EIT Digital Summer School Report
Team Obin

Adrien Beaugendre, Lukas Brückner, Davide Di Matteo, Francesco Minna, Marco Muratore

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Team

Lukas Brückner
CEO

Marco G. Muratore
UX Designer

Francesco Minna
IoT & Backend

Davide Di Matteo
Data Engineer

Adrien Beaugendre
Mobile App Dev

Creative Process

Introduction

We are Obin and in the past weeks we have been working on a project at the EIT TalTech's Summer School with the task of "*Integrating Personalized Mobility Solutions for Digital Cities*". The goal of this program is to face a real-life experience of the challenges which entrepreneurs encounter when setting up a new venture, specifically we have decided to focus on the trash collection activities with the aim of reducing the costs and engaging citizens in the process.

Problem Discovery

Since waste collection activities are among the core processes in managing a city, we have decided to tackle this problem improving the efficiency in the logistics involved in planning such activities.

After having talked and interviewed different people responsible for the waste management in different cities from different countries, it emerged that trash collection is a very inefficient process, highly time-consuming and money consuming. The main problem — reported by the vast majority of the people interviewed — is the non-dynamic collection schedule. In fact, more than 70% of the outcomes from the survey reported that it often happens that public bins and dumpsters are half-empty, resulting in a non-optimal collection.

Moreover, it has been reported as a common issue the fact that trash overflows from certain bins while the scheduled collection is far from being executed. However, these problems are not only affecting the logistics around waste-centered activities, but they also contribute to other major issues present in cities.

In fact, garbage trucks are among the most polluting vehicles inside the cities contributing to high CO_2 levels. Another relevant aspect is the traffic queues caused by collecting trash in narrow roads.

Interviews & Survey

We have contacted 7 different people involved in the waste management of various cities from different countries, in the specific Rennes, Lyon, Graz, Trieste, Gorizia, Tallinn, and Nürnberg. The reason behind this decision is that waste management practices are not uniform among countries.

In fact, we proposed a short survey to identify the most common problems and highlight the possible solutions. The most relevant problems reported are the *inefficiency of the routes used by trucks for the collection* and the *bins — not so full — being collected*; these two issues are correlated and, more precisely, there is a causal relation with the first one being implied by the second one.

Moreover, two common minor problems arose: the *trash overflowing from the bins* and *the waste placed in the wrong bins*.

What do we get from Data?

Previsions for 2025 announce a global market size of €530B for waste management. Each year cities are spending a lot of money on waste management.

For example, the waste management budget for Rennes is €57.16Mio. That number is 6% of the city global budget. Specifically, the waste collection costs are around €25 Mio for a city of 500.000 habitants.

Annually, every person produces on average almost 500 kg of waste, which only 30% is then recycled. A study from Paris says, in a classic bin 80% of waste could be recycled.

Prototype

As a Minimum Viable Product, we created four different prototypes to show the potentials of the main features of our system:

- The Truck Tablet App for monitoring the garbage levels of bins and for providing the best routes to optimize time and fuel consumption and reduce the waste of money.
- The Bin interface for the screen which recognizes the citizen with the analysis of the waste generated and the level in the ranking which rewards the most efficient and respectful people.
- The 3D representation of the Obin with the solar panels in it to receive energy from the sun and the screen to interact with.
- The working prototype of the Obin which features voice recognition, direct suggestions and garbage level monitoring.

Truck Tablet App

The tablet app is built-in each tablet which will be connected to trucks sensors to receive real-time information and show them in the system or send them to the control center or to other trucks.

UI mockup for the tablet app

It has four different sections:

1. <u>Overview</u> to receive information about the weather conditions, the consumptions of the truck, the progress of the collection and additional reminders about events, road closed or truck maintenance.

2. <u>Route</u> to choose the daily way of the truck depending on garbage level of each bin (with three different colors green—> < 50% full; yellow—> 50-75 % full; red—> < 75% full), the distance, the full consumption and the other trucks paths.

