



Design and behavioural research study to create evidence-based, EU harmonised consumer waste sorting labels

Interim Report 1

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Abstract

This Interim Report presents early results of the EU study to develop harmonised, evidence-based waste sorting labels for packaging and receptacles. The project evaluates the Nordic pictogram system and other national schemes to inform the design of an EU-wide solution that enhances consumer understanding and supports better sorting behaviours. A first prototype label has been tested through an online survey in 21 Member States (N=16,380) and participatory workshops in six countries (N=245). Findings highlight the importance of visual clarity, intuitive icons, and consistent use of colour. Evidence shows that text is the most effective design element for improving sorting accuracy, especially when including material identifiers and clear instructions. Component pictograms significantly support the sorting of multi-material packaging. Colour improves salience for some categories, though its effect on overall accuracy is limited. Additional labels reduce salience and can distract from core sorting information. Participants expressed high motivation and confidence in their ability to sort correctly. These findings will inform a second prototype to be tested in a behavioural experiment. By combining behavioural science with participatory design, the study generates actionable insights to support future EU policy and the effective rollout of standardised labels across Europe.

1. Introduction

This document is the **Interim Report 1** of the project “Design and behavioural research study to create evidence-based, EU harmonised consumer waste sorting labels”. As indicated in the ToR, this report is the second formal deliverable of the project (D2), and it has been drafted following the development of the activities conducted under Task 2.

The overall purpose of this study is to develop evidence-based and participatory-design based EU harmonised waste sorting labels on packaging and receptacles to facilitate waste sorting by consumers. This overall purpose is then divided into five specific objectives:

1. **Objective #1:** Evaluate the suitability of the Nordic and other pictogram schemes as a basis for an EU harmonised waste sorting labelling system.
2. **Objective #2:** Generate insights and evidence to support the design of EU harmonised waste sorting labels that are understandable, appreciated and effective.
3. **Objective #3:** Conceptually and graphically design a proposal for an EU harmonised waste sorting labelling system based on the evidence and insights gathered.
4. **Objective #4:** Conduct experimental testing of the proposed EU harmonised waste sorting labelling system with consumers.
5. **Objective #5:** Generate insights and guidance on the implementation, use and communication of the EU harmonised waste sorting labels to enhance users’ understanding, appreciation and effectiveness of these labels.

To meet the specific objectives and corresponding research questions, the study comprises three tasks, covering different research methods (desk research, online survey, participatory workshop, behavioural experiment). Moreover, the JRC also contributes with inputs to support the work in different phases of the study. The study aims to combine the methods coming from the field of behavioural science (i.e., online survey and experiment) with the methods typical of the field of design applied to policy (i.e., participatory design workshop, prototype development). The combination of methodologies allows for an evidence-based and participatory approach to the overall policy objective.

From January to December 2024, the study team completed the first task and advanced significantly in the second task of the study. In the **first task**, the team conducted a comprehensive analysis of existing waste labelling systems across EU Member States (MS), including an in-depth evaluation of the Nordic pictogram system and other national schemes. This phase leveraged materials provided by the JRC, such as the stakeholder matrix, expert literature review, and country-specific data, to assess the suitability of these systems for harmonised application across the EU27.

Progress in the **second task** included (i) the development of Prototype 1 for an EU harmonised sorting label system, (ii) an online survey across 21 MS to evaluate various aspects of the Nordic pictogram system and to investigate how key label elements impact consumer perceptions and reactions, and (iii) twelve participatory workshops in six MS to capture citizens’ views, challenges, and expectations, further enriching the design process. First, the overall graphical aspects of the labels in Prototype 1 build on the Nordic system and closely align with those established by this initiative. The design has not been informed by the results of the online survey as these were unavailable at that time. Instead, it is primarily theory-driven, relying on extensive desk research and the expertise of the consortium members and consulted expert stakeholders. Second, the online survey evaluated various aspects of the Nordic system, collected perspectives, preferences, and feedback regarding label elements on participants, and investigated how

key label elements impact key consumer perceptions and reactions. Third, the participatory workshops gather feedback from 245 citizens on Prototype 1 through their individual views and gather their needs and insights on a very granular level about the designed waste sorting label system. The findings of the two research activities – namely the survey and the workshops – will inform the development of Prototype 2, which will then be tested in the subsequent behavioural experiment.

