D6.4

Outcome reports of the co-designed Citizen Science Interventions

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Acronym	Description
BC	Biowaste Club
BCM	Biowaste Club Meeting
CE	Circular Economy
CS	Citizen Science
HoReCa	Hotel/Restaurant/Catering
H2020	Horizon 2020
LHs	Lighthouse Cities and Regions
OFMSW	Organic Fraction of Municipal Solid Waste
PDA	Project Development Assistance
SfC	Science for Change
WP	Work Package

1. Executive summary

Approximately 88 million tonnes (173 kg per person) of food is wasted every year in the 28 EU Member States along the entire food value chain [1]. In parallel, EUROSTAT indicates that majority of municipal waste generated in Europe is still disposed of through landfilling (24%) or incineration (27%). This alarming statistic highlights the urgent need for action. In response to this pressing issue, the HOOP project is actively supporting 8 European Lighthouse Cities and Regions (LHs) to implement circular bioeconomy solutions to produce innovative and sustainable bio-based products from urban biowaste and wastewater. One crucial aspect of this endeavour is 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 (SfC) implemented between 2022 and 2023 a **Citizen Science (CS)** program utilizing the gamified App **HOOP Trainers**, adapted to 4 HOOP Lighthouses (LHs) context and needs: Lazio Region (Italy), Münster (Germany), Murcia (Spain) and Western Macedonia region (Greece). **The program's objective was to collaboratively identify and advance more efficient sorting, collection, and recycling systems, with a particular emphasis on the Organic Fraction of Municipal Solid Waste (OFMSW), while also actively engaging and raising awareness among citizens in HOOP LHs.** The data collected through the HOOP Trainers App by 1296 users played a significant role in discussions within the Biowaste Clubs Meetings (BCM), in which 164 citizens participated, contributing to the formulation of the co-created recommendations that are shown below.

In terms of gender distribution, on average, nearly 61% of App users were female, a 30% were male, a 5% were non-binary and a 4% preferred not to provide their gender. The largest age group of users was 20-39 years. **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.** Students were specially engaged to participate in the BCMs to analyze the HOOP Trainers outcomes and co-create improvement proposals. The recommendations co-produced can be grouped in three areas: **waste separation and recycling strategies, promotion of sustainable practices and circularity and reuse actions**.

This document summarizes the methods to implement the 4 HOOP CS interventions, highlights the local outcomes obtained in Lazio Regio, Münster, Murcia and Western Macedonia region through the HOOP Trainers App, and outlines the local recommendations for optimising the separate collection of OFMSW obtained in the BCMs by collaboratively analyzing the HOOP Trainers outcomes. Additionally, explains the next steps of the *T6.3. Citizen Science for optimising the separate collection of OFMSW in the LHs*: to ensure that the effectiveness of the App is replicated, adjustments have been implemented to adapt it to the local context of Greater Porto area (Portugal) and Kuopio (Finland) needs. Both cities are evaluating how to use the App, they will gather data until December 2023 and a summarized report with the results will be provided to them if they collect a minimum amount of data. In parallel, SfC will share the learning of the CS interventions with the HOOP Network of Cities and Regions in specific HOOP Lunch Talks, during the National Replication Workshops and specific conferences.

2. Introduction

The EU Bioeconomy Strategy sees cities becoming major circular bioeconomy hubs, where biowaste is a feedstock for safe and sustainable bio-based products. But until now very few cities and regions have developed circular bio-based economy strategies or projects for the production of innovative bio-based products. The HOOP project aims to be the catalyst, providing Project Development Assistance (PDA) to eight LHs (Albano-Laziale (Italy), Almere (The Netherlands), Bergen (Norway), Kuopio (Finland), Münster (Germany), Murcia (Spain), Greater Porto (Portugal) and Western Macedonia (Greece)). HOOP supports these LHs in developing large-scale urban circular bioeconomy initiatives that will focus on making bio-based products from urban biowaste and wastewater.

D6.4 Outcome Reports of the Co-Designed Citizen Science Interventions centers on the results derived from the CS interventions implemented by SfC within a specific cohort of LHs. These interventions were strategically employed to enhance the efficiency of segregating the OFMSW, as a significant facet of the support extended to LHs under the umbrella of the HOOP Project. Even though the Grant Agreement states that CS interventions were to be planned in those LHs "that are within a less advantage stage of implementation of the OFMSW collection and others that need to start implementing it", the HOOP team initially proposed to all LHs to be involved in this task. The selection of the LHs to work with was done according to the outcomes of *D2.3 Report on the baseline studies for the Lighthouse Cities and Regions*, to make sure that LHs with poor indicators on OFMSW collection were included in the working group, and to the will of LHs to participate. The final selection include:

- Murcia: implemented the OFMSW collection only at pilot scale in a few neighbourhoods in the frame of the H2020 VALUEWASTE project. They're in the process of planning the collection for the whole municipal extension and the result of the CS intervention will help the make more effective both the communication campaign and the collection system.

- Western Macedonia: the OFMSW collection has been gradually implemented since 2016 and already covers the whole region. However, the collection rate and the quality of the biowaste selectively collected is not satisfying and the CS intervention will help the make more effective both the communication campaign and the collection system.

- Münster: one of the EU frontrunners in the selective collection of biowaste and its valorization through anaerobic digestions and composting, already shows excellent rates of quantity and quality of collected biowaste. However, they've always faced challenges when it comes to the quality of the biowaste from household building blocks. The CS interventions are meant to help the waste management company to create strategies to improve this indicator.

- Lazio Region: the HOOP team decided to work with all municipalities represented by ANCI Lazio because Albano Laziale already showcases excellent indicators of quantity and quality of collected OFMSW since long time.

Implementing CS interventions is a complex endeavor that demands active participation from LHs. Initially, the Greater Porto area and Kuopio were not included in the CS interventions cohort due to the considerable challenges posed by their unique needs and available resources. However, following the initial interventions, we also adapted the App to suit their requirements. Both cities are evaluating how to use the App, they will gather data until December 2023 and a summarized report with the results will be provided to them if they collect a minimum amount of data.

After engaging in discussions with the LHs of Almere and Bergen, as well as with CSCP, WP6 coordinator, we recognized that a more strategic approach would involve concentrating their efforts and resources on Task 6.2, which involves stakeholder engagement through the BCs to foster a bottom-up Urban Circular Bioeconomy, and Task 6.4, which entails pilot actions focused on education, awareness raising, and fostering acceptance of biowaste-derived products, aligning better with their specific needs and timelines.

In the following paragraphs, the reader will find a description of the CS activities carried out and a discussion of all results already available.

2.1. Citizen Science

As we face socio-environmental global challenges that need local intervention to tackle them, science and technology need more eyes, ears and perspectives than any scientist possesses. Here's where CS plays a fundamental role: the involvement of citizens in scientific research through a wide range of roles. The HOOP gamified CS App, designed by SfC, aims to answer research questions from each LH (e.g. why citizens struggle to sort waste) and to inform and motivate behaviour change. The gamified App consists of an avatar's training that has a challenge: **convert biowaste into useful bioproducts by overcoming 3 missions**:

- **Mission 1**: Dubiop, the avatar who serves as the protagonist in the game, requires assistance in waste separation and needs guidance to deposit waste in the correct bins. The types of waste items vary among the LHs involved, and in each LH App adaptation, certain waste items that generate more uncertainties are integrated.
- **Mission 2**: Since Dubiop lacks the ability to communicate directly with humans, users take it upon themselves to engage with their neighbors and share their experiences, thereby aiding Dubiop in comprehending what measures would facilitate recycling in their city. The types of questions vary slightly among the LHs involved, depending on the specific challenges they face in waste sorting.
- **Mission 3**: In this final mission, users play a pivotal role in assisting Dubiop as it selects and generates its ultimate bioproduct through the organic fraction of the waste sorted correctly. The types of bioproducts are consistent across LHs, representing the primary categories of bio-based products produced within HOOP

Throughout the game, players assume the role of trainers guiding the avatar to overcome challenges by accurately sorting waste, interacting with various stakeholders to assess the volume and accuracy of sorted waste, and making informed decisions about the creation of specific bioproducts. The avatar evolves based on citizens' decisions. Involving citizens following a bottom-up approach has generated new datasets useful in co-designing new waste collection systems, exploring acceptance of biobased products and increasing social knowledge on biowaste.

The structure of the App is the same for all the LHs involved, however the content for each LH is made *ad hoc* for the Mission 1 and 2 of each city or region. The total amount of CS interventions is summarized in **Table 1**, while the timeline and the methodology to carry out these interventions is described in *Section 2.2. Methodology*.

Table 1. Global HOOP CS interventions in numbers

6 LHs involved

6 Apps (4 Apps were utilized in the HOOP CS interventions in Murcia, Western Macedonia Region, Lazio Region, and Münster. Following the initial creations, 2 additional adaptations were developed to reach Greater Porto area and Kuopio demands).

10 co-design sessions with the LHs, CETENMA and CSCP to conceptualize the App with **99 participants in total**.

1 replicable methodology designed to collaboratively optimize the separate collection of the organic and non-organic waste fraction.

1460 participants in Murcia, Western Macedonia region, Lazio Region and Münster (including 1296 HOOP Trainers users and 164 citizens involved in 7 specific BCMs aimed analyzing the HOOP Trainers outcomes)

7 BCMs addressed to transform the outcomes of HOOP Trainers into recommendations to improve the actual separation system

7 reports outlining the CS interventions outcomes (2 for Murcia, 2 for Western Macedonian, 2 for Lazio Region and 1 for Münster).

2.2. Methodology

The following methodology describes the timeline for the actions summarized in Figure 1.

Figure 1. Scheme of the phases followed to conceptualize, design and implement the HOOP CS interventions
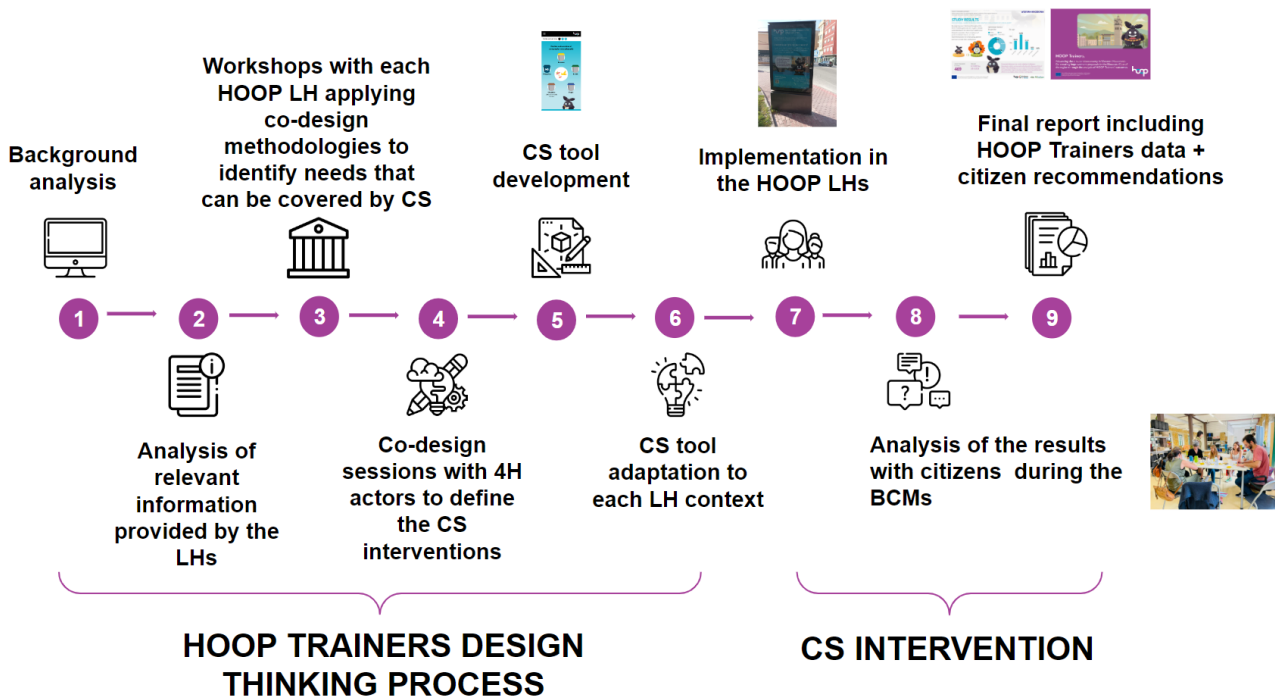
2.2.1. HOOP TRAINERS DESIGN THINKING PROCESS

Design Thinking is an iterative process used to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. Figure 2 schematizes the Design Thinking steps followed to conceptualize and design the HOOP Trainers App (phases 1-6 of Figure 1), the main tool used during the CS interventions.

Figure 2. Scheme of the HOOP Trainers Design Thinking Process

EMPHATIZATION (PHASES 1 AND 2)
Understanding of the context and the users
Observation and interaction with the HOOP LHs. Analysis of the baseline analysis performed in WP2 and the information obtained in T6.1.

DEFINITION (PHASE 3)
Framing the needs, challenges or goals
Co-design workshops with HOOP LHs 4H stakeholders to identify needs to optimize the separate collection of OFMSW that could be covered by CS.

IDEATION (PHASES 4 AND 5)
Exploration and selection of possible ideas
Development of the CS App concept to address 3 common goals for each HOOP LH
- Tackle disinformation on waste separation
- Identify prioritarian actions for optimising the separate collection of OFMSW
- Analyse the social acceptance of bioproducts

PROTOTYPE (PHASES 5 AND 6)
Turning the idea into a reality
Conception of the HOOP CS App allowing its further experimentation and interaction for improvement

TEST (PHASE 6)
Evaluation of the solution and changes
Testing and evaluation of the App with real users to improve and perfect it.

* This step included co-design sessions

* This step did not include a co-design methodology but the incorporation of citizens and other 4H views to improve the tool

Below are detailed the co-design interventions applied in the definition step (Phase 3):

2.3.1.1. Workshops with each HOOP LH applying co-design methodologies to identify needs that can be covered by CS

To prepare the design and development of HOOP Trainers, SfC conducted individual co-design sessions with partners from Murcia, Western Macedonia region, Münster, Kuopio, Bergen, Greater Porto area, Albano Laziale, and Almere (Table 2). The main goal was to align their circular bioeconomy opportunities with the potential of CS and allocate the CS interventions. Each co-design session had three specific objectives: prioritizing urban circular bioeconomy opportunities based on the baseline analysis conducted by ITENE in the *T6.1. Setting the scene,* which was summarized in the *D2.3. Report on the baseline studies for the Lighthouse Cities and Regions* submitted in January 2022, identifying knowledge gaps related to these opportunities, and exploring how citizen science can contribute to data collection. The sessions were conducted online using the Miro tool.

