Advancing the circular bioeconomy in Western Macedonia

Co-creating improvement proposals in the Biowaste Club of the region through the analysis of HOOP Trainers' outcomes

The HOOP project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°101000836.

This document is the result of a participatory research using citizen science and co-creation methodologies to identify strategies for optimising the separate collection of the organic and non-organic fraction of waste in the region of Western Macedonia.

The research goal consisted in the co-creation of improvement proposals based on the challenges identified in the HOOP Trainers game, a gamified citizen science tool with pedagogical purposes. The collected data allowed us to gain valuable insights into the neighborhood's perception of biowaste separation, the acceptance of products derived from it, and collect opinions to develop a greener and more circular city. During two co-creation workshops, participants reflected on the HOOP Trainers outcomes and provided recommendations to enhance citizens' motivation to recycle, overcome barriers that hinder proper waste separation, and implement effective communication actions to raise awareness.

This research has been conducted within the framework of the European project HOOP. It has been possible thanks to 469 HOOP Trainers users and the active participation of 32 co-investigators from Western Macedonia, including 12 students aged 16 years old from the 1st High School of Kozani and 20 students from the Department of Product and Systems Design Engineering of the University of Western Macedonia, who have been involved in the data analysis process and the conversion of the results into recommendations. The transformation was done in two Biowaste Club (BC) events co-organized by Science for Change, CluBE and DIADYMA SA.

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Images: Captured during Biowaste Clubs events.

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1. Introduction

HOOP project: Vitalising Europe's Urban Bioeconomy

Did you know that, on average, Europeans generate approximately 200 kg of organic waste per year, and a staggering 75% of this waste is either landfilled or incinerated? This alarming statistic highlights the urgent need for action. In response to this pressing issue, the HOOP project is actively supporting 8 European lighthouse (LH) cities and regions in implementing circular bioeconomy solutions to produce innovative and sustainable bio-based products from urban biowaste and wastewater. One crucial aspect of this endeavour involves the creation of Biowaste Clubs (BC), which serve as **collaborative spaces where stakeholders regularly exchange ideas and foster a shared vision for enhancing circularity within their cities**.

To facilitate these exchanges, Science for Change implemented in 2023 a citizen science program utilizing the gamified App HOOP Trainers, which was adapted to 6 HOOP lighthouse context and needs: Kuopio (Finland), Lazio Region (Italy), Münster (Germany), Murcia (Spain), Porto (Portugal) and Western Macedonia (Greece). **The program's objective was to collaboratively design a highly efficient selective collection system, with a particular emphasis on the Organic Fraction of Municipal Solid Waste (OFMSW), while also actively engaging and raising awareness among citizens in HOOP lighthouses**. The data collected through the App has played a significant role in discussions within the Biowaste Clubs, contributing to the formulation of the co-created recommendations that you'll see below. By analyzing users' decisions during HOOP Trainers missions, a deeper understanding of citizens' perspectives on biowaste separation, acceptance of products derived from biowaste, and their proposals for building a greener and more circular region has been attained.

HOOP Trainers: Shaping the circular bioeconomy through citizens science and co-creation

In order to create customized versions of HOOP Trainers for each lighthouse, collaborative co-design sessions were conducted with representatives from each city. In Western Macedonia, the co-design sessions were arranged with CluBe and DIADYMA SA. The aim was to align their local circular bioeconomy challenges with the potential of citizen science. These sessions proved valuable in identifying waste selection challenges, determining the necessary data to address them, and devising strategies to involve citizens in the data collection and analysis processes.

While each lighthouse has its own adapted version of the game, they all share a common objective: **training an avatar called Circlo to transform organic waste into useful bioproducts by completing three missions. As Circlo learns the art of giving waste a new purpose, it evolves into Circloop, a creature capable of constructing a more sustainable city**.

Circlo symbolizes a city that adheres to a linear production and consumption model, where raw materials are extracted to manufacture new products for consumption, only to be disposed of through landfill or incineration once they are no longer useful. Circloop represents a green and circular city that reduces, recycles, reuses, repairs, and recovers the waste it generates. By doing so, the city breathes new life into its waste, finding diverse ways to reuse it, while minimizing waste-related pollution and emissions, and easing the strain on natural resources.

Circlo Circloop

HOOP Training missions in Western Macedonia

MISSION 1: Correct waste sorting

Circlo lacks the knowledge to properly separate waste and needs assistance in depositing items into the appropriate bins. Users are tasked with training Circlo to effectively sort the following **types of rubbish**:

MISSION 2: Uncover the situation in Western Macedonia

More details of the questions asked in this mission are shown in the next page.