3. <u>Alerts</u> to have a list of all the traffic, accidents, events or closed streets in the area.

4. <u>Search</u> for advanced search of a specific bin, area, neighbor or truck.
   We focused on the second section to provide a depth view of the route optimization, one of the core features of our product.

An overview of the interface with a succession of action: selection of the working area (images 1 and 2), automatic detection of full bins and overview (image 3), creation of a customized path (image 4), manual selection of additional bins (image 5) and validation of the route (image 6).

Obin Interface

The bin interface of the built-in monitor shows in the home page, the name of the citizen which is using the bin, the amount of general waste produced the current month and the ranking in the Obin serious game which involves people to reduce waste and improve efficiency for receiving discounts in taxes.
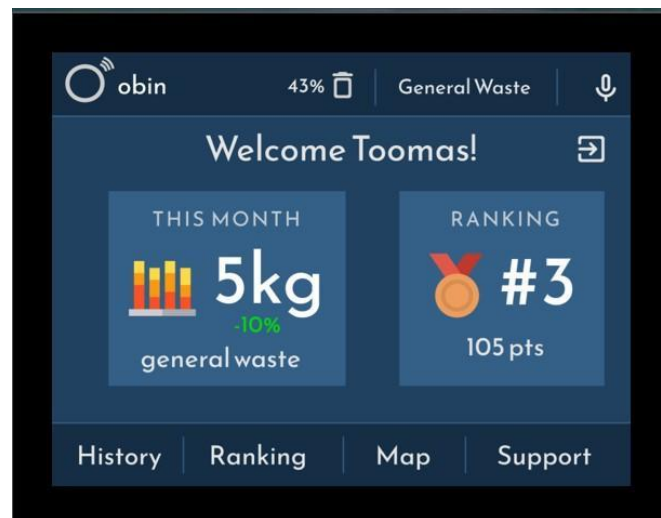
UI mockup for the garbage bin

The history tab will give an overview of the actions of the citizens, the ranking tab shows the serious game classifications and gives information about how to improve efficiency, the map section indicates the location of other bins and where to put specific wastes. In conclusion the support section is for calling the company service in case of problems or malfunctions.

3D Representation of Obin

The 3D representation of the obin highlights how simple and efficient at the same time can be an advanced bin: the solar panel at the top provides energy to the monitor which is equipped with a microphone to feature voice assistant, speakers to give information through the voice and all the other functions that had been explained in the Bin Interface section. The cost of the obin is approximately under 100$ because it is not needed to change pre-existent bins, but it only adds advanced features.

3D model of how the obin solution can be integrated into existing garbage containers

Cardboard prototype

The working prototype is equipped with a Raspberry Pi, a Bluetooth speaker, a portable power bank and a microphone. It is able to recognize the citizen, giving information about the level of the garbage inside the bin and provide suggestions as where to put a specific waste.

By using a cardboard bin, we were able to develop a first real-working version of our smart bin: in particular, we used a Raspberry pi 3 and an ultrasonic sensor to measure the level of garbage inside, powered by a power bank. On top of this, we then attach the microphone and the speaker to engage the citizens in the waste collection process.

For the technological part, we had chosen the ultrasonic sensor because is a well-known technology for this kind of measure, that can be developed with few python's lines: also, we added two LEDs, one green and one red, that we switched on based on the percentage of the garbage inside.

Also, an advanced version of our bin will use a dedicated printed board, or a raspberry pi w zero, with even lower energy consumption, that guarantees long-term functions without external power, but only with solar panel, even during the seasons with few sun hours, inside the box made with a 3d printer.

Then, the printed board and the sensor will be put inside a small dedicated box that will be attached inside the bin. We planned to build a waterproof and shock-resistant box, that is able to protect the technology inside from vary threat.