During the sessions, participants engaged in selecting the three most significant opportunities for urban circular bioeconomy, with the understanding that citizen participation would be vital in addressing these opportunities through CS. They also discussed the barriers that need to be overcome in order to tackle these opportunities effectively. Furthermore, the participants identified the specific data required to address knowledge gaps in these areas. In addition, participants reflected on the ladder of participation and engagement in CS projects [2], selecting the level at which they felt most comfortable participating.

The sessions allowed us to pinpoint the crucial data needed to address circular bioeconomy opportunities in each LH and initiate the conceptualization of a unified app flow for the game across all LHs.

Table 2. Total of online actions done to co-design HOOP Trainers in the definition step (Phase 3)

Name of the event	LH	Date	Participants	Goals	Audience
Co-design session to align Kuopio circular bioeconomy opportunities with the potential of CS	Kuopio	Sep 2021	7	Prioritize Kuopio's opportunities to foster bioeconomy, detect knowledge gaps and explore how CS can contribute to gather the data needed	SAVONIA
Co-design session to align Bergen circular bioeconomy opportunities with the potential of CS	Bergen	Oct 2021	8	Prioritize Bergen's opportunities to foster bioeconomy, detect knowledge gaps and explore how CS can contribute to gather the data needed	BIR
Co-design session to align Greater Porto circular bioeconomy opportunities with the potential of CS	Greater Porto	Oct 2021	8	Prioritize Porto's opportunities to foster bioeconomy, detect knowledge gaps and explore how CS can contribute to gather the data needed	LIPOR
Co-design session to align Murcia circular bioeconomy opportunities with the potential of CS	Murcia	Oct 2021	2	Prioritize Murcia's opportunities to foster bioeconomy, detect knowledge gaps and explore how CS can contribute to gather the data needed	Municipality of Murcia
Co-design session to align Almere circular bioeconomy opportunities with the potential of CS	Almere	Nov 2021	3	Prioritize Almere's opportunities to foster bioeconomy, detect knowledge gaps and explore how CS can contribute to gather the data needed	Municipality of Almere
Co-design session to align Münster circular bioeconomy opportunities with the potential of CS	Münster	Mar 2022	7	Prioritize Münster's opportunities to foster bioeconomy, detect knowledge gaps and explore how CS can contribute to gather the data needed	Abfallwirtschaftsbetriebe Münster (AWM)

Name of the event	LH	Date	Participants	Goals	Audience
Co-design session to align Western Macedonia bioeconomy opportunities with the potential of CS	Western Macedonia	Jul 2022	5	Prioritize Western Macedonia's opportunities to foster bioeconomy, detect knowledge gaps and explore how CS can contribute to gather data	CluBE, DIADYMA and CSCP
Co-design session to align Albano Laziale circular bioeconomy opportunities with the potential of CS	Lazio	Jul 2022	4	Prioritize Albano Laziale's opportunities to foster bioeconomy, detect knowledge gaps and explore how CS can contribute to gather the data needed	Partner ANCI Lazio

Below are detailed the co-design interventions applied in the ideation step (Phases 4 and 5):

2.3.1.2. Workshops with potential HOOP Trainers users applying co-design methodologies to shape the app flow and possible app scenarios

After concluding the definition step and with the intention of integrating gamification and storytelling into the App, we conducted **up to two co-design sessions involving potential users** (**Table 3**). The main objective was to collaboratively develop engaging scenarios that would address the three key challenges identified during the definition step: **combating disinformation on waste separation**, **identifying priority actions for optimizing the separate collection of OFMSW**, and **analyzing the social acceptance of bioproducts**.

Table 3. Total of online actions done to co-design HOOP Trainers in the ideation step (Phase 4)

Name of the event	LH	Date	Nº participants	Goals	Audience
Storytelling for circular bioeconomy: co-designing scenarios to tackle biowaste management challenges	Kuopio	March 2022	15	Draw potential App scenarios	Students (Savonia University of Applied Sciences, Kuopio)
Laboratorio digitale per articolare strategie di bioeconomia circolare	Albano Laziale	May 2022	40	Identify the challenges to implement circular bioeconomy in Lazio and co-create strategies to tackle them and possible HOOP Trainers scenarios	Students (LICEO SCIENTIFICO, Rome)

Building upon the insights gained from these sessions, we determined that the App's foundation would center around a captivating and stimulating story. In this narrative, users would be tasked with training a fictional avatar to effectively convert organic waste into valuable bioproducts. Through engaging interactions with key stakeholders involved in the biowaste valorization process, as well as actively listening to users' perspectives, the avatar could gain a deeper understanding of the essential elements required to progress towards a circular bioeconomy and thus provide recommendations to the municipality.

The HOOP Trainers immersive and challenging story would unfold through a series of three missions, carefully crafted to address each of the identified challenges. By seamlessly integrating these missions into the App, users would gain access to a comprehensive and enriching platform that enhances their overall experience. Through engaging with the App, users would not only develop a deeper understanding of the significance of waste management and circular bioeconomy practices but also have the opportunity to contribute valuable data for analysis within the BCMs.

2.2.2. CS INTERVENTIONS

The CS initiatives focused on the phases 7, 8, and 9 of Figure 1. These phases included crucial tasks such as disseminating the HOOP Trainers App link to facilitate data collection by citizens, organizing co-creation workshops for citizens to analyze the App results and formulate recommendations, and reporting the achieved outcomes

As mentioned in the Introduction, after conducting the co-design sessions and considering the level of advancement and specific needs of each LH, the following locations were chosen as intervention sites to implement CS interventions: Murcia, Laziale Region, Western Macedonia region and Münster. Greater Porto area and Kuopio were identified as potential LHs in which the App could be replicated in future steps. Almere and Bergen were not selected as, according to their needs and timeline, it was more strategic to focus their activities and resources on T6.2 and T6.4.

2.3. HOOP Trainers, the HOOP CS App

HOOP Trainers is the gamified tool of the HOOP CS interventions. Gamification allows reflection on real problems in fictitious scenarios and makes it possible to create tangible solutions. The analysis of the reported data has provided relevant information to improve the current recycling system in the HOOP LHs involved in the CS interventions: Murcia, Western Macedonia, Lazio Region and Münster. These data are reported in section *3. Outcomes of the CS interventions through the HOOP CS App.* Additionally, participants have been able to discuss the results obtained in the HOOP BCMs.

2.3.1. MAIN GOALS

The App focuses on the three major challenges emerged as common themes during the co-creation sessions with the LHs:

- Addressing **disinformation** regarding waste separation
- Identification of **priority actions for optimizing the separate collection of OFMSW and - in some LHs - also the non-organic waste**. The required actions varied across the LHs, but they could be categorized into four main groups: **motivations**, **barriers**, **communication channels** to provide information to citizens, and agreement on **potential actions by municipalities and waste management companies** to enhance the waste system.
- Analysis of the **social acceptance of bioproducts**.

Each LH presented unique barriers and data requirements for addressing the identified challenges. **As a result,**

we made the decision to develop a unified structure and App flow consisting of three missions, each specifically designed to address one of these major challenges. The content within each part was adapted to cater to the specific needs of each LH.

SfC, in collaboration with the LHs, made the decision to involve citizens not only in data collection but also in data analysis. This has been achieved within the project through co-creation activities conducted in the BCM, where the outcomes of the App have been transformed into improvement proposals aimed at addressing the three main challenges of the App. This approach ensured that citizens had an active role in shaping the research and its outcomes, fostering a sense of ownership and empowerment in finding solutions to the identified challenges.

During the HOOP Trainers game, users tackle circular bioeconomy challenges by helping an avatar called Dubiop to convert biowaste into useful bioproducts. With a simple click, users can seamlessly access the link (eliminating the need for downloading). Additionally, the game is crafted to offer an intuitive and self-explanatory experience.

2.3.2. CHARACTERS

Each LH has its own game adaptation but shares a common goal: **train the avatar Dubiop to turn organic waste into useful bioproducts by completing three missions**. When Dubiop learns how to give a new life to waste, it transforms into **Cirklop**, a creature that is able to build a **more sustainable city** (*Figure 3*).

Dubiop symbolises a city that constantly extracts raw materials, manufactures new products for consumption and discards them after use. It generates high rates of pollution by dealing with so much waste and depletes natural resources due to its continuous extraction.

On the other hand, its transformation, **Cirklop**, is a metaphor for a green and circular city that reduces, recycles, reuses, repairs and recovers the waste it generates. In this way, it gives new lives to the waste it produces so that it can be reused in many different ways.

Figure 3. Dubiop to Cirklop evolution

The avatars are given a distinct name among countries, tailored to resonate with the local language, thereby enhancing its engagement factor. Thus, Dubiop is called Lineop in Murcia, Circlo in Western Macedonia, Dubbiopp in Regione Lazio, Müllmuffel in Münster, Haihuli in Kuopio and Porto in Bitaites. Alternatively, Cirklop

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is called Circloop in Western Macedonia, Virtuopp in Regione Lazio, Recyclius in Münster, Parantainen in Kuopio and Finório in Porto. In Murcia has mantained the name of Cirklop.

2.3.3. MISSIONS

During less than 10 minutes, users tackle 3 missions (Table 4):

Table 4. HOOP Trainers missions

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Mission 1: Properly sort 10 waste items into their respective bins

Description:

Dubiop requires assistance in waste separation and needs guidance to deposit waste in the correct bins. Users are encouraged to train Dubiop, enabling it to learn to properly sort waste. The waste items vary across LHs involved.

Data gathering goal:

Gain insights on citizens' knowledge on organic and non-organic waste sorting.

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Mission 2: Examine the concerns and perspectives of different stakeholders regarding waste sorting

Description:

With the invaluable assistance of users, Dubiop has acquired more knowledge to proficiently separate waste. Nevertheless, for Dubiop to sustain its transformative efforts, it relies on a larger community of individuals who diligently sort their waste. Since Dubiop lacks the ability to communicate directly with humans, users take it upon themselves to engage with their neighbors and share their experiences, thereby aiding Dubiop in comprehending what measures would facilitate recycling in their city. The typology of questions varies among LHs involved.

Data gathering goal:

Collect the opinions and perceptions of citizens regarding the waste collection system.

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	Mission 3: Generate a bioproduct with the biowaste properly sorted
	Description: Having actively listened to the dialogues between users and their neighbors, Dubiop has gained valuable insights on how to enhance waste separation practices. Equipped with this newfound understanding, Dubiop is now prepared to breathe new life into the city's waste. In this final mission, users play a pivotal role in assisting Dubiop as it selects and generates its ultimate bioproduct. The typology of bioproducts are the same among LHs (fertilisers, nutrients, bioplastics and green chemicals products) *Data gathering goal:* *Collect data on the societal acceptance of bioproducts*

2.3.3.1. HOOP Trainers missions per LH

In Mission 1 users are tasked to effectively sort 10 types of rubbish. Table 5 shows the waste types of rubbish that users must correctly sort in each LH.

Table 5. HOOP Trainers types of rubbish to be sorted correctly per LH in Mission 1

Murcia	
Western Macedonia region	
Lazio Region	

Münster	
Greater Porto area *The App was adapted as a replication of the CS intervention tools, with data collection continuing until December 2023*	
Kuopio *The App was adapted as a replication of the CS intervention tools, with data collection continuing until December 2023*	

In Mission 2 users must actively initiate conversations with their neighbours, exchanging experiences and insights to identify the most effective measures to promote recycling in the LH. 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 related to waste separation**. Additionally, users are asked about their **suggestions for prioritising actions that they believe the municipality or the waste treatment manager should undertake**. Lazio region also focused part of their questions in **identifying potential strategies for HoReCa sector professionals to effectively separate the cooked and uncooked organic waste fractions**

In Mission 3 users of the whole LHs are enthusiastically invited to choose and create one of the following types of bioproducts from the abundant resources at hand: Fertilizers, nutrients, bioplastics, green chemicals products.
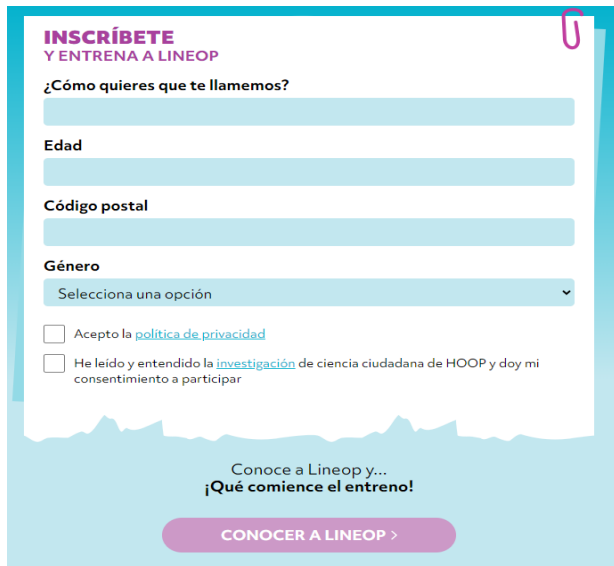
2.3.4. PERSONAL DATA PROTECTION

The data requested from HOOP Trainers users included their NickName, age, gender, postal code, knowledge of waste separation, and personal opinions on waste separation (*Figure 4*). This information was collected to gather demographic data and align it with citizens' perceptions and needs. All HOOP Trainers results complied with the General Data Protection Regulation (GDPR), more details can be found in the Version 2 of *D1.2 Data Management Plan* soon available in HOOP website.

Personal information gathered for this study was kept confidential in line with the Regulation (EU) 2016/679 of the European Parliament and of the council of 27th April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). The results of citizens participation are kept anonymous for the final

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outcome. Public results contain information in the form of percentages, statistics and general information, no individual or personal information will be included.