This **Interim Report 1** is structured as follows. Section 1 consists of this introduction. Section 2 provides an overview of the status of the study project, detailing what has been completed and what remains to be carried out. Section 3 offers a high-level description of the methods used for the three main tasks and subtasks of the study: the design of Prototype 1 and the online survey (subtask 2.1), and the design of the participatory workshops (subtask 2.2). Section 4 presents the key findings from the online survey and the participatory design workshops. Finally, we provide additional details and materials in the Annex: a selection of examples from Prototype 1 (Annex 1), materials from the participatory workshop (Annex 2), and the online survey protocol (Annex 3).

2. Status of the project

In this section, we provide an overview of the status of the study. First, in sub-section 2.1, we describe the tasks completed to date, along with the deliverables submitted and approved by the JRC. Then, in sub-section 2.2, we outline the next steps and present the updated work plan.

According to the TS, this First Interim Report should contain the results of the following activities: (i) online survey, (ii) participatory workshops, and (iii) Prototypes 1 and 2. While (i) and (ii) are included in the content of the present report, only the development of Prototype 1 is included. As explained later in section 3.1, the design of the first prototype has not been informed by the results of the online survey, as planned by the TS, as these were unavailable at that time. Instead, the design of Prototype 1 is primarily theory-driven, relying on extensive desk research and the expertise of the consortium members and consulted expert stakeholders. Regarding Prototype 2, the design will be informed by the results of the online survey and the participatory workshops, and it will be included in the Second Interim Report.

2.1. Tasks completed

The study team has made significant progress in the first phase of the study and has completed several key tasks. These include the analysis of pictogram systems (Task 1), the activities related to behavioural design evidence gathering (Task 2) as well as the development of the first prototype and the online consumer survey (Subtask 2.1), and the participatory design workshops (Subtask 2.2). In this sub-section, we briefly present the activities completed.

2.1.1. Analysis of the pictogram systems (Task 1)

The aim of Task 1 is to conduct a comprehensive analysis of the Nordic and other relevant waste-sorting labelling systems to assess their applicability to EU MS. Between March 2024 and June 2024, the study team completed the desk research phase, which included (i) an examination of behavioural aspects related to waste sorting labelling, focusing on design features, effectiveness, and psychological barriers to sorting behaviour, (ii) an analysis of five major national waste sorting labelling schemes used in Germany, Italy, Spain, France, Belgium and Nordic and Baltic countries (relevant for Denmark, Norway, Sweden, Iceland, Finland, Estonia, Latvia, Lithuania), and (iii) a qualitative evaluation of waste sorting labelling schemes agreed upon with the JRC, to inform ongoing work.

The results of these activities were included in the Inception Report, which was approved by the Contracting Authority in July 2024.

2.1.2. Design of Prototype 1 (Subtask 2.1)

As part of Task 2, the Consortium developed Prototype 1 of a harmonised EU waste sorting labelling scheme between July and August 2024. This prototype is based on the Nordic Pictogram System and introduces additional pictograms and categories, including combined groups like plastic & beverage cartons and paper & cardboard, with a specific focus on materials used in product packaging (see Section 3.1 for details about the methodology). Given that the development of the online survey was delayed, Prototype 1 was not, as originally planned, informed by the survey results, but it was based on the information gathered through desk research, the qualitative assessment of the study team, interactions with expert stakeholders, as well as the knowledge of the design team led by Silke Krukow.

The scheme is designed to label both packaging and receptacles, with classification divided into seven waste fractions: paper & cardboard, residual, plastic & cartons, glass, metal, wood, and biowaste.

Following the TS, Prototype 1 serves as the foundation for the participatory design workshops in Subtask 2.2.

