction companies, there is already visible interest in construction leftovers, as can be seen from people searching for such materials in Facebook groups and elsewhere.

4. Presence of certification bodies in the country.	- There are certification bodies in Estonia; for bio waste, it works brilliantly, that it could also take other materials such as CDWs, because the system of certifying is exactly the same. Construction material might be slightly easier than the bio waste because there are existing standard for virgin material. Having quality classes could be needed, though may require paper work (Interviewee 5).
5. Green loans are offered by banks.	- Banks offer the “sustainable companies” green loans, or low interest rate as compared to “non-sustainable companies” who get higher interest rates (Interviewees 1 and 7). - A company has to do ESG reporting to show what they are doing already in terms of the production or services, scopes 123 for categorizing the carbon emission of the company. If the company is not doing well they will either not get the loan or will get a high interest rate (Interviewee 6).
6. Municipal landfills have reduced in numbers, which increases pressure to implement CE practices in wastes.	- Landfills have been reduced from 350 municipal landfills 20 years ago, to 5 landfills. CDWs goes to these landfills. And since the number of landfill has been limited, together with the increased recycling ambition of the Estonian government, these forces companies and citizens to recycle or upcycle CDWs and waste in general (Interviewee 5).
7. There are many recycling opportunities in the landfill sites.	- There are a lot of recycling opportunities, which is not yet fully realized in the landfill. At the moment, the landfill recycles a lot, but there is still a lot of left over CDWs that can be recycled, which could help achieve the recycling goal of the government (Interviewee 5).
8. Presence of online marketplaces to sell second-hand materials.	- There are existing market places right now in Estonia, both B2B and C2C, where it is possible to exchange or trade second hand materials (including CDWs) that are still good to use (Interviewee 1).
9. Education is provided to higher management of landfills.	- University lecturers are educating people from higher management of landfills, who in turn, are expected to educate their staffs in terms of recycling, the possibilities for making something out of wastes, and so forth. There were also sessions being provided to the waste management companies as well as authorities in the past, and by doing it again could prevent information lost (Interviewee 5).

Source: Interviews, June 2023

4.4 Urban Resource Center (URC) Initiative(s)

At the moment, there is an on-going plan for establishing the first URC in Tartu. It is expected to start the designing of the URC in the near future. The various stakeholders and initiatives that were discussed in Section 4.2, as well as current innovative experiments and practices, have potentials to contribute to the formal establishment of URC(s) in Tartu city. These include repair cafes, green or drop-off points, marketplaces, and social hubs. The idea is to link them together via the URCs and use their expertise in the URC's operation. This information has been validated through the workshop conducted in Barcelona (Personal Communication, Interviewees 9 and 10, October 2023).

Future URC design and Stakeholders

The design of URC could include public-private partnerships. According to Interviewees 9 and 10 (Personal Communication, October 2023), the municipality should be the owner, while other stakeholders such as citizens, fixing and repair shops, city districts, waste handlers, universities, and schools will be involved. The same interviewees mentioned that the location of the URC could be integrated into one of the existing train stations.

Figure 3 shows what a URC could look like in Tartu. URC will have various purposes. First, it will serve as a repair shop where an individual can get training on repairing or adding value to goods. The URC will not only focus on CDW but also on other types of second hand materials such as electronics, furniture, and textile, which could still be repaired. Second, it will also serve as a collection point for CDWs and other wastes that can still be used and recycled. Third, the future URC could also serve as a physical marketplace for shopping and selling second-hand items. The digital platform on Tartu city’s website could be used as an exchange platform in URC's operation. And fourth, to involve the citizens, the URC can be used as a social hub, which facilitates innovation and learning, as well as the socializing aspect of the citizens. For example, members of Wo(Men’s) shed movement could conduct their activities in the URC.