To advance Circlo's transformation, more individuals must sort their waste effectively. Thus, in Mission 2, users must actively initiate conversations with their neighbours, exchanging experiences and insights that can aid Circlo in comprehending the most effective measures to promote recycling in Western Macedonia. Of particular emphasis is the sorting of organic waste fractions.

The questions primarily revolve around the **factors that motivate and hinder waste sorting**, as well as the **preferred communication channels for obtaining information**. Additionally, users are asked about their **suggestions for prioritising actions that they believe the municipality should undertake**.

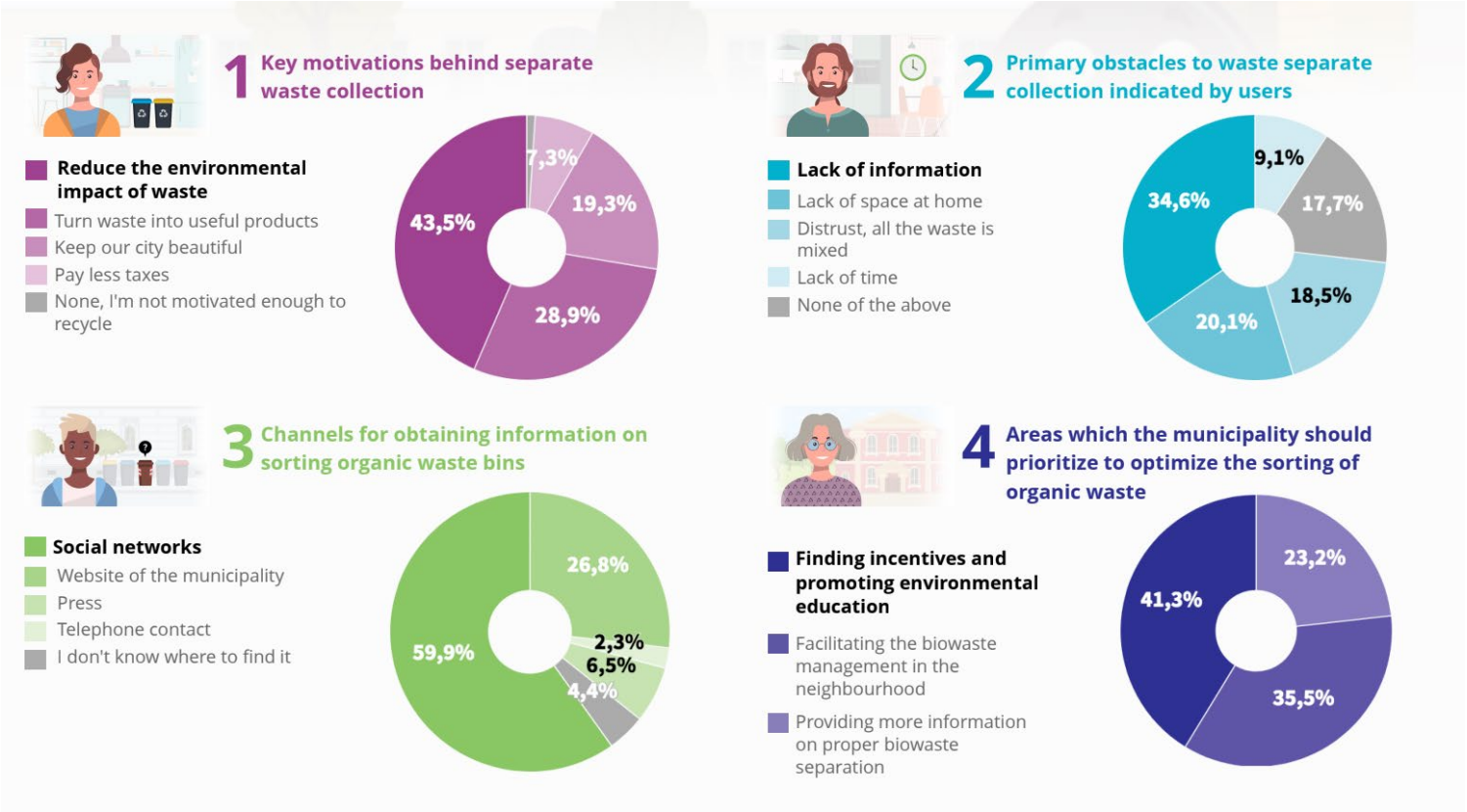
MISSION 3: Create a Bioproduct

Building upon the success of the previous two missions, users are enthusiastically invited to assist Circlo in choosing and creating one of the following types of bioproducts from the abundant resources at hand:

- Fertilisers
- Nutrients
- Bioplastics
- Green chemicals products

Specific questions and corresponding answers from Mission 2

Bellown are shown the Mission 2 questions addressed to HOOP Trainers players regarding domestic waste separation, which came from the co-design session done with CluBe and DIADYMA SA:



Summary of the quantitative outcomes obtained in each training mission

In Western Macedonia, 469 HOOP Trainers users played the game and a total of **379 players successfully finalized the 3 missions**. Women constituted the majority of users with 61% participation, followed by men at almost 36%. The number of non-binary participants was insufficient to draw any statistically significant conclusions. In terms of age distribution, almost 46% of participants were between 20-39 years old, followed by almost 27% in the 14-19 age group, and 24.3% in the 40-59 age group. There were also a few users over 60 years old.

During **Mission 1**, the waste items that caused the most uncertainty among participants were the **ceramic bowl** (with approximately 50% of users making mistakes), **diapers** (28.5% of users made errors), and **eggshells** (almost 22% of users made errors). The waste items that generated less doubts among users were light bulbs (just a 3,4% of users made errors) and magazines (7,9% of users made mistakes). No significant differences were found between female and male participants regarding the most common waste separation uncertainties.

In **Mission 2**, users expressed primary **motivations** for separate waste collection, including **reducing the environmental impact of waste** (43.5%), **transforming waste into bioproducts** (almost 29%), and **maintaining city aesthetics** (approximately 19%). Paying fewer taxes was a less significant motivation. None relevant differences were found in the motivations highlighted by female and male. **Key obstacles** reported were **lack of information** (nearly 44%), **limited space at home** (around 29%), and **distrust** (18.5%). Lack of time was not a significant obstacle (around 9%), while the option "Others" accounted for 18% of responses, reflecting additional obstacles identified during the Biowaste Club meetings. The key obstacles differed a bit between females and males. Specifically, while 40.5% of females cited the lack of information as the main challenge, only 30% of males did so. Moreover, none of the female participants mentioned the lack of time as an issue, while this was exclusively highlighted by male participants. **Social networks** were the most utilized **channel** for obtaining information on sorting organic waste (close to 60%), followed by the municipality's website (approximately 27%), and the press (around 6%). The municipal website appears to be more frequently used by females, as approximately 30% of them selected it as their primary option, while only 18% of males did the same. Conversely, the press, though chosen by a small number of users overall, is more commonly utilized by males, with 11% of them selecting it as their main channel compared to just 4% of females.

When users were asked about the areas that the municipality should prioritize to optimize the sorting of organic waste, the responses were more fairly distributed. The top priorities identified were **finding incentives and promoting environmental education** (around the 41%) — the type of incentive and environmental education campaigns were identified in the Biowaste Club meetings — facilitating neighborhood-level biowaste management (a 35,5%), and providing more information on proper biowaste separation (around the 23% of the results). Non relevant differences between male and female were identified.

In **Mission 3**, 43% of users chose to create **fertilizer**, followed by 23% opting for bioplastics, and the remaining users split between creating nutrients (20%) and green chemical products (14%). The ranking of preferences is consistent between female and male participants.

The detailed HOOP Trainers outcomes can be shown in the document *HOOP Trainers App game implemented in Western Macedonia: Study results*.

The HOOP Trainers data was collected with a confidence level of 95%. Nevertheless, it is crucial to recognize and acknowledge the potential presence of common biases, including sampling bias and social desirability bias, which could have influenced the outcomes obtained. By acknowledging these biases, we can ensure a more comprehensive and nuanced understanding of the data and its limitations.

Biowaste Club meetings to transform HOOP Trainers outcomes into improvement proposals

On the 9th of June, the outcomes derived from the data analysis of the **HOOP Trainers Mission 2** were examined during two Western Macedonian Biowaste Clubs meetings. **The first Biowaste Club of the day was tailored for highschool students, while the other catered to university students. The purpose of these events was to collaboratively transform the obtained HOOP Trainers outcomes into improvement proposals for optimising waste sorting management in the region**[1].

The outcomes discussed in the Biowaste Clubs meetings, focused on the **first three questions of Mission 2, which delved into the factors motivating and hindering waste sorting, as well as the preferred communication channels for obtaining information**.