For the final version of the box, with all the technology inside, we estimated a final price of 10€, which includes the box and the various sensors, ready to use. Also, the set-up process is very fast and easy, since the operator should only stick the box inside the bin.

In order to optimize the truck's route and, in general, all the waste management process, we want to create a Wireless Mesh network among all the smart bins: through this, we are able to establish a communication

between two bins, and then to the company cloud, that can use this data to create a dashboard for the trucks or for the citizens.

An example on how to build a mesh network with raspberry pi can be found here: https://developer.ibm.com/tutorials/create-iot-mesh-network/

We had chosen the Wireless mesh network because is a well-established technology to create a network among IoT devices (with the endpoint-repeater-gateway hierarchy), it's a low-energy network that can be powered for long period with solar panel, and can be implemented by using different protocols based on the distance of the bins (e.g. Lora network, Wifi low-energy, or even Bluetooth).

A demonstration of the features has been recorded: https://drive.google.com/open?id=1Z78xoMi8LLs32pJv92A7e-wacw2nrdYS

Business Plan

Executive Summary

Waste management in cities faces different challenges today. On one hand, waste collection is often inefficient because there is no data available on which garbage containers are full, so they are collected via static routes. This lack of real-time data also makes it difficult to evaluate and track changes in the waste management. Secondly, citizens often don't feel involved in the process and responsible about garbage, and only 30% of the overall waste is recycled. But cities have to fulfill certain recycling requirements set by the EU commission in order to avoid fines. Hence, cities pay a relevant portion of their budget on waste collection: €25 Million in Tallinn. Globally, the market size for waste management is growing to €500 Billion in 2025, up from €297 Billion in 2017.

To address this, Obin provides a comprehensive solution involving all stakeholders. A pluggable IoT box solution with sensors and advanced interactions for the citizens can upgrade any type of garbage bin. Fill-level sensors allow the collection of real-time data and optimize the waste collection as well as the container positioning. This saves 30% of waste collection costs. To engage the citizens, speakers and a screen provide a new way of interacting with the waste collection system in order to make the process more enjoyable. Good recycling habits results in points which can be used to save on waste taxes.

The whole solution is provided as a service, incl. renting of the hardware. After a setup fee per bin, a monthly fee per bin is charged.

After a first working prototype the next step is to develop an MVP in the next 6 months. A 2-step pilot will be done in Rennes, France. Later, an expansion to more cities is planned and the product portfolio will be expanded.

Problem

Waste management is a complex process with different stakeholders which results in different challenges and inefficiencies. Traditionally, waste collection is organized statically, so that garbage trucks have the same pre-defined schedules and routes. This has proven to lead to wasted resources and inefficiencies: Some garbage bins are emptied even if they are nearly empty, and on the other hand, some garbage containers overflow because they are not emptied in time. As the Head of Waste Management in Tallinn told us during an interview, this is especially problematic for public bins because their filling cycle is irregular since many different people are using one. When trucks navigate to locations which don't need to be emptied, more garbage men, trucks are required, which also lead to higher traffic and CO2 emissions. A city like Tallinn spends around €25 million for the waste collection activities, so increasing efficiencies in the process would free up public budget for other areas.

Additionally, there is not a lot of data available on the garbage and waste behavior. However, there are regulations and political goals in place which aim to improve the recycling quote and resource reuse. In the EU, the overall recycling rate was only 30% in 2017, but the goal is to reach at least 50%. As we learned, tracking and evaluating new concepts or changes in the garbage system are difficult to measure and often data is available with a significant delay.

Finally, the citizens who are a key player in the garbage process are not being integrated very well. In the EU, every citizen produces more than 480kg of trash per year. But they feel the responsibility of this process lies at the public administration and once the trash leaves their house it's not their problem anymore. One reason for this is that there are many recycling rules in place which confuses many users, and the user experience of garbage bins is not enjoyable.