Figure 4. Personal data asked before starting HOOP Trainers and access to information to participants and inform consent

The minimum age for participation was determined in accordance with the data privacy laws of each participant country. For instance, in Finland, the Laki sähköisen viestinnän palveluista mandates a minimum age of 15 for consenting to any data processing. In Italy, Il Codice in materia di protezione dei dati personali sets the minimum age at 14. In Greece, Γενικός Κανονισμός για την Προστασία Δεδομένων Προσωπικού Χαρακτήρα specifies a minimum age of 15. In Spain, the Ley Orgánica Española de Protección de Datos Personales y garantía de los derechos digitales establishes a minimum of 14. In Portugal the Lei n.º120/XIII/3.a/Gov Assegura a Execução, na Ordem Jurídica Nacional, do Regulamento (Ue) 2016/679, Relativo À Proteção Das Pessoas Singulares No Que Diz Respeito ao Tratamento de Dados Pessoais e à Livre Circulação Desses Dados sets the minimum age at 13 and the German data protection law requires users to be at least 16 years old. Digital mechanisms were implemented to prevent users below these specified ages from starting the game.

Additionally, in some cities and in order to foster participation, users aged 18 and older had the opportunity to enter a contest to win circular daily objects upon completing all the game missions. In such cases, participants were also asked to provide an email address and telephone number.

3. Outcomes of the HOOP CS interventions

As explained in the Section 2.2. Methodology, after conducting co-design sessions with each LH, where we assessed how circular bioeconomy opportunities align with CS integrating information from T6.1.2, and consulting the *D2.3 Report on the baseline studies for the Lighthouse Cities and Regions,* we identified the LH group that will be involved in the CS interventions. This selected group includes Murcia, Western Macedonia, Münster, and Lazio Region. Furthermore, after the initial interventions and in order to ensure that the effectiveness of the App is replicated, adjustments have been implemented to cater to the unique requirements of Porto and Kuopio. Both cities are not part of the CS interventions LHs cohort, but are now evaluating how to sue the App and will collect data until December 2023. Almere and Bergen are not involved in the CS activities as we recognized that a more strategic approach would involve concentrating their efforts and resources on Task 6.2 and Task 6.4.

Remarkably, citizen involvement in the interventions of each city has exceeded the KPIs outlined in the Grant Agreement. According to the agreement, each LH is expected to actively engage 20-30 citizens in CS initiatives. *Table 6* illustrates the final participant count for each LH.
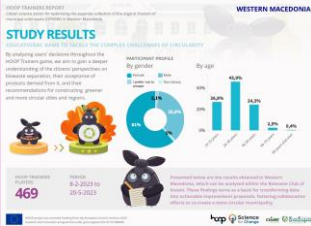
Table 6. Total of participants involved in the CS intervention per LH

HOOP LH	Participants in the CS interventions
Regione Lazio	**364 participants** (including 296 HOOP Trainers users and 68 citizens that participated in the co-creation BCMs)
Murcia	**314 participants** (including 263 HOOP Trainers users and 51 citizens that participated in the co-creation BCMs)
Western Macedonia	**501 participants** (including 469 HOOP Trainers users and 32 citizens that participated in the co-creation BCMs)
Münster	**281 participants** (including 268 HOOP Trainers users and 13 students involved in the educational BCMs)
Total	**1296 HOOP Trainers users and 164 participants in offline activities. In total, 1460 participants.**

The following section outlines the primary outcomes achieved in each CS intervention for every LH. *Table 7* provides a schematic representation of the content identified for each LH.
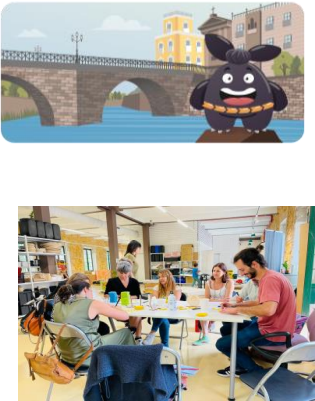
Table 7. Graphical depiction of the outcomes concerning the CS interventions within each LH

Dissemination actions undertaken to promote the HOOP Trainers game	Outcomes obtained through the HOOP Trainers game	Discussion of the results in the BCMs*
For example…	**Summary** of the main results A detailed report of the entire results can be found in the **Annex** mentioned in the section:	**Summary and conclusions** of the main highlights A detailed report of the main results obtained during the co-creation sessions can be found in the **Annex** mentioned in the section: *In Münster, the presentation of HOOP Trainers through the BCM took the form of an educational activity. Its aim was to stimulate environmental contemplation, specifically focusing on waste separation. This event was not structured as a co-creation session for discussing the results.*

3.1. Murcia

This section describes the CS intervention carried out in Murcia. **Table 8** summarizes the intervention numbers.

Table 8. CS interventions in Murcia in numbers

1 App in Spanish adapted to the Murcian context

1 replicable co-creation methodology designed to collaboratively optimize the separate collection of the organic and non-organic waste fraction.

314 co-investigators (including 263 HOOP Trainers users and 51 citizens that participated in 2 co-creation events)

2 co-creation events to transform the outcomes of HOOP Trainers into recommendations to improve the current separation system.

1 report visualizing the HOOP Trainers outcomes and **1 report highlighting the main improvement proposals** emerged during the BCM. Both included as Annexes.

3.1.1. HOOP TRAINERS APP DISSEMINATION

The HOOP Trainers App was effectively disseminated with the Municipality of Murcia, a HOOP partner in the region, utilizing social media channels and local press. Moreover, informative materials were generated,

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including MUPIS strategically displayed in public areas (as depicted in *Figure 5*). The game's link received additional promotion through roll-ups exhibited at the Cañada Hermosa waste treatment plant and the Circular Education Lab of Murcia (*Figure 6*).

Concurrently, the App's dissemination extended to educational workshops organized by CETENMA, HOOP BCMs, and local circular economy events, thereby enhancing its outreach and impact.

Figure 5. MUPI disseminating the QR of HOOP Trainers

Figure 6. Roll up promoting HOOP Trainers in the Circular Education Lab of Murcia

3.1.2. HOOP TRAINERS OUTCOMES OBTAINED

Below are summarized the main outcomes obtained in each Mission. The details of the whole results are shown in the Annex 1 "HOOP Trainers App game implemented in Murcia: Study results". Which are also analyzed by age and gender.

3.1.2.1. Presentation of results

In Murcia, 263 HOOP Trainers users played the whole missions of the game. Women comprised the majority of users, constituting approximately 57% of the participants, while men accounted for nearly 36%. The number of non-binary participants was too low to draw any statistically significant conclusions. In terms of age distribution, nearly 47% of participants were between 40-59 years old, followed by just about 30% in the 20-39 age group, and almost a 16% in the 40-59 age group. There were also a few users over 60 years old.

During **Mission 1** (*Figure 7*), the waste items that caused the most uncertainty among participants were **cork** (with approximately 74% of users making mistakes), **diapers** (nearly 39% of users made errors), and **eggshells**
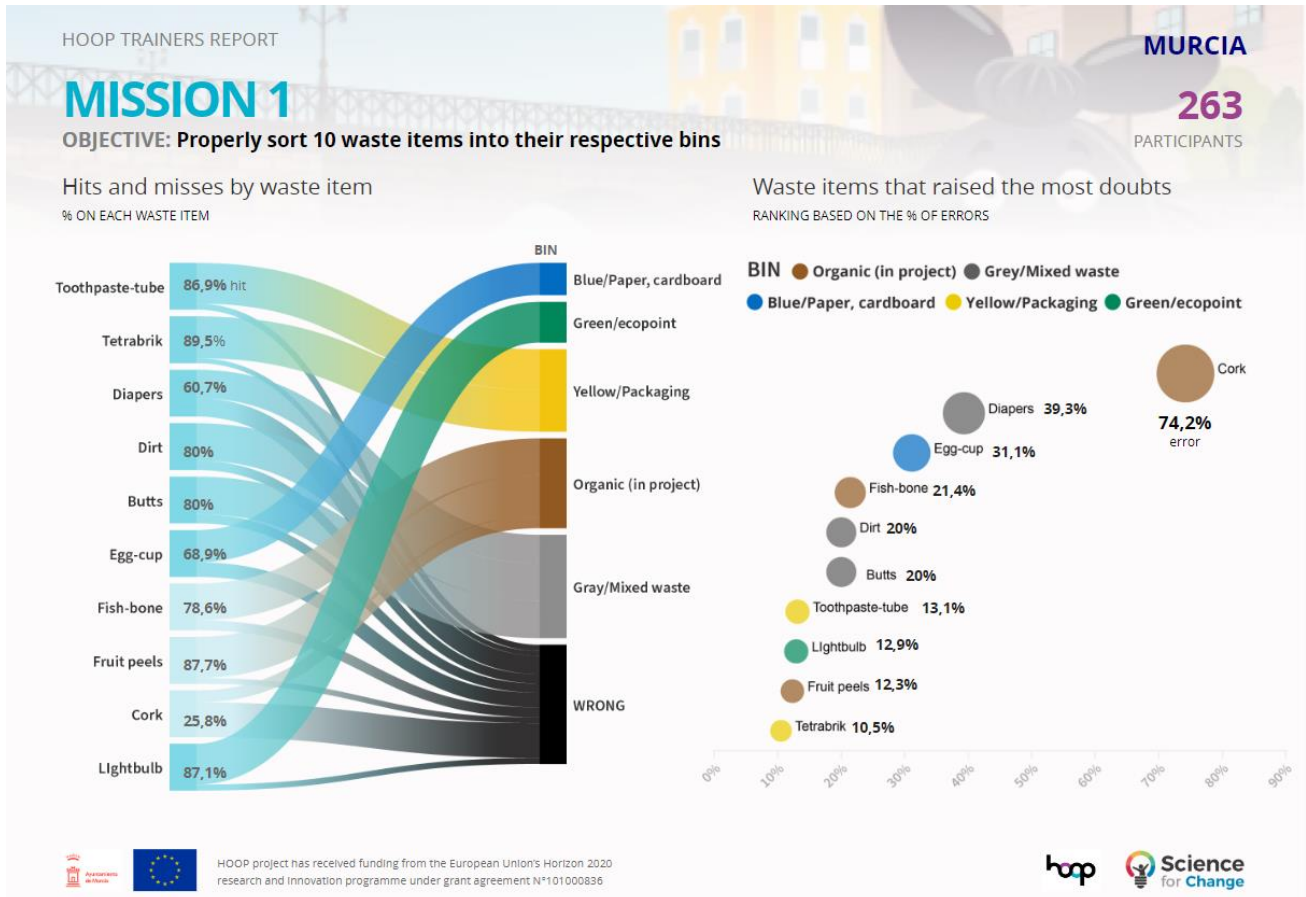
(almost 31% of users made errors). In contrast, tetra-bricks (only 10,5 % of users made mistakes) and fruit peels (12,3% of users made mistakes) generated fewer doubts among users.

Figure 7. Outcomes of HOOP Trainers Mission 1 (Murcia). More details at Annex 1 "HOOP Trainers App game implemented in Murcia: Study results"


In **Mission 2** (*Figure 8*), users expressed primary **motivations** for separate waste collection, including **reducing the environmental impact of waste** (nearly 64%), **transforming waste into bioproducts** (around 20%), and **maintaining city aesthetics** (approximately 9%). Paying fewer taxes was a less significant motivation. No relevant differences were found in the motivations highlighted by females and males. In terms of median age distribution, it was notable that paying fewer taxes was a significant preference among individuals aged 44, in contrast to the greater relevance of maintaining the beauty of our city for younger users with a median age of 30 years. **Key obstacles** reported were **limited space at home** (nearly 32%), **lack of information** (around 17%), and **distrust** (nearly 16%). Lack of time was not a significant obstacle (around 9%), while the option "Others" accounted for 25% of responses, reflecting additional obstacles identified during the Biowaste Club meetings held in Murcia to discuss the HOOP Trainers results. The key obstacles varied slightly between females and males, particularly concerning the lack of information and space at home. Notably, the lack of information appears to be a more significant challenge for males, with 21% citing it as their primary obstacle, while approximately 15% of females reported the same. On the other hand, the limited space at home seems to be a more prevalent concern for females, as nearly 36% of them mentioned it as a main issue compared to around 30% of males. The most significant disparities in median age distribution among these barriers are apparent, with the issue of "lack of time" peaking at 25 years, and "distrust" showing its peak at 42

years. **Social networks** seem to be the most utilized channel for obtaining information on sorting organic waste (close to 35%), followed by the **municipality's website** (approximately 23%), and the press (around 19%). Social networks appear to be more frequently used by females than males, with approximately 41% of females selecting it as their primary option, while nearly 27% of males did the same. In contrast, the press, though chosen by a small number of users overall, has been exclusively preferred by males as their first option. It is noteworthy that almost 22% of citizens from Murcia expressed **uncertainty about where to find information** (an option chosen by nearly 28% of males, in comparison to approximately 19% of females.). Regarding the age demographics of users of these communication channels, it's worth noting that telephone contact is primarily favored by older participants.

Figure 8. Outcomes of HOOP Trainers Mission 2 (Murcia). More details at Annex 1 "HOOP Trainers App game implemented in Murcia: Study results"
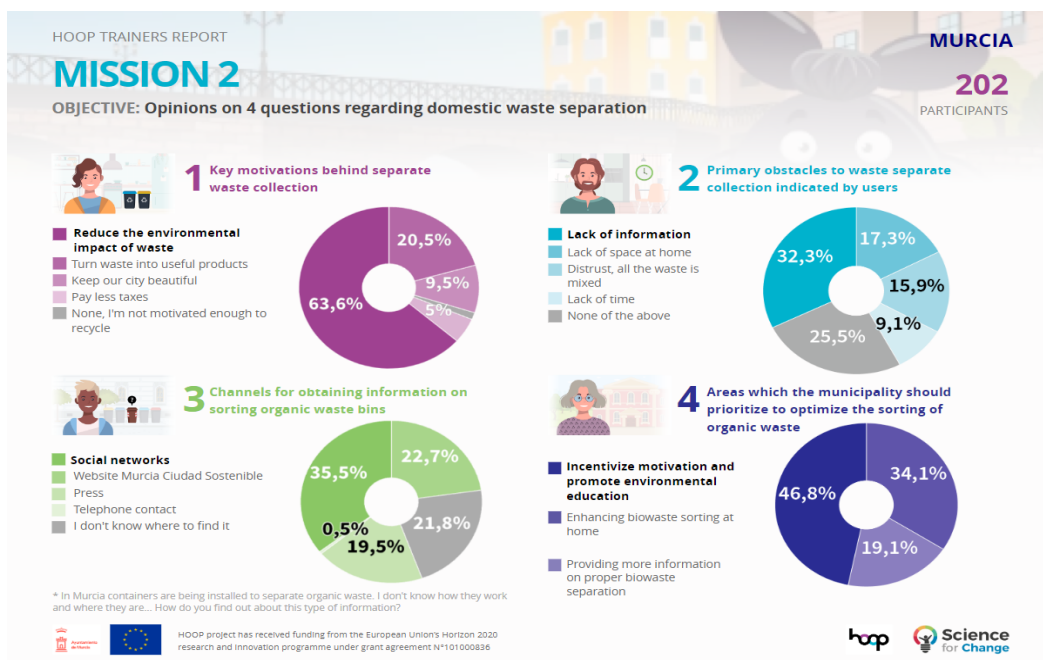

When users were asked about the areas that the municipality should prioritize to optimize the sorting of organic waste, the responses were more fairly distributed. The top priorities identified were **finding incentives and promoting environmental education** (almost the 47%) - the type of incentive and environmental education campaigns were identified in the Biowaste Club meetings -, facilitating waste sorting at home (around 34%), and providing more information on proper biowaste separation (around the 19% of the results). Facilitating waste sorting at home was prioritized as a main action by nearly 38% of females, whereas approximately 30% of males chose the same option. None relevant differences in terms of age distribution of answers were identified.