By analyzing the HOOP Trainers results, a group of 12 students from 16 years old from the 1st High School of Kozani, delved into the perceptions of their community members and embarked on constructive discussions. These discussions encompassed various challenges, including the creation of impactful awareness campaigns that resonate with a broader audience or the devising strategies to streamline waste sorting procedures within citizens' homes. 20 students from the Department of Product and Systems Design Engineering of the University of Western Macedonia also took on the role of analyzing the HOOP Trainers outcomes. Their discussions also encompassed a wide range of challenges, including the pay as you throw system, re-thinking garbage bag design or creating innovative communication campaigns.

The following synthesis presents the final recommendations co-produced by the participants. These proposals have been drafted based on the recommendations submitted during the co-creation sessions. The proposals are categorized according to the challenges identified in HOOP Trainers and are listed in order of priority based on user feedback from the game.

[1] *Mar Escarrabill and Blanca Guasch conceptualized the sessions. The methodological design of the co-creation sessions was carried out by Blanca Guasch under the Torres Quevedo grant for contracts PTQ2020-011264, financed by the Ministerio de Ciencia e Innovación: MCIN/AEI/10.13039/501100011033 and by the European Union NextGenerationEU/PRTR. Julia de la Cruz and Francisca Fuenzalida designed the materials used in the sessions.*

2.1.
Enhancing organic and non-organic waste separation in Western Macedonia:
Motivations and Recommendations

How to read these recommendations

In the following pages, you will discover the recommendations put forth by the Biowaste Club participants in response to the challenges identified by the HOOP Trainers players. The outcomes will be distributed as follows:

HOOP

2.1. Enhancing organic and non-organic waste separation in Western Macedonia: Motivations and Recommendations

Topic posed to HOOP Trainers players to collect their perceptions, analyzed by the Biowaste Club participants

Reduce the environmental impact of waste

One of the **potential responses** that players could choose from for the posed topic

*It is the main motivation for **43,5%** of HOOP Trainers players.*

Percentage of players who chose that particular answer

highschool students

Promote a cleaner environment by **refraining from polluting our coasts and seas** with rubbish and plastic waste.

Prioritize the organization and implementation of **effective waste collection projects** tailored to the region of Western Macedonia.

university students

Implement the installation of **compost bins in every neighborhood** to promote sustainable waste management practices.

To encourage responsible disposal of broken electric devices, a rewarding system could be introduced in the form of **discount coupons for individuals who choose to return their malfunctioning or obsolete electronics**.

Profile of the Biowaste Club participants

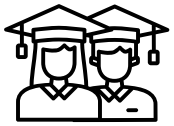
Recommendations proposed by the Biowaste Club participants

Reduce the environmental impact of waste

*It is the main motivation for **43,5%** of HOOP Trainers players.*

Promote a cleaner environment by **refraining from polluting our coasts and seas** with rubbish and plastic waste.

Prioritize the organization and implementation of **effective waste collection projects** tailored to the region of Western Macedonia.



Implement the installation of **compost bins in every neighborhood** to promote sustainable waste management practices.

To encourage responsible disposal of broken electric devices, a rewarding system could be introduced in the form of **discount coupons for individuals who choose to return their malfunctioning or obsolete electronics**.

Transform waste into useful products

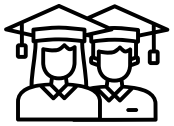
*It is the main motivation for **28,9%** of HOOP Trainers players.*

Extend a helping hand to those in need by generously **offering the clothes we no longer use** to individuals who can truly benefit from them. This act of generosity not only promotes resourcefulness but also directly addresses the pressing needs of those who may be less fortunate.

Embrace the power of composting by **transforming organic waste into fertilizers**.

Embrace the concept of upcycling by creatively **repurposing old clothes** and transforming them into new and unique products.

Opt for the **reuse of packaging materials** as a means to minimize environmental pollution.



Explore the option of **renting electrical devices** as an alternative to purchasing them outright.

Develop and implement engaging workshops specifically designed to **impart valuable skills in transforming waste materials** into practical and valuable products.

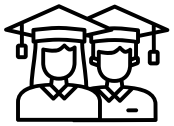
Keep out city beautiful

*It is the main motivation for **19,3%** of HOOP Trainers players.*

Take a stand against environmental pollution by **refraining from littering** and ensuring the cleanliness of our surroundings.

