FinEst Centre
for Smart Cities

SMART CITY CHALLENGE 2025
Solution idea for the city challenges

Solution Idea Title - Smart Waste Sorting Container
Planned pilot project duration – 24 months
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1. Challenge and Context

Waste separation in Estonia remains a significant challenge. Residents often lack clear, practical guidance on which items belong in which bin, leading to incorrect sorting that generates extra costs and reduces recycling efficiency. Since 2024, separate collection of bio-waste is mandatory in Estonia and national waste reform has set much stricter recycling targets. Meeting these targets requires solutions that help residents sort waste conveniently and correctly, raise public awareness, and ensure compliance with EU objectives.

Harku municipality is therefore looking for a practical, scalable tool that improves sorting behavior at the source, optimizes collection logistics and supports data-driven decision-making. Latvia or Finland, which are also interested in solving this problem, may be potential partners.

2. Proposed Solution

We propose an automated and non-automated modular Smart Waste Sorting Container. It builds on existing fill-level monitoring technology (the Tarkbox sensor system developed by TalTech's ViDRiK center) and adds intelligent features to assist residents in sorting their waste. The container not only detects how full it is but also interacts with users at the moment of disposal – providing guidance, feedback and data collection.

2.1 Core Technology: Fill-Level Sensing and Data

- Fill-level sensor (Tarkbox unit) measures the container's status in real time.
- Data is transmitted to a cloud-based monitoring platform with dashboards and alerts.
- Volumes by waste type can be tracked to optimize collection routes, support reporting obligations and plan infrastructure investments.

Tarkbox and its web platform are already deployed in Estonia, which reduces technical risk and accelerates implementation.

2.2 Non-automated version

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The non-automated smart container version will include an integrated display, speaker and camera. This solution is for larger fraction-specific containers (such as those for paper/cardboard or beverage cartons). The focus will be on AI-based guidance, access control and error logging rather than fully mechanical separation, which keeps costs manageable. When a resident deposits an item, the system detects the action and provides immediate feedback:

- The screen can confirm correct sorting or suggest the correct fraction if the item is misplaced.
- A voice prompt can provide short, clear instructions (e.g. “Please use the bio-waste compartment for food scraps”).
- If users are uncertain, a camera with AI assistance can help identify the type of waste and indicate the correct bin.

This interface turns a routine action into a short “teaching moment”, making sorting intuitive even for residents who are not familiar with all rules.

2.3 Automated version with sorting and compaction

Unlike purely static bins, our automated solution introduces simple automatic sorting and volume reduction, with a clear roadmap for scaling:

- We begin with two fractions (e.g. mixed packaging vs bio-waste) using AI-camera, weight sensor data to guide and, where feasible, mechanically direct items to the correct compartment.
- The design is modular and upgradable to 4–5 fractions as regulations and local needs evolve (e.g. paper, glass, metal, plastics, bio-waste).
- For selected small containers (e.g. plastic bottles or packaging), we will evaluate an automatic compactor. This will reduce the volume of waste, lower the number of required pickups and further cut CO_2 emissions.

Mechanical components such as gates, conveyors or compaction units will be developed in cooperation with TalTech Virumaa Kolledž experts in mechanics (Prof. Veronika Shirokova). The AI component will be developed in collaboration with data science experts (Prof. Olga Dunajeva).

2.4 Competitive Advantage over Existing Solutions

There are already smart container products on the market, such as those offered by Arcubed. These demonstrate that smart containers are technically feasible and commercially relevant. However, our solution is better aligned with local needs because:

- It leverages a local, already deployed platform (Tarkbox), reducing integration risk and cost. A key advantage is that we already have a web-based monitoring platform for containers,

which allows real-time monitoring of all containers, custom alerts, notifications and visualization.

- It is modular and designed for gradual expansion from 2 to 4–5 fractions, matching Estonian waste separation requirements.
- It provides rich error analytics and educational feedback, not just fill-level monitoring or simple compaction.
- It is designed in close cooperation with TalTech (ViDRiK and engineering experts), ensuring strong local expertise, easier customization and long-term support for Estonian municipalities.

3. Expected Impact

The project is expected to generate environmental, social and operational benefits. Environmentally, it improves sorting at the source, directly supporting national and EU recycling targets and reducing waste sent to landfill or incineration. Dynamic collection based on real-time fill-level data means fewer unnecessary truck trips, lower fuel consumption and reduced CO_2 emissions, especially when combined with compaction.

For citizens, the smart container turns complex sorting rules into a simple interaction: instead of memorizing long lists of what goes where, residents receive clear instructions at the moment they dispose of waste.

For municipalities, the main value is data. Instead of relying on experience and complaints, they gain quantitative information about fill levels, typical errors and usage patterns at specific sites. This allows them to redesign routes based on actual behavior, cut unnecessary costs and better justify investments in new infrastructure.

4. Piloting and Scaling Plan

The pilot will run for 24 months. In the first 10–12 months, the technical concept will be finalized and a prototype built. This includes mechanical and electronic design, integration of sensors and communication modules, development of the user interface and AI-assisted recognition, and extensions to the existing web platform.

In the second phase, several prototypes will be installed at locations with known overflow or sorting problems, such as village centers, bus stops, areas near apartment buildings and temporary high-traffic zones during events. Data on usage, fill dynamics and sorting errors will be continuously collected and analyzed by the project team and municipal staff. Short user surveys or QR-code feedback will complement these data and show how residents perceive the new containers. When appropriate, educational activities with schools and local communities will be organized around pilot sites to reinforce behavioral change and test communication messages.

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After several months of operation, a mid-term evaluation will compare the situation before and after installation, focusing on sorting quality, volumes of separately collected fractions, overflow incidents, collection frequency and user satisfaction. The prototype and software will then be refined. By the end of the pilot, there will be a tested technical solution, a set of performance indicators and a practical scaling plan.

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