Solution

At Obin, we want to provide a holistic solution to the waste collection process involving all stakeholders. We believe that it is especially important to engage the citizens in order to improve the overall process. Hence, our mission is to *Engage Citizens in Digital Waste Management*.

Obin is a state-of-the-art IoT-based solution which not only improves the efficiencies for the waste collection, it also provides advanced interactions with its users in order to make the whole experience of using garbage containers enjoyable. It comprises sensors, batteries, solar panels, connectivity modules, a screen, and interaction elements incl. voice operators. It is designed as a pluggable box so that it can be integrated into any existing garbage container.

Using fill-level ultrasound sensors, it is possible to get real-time data on all connected garbage bins and containers. This is then used to optimize the waste collection processes: Allocate the exactly needed amount of trucks and garbage men via predictive intelligence and optimize the truck routes just-in-time to empty only those bins which are close to being full. For this, each truck will be equipped with a tablet running our software which provides insights into the garbage fill-levels and route navigation. Existing solutions have shown that this can save up to 30% of waste collection operating costs.

Additionally, the sensors in the bins also provide detailed data for public administrations in order to better allocate public bins, manage their sizes and locations and understand very quickly if changes to the waste management process have the desired effect on the garbage levels and recycling rates.

Finally, the screen and voice control make the throwing experience finally less annoying to the citizens. Registered citizens can authenticate themselves via a badge or their NFC-enabled smartphone. That way, the bin can track how much each user throws away into what type of bin. This allows to collect points which can be used to save on waste taxes because in the end, through better recycling, the public administration actually saves money. This smart bin also makes the levels of the bin transparent. By showing all users the fill-level, the history and comparison to other bins citizens are more likely to feel responsible for their own garbage.

Target Market

First of all, we mainly target waste management companies that operate alone on the territory and that work with public bins. This excludes from our target the companies that perform a door-to-door collection approach and the ones that coexist in the same urban area, working in different districts of the city. The last point automatically excludes large cities and the reason behind this decision is due to simplicity, since it would be much better to operate and work together with just one company per city.

In Europe, there are approximately 400 major waste management companies that we plan to target. Most of them operate in more than one town/city, making the scale process through the years much simpler. As shown by the interview conducted, the vast majority of such companies are still very inefficient in the collection activities, making them the perfect target for our product. Moreover, the global market size of Europe is 500Bi and even a small city has few million euro per year of costs related to waste and waste collection.

Secondly, we have also decided to work with the municipality of the cities in which we plan to implement our solution. In fact, later on we would like to provide analytics and insights to the municipality together with the delivery of our Citizen App, that will be created with the help of the city in order to guide and simplify the waste disposal for the single citizen.

Competition

The study of our competition is focused on several actors in waste management collection. The study is focused on different points (quality of the technical solution, data analysis, citizen engagement in the solution, wastes sort, price). After the study we kept three major competitors; Sensoneo, ECube Labs, Bee2Waste.

- **Sensoneo:** 230+ projects, from 99 to 238 EURO per device (including system access), many countries across the world (mostly Europa and USA)
    - Smart ultrasonic IoT sensors (even temperature measurement and tilt recognition)
    - Route Planning
    - System to visualize and manage the bins and interact with the levels. The solution is good.
    - Data Analysis
    - App for citizens to check where to throw what
    - Different categories of a bind for a different kind of waste
    - Cost reduction of 30% in trash collection activities
- **ECube:** operates in several countries all around the world, their smart bin looks very good and offers plenty of new configurations, they do not have interactions with citizens.
    - Ultrasonic fill-level sensors
    - Solar-powered waste compacting bins
    - Route Planning
    - Truck and Fuel monitoring
    - The smart waste logistics solution reduces waste collection frequency dramatically, which enables you to save on fuel, labor, and fleet maintenance costs. Altogether the solution can reduce your operational costs by up to 80%.
    - Platform with machine learning algorithm
- **Bee2Waste:** it is part of a bigger company (or incubator) Compta, they operate in just a few cities, it seems they do not have interactions with citizens, but it seems they offer support for every kind of activity related to trash collection.
    - Operations Planning and Management
    - Interaction with Vehicles, Collection Points, other Types of equipment & Final Waste Destinations
    - Interface with Producers, Citizens & Regulators
    - Data-Collection, Monitoring & Analytics
    - Patterns Identification & Predictions
    - Human Resources Management
    - Assets Management
    - Tracking, Location, Geo-Fencing
    - Intelligent "Routes Planning"
    - PAYT/RAYT/SMART Models Ready
    - Reporting & KPI's Monitoring