Enhance waste management infrastructure by **installing additional bins in every neighborhood**.

Promote the **minimization of car use** as a means to alleviate traffic congestion.



Implement **targeted vocational actions to raise awareness among children and young people** about environmental issues.

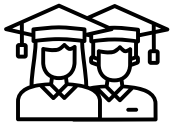
Install **additional recycling bins in public spaces and parks** to promote proper waste disposal and recycling.

Pay less waste taxes

*It is the main motivation for **7,3%** of HOOP Trainers players.*

Implement measures to effectively **reduce the overall volume of waste generated**.

Embrace a **packaging reduction approach** to minimize the use of packaging materials.



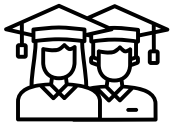
Introduce a **recycling bonus card system** to incentivize and reward individuals who actively participate in recycling initiatives, ultimately leading to a reduction in taxes.

None, I am not motivated enough to recycle

*It represents the response of only **1%** of the HOOP Trainers players.*

Raise awareness among students by organizing **engaging workshops** focused on reuse and recycling.

Ensure that non-motivated individuals have a**ccess to accurate and up-to-date information** by inviting specialists in the field to share their expertise.



Implement **rewarding systems** that incentivize recycling efforts.

[2] *Detailed in the section "Enhancing organic and non-organic waste separation in Murcia: Barriers and Recommendations".*

2.2.
Enhancing organic and non-organic waste separation in Western Macedonia: Barriers and Recommendations

Lack of information

*It is the main barrier for **34,6%** of HOOP Trainers players.*

Launch **impactful awareness campaigns through various media channels** to educate and engage the public on environmental issues.

Produce and showcase **documentaries** that raise awareness among citizens about pressing environmental concerns.

Provide citizens with **clear and comprehensive guidelines** on what and how to recycle through analytical directions.

Organize **recycling events in schools addressed to children** to instil environmental awareness and sustainable habits from an early age.

Promote environmental awareness in **schools** by incorporating dedicated programs and activities into the curriculum.

Utilize awareness **spots in media** to disseminate key messages and promote sustainable practices.

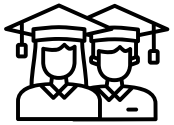
Organize **events, workshops, and training sessions** to provide information and empower individuals on sustainable practices.

Lack of space at home

*It is the main barrier for **20,1%** of HOOP Trainers players.*

Ensure that every family has **access to suitable waste bins** for efficient separation and collection of different types of waste **within their homes**.

Install recycling bins in every apartment building to promote recycling convenience and accessibility for residents.



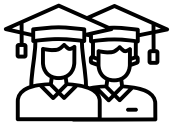
Develop a **garbage bag design** that enhances separate waste collection.

Integrate designated spaces for separate collection bins when designing new homes. As part of the architectural planning process, it is essential to allocate dedicated areas or storage solutions for separate collection bins.

Distrust, all the waste gets mixed

*It is the main barrier for **18,5%** of HOOP Trainers players.*

Implement a **systematic control mechanism to monitor the waste separation** system and minimize errors.



Publish photos or videos showcasing the waste separation process to increase transparency and awareness.

Others

*It is the main barrier for **17,7%** of HOOP Trainers players.*

Ensure the **availability and easy access of recycling bins** in every neighborhood.

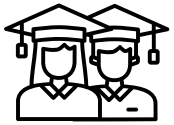
Schools should implement **incentive programs** to motivate students to recycle more actively.

Introducing **rewarding initiatives** is crucial as it provides the necessary motivation for individuals to recycle, addressing the lack of incentives currently in place.

Lack of time

*It is the main barrier for **9,1%** of HOOP Trainers players.*

Implement the appointment of a **garbage manager** in every apartment building to oversee and coordinate waste management activities.



Install more recycling bins in every neighborhood to facilitate convenient and accessible recycling for residents.

Assign a **responsible individual to each group of bins** to properly sort the waste.

2.3. Enhancing organic and non-organic waste separation in Western Macedonia: Communication channels and Recommendations

Social media

*It is the main channel for **59,9%** of HOOP Trainers players.*

Use of **YouTube** videos, **Instagram** and **Pinterest** posts to disseminate educational content and raise awareness about environmental issues.

Engage with the community through **Discord** and **Twitter** (utilizing relevant hashtags) to promote recycling and encourage sustainable practices.

Create a **Spotify podcast dedicated to discussing environmental topics** and raising awareness about the importance of waste sorting.