In **Mission 3** (*Figure 9*), 33% of users chose to create **bioplastics**, followed by 31% opting for fertilisers, and the remaining users split between creating nutrients (20%) and green chemical products (16%). Some differences can be detected between the bioproducts preferred by females and males. Fertilizers were chosen as the primary option by 45,5% of males, in comparison to almost 22% of females. Conversely, green chemical products were selected as the main option by approximately 20% of females, while only about 8% of males opted for it. Nutrients were also more preferred by females (almost 24%) than by males (around 13%). In terms of the median age distribution of the responses, no significant differences can be observed between fertilizers

and bioplastics (both with a median age of nearly 38), but notable distinctions emerge between nutrients (median age of 30 years) and green chemical products (median age of 44).

Figure 9. Outcomes of HOOP Trainers Mission 3 (Murcia). More details at Annex 1 "HOOP Trainers App game implemented in Murcia: Study results"
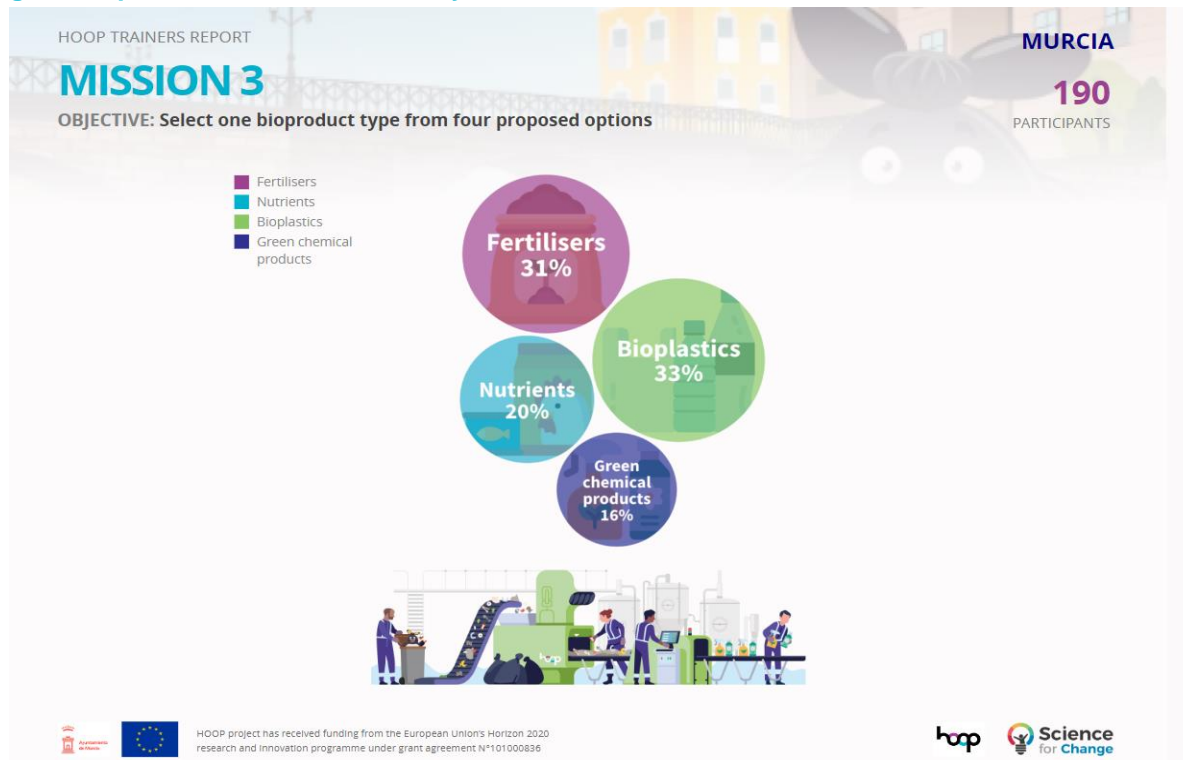
On the 25th of April and the 17th of May of 2023, the outcomes derived from the data analysis of the **HOOP Trainers Mission 2** were examined during two Murcian BCMs. **The first Biowaste Club was tailored for highschool students, while the other catered to members of the association** Madres por el Clima (Mothers for Climate). **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 BCMs, 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.**

Through the analysis of the HOOP Trainers results, a group of 39 students aged 14-15 from the high school Monte Miravete engaged in insightful discussions during a workshop held at the waste treatment plant Cañada Hermosa (*Figure 10*). The workshop covered various challenges, such as devising impactful social media campaigns with influencers to reach a wider audience and creating strategies to enhance waste sorting

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procedures. Among these strategies were installing additional bins near residential areas and introducing automatic sorting systems.

In addition to the students, 12 members of the association Madres por el Clima (*Figure 11*) also participated in transforming the HOOP Trainers outcomes into recommendations in a second Biowaste Club event held in the Circular Education Lab of Murcia. Their discussions focused on a diverse array of challenges, including systemic issues affecting circularity, rethinking packaging systems, and improving access to more affordable bins that facilitate waste separation in small spaces. Madres por el Clima members were particulary engaged during the Murcian CS intervention. They acted as "local champions" and facilitated the uptake of the HOOP activities by further citizens and helped spread the key HOOP learnings and success stories across Lighthouses and beyond. Detailed information regarding local champions can be found at *D6.5. Report on the education and awareness raising & acceptance activities*, submitted in September 2023.

Figure 10. BCM addressed to high school students to discuss the HOOP Trainers outcomes


Figure 11. BCM addressed to the members of the association Madres por el Clima to discuss the HOOP Trainers outcomes

The following synthesis presents the final recommendations co-produced by the participants (Table 9, Table 10 and Table 11). 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. The summarized recommendations put forth by the Biowaste Club participants are distributed as follows (*Figure 12*).

Figure 12. Scheme of the distribution of the summarized recommendations put forth by the BCMs participants
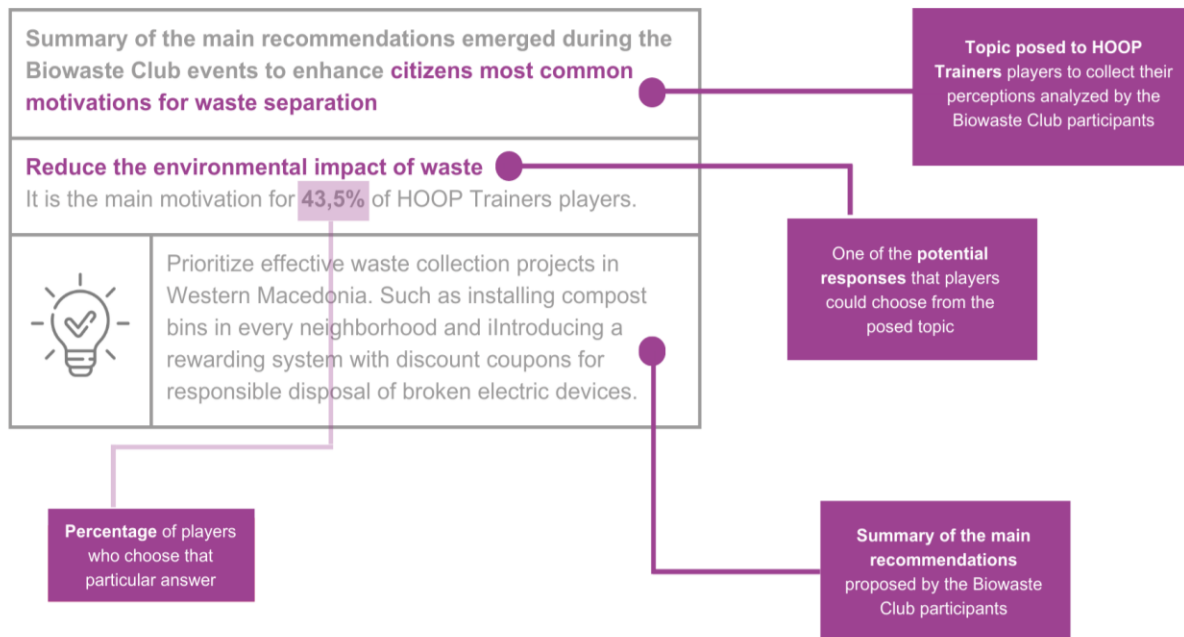
The whole results can be found in the "Annex 2: Advancing the circular bioeconomy in Murcia: Co-creating improvement proposals in the Biowaste Club of the region through the analysis of HOOP Trainers' outcomes".

3.1.3.2. Motivations and Recommendations

This section summarizes in *Table 9* the main recommendations emerged during the BCMs held in the LH of Murcia to enhance citizens most commons motivations for waste separation.

Table 9. Summary of the main recommendations emerged during the BCMs to enhance citizens most common motivations for waste separation

Reduce the environmental impact of waste
*It is the main motivation for **63,63%** of HOOP Trainers players.*
Support **research centers**, **engage businesses** in eco-conscious practices, **educate citizens** on sustainability, **combat food waste**, and encourage a **cultural shift to sustainable alternatives**.
Transform waste into useful products
*It is the main motivation for **20,45%** of HOOP Trainers players.*

	Enhance waste separation with **labeled bins**, **repurpose materials creatively**, implement sustainable practices in **HoReCa**, promote **intergenerational knowledge exchange**, and **encourage "ugly" produce consumption** to reduce food waste.

Keep our city beautiful

*It is the main motivation for **9,54%** of HOOP Trainers players.*

	Educate on waste sorting, **incentivize** recycling, **enforce cleanliness regulations**, promote **waste reduction**, appreciate waste collection efforts and foster a change in mentality for **responsible public space care**.

Pay less waste taxes

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

	Recommendations related to **financial penalties** and **positive reinforcement** for waste separation emerged during the sessions. One group specially mentioned the need **for more information on waste management costs** and **imposing taxes on environmentally impactful organizations**.

None, I am not motivated enough to recycle.

*It represents the response of only **1,36%** of the HOOP Trainers players*

	Logistical difficulties, **systemic issues** favouring single-use products, and general **environmental apathy** are factors contributing to low motivation to recycle.

3.1.3.3. Barriers and Recommendations

This section summarizes in *Table 10* the main recommendations emerged during the BCMs held in the LH of Murcia to enhance citizens most commons barriers for waste separation.

Table 10. Summary of the main recommendations emerged during the BCMs to tackle citizens most common barriers for waste separation

Lack of space at home
*It is the main barrier for **32,27%** of HOOP Trainers players.*
Promote **triple vertical bins for space and cost efficiency**, create **recycling points in the city center**, and **establish urban gardens with composting facilities**.
Others
*It is the main barrier for **25,45%** of HOOP Trainers players.*
Prevent negative recycling influence, enforce stricter **European regulations**, adopt **sustainable institutional practices**, **ban single-use items at events,** use **computer systems for single bags at supermarkets**, and consider laws against single-use bags and trays.
Lack of information
*It is the main barrier for **17,27%** of HOOP Trainers players.*
Improve **waste bin labeling** and product packaging instructions. Raise recycling awareness among children and all generations. Enhance **transparency** in waste management communication. **Educate teachers** on sustainability and combat fake news with accurate recycling information. **Implement impact equivalences** and **environmental impact indicators** in stores.
Distrust, all the waste is mixed
*It is the main barrier for **15,90%** of HOOP Trainers players.*
Enhance **recycling education in schools** and **showcase waste treatment centers' operations** to build trust. Organize citizen visits to the treatment center and **distribute free books made from recycled materials** to demonstrate positive recycling outcomes.

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Lack of time
*It is the main barrier for **9,09%** of HOOP Trainers players.*
Install **bins near residential areas** and introduce **automatic sorting systems** for centralized waste disposal. Encourage waste separation in agendas, explore incentives for recycling, and address barriers like laziness or logistical challenges.

3.1.3.4. Communication channels and Recommendations

This section summarizes in ***Table 11*** the main recommendations to communicate the importance of waste separation emerged during the BCMs held in the LH of Murcia.

Table 11. Summary of the main recommendations to communicate the importance of waste separation emerged during the BCMs

Social Media
*It is the main channel for **35,45%** of HOOP Trainers players.*
Utilize **influencers** for recycling campaigns on platforms like Instagram and TikTok. Create a **recycling-focused YouTube channel** and conduct online surveys. Use **catchy songs** and **interactive games** to engage children and adults. Incentivize recycling with **monetary rewards** and promote participation through **compelling videos**.
Web Murcia Ciudad Sostenible
*It is the main channel for **22,72%** of HOOP Trainers players.*
Improve general websites to educate on recycling's importance and proper methods. Consider developing a **mobile app for calculating carbon footprints** from purchases.
Lack of knowledge of where information can be found
*It is the main channel for **21,81%** of HOOP Trainers players.*
Conduct awareness talks in schools and **empower teachers** to discuss recycling. Establish a **school radio program on recycling.** Address information overload, provide accurate information, and **target teenagers with relatable narratives**.