There exist other smaller companies: Smartup Cities is a French company, it has not operated yet. The developed solution used sensors and route planning. Compology is another company that provides a camera-based trash recognition solution. It is meant to work and report contamination levels in the bins to provide a much different recycle. They are announcing 5 years of battery duration. They don't provide any other services. Finally, Enevo is a Finnish-American company. It offers a sensor solution, route solution, and data analysis.

To conclude, there are 3 main competitors which offer broad services regarding trash collections, however, they lack the integration with the citizen and their interaction in the process, which can be very valuable.

The other minor companies seem very young and they do not have an extensive solution, the only one that despite that has a good market is Enevo. In the end, we need to focus on citizen integration and make that our strength. Apparently, in some countries, citizens pay the trash tax based on the time of collection per year. If we reduce this through our idea, we could sell the sensor straight to them.

Moreover, in Estonia (and in many other countries) there is no solution at the moment in this field, so there is a market out there.

Execution

Go-to-market Strategy

Waste management practices are not uniform among countries (developed and developing nations), regions (urban and rural areas), and residential and industrial sectors can all take different approaches. For these reasons, in order to reduce our production cost and dive directly into the market, we decided to adopt a Go-to-Market strategy. As a result, we are deferring the release of the Citizen App, focusing solely on the MVP, which comprises the integration of our tools into pre-existing bins together with a route planner system for truck drivers. With this approach we can reinvest the earnings from the first year, specifically 2019, and from the first two quarters of the testing year in Rennes, adding all the features to the system and making our product more scalable and durable through different cities.

Initial Customer Acquisition

After checking how the waste collection works in different European cities, we concluded that each city has its own collection principles. In the first step, we decided to focus on France, specifically Rennes for our prototype testing.

Rennes and the municipal area is a city of 438.865 citizens. The waste collection is managed by *Rennes Metropole* for all the whole urban space of Rennes. They operate with different waste collection solution: public collection bins and door to door collection. Our solution is to focus on the public collection bins, as already mentioned in the Target Market section. The waste market size is of €57.16 Mio and the waste management is a real concern for the city council of Rennes and for its citizens; in fact, 71% of the population think the cleanliness is really important and the Rennes' major said, "*Cleanliness is everyone's business*".

After discussing with Maryline Beaujouan and Pierre Guillin (employees at waste and energy network management), we learnt that Rennes was studying a similar solution to the one we propose. For the moment, they are not satisfied with solutions they might adopt, and they were interested to discuss our product, since the valued our unique idea to engage everyone in the waste disposal process through to the citizen app that we provide.

Earning Model

The solution is provided as a complete service. The hardware for the bins is rented to the customer and the software is licensed. This is preferred because the of different stakeholders being involved in the process, and the question of ownership in case of hardware could become difficult. Contracts will be made on a 2-year basis because shorter runtimes are not worth it, and the waste management sector has long cycles. For a new contract there is a setup fee of 50€ charged for every bin and truck which is connected to the system. This is around the estimated costs of a technician installing it who is sent by us. Then, there is a monthly fee charged: 10€ per bin and 5€ per truck. This will also include the license to the software for the mobile apps and the waste management system. Through this subscription model we will be able to recover the initial hardware costs for the bin sensor, interaction technology and the truck tables in the second year of the contract.