Leverage **TikTok** as a platform for promoting recycling through creative and engaging content.

Encourage the use of **recycling-related hashtags on social media platforms** to create a sense of community and inspire others to participate in sustainable behaviors.

Encourage politicians to actively promote recycling through their social media accounts, leveraging their influence and reach to raise awareness.

Develop **impactful videos** and advertisements to raise awareness about waste sorting.

Implement **questionnaires and surveys to gather feedback from citizens** and understand their attitudes and behaviors towards recycling and waste management.

Organize a **recycling challenge on platforms like Instagram or TikTok** to encourage individuals to actively participate in recycling initiatives and share their experiences.

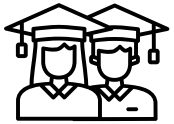
Produce podcasts featuring experts in the field to provide insightful discussions and valuable information on environmental topics, such as the importance of recycling.

Website of the municipality

*It is the main channel for **26,8%** of HOOP Trainers players.*

Share **posts about local events** related to recycling and sustainability to raise awareness and encourage community participation.

Develop **user-friendly and informative apps** dedicated to recycling, providing individuals with convenient tools and resources to learn about recycling practices.



Produce **engaging videos and animations featuring famous characters** or influential individuals to promote recycling and convey the importance of sustainable behaviors.

Organize **events** focused on recycling and sustainability.

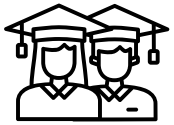
Distribute **newsletters** that highlight the latest news and updates on recycling initiatives to keep citizens informed and inspired.

Press

*It is the main channel for **6,5%** of HOOP Trainers players.*

Produce **environmental podcasts** that cover topics related to recycling.

Promote the **inclusion of articles about recycling in magazines and newspapers**.



Enhance readers' engagement and knowledge by incorporating **crosswords about the environment, recycling, and other related topics** in magazines and newspapers, encouraging gamified learning and reinforcing key concepts.

Introduce **caricatures and sketches that focus on environmental themes**, recycling, and ecology in magazines and newspapers, utilizing visual humor and creativity to capture readers' attention.

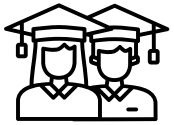
Lack of knowledge of where to find information

*It is the main channel for **4,4%** of HOOP Trainers players.*

Create **inspiring songs about the environment** that raise awareness and promote sustainable behaviors, leveraging the power of music to engage and educate listeners.

Develop **impactful advertisements** that highlight environmental issues and encourage individuals to take action.

Distribute **informative leaflets**.



Encourage **voluntary actions** to promote environmental care.

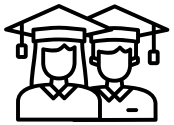
Display **informal posters and leaflets in public spaces** to raise awareness about environmental issues.

Set up **information kiosks at bus stops and supermarkets** to provide accessible and educational materials on environmental topics.

Telephone contact

*It is the main channel for **2,3%** of HOOP Trainers players.*

Reach out to companies via phone to inform them about potential environmental issues where they can make a positive contribution.



Implement a **rewarding system where individuals receive SMS notifications acknowledging their recycling efforts**, promoting a sense of accomplishment and encouraging continued participation in recycling programs.

Introduce **chat bots** that provide real-time assistance and information on recycling practices.

Implement **GPS tracking technology in recycling bins** to optimize the waste collection system.

Develop **interactive apps** and games that educate and entertain users about recycling, fostering a sense of environmental responsibility and motivating individuals to adopt sustainable habits.


Vitalise Europe's
The HOOP project supports 8 lighthouse cities and regions in developing large-scale urban circular bioeconomy initiatives that will focus on mak
io-based products from urban bi
and wastewater.
hoop

3. Next steps

Next steps

The HOOP project is actively supporting 8 European lighthouse (LH) cities and regions in implementing circular bioeconomy solutions to produce innovative and sustainable bio-based products from urban biowaste and wastewater. The participation of citizens in advancing to circularity is crucial to its success. HOOP Trainers program's objective - aligned with the HOOP Biowaste Clubs - has been to collaboratively design a highly efficient selective collection system, with a particular emphasis on the Organic Fraction of Municipal Solid Waste (OFMSW), while also actively engaging and raising awareness among citizens in HOOP lighthouses. The discussion of the data collected through the App have contributed to the formulation of the co-created recommendations shown in this document. **These recommendations will enhance the HOOP circular innovations applied in Western Macedonia and future region interventions aligning them with social needs.**