Press	
*It is the main channel for **19,54%** of HOOP Trainers players.*	
	Create **educational TV spots** with **engaging cartoons** to teach proper recycling techniques to children and consider a **dedicated recycling-focused newspaper** for the general public.

Telephone contact	
*It is the main channel for **0,45%** of HOOP Trainers players.*	
	Provide a helpline for **individuals who lack internet access**.

3.1.3.5. Main conclusions

The two co-creation sessions held in Murcia yielded an array of valuable recommendations and creative strategies inspired by the HOOP Trainers outcomes. These proposals are addressed to multiple stakeholders (research centres, industry, policy makers and citizens).

Waste separation was a central theme, and the participants emphasized the importance of labeled bins and creative repurposing of materials. To improve recycling efforts, participants suggested providing citizens with triple vertical bins, introducing more recycling points in the city center and creating urban gardens with composting facilities. Recommendations related to financial penalties and positive reinforcement for waste separation were also discussed, highlighting the need for information on waste management costs and imposing taxes on environmentally impactful organizations. Several systemic challenges contributing to low motivation to recycle were identified, including logistical difficulties, favoring single-use products, and general environmental apathy.

Education and awareness-raising were recurring themes, with suggestions to improve waste bin labeling, provide product packaging instructions, and raise recycling awareness among children and all generations. Enhancing transparency in waste management communication and combating fake news with accurate recycling information were also proposed. Engaging influencers, creating recycling-focused content on social media platforms, and incentivizing recycling with monetary rewards were ideas to promote recycling participation. Addressing teenagers with relatable narratives and utilizing various media, such as TV spots, cartoons, and a dedicated recycling-focused newspaper, were also recommended for effective educational outreach.

In conclusion, the co-creation sessions in Murcia provided valuable insights and actionable strategies to address waste management and recycling challenges. By involving multiple stakeholders and implementing the proposed recommendations, Murcia can move closer to circularity.

3.2. Western Macedonia Region

Below is described the citizen science interventions carried out in Western Macedonia. *Table 12* summarizes the CS intervention in numbers.

Table 12. CS intervention in Western Macedonia Region in numbers

1 App in Greek adapted to the Western Macedonian context

1 replicable co-creation methodology designed to collaboratively optimize the separate collection of the organic and non-organic waste fraction.

501 co-investigators (including 469 HOOP Trainers users and 32 secondary students that participated in the co-creation events)

2 co-creation events to transform the outcomes of HOOP Trainers into recommendations to improve the actual separation system.

1 report visualizing the HOOP Trainers outcomes and 1 report highlighting the main improvement proposals emerged during the BCM. Both included as Annexes.

3.2.1. HOOP TRAINERS APP DISSEMINATION

The HOOP Trainers App was disseminated by CLuBE and DIADYMA SA (HOOP partners in the region) via social media and local press. Additionally, they created disseminating materials (such as bookmarks). The link of the game was also promoted during the Biowaste Clubs events carried out by CLuBE and DIADYMA SA and during the educational workshops developed in the region by DIADYMA SA. *Figure 13* reflects the dissemination action carried out in the region to spread the voice of the link.

Figure 13. Dissemination material created to promote the use of the App
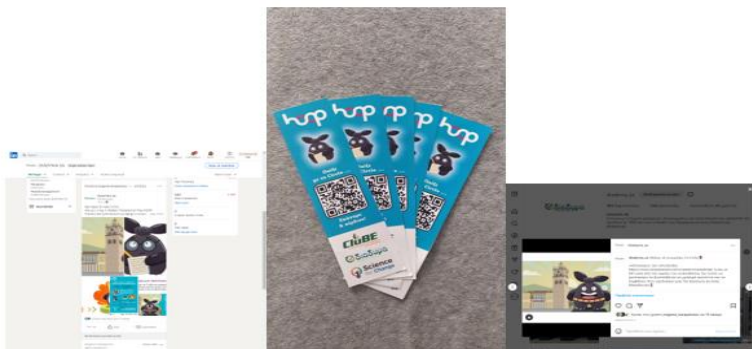
3.2.2. HOOP TRAINERS OUTCOMES OBTAINED

Below are summarized the main outcomes obtained in each Mission. The details of the whole results are shown in the Annex 3 "HOOP Trainers App game implemented in Western Macedonia: Study results". Which are also analyzed by age and gender.

3.2.2.1. Presentation of results

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.

Figure 14. Outcomes of HOOP Trainers Mission 1 (Western Macedonia). More details at Annex 3 "HOOP Trainers App game implemented in Western Macedonia: Study results"
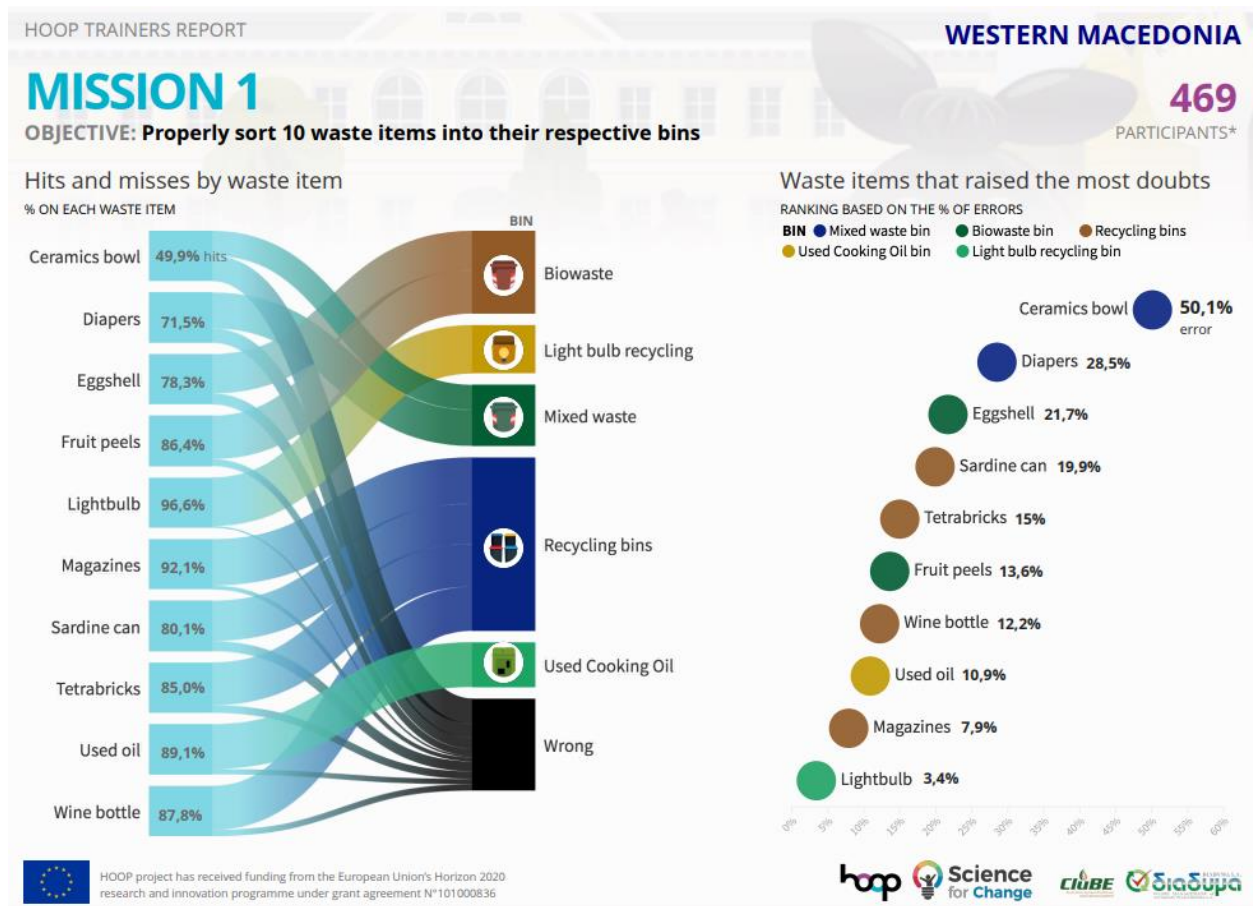
During **Mission 1** (**Figure 14**), the waste items that caused the most uncertainty among participants were the **ceramic bowl** (with approximately 50% of users making mistakes), **diapers** (28.5% of users made errors),

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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).

Figure 15. Outcomes of HOOP Trainers Mission 2 (Western Macedonia). More details at <u>Annex 3 "HOOP Trainers App game implemented in Western Macedonia: Study results</u>"
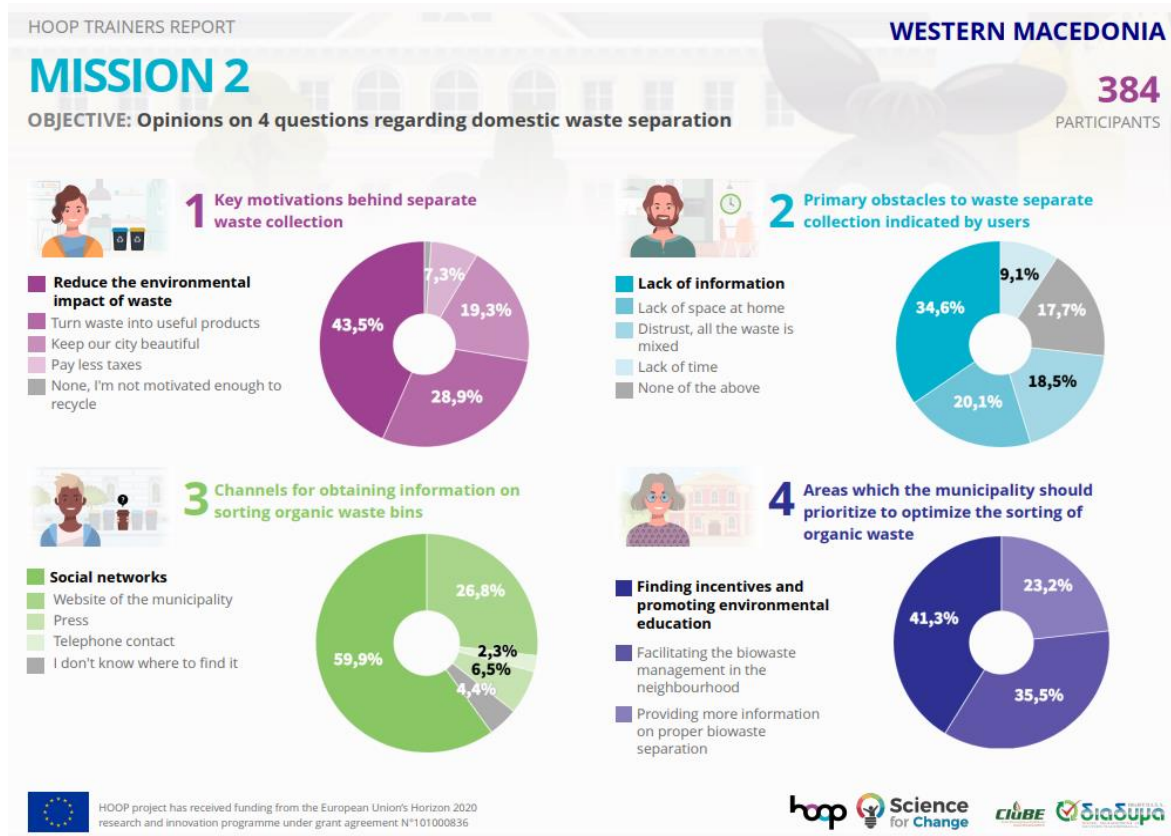
In **Mission 2** (**¡Error! No se encuentra el origen de la referencia.**), users expressed primary **motivations** for separate waste collection, including **reducing the environmental impact of waste** (43.5%), **transforming waste into bioproducts** (almost 29%), and **maintaining city aesthetics** (approximately 19%). Paying fewer taxes was a less significant motivation. None relevant differences were found in the motivations highlighted by female and male even in the age distribution of the answers. **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 BCMs. 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. None relevant differences were found in terms of age distribution when selecting key obstacles. **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. Regarding the age demographics of users of these communication channels, it's worth noting that telephone contact is primarily favored by older participants.

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 types 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). No significant differences between male and female were identified neither in age distribution.

In **Mission 3** (*Figure 16*), 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 and no significant differences can be found in terms of age distribution when choosing a bioproduct.

Figure 16. Outcomes of HOOP Trainers Mission 3 (Western Macedonia). More details at Annex 3 "HOOP Trainers App game implemented in Western Macedonia: Study results"
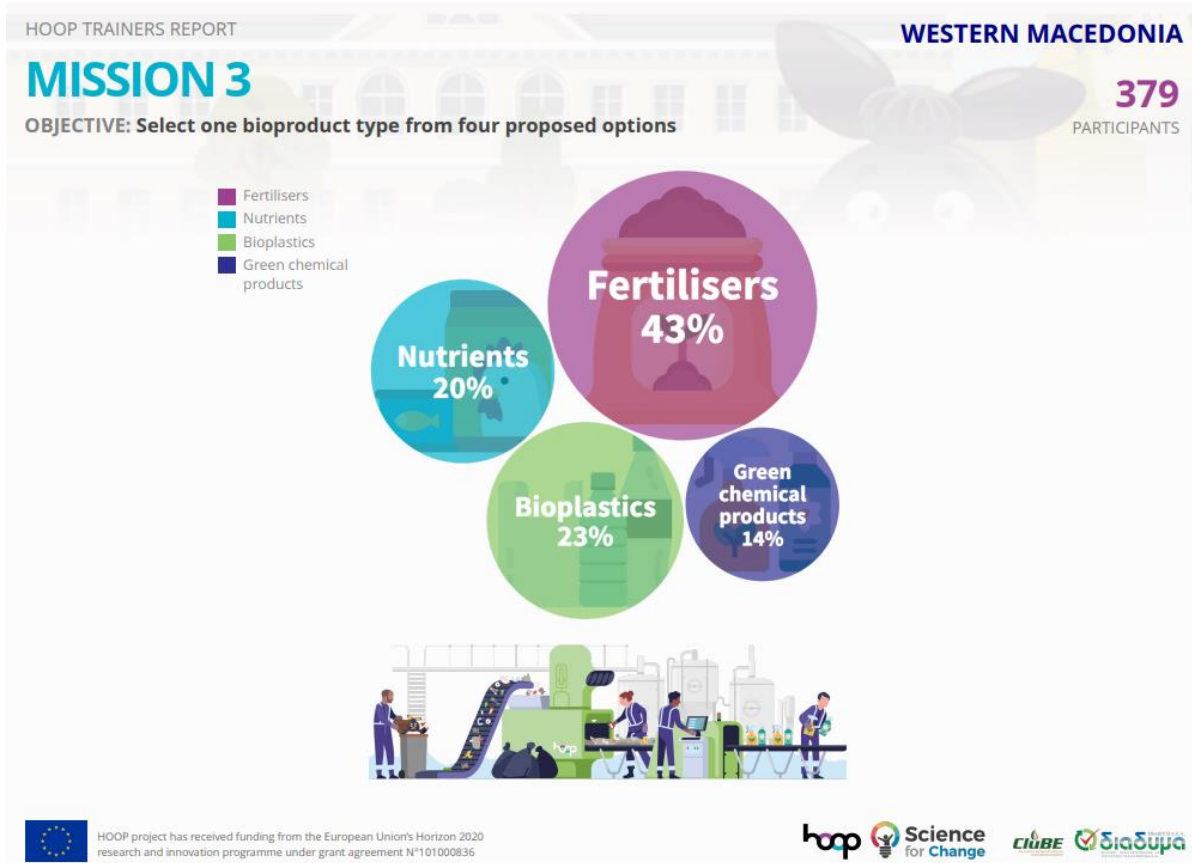
On the 9th June 2023, the outcomes derived from the data analysis of the **HOOP Trainers Mission 2** were examined during two Western Macedonian Biowaste Clubs meetings. **The first Biowaste Club of the day was tailored for highschool students, while the other catered to university students**. **The purpose of these events was to collaboratively transform the obtained HOOP Trainers outcomes into improvement proposals for optimising waste sorting management in the region**.