Roadmap

After having created the basic prototype our next step is to develop a full-fledged minimum viable product. This includes a hardware system which can easily be attached to existing public garbage containers with fill-level sensors, a controller unit, a screen, a solar panel, connectivity modules and speakers. For this we want to partner up with experts in the IoT domain to co-develop such a hardware, like Thinnect.

It also requires the software parts of the solution: a basic waste management system with real-time analytics of the garbage levels, a table app for trucks which provides optimized routing, and the software for the garbage bin interaction. In parallel to the development, we will perform a series of tests with low-tech solutions in order to evaluate the features and required interaction level for the citizens at the bin.

The development will take 6 months. After that we will start a first pilot test in Rennes, France. First, a small-scale pilot in 2 districts with 10 connected bins will run for 3 months in order to evaluate the real-world application and gather feedback on the garbage bin interaction. Next, we will expand to the city and connect over 300 bins. Over the following 12 months we will make sure the scalability of the system works as designed. Also, we will develop further analytics features for the waste management system and create the citizens' app.

Sales forecast
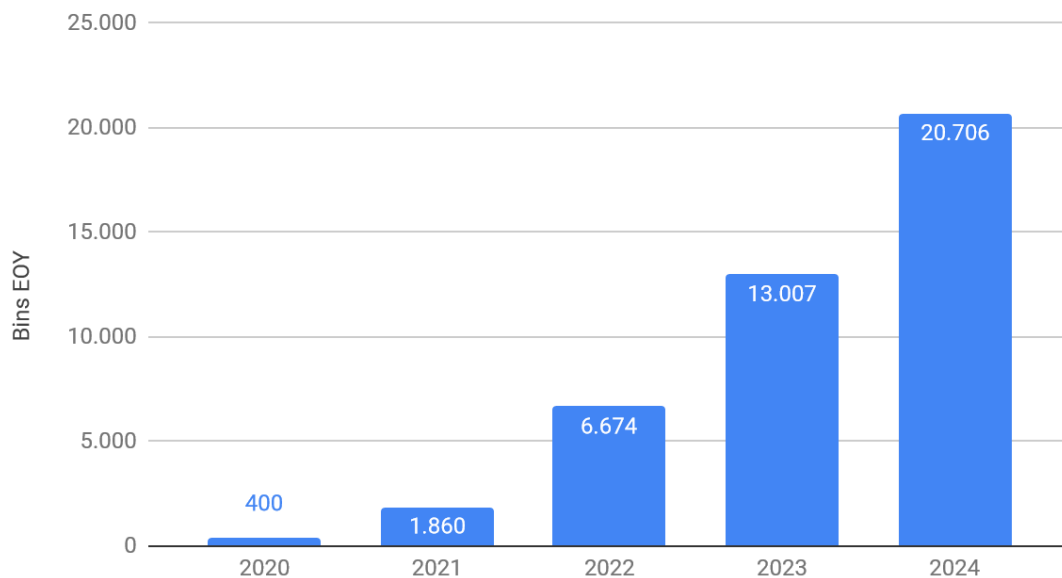
After the successful pilot phase, we will expand to more cities in southern Europe, like France, Italy and Spain. Additionally, we will expand our service by creating sensors for trucks, NFC tags for door-to-door collection and create our own highly usable garbage container. These additional products will make it feasible to measure the garbage of private households precisely and enable better control over the waste management.

Financial Plan

During the first 1.5 years our focus is on development and pilot phases. Therefore, the sales numbers and respectively the revenue will be small. In 2020, we expect to rent 400 bins and create losses of €234k.

After that, the expansion will see an increase in sales to nearly 2.000 in 2021. However, due to the costs and low number of existing subscriptions we expect losses of €285k. There will be a change of trends in 2022 when the sales activities start to grow a lot. At this point, the negative cash flow will reach the peak with -€660k.