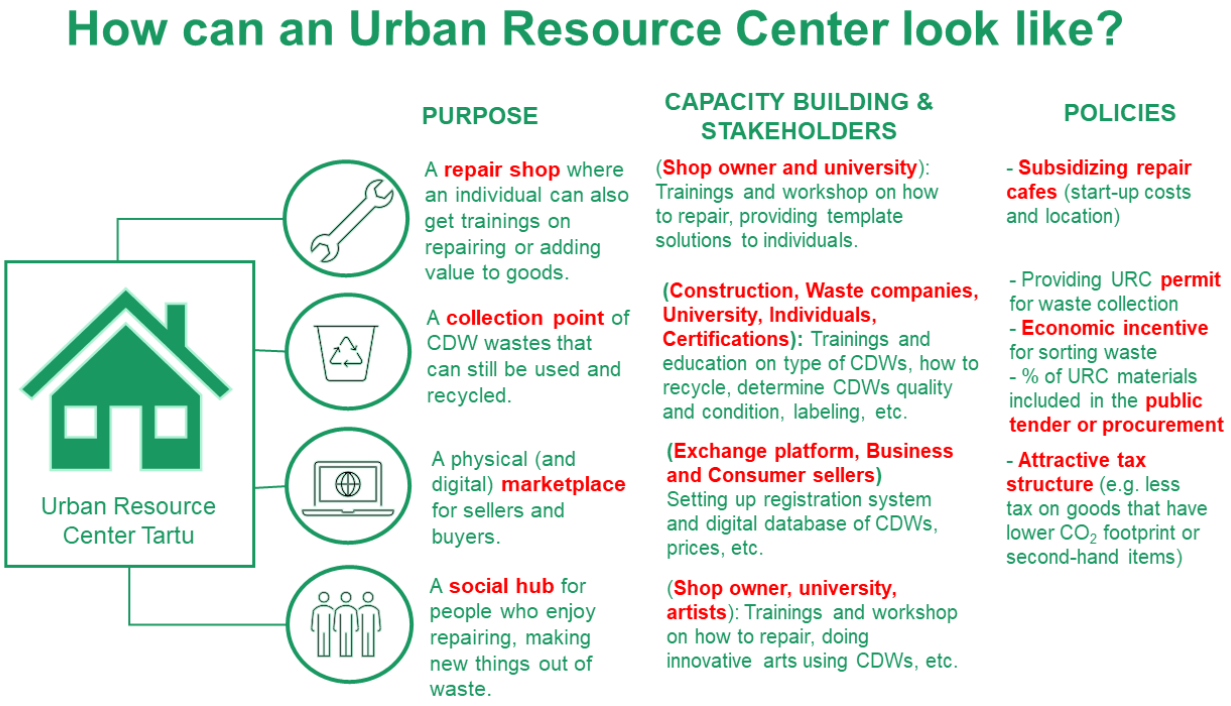

Figure 3. Possible Design of URC in Tartu City.

The proposed URC in Figure 3 is the first phase and involves a simple set of stakeholders. In the second phase, once proven successful in its operation, it could be replicated in other places in the city. Other inputs can also be added in the second phase, such as digitalization to make efficient waste recycling, use of AI for waste separation, photos combined with 3D printing to mark reparable components, and incorporating certifications to ensure the quality of CDWs. This is well aligned with the digital capabilities of Estonia.

Business Model

In order for the URC to sustain its operation in the long-term, the possible business model that could be adapted are the following:

1. The URC could offer space to existing and new repair shops in exchange for a fixed small amount of rent. In addition to repairing items from citizens, the repair cafes can hold workshops and repair sessions for interested parties.
2. As a physical and digital marketplace, citizens can leave second-hand or unused items in the URC, which could be recycled and upcycled. Recycled items can be given for free or sold depending on the material's quality level. Upcycled items can be sold to individuals or businesses.
3. The URC could collaborate with different stakeholders, e.g. university lecturers or creative designers to hold income generating activities, such as events, symposiums, and workshops which are open for public and visitors of the city.

4. As a social hub, the URC will charge membership fees to its members, or citizens who want to find a place to innovate and connect with other citizens. The benefits of being a member of the social hub of URC include free access to workshops, creative sessions or training, and social interaction with other members. Non-members are welcome but need to pay the entrance for the workshop for a small amount.
5. The items that members make could be sold for a price, for instance, in a store focusing on circularity or selling unique items.

5. Recommendations

Based on the Future URC Design and Stakeholders as well as the Business Model in section 4.4, set of recommendations have been formulated concerning Capacity Building and Policies that will support the operation of the URC in the city of Tartu.

Capacity Building

1. The outcome of the workshop in Barcelona (Personal Communication, Interviewees 9 and 10, October 2023) shows that before a URC prototype is implemented, it is essential to investigate first the business models and profitability analysis. Studies are needed, and this is where the universities or research institutes can help conduct feasibility studies.
2. In relation to the business model, there is a need to conduct workshops with stakeholders to understand how a URC could be financially viable. Insights such as the needs of each stakeholder, who can support those needs, and how they can benefit from the establishment of URC need to be clear to ensure that there will be a viable business model(s).
3. Exploring URCs from other European countries will provide idea on the type of stakeholders as well as what business models could be implemented in the URC of Tartu city.
4. Capacity-building activities, such as trainings and knowledge transfer are needed when involving citizens and waste recycling companies, universities, shop owners, artists, etc. The content must be related to identifying waste types, sorting and segregating, and recycling and upcycling of waste.

Policy Recommendations

1. As the owner of the future URC, the municipality needs to provide the physical space to establish the URC.
2. There is also a need to subsidize the repair shops in the first or second year so they can kick-start their operation. Since the URC will collect CDW, the municipality can also provide a permit for waste collection.
3. Another policy recommendation is to provide economic incentives for sorting and reusing waste. For example, second-hand materials from URC could be used for public tenders or procurement.
4. On a national level, an attractive tax structure could be needed for circular/recycled/second-hand goods/less CO_2 emission goods. For instance, fewer taxes are provided on these goods than on new items. This could encourage citizens to use more recycled products as compared to new ones.

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Appendix 1. The Framework for CE transition in Estonia