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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 summary presents the final recommendations co-produced by the participants (Table 13, Table 14 and Table 15). 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. All the detailed recommendations can be found in the "Annex 4: 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".

3.2.2.2. Motivations and Recommendations

This section summarizes in Table 13 the main recommendations emerged during the BCMs held in the Western Macedonia Region to enhance the most commons motivations for waste separation.

Table 13. Summary of the main recommendations emerged during the BCMs to enhance citizens most common motivations for waste separation

Reduce the environmental impact of waste	
*It is the main motivation for **43,5%** of HOOP Trainers players.*	
	Prioritize effective waste collection projects in Western Macedonia. Such as **installing compost bins in every neighborhood** and introducing a **rewarding system with discount coupons for responsible disposal of broken electric devices**.

Transform waste into useful products	
*It is the main motivation for **28,9%** of HOOP Trainers players.*	
	Embrace composting and upcycling for sustainable waste management by **reusing creatively packaging materials**. Consider **renting electrical devices as an eco-friendly** option. Organize **engaging workshops to teach valuable waste transformation skills.**

Keep our city beautiful

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

Improve waste management by installing **more bins in neighborhoods** and encourage proper waste disposal with **additional recycling bins in public spaces and parks**.

Raise environmental awareness among children through targeted actions.

Pay less waste taxes

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

Incentivize a **multiple scale packaging reduction approach**, and introduce a **recycling bonus card** system to reward active participation, potentially leading to **tax reductions for recycling efforts.**

None, I am not motivated enough to recycle.

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

For those unmotivated people, raise awareness by **engaging interventions**, ensure that they have **access to accurate and up-to-date information** and implement **rewarding systems** that incentivize recycling efforts.

3.2.2.3. Barriers and Recommendations

This section summarizes in Table 14 the main recommendations emerged during the BCMs held in the Western Macedonia Region to tackle the most commons barriers for waste separation.

Table 14. Summary of the main recommendations emerged during the BCMs to tackle citizens most common barriers for waste separation

Lack of information

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

Launch **impactful awareness campaigns through diverse media channels** (such as media spots or documentaries) to **engage the public and provide clear recycling guidelines**. Organize recycling events and **programs in schools** to instill eco-consciousness from an early

	age and **training sessions to empower older individuals** on sustainability.

Lack of space at home

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

	Ensure every family has suitable waste bins within their homes for efficient separation and collection. Install **recycling bins in apartment buildings** for convenient access. Develop **garbage bag designs that support separate waste collection. Integrate designated spaces for separate collection bins in new home designs** during the architectural planning process.

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.**

None of the above

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

	Ensure **widespread availability of bins in neighborhoods**. Introduce **rewarding initiatives** to address the lack of motivation for recycling and foster a recycling culture.

Lack of time

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

	Appoint **garbage managers** in apartment buildings to oversee and coordinate waste selection activities. **Install additional recycling bins** in neighborhoods for convenient access and **assign responsible workers to each group of bins to ensure proper waste sorting**.

3.2.2.4. Communication channels and Recommendations

This section summarizes in Table 15 the main recommendations emerged during the BCMs held in the Western Macedonia Region to communicate the importance of waste separation.

Table 15. Summary of the main recommendations to communicate the importance of waste separation emerged during the BCMs

Social Media
*It is the main channel for **59,9%** of HOOP Trainers players.*
To raise awareness about the importance of waste separation, utilize various social media platforms such as **YouTube, Instagram, Pinterest, Discord, Twitter, Spotify, and TikTok** to address different audiences. Engage the community with educational content, hashtags, and **recycling-related challenges**. Additionally, **encourage politicians and influencers to promote recycling through their social media accounts.** Take advantage of the social media campaigns to **gather feedback through questionnaires and surveys to understand attitudes and behaviors towards recycling.** In parallel, create **impactful videos, advertisements, and podcasts** featuring experts to discuss environmental topics and waste sorting.
Website of the municipality
*It is the main channel for **26,8%** of HOOP Trainers players.*
Share **local event posts**, create **user-friendly recycling apps**, produce **engaging videos with famous characters**, organize recycling events, and distribute **newsletters with updates on recycling initiatives** to raise awareness and encourage community participation.
Press
*It is the main channel for **6,5%** of HOOP Trainers players.*
Include recycling articles in magazines and newspapers. **Enhance engagement with crosswords, caricatures, and sketches** in print media to promote **gamified learning and capture readers' attention.**

Lack of knowledge of where information can be found. *It is the main channel for **4,4%** of HOOP Trainers players.*	
💡	Create **inspiring songs that raise awareness** about sustainable behaviors. Distribute informative leaflets and display **impactful posters in public spaces**. **Encourage voluntary actions** for environmental care, and **set up information kiosks at bus stops and supermarkets** to provide accessible educational materials on environmental topics.
Telephone contact *It is the main channel for **2,3%** of HOOP Trainers players.*	
💡	Implement a **rewarding system through SMS notifications** to acknowledge and motivate recycling efforts. Introduce **chat bots for real-time recycling assistance** and use **GPS tracking in recycling bins** to optimize waste collection. Develop **interactive apps** and games to **educate and entertain users about recycling**, fostering environmental responsibility.

3.2.2.5. Main conclusions

The participants of the two co-creation workshops held in Kozani proposed a comprehensive approach to optimize waste management and recycling, acknowledging the importance of addressing circularity challenges.

Waste separation at home emerged as a central theme, with suggestions to install more compost bins and strategic bins in public spaces, alongside implementing a rewarding system to encourage responsible waste disposal. Incentivizing a multiple-scale packaging reduction approach was seen as a key measure to minimize waste generation. Ensuring every family has suitable waste bins for efficient separation, as well as installing recycling bins in apartment buildings, and incorporating designated spaces for separate collection bins in new home designs during architectural planning were emphasized.

Embracing composting, upcycling, and conducting engaging workshops were highlighted as effective means to promote sustainable waste management practices and reduce errors. Improving waste management infrastructure, raising environmental awareness among children, and incentivizing recycling efforts were identified as vital steps towards cultivating a recycling culture. Effective communication through social media, innovative awareness campaigns, and educational initiatives across diverse media channels were recognized as essential to disseminate information and foster active participation.

In conclusion, the participants acknowledged the challenges presented during the sessions, focusing on the need for **innovative communication strategies** to provide accurate information and engage citizens effectively. Moreover, they reflected on the **importance of designing user-friendly waste separation systems at home to facilitate recycling efforts.** According to participants, by implementing these strategies and addressing the most voted HOOP Trainers challenges, Kozani can make significant progress in optimizing waste management and adopting a more circular approach.

3.3. Lazio Region

Below is described the citizen science interventions carried out in the Lazio Region. *Table 16* summarizes the intervention in numbers.

Table 16. CS interventions in the Lazio Region in numbers

1 App in Italian adapted to the Regione Lazio context

1 replicable co-creation methodology designed to collaboratively optimize the separate collection of the organic and non-organic waste fraction.

337 co-investigators (including 296 HOOP Trainers users and 68 secondary students that participated in the co-creation events)

2 co-creation events to transform the outcomes of HOOP Trainers into recommendations to improve the actual separation system.

1 report visualizing the HOOP Trainers outcomes and 1 report highlighting the main improvement proposals emerged during the BCM. Both included as Annexes.

3.3.1. HOOP TRAINERS APP DISSEMINATION

The HOOP Trainers App was disseminated by ANCI Lazio (HOOP partners in the region) via **social media** and **local, regional and national newspapers**. Additional disseminating materials were created (such as **posters** and **bookmarks**). The link of the game was also shared during the **Biowaste Clubs events** carried out by ANCI Lazio and during the **educational workshops** developed in the region by the Italian partner.

3.3.2. HOOP TRAINERS OUTCOMES OBTAINED

Below are summarized the main outcomes obtained in each Mission. The details of the whole results are shown in the Annex 5 "HOOP Trainers App game implemented in the Lazio Region: Study results".

3.3.2.1. Presentation of the results

In the Lazio Region, 296 HOOP Trainers users played the game. **Women comprised the majority of users, constituting almost 61% of the participants**, while men accounted for nearly 24%. The number of non-binary participants and individuals who chose not to provide their gender was insufficient to draw any statistically significant conclusions. In terms of age distribution, **nearly 82% of participants were between 14-19 years old**, followed by just about 7% in the 20-39 age group, and almost a 5% in the 40-59 age group. There were also a few users over 60 years old.

During **Mission 1** (*Figure 17*), the waste items that caused the most uncertainty among participants were **greasy pizza boxes**, **tickets**, **ceramics** and **broken toys** (nearly 37% of users made errors). In contrast, the waste items that generated fewer doubts among users were carton boxes (approximately 4% of users made mistakes) and fish bones (nearly 10% of users made mistakes).

Figure 17. Outcomes of HOOP Trainers Mission 1 (Lazio Region). More details at Annex 5 "HOOP Trainers App game implemented in the Lazio Region: Study results"
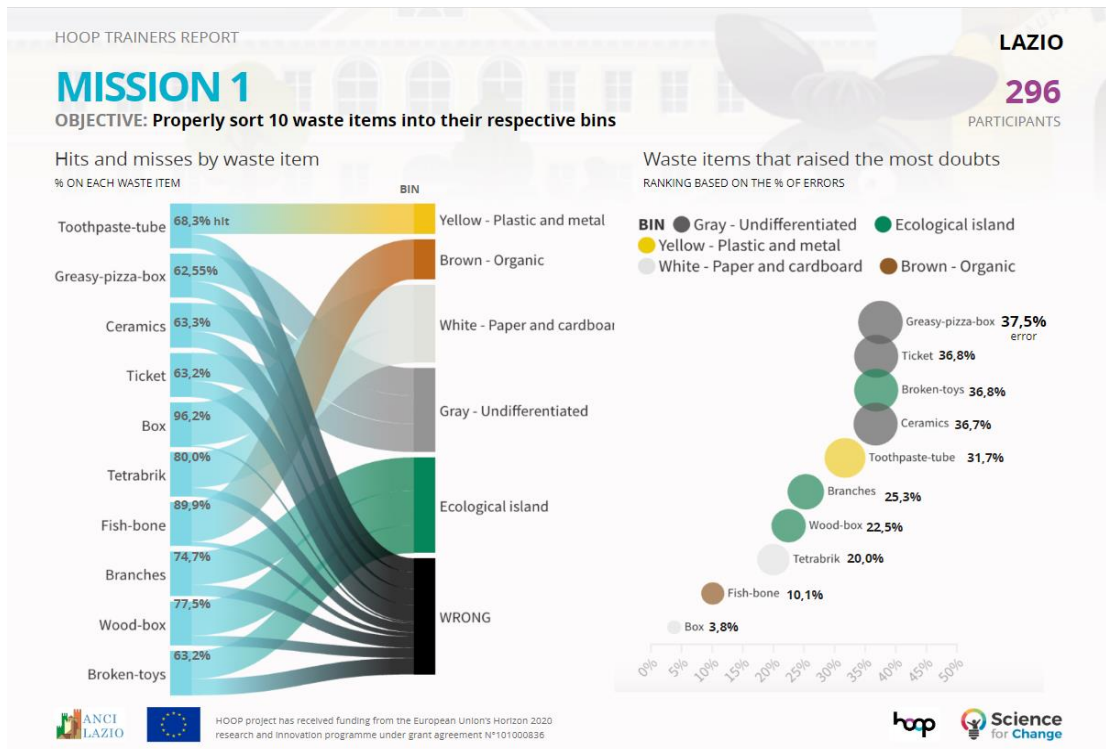
In **Mission 2** (*Figure 18*), users expressed primary **motivations** for separate waste collection, including **reducing the environmental impact of waste** (nearly 46%), **transforming waste into bioproducts** (around 22%), and **maintaining city aesthetics** (approximately 15%). The possibility to pay fewer taxes was the main motivation for almost 14% of participants. The most significant differences between genders were observed in the area of taxes, 20% of males identified it as their primary motivation, whereas only 10% of females did the same. Notably, the median age of users who selected "I'm not interested in recycling" peaked at 59 years, while the median age for the other options was nearly 22 years. **Key obstacles** reported were **limited space at home** (nearly 25%), **distrust** (around 21%), and **lack of time** (nearly 15%). Lack of incentives was a less significant obstacle (around 10%), while the option "Others" accounted for almost 29% of responses, reflecting additional obstacles identified during the BCMs held in Rome. The key obstacles varied slightly between females and males, particularly concerning the lack of incentives and the option "others". Notably, the lack of incentives appears to be a more significant challenge for males, with almost 23% citing it as their primary obstacle, while approximately nearly 5% of females reported the same. Furthermore, there is a notable distinction in the median ages of users who chose the "lack of incentives" option compared to others, with this choice having a median age of 56, in contrast to the other options, which have a median age of approximately 23. On the other hand, the option "others" seems to be a more prevalent concern for females, as nearly 33% of them mentioned it as a main issue compared to around 23% of males. In terms of **identifying potential strategies for HoReCa sector professionals to effectively separate the cooked and uncooked organic waste fractions**, the most

voted option appears to be introducing a **new municipal service with double collection of wet waste**, which garnered close to 33% of the votes. Following that, approximately 25% of users favored recycling organic waste using a **compost bin**, and around 21% suggested choosing suppliers who help professionals reduce waste and dry waste. Interestingly, compost bins seem to be a more appealing option for males than females, with approximately 31% of males selecting it as their primary choice, compared to nearly 24% of females. Conversely, around 25% of females preferred choosing suppliers who help professionals reduce waste and dry waste as their first option, while only 12,5% of males did the same. In the context of age distribution, it's noteworthy that the "lack of incentives" option was chosen by respondents with the highest median age for this question, which was 45 years.