Profit vs Accummulated profit
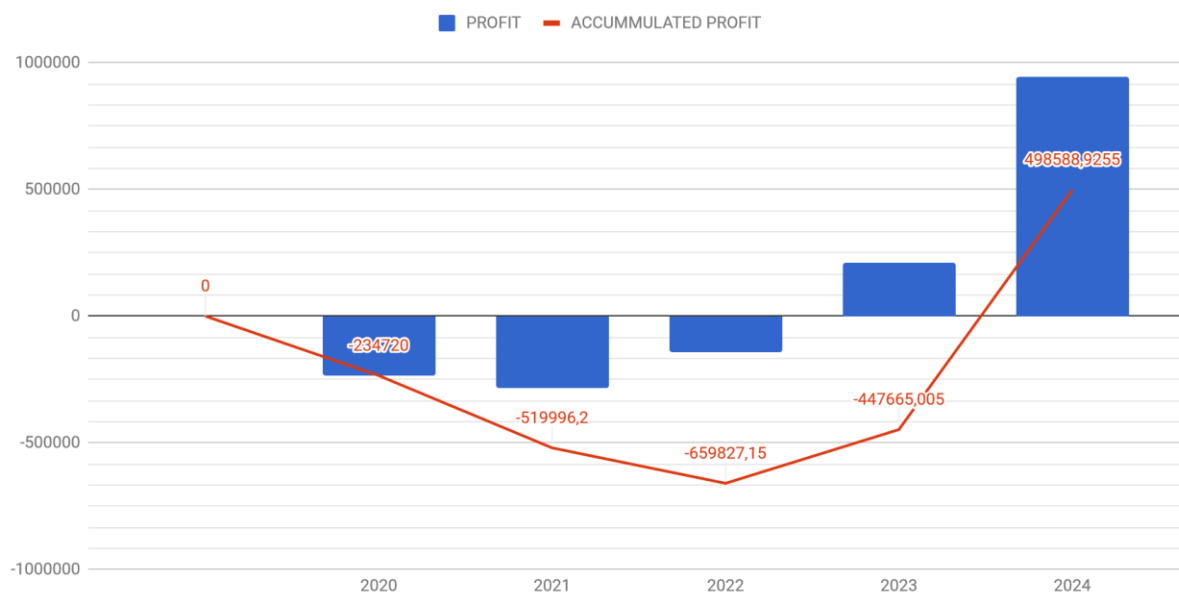
Starting in 2023, the number of active subscriptions will be able to compensate for the upfront sales costs and development costs. Hence, a first profit of €212k will be reached. After five years, the cashflow will be positive and further investments or stronger self-sustained growth is possible. At this point, we expect to sell more than 20.000 bins per year.

For the initial period we need €250k of seed investment in order to develop the MVP and start the pilot phase. Later, additional €500k will be needed to fuel the growth and start the path to profitability. The full financial plan and forecast is attached to this report.

Team Reflection

We found the process of quickly going through the creation of a new venture in two weeks challenging but rewarding. It was a good challenge to work on a new market field. After checking the market and competitors, there were a lot of existing solutions. So, the new challenge was to find added value to our initial solution. This was met with demotivation sporadically, so we needed to find ways to motivate ourselves despite the

uncertainty and the competition. With the coaches' help we found the solution to invest more citizens in waste management

It was also great to see the great network in effect. Being able to talk to the Head of Waste Management was really informative. This encouraged us to also contact other experts, like in Rennes. We learned the benefits of getting in touch with your potential customers and experts, even if it takes a bit getting used to it. In the end we found that they are still looking for a real solution.

When considering our own competencies, we see that we are well equipped on the technical side. The role which would be most beneficial for us would be some sales competencies. That would enable us to go to the market easier and for the expansions. All in all, during these two intensive weeks, we have faced to classical issues for entrepreneurs and we succeeded to solve it.

Sources

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