When users were asked about the **areas that an entrepreneur should prioritize to optimize the sorting of organic waste**, the responses were fairly distributed. The top priorities identified were as follows: **Organize school activities to provide information** (around 36,5%); **promote environmental education for the recovery of raw materials across a wide range of age groups** (nearly 35%) and design information campaigns to improve staff collection in catering (approximately 28,5% of the responses). Notably, promoting environmental education for the recovery of raw materials was selected as the main action by nearly 37,5% of males, whereas approximately 27% of females chose the same option. Furthermore, this particular option was selected by respondents with the lowest median age for the question, which was 21 years. The specific types of activities were identified during the BCMs.

Figure 18. Outcomes of HOOP Trainers Mission 2 (Lazio Region). More details at Annex 5 "HOOP Trainers App game implemented in the Region of Lazio: Study results"
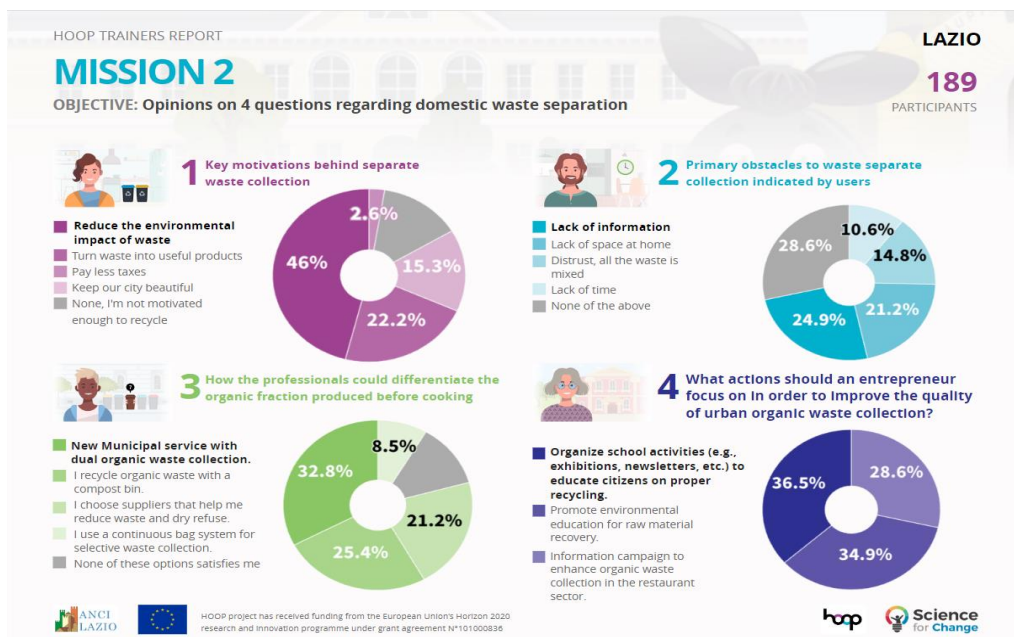
In **Mission 3** (*Figure 19*), 32% of users chose to create **fertilizers** or **nutrients**, followed by bioplastics (23%) and green chemical products (13%). A few slight differences can be detected between the bioproducts preferred by females and males, particularly concerning fertilizers. This option was chosen as the primary choice by 37,5% of males, compared to almost 30% of females. No significant differences can be found in terms of age distribution when choosing a preferred bioproduct.

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Figure 19. Outcomes of HOOP Trainers Mission 3 (Lazio Region). More details at <u>Annex 5 "HOOP Trainers App game implemented in the Lazio Region: Study results</u>"

On the 13th of April of 2023, the **HOOP Trainers Mission 2** challenges were discussed in two Italian Biowaste Clubs events carried out in the <u>Riscarti Festival</u> of Rome. During both events, 68 secondary students from the Istituto Comprensivo IC Campagnano in the Municipality of Campagnano and the Caravaggio Artistic Institute in Municipio I of Roma Capitale **collaboratively transformed the HOOP Trainers challenges into improvement proposals for optimising waste sorting management in the region**[2].

The discussions of both Biowaste Clubs meetings, focused on the **first three questions of Mission 2**, **delved into the factors motivating and hindering waste sorting, as well as the areas that an entrepreneur should prioritize to optimize the sorting of organic waste** (Table 17, Table 18 and Table 19).

The following synthesis presents the highlights of 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

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of priority based on user feedback from the game. All the detailed recommendations can be found in the "Annex 6: Advancing the circular bioeconomy in the Region of Lazio: Co-creating improvement proposals in the Biowaste Club of the region through the analysis of HOOP Trainers' outcomes".

3.3.2.2. Motivations and Recommendations

This section summarizes in *Table 17* the main recommendations emerged during the BCMs to enhance citizens most common motivations for waste separation.

Table 17. Summary of the main recommendations emerged during the BCMs to enhance citizens most common motivations for waste separation

Reduce the environmental impact of waste
*It is the main motivation for **46,03%** of HOOP Trainers players.*
Promote **concrete actions** to conserve resources effectively. Such as **prioritizing reuse over recycling**, **choosing local and seasonal food options** and advocating for the **manufacturing of biodegradable products**.
Transform waste into useful products
*It is the main motivation for **22,22%** of HOOP Trainers players.*
Purchase second-hand items and **transform trash into art pieces** or everyday objects.
Keep our city beautiful
*It is the main motivation for **15,34%** of HOOP Trainers players.*
Choose **public transport** and **educate children**.
Pay less waste taxes
*It is the main motivation for **13,75%** of HOOP Trainers players.*
Students did not delve into this aspect.

None, I am not motivated enough to recycle.
*It represents the response of **2,64%** of HOOP Trainers players.*

	Create **campaigns targeted at unmotivated individuals** and incorporate **environmental education into the school curriculum**

3.3.2.3. Barriers and Recommendations

This section summarizes in *Table 18* the main recommendations emerged during the BCMs tackle the citizens most common barriers for waste separation.

Table 18. Summary of the main recommendations emerged during the BCMs to tackle citizens most common barriers for waste separation

Others
*It represents the response of **28,57%** of HOOP Trainers players.*

	Students did not delve into this aspect.

Lack of space at home
*It is the main barrier for **24,87%** of HOOP Trainers players.*

	Install additional **bins near the busiest blocks,** implement **labeled buckets at home** and offer **comprehensible tips.**

Distrust, all the waste gets mixed
It is the main barrier for 18,5% of HOOP Trainers players.

	Implement **mechanized waste sorting systems equipped with robotic arms** and offer visual engaging information.

Lack of time

*It is the main barrier for **14,81%** of HOOP Trainers players.*	
💡	Establish waste separation as a **habitual practice and organize your schedule**
Lack of incentives *It is the main barrier for **10,58%** of HOOP Trainers players.*	
💡	Introduce a **pay as you throw system**, apply **increased fines** and augment **government funding to support environmental initiatives**.

3.3.2.4. Potential strategies for HoReCa sector professionals to effectively separate the cooked and uncooked organic waste fractions

This section summarizes in ***Table 19*** the main potential strategies for HoReCa sector professionals to effectively separate the cooked and uncooked organic waste fractions emerged during the BCMs held in Rome.

Table 19. Summary of the main potential strategies for HoReCa sector professionals to effectively separate the cooked and uncooked organic waste fractions emerged during the BCMs

New municipal service with double collection of wet waste *It represents the response of **32,80%** of HOOP Trainers players.*	
💡	Collect pre- and post-cooking waste separately by implementing a **two-bucket system in the HoReCa locals** and designing **specific transport systems** to move the waste.
Recycling organic waste using a compost bin *It represents the response of **25,40%** of HOOP Trainers players.*	
💡	Students recommendations focused on introducing **innovative solutions** to encourage waste minimization.

Choosing suppliers who help professionals reduce waste and dry waste	
*It represents the response of **21,16%** of HOOP Trainers players.*	
💡	Students emphasized the role of consumers over suppliers. Such as practice **portion control when serving food** or provide **comprehensive information.**
Others	
*It represents the response of **12,17%** of HOOP Trainers players.*	
💡	Repurpose post-cooked food waste by using it as a **natural fertilizer**
Using a continuous bag system for separate collection	
*It represents the response of **8,46%** of HOOP Trainers players.*	
💡	Employ **designated and durable material bags** to ensure efficient sorting

3.3.2.5. Main conclusions

Secondary students explored practical measures for building a more circular Lazio Region and identified creative strategies suitable for their age without delving into technical complexities. Participants emphasized the importance of **prioritizing reuse over recycling through actions involving various stakeholders**. Such as choosing local and seasonal food options, promoting the purchase of second-hand items, and advocating for the production of biodegradable products. Additionally, engaging artists to transform trash into art pieces was seen as a creative way to promote reuse.

To make **waste separation more accessible and effective**, participants suggested practical measures like installing additional bins in busy areas, implementing labeled buckets at home, and providing clear guidelines for waste disposal. **Education and awareness-raising** emerged as recurring themes during discussions, with a focus on targeted campaigns to educate the public and motivate even the least enthusiastic individuals to adopt waste separation as a habitual practice. Participants believed that introducing **a pay as you throw system**, applying increased fines, and securing government funding for environmental initiatives could further incentivize responsible waste management.

Regarding waste collection in the **HoReCa sector**, participants explored the possibility of implementing a two-bucket system to separate pre- and post-cooking waste. They also suggested designing specific transport
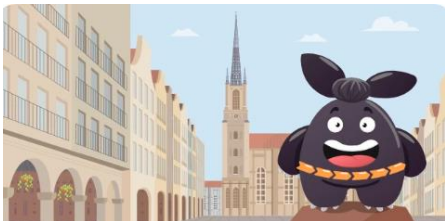
systems that utilize durable material bags for waste movement. In this context, innovative solutions like practicing portion control when serving food were highlighted as effective ways to minimize waste generation.

In conclusion, the discussions on building circular cities underscored the significance of prioritizing reuse, engaging various stakeholders, and promoting waste separation in multiple sectors through education and practical measures. By adopting these strategies and fostering a culture of responsible waste management, cities can move closer to a more sustainable and circular future.

3.4. Münster

Below is described the citizen science intervention carried out in Münster. *Table 20* summarizes the intervention in numbers.

Table 20. CS intervention in Münster in numbers

1 App in German adapted to the Münster context

1 replicable education activity designed to foster an environmental dialogue at class aiming to reflect on the separate collection of the organic and non-organic waste fraction.

268 HOOP Trainers users

1 educational activity to present HOOP Trainers outcomes to an audience of **13 students**, fostering a waste separation dialogue within the classroom.

1 report visualizing the HOOP Trainers outcomes included as an Annex in this Deliverable.

3.4.1. HOOP TRAINERS APP DISSEMINATION

The HOOP Trainer app was disseminated in Münster via social media channels and in external and internal networks of both awm and the city of Münster. In addition, the app was promoted by awm via the official website, a local newspaper and at local trade fairs / events with a focus on circular economy and sustainability (18th Circular Economy Days 2023, Compost Festival'23).
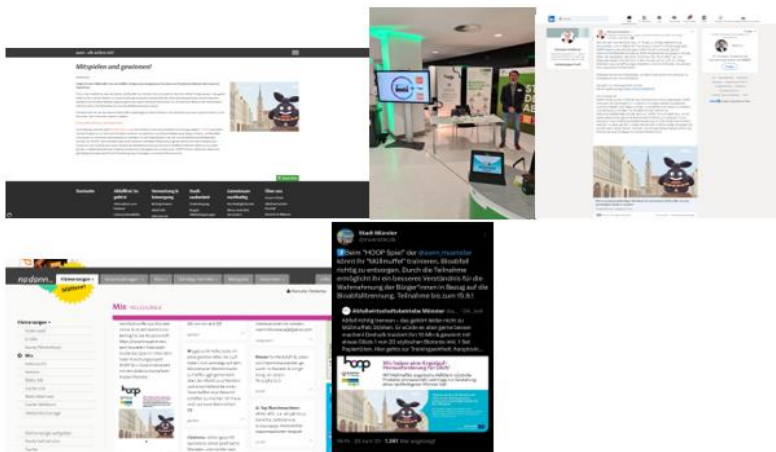
reflects the dissemination activities carried out.

Figure 20. Images that reflect the promotion of the link via the AWM website, the Trade Fair with the App being promoted on an ipad, Linkedin, Local Newspapers and Twitter (now X).
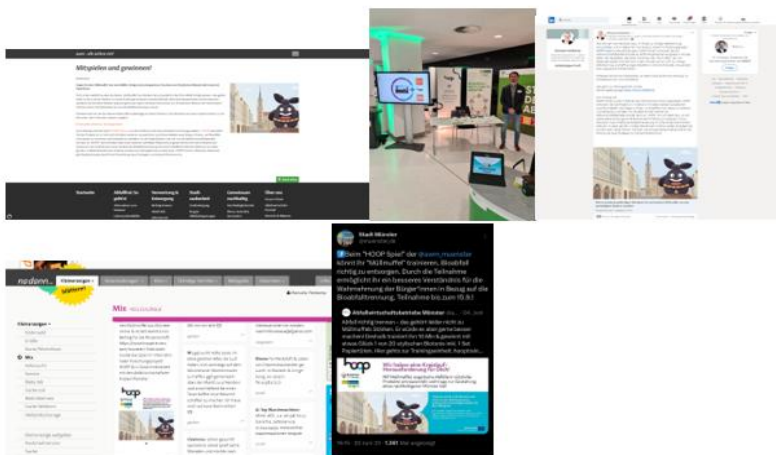
3.4.2. HOOP TRAINERS OUTCOMES OBTAINED

Below are summarized the main outcomes obtained in each Mission. The details of the whole results are shown in the Annex 7 "HOOP Trainers App game implemented in Münster: Study results".

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3.4.2.1. Presentation of the results

In Münster, 268 HOOP Trainers users played the game. **Women constituted the majority of users with 62% participation**, followed by men at almost 30%. The number of non-binary participants and people that preferred not to answer was insufficient to draw any statistically significant conclusions. Regarding age distribution, approximately **46% of participants fell within the 20-39 years age bracket**, with nearly 40% belonging to the 40-59 age group, and approximately 11% falling within the 60-79 age range. Additionally, a small number of users were in the 14-19 age and over 80 groups.

In **Mission 1** (*Figure 21*), participants encountered the highest degree of uncertainty with certain waste items. Notably, the **biodegradable plastic bag** posed challenges for approximately 89% of users, while nearly 87% made errors with the **greasy pizza box**. Additionally, both **medicines** and **pans** resulted in mistakes for around 45% of users. The waste items that generated less doubts among users were newspapers (just 3% of users made errors) and fruit peels around 5% of users made mistakes).

In **Mission 2** (*Figure 22*), users expressed their primary **motivations** for engaging in separate waste collection, with nearly 61% expressing the desire to **transform biowaste into useful products** and approx. 33% aiming to **mitigate the environmental impact of biowaste**. Paying fewer taxes was a less significant motivation and mainly choiced by the older users of the App, with a median age of nearly 50 years. None relevant differences were found in the motivations highlighted by female and male. **Key obstacles** reported included the **demanding nature of the separation process, which required significant exertion** (nearly 36%), **distrust within the complete separation process** (around 22%), and issues of **paper biowaste bags being excessively dirty and fragile** (nearly 19%). The perception that the separation process was unnecessary did not pose a significant obstacle (around 9%), while the option "Others" accounted for 13% of responses. The key obstacles differed a bit between females and males. In particular, nearly 41% of males identified distrust as the primary challenge, whereas approximately 19% of females expressed the same concern. Considering age distribution, the contrasting choices made were the perceived fragility of paper biobags, which had a median age of 38 years, and the issue of distrust, which had a median age of 48.

Figure 21. Outcomes of HOOP Trainers Mission 1 (Münster). More details at Annex 7 "HOOP Trainers App game implemented in Münster: Study results"
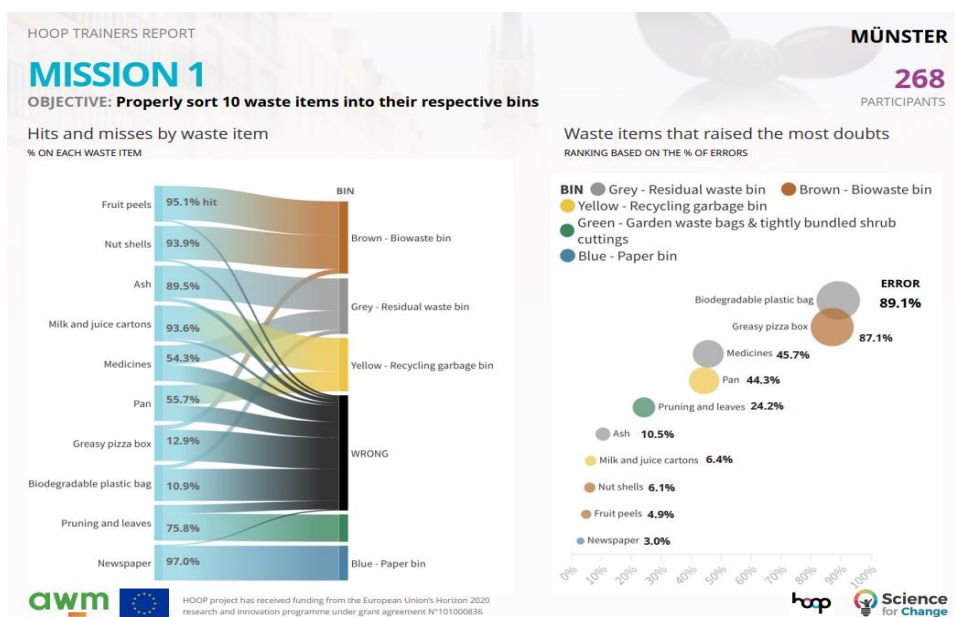
Figure 22. Outcomes of HOOP Trainers Mission 2 (Münster). More details at Annex 7
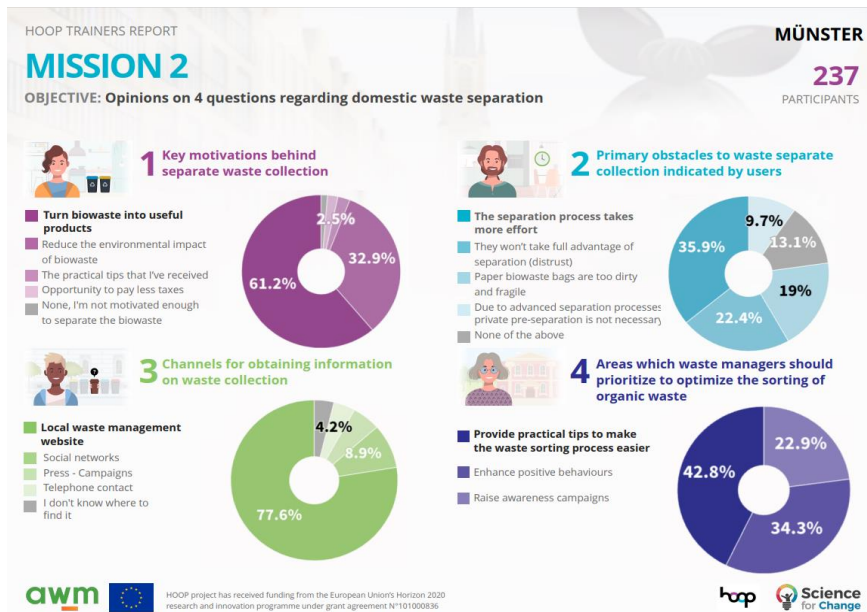
The **local waste management website** was identified as the most utilized channel for obtaining information on sorting organic waste (close to 78%), followed by Social Media networks (nearly 9%). The municipal website appears to be more frequently used by females, as approx. 82% of them selected it as their primary option, while a 70% of males did so. Conversely, the press, though chosen by a small number of users overall, is more commonly utilized by males, with 8% of them selecting it as their main channel compared to just 4% of females. While there isn't a significant disparity in the age distribution of users responding to this question, it's clear that telephone contact emerges as the predominant method for obtaining information in older users.

The top areas that users pinpointed as priorities for waste managers to consider when optimizing organic waste sorting included: **providing practical tips to make the waste sorting process easier** (around the 43%), **enhancing positive behaviours** (nearly 34%), and creating **raise awareness campaigns** (around the 23% of the results). This final point was mentioned by 9% more females than males. No significant differences can be detected in terms of age distribution when selecting a more suitable bioproduct.

In **Mission 3** (*Figure 23*), nearly 40% of users chose to create **fertilizer**, followed by around 30% opting for bioplastics, and the remaining users split between creating nutrients (around 21%) and green chemical products (nearly 9%). The ranking of preferences is consistent between female and male participants and in terms of median age distribution.

Figure 23. Outcomes of HOOP Trainers Mission 3 (Münster). More details at Annex 7 "HOOP Trainers App game implemented in Münster: Study results"

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In Münster, the outcomes of the HOOP Trainers App were presented to an audience of 13 students. These outcomes were strategically employed as an educational tool to discuss the importance of waste sorting and waste valorization in the classroom and fostering environmental discourse among the students.

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4. Conclusion

The CS interventions were designed to engage citizens actively and collaboratively to generate potential solutions for specific challenges for urban circular bioeconomy within each LH, with a primary focus on optimizing the separate collection of OFMSW. These interventions aimed to address various aspects, including improved communication, behavior change or logistical efficiency.

Throughout the preceding stages of the methodology, we have delved into the significance of integrating both digital and physical spaces to establish an inclusive, easy accessible platform where citizens can freely express their ideas. Leveraging the HOOP Trainers App in the BCMs, we have successfully collected suggestions for innovative solutions, which were further elaborated upon during the co-creation workshops. Notably, our emphasis has been on engaging students, recognizing their often overlooked perspectives and providing them with a voice. Empowering high school students to participate in "adult" discussions represents a progressive and empowering endeavor.

Regarding the quantitative results obtained from the HOOP Trainers App across all the LHs involved, it's noteworthy that the waste items causing the most uncertainty among participants vary from LH to LH. However, some recurring items include diapers, ceramics, and greasy pizza boxes. Across all participating LHs, the primary motivations for implementing separate waste collections were consistent. The overarching goals were to reduce the environmental impact of waste and contribute to the transformation of waste into bioproducts. Although the main obstacles encountered differed slightly among LHs, they all shared global links to logistical challenges (both at home and in the broader context), a lack of information, and issues related to distrust. In terms of communication, users consistently identified each municipality's website and social media platforms as the most common channels for obtaining information on waste sorting.

After collecting data through the App, citizens were invited to transform the outcomes of the HOOP Trainers game into recommendations to optimize the waste separation system of their local context. The improvement proposals obtained can be grouped in three main areas: waste separation and recycling strategies, promotion of sustainable practices and circularity and reuse actions.

During the sessions participants emphasized the importance of waste separation at home, suggesting measures like installing compost bins in accessible locations and incorporating strategic bins in public spaces. Recommendations also included providing suitable labeled waste bins for families, recycling bins in apartment buildings and incorporating separate collection spaces in new home designs. Practical measures for accessible waste separation also included creating clear disposal guidelines.

Creative strategies for sustainable waste management were also identified, such as creating urban gardens with composting facilities and introducing a rewarding system for responsible waste disposal. Education and awareness-raising were key themes, with suggestions for improved labeling, packaging materials information and recycling awareness for all age groups. Influencer engagement and social media content were proposed to promote recycling participation.

The importance of prioritizing reuse over recycling was also emphasized, with actions like choosing local and seasonal foods, advocating for second-hand purchases and involving artists in transforming trash into art.

Participants also highlighted the need to increase government funding for environmental initiatives to incentivize responsible waste management.

Overall, the conclusions underscore the significance of waste separation, recycling strategies, education and creative actions to move towards circularity and sustainable waste management.

The data collected from the HOOP Trainers App is a sample that provides a confidence level of 95% of confidence with a 5% error in Western Macedonia and 90% of confidence with a 5% of error in Münster, Murcia and Lazio Regione, ensuring valuable insights. The values have been calculated through the Sample Size Calculator Calculator.net. However, it is essential to be mindful of its limitations when interpreting the findings. Additionally, we must acknowledge the possible presence of common biases, such as sampling bias and social desirability bias (the tendency to answer questions in a manner that will be viewed favorably by others), which could have influenced the outcomes obtained. By recognizing and addressing these biases, we can attain a more comprehensive and nuanced understanding of the data and its constraints. Given that the main objectives of this initiative were the engagement and participation of citizens, the method for sampling and obtaining data was not probabilistic but strategic, and therefore the representativity of the sample over the whole population of the participant LHs is not assured completely (e.g., the overrepresentation of some age groups). All these factors were thoroughly considered during the BCMs, which presented a valuable opportunity to integrate the opinions of the HOOP Trainers digital users with citizens from each LH participant.

More investigations will be needed to keep delving into more accurate solutions to tackle challenges to optimize waste separation in each LH participant.

In summation, the critical role of citizen participation in shaping circular cities, particularly in enhancing waste separation both in terms of quantity and quality, becomes abundantly clear. With the insights gathered, the LHs now possess a wealth of valuable recommendations to inform and guide their actions toward optimizing the separate collection of the organic and non-organic fraction. In order to discuss next steps in the implementation of the recommendations, the results of the CS interventions will also in the coming months of the HOOP project be further taken up in the BCs of each LH. The high amount of citizen participation and the productive discussions and useful results and recommendations obtained are great proof of how valuable and effective CS is as a participatory method applied to advance towards circularity. It not only generates new datasets but also empowers citizens, raises awareness, facilitates comprehension of the challenges and motivations behind behavior changes, and fosters engagement while connecting all stakeholders. The impact of the CS interventions will be analyzed in the *D6.6. Report on the impact assessment* due by May 2024.

The next steps for this Task involve replicating the tool in the Greater Porto area and Kuopio and provide them a summarized report with the outcomes obtained if they reach a minimum amount of data. Additionally, SfC focus will shift towards disseminating the project's outcomes and the lessons learned during the interventions. This includes sharing our experiences with other members of the HOOP Network of Cities and Regions during Episode 1 of the HOOP Lunch Talks Season 3, titled "HOOP Trainers: Neighbors Shaping Circular Bioeconomy through Play and Debate," scheduled for 28th September 2023. We will also share our findings during the Murcian National Replication Workshop in October 2023, and participate in specific conferences throughout 2023 and 2024.

Furthermore, LHs will share the outcomes with local stakeholders and utilize them for educational purposes.

5. References

[1] Brusselaers, J., & Van Der Linden, A. (2020). Bio-waste in Europe—turning challenges into opportunities. *EEA Report*, *2020*(4).

[2] Haklay. 2013. Citizen Science and volunteered geographic information: Overview and typology of participation, Crowdsourcing Geographic Knowledge

6. Annexes

Annex 1: HOOP Trainers App game implemented in Murcia: Study results

Annex 2: Advancing the circular bioeconomy in Murcia: Co-creating improvement proposals in the Biowaste Club of the region through the analysis of HOOP Trainers' outcomes

Annex 3: HOOP Trainers App game implemented in Western Macedonia: Study results

Annex 4: 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

Annex 5: HOOP Trainers App game implemented in the Region of Lazio: Study results

Annex 6: Advancing the circular bioeconomy in the Region of Lazio: Co-creating improvement proposals in the Biowaste Club of the region through the analysis of HOOP Trainers' outcomes

Annex 7: HOOP Trainers App game implemented in Münster: Study results