2.1.3. Online survey (Subtask 2.1)

Subtask 2.1. involves designing and administering an online survey to examine how key label elements influence consumer perceptions and reactions. The survey is divided into sections that assess the noticeability and understandability of the labels, the association of colours and pictograms, visual preferences and attitudes, as well as perceived challenges and needs related to waste sorting (see Section Errore. L'origine riferimento non è stata trovata. for methodological details).

The conducted survey deviates from the approach outlined in the Technical Specifications (TS). According to the TS, the survey was originally designed to “evaluate various aspects of the Nordic and other relevant pictogram systems for waste sorting within the context of country-specific separate waste collection schemes and waste-related norms.” However, during project discussions, the Contractor and the JRC agreed to focus exclusively on the Nordic pictogram system. This decision was driven by the fact that the Nordic system is the only one among existing schemes that align with the requirements of the PPWR (recital 64 and recital 66 of the provisionally agreed PPWR). The requirements mandate that the system must identify the material composition of packaging and apply a matching system - namely, using identical labels for packaging and receptacles to facilitate consumer disposal by symbol matching.

To ensure the study's alignment with the PPWR and enable robust comparisons, the survey applied a universal rather than country-specific separate waste collection scheme. This approach allowed for a controlled assessment of the Nordic pictogram system while still capturing the influence of participants' prior experience with their respective waste collection systems. Such a design balances the need for comparability across contexts with the ability to explore the interaction between participants' familiarity and the experimental collection scheme.

A pilot study was conducted in Ireland in August 2024, followed by a soft launch with approximately 30 participants per country at the end of September 2024. This soft launch aimed to verify proper assignment to experimental conditions, assess average survey duration, check translation issues, and ensure the quality and reliability of responses.

The survey remained open for 6 weeks (from October 4th to November 26th) and targeted ~800 participants from 21 MS (N=16,380 in total), based on a set of predetermined quotas agreed upon with the JRC (i.e., gender, age, education, living area, income). The results of the online survey are reported in Section Errore. L'origine riferimento non è stata trovata.. Due to a lower response rate in difficult-to-reach quotas (i.e. low-educated, low-income, rural areas), which resulted in delays in the initial timeline of the data collection, the Consortium implemented mitigation measures to ensure reaching the target. It was agreed to follow a two-step process to evaluate the need for mitigation measures. First, participation via mobile phones was enabled and then some quotas were relaxed. The survey was slightly revised to allow participants to complete it on a mobile phone - as today almost 50% of panellists take surveys on mobile. After making technical adjustments, the mobile version was launched on the 31st of October. The Consortium observed a notable increase in data collection in countries where progress had previously lagged. However, in countries where data collection was already advanced, the observed progress was limited. Initially, the agreed deviation for soft quotas was set at 10%. To reach the ‘hard-to-reach’ soft quotas, it was agreed on the 7th of November to maintain strict 100% adherence to hard quotas (gender and age) while allowing a \pm 20% deviation in soft quotas (rural/urban, income, education), ultimately enabling the Consortium to achieve almost full data collection by the 26th of November, with 7.5% of respondents completing the survey via mobile.

The online survey addresses Objectives #1 and #2 of the ToR by assessing the suitability of the Nordic system and offering critical insights to guide the development of a harmonised EU waste sorting labelling system. As mentioned before, the survey deviates from the TS, as it did not use Prototype 1 as originally planned, but it focused exclusively on different label versions of the Nordic system. The survey investigates the impact of specific variations of the Nordic system (e.g. colour vs black and white, text describing the material vs no text, component pictograms) on the saliency of the label and on the ability of consumers to sort waste correctly, to derive learnings for adequate design of later prototypes. The specific variations used are presented in Section 3.3. The results of the online survey are presented in Section 4.2.

2.1.4. Participatory design workshops (Subtask 2.2)

Subtask 2.2. involves designing and conducting participatory design workshops with citizens, aimed at gathering their views, needs and insights regarding the design of a waste sorting label system (see Section 3.2 for methodological details). Prototype 1 was used for this activity, enabling participants to provide feedback on the prototype and share detailed insights and needs regarding the design of the waste sorting label system.

The workshops were held between 30th September and 11th October 2024 with citizens in six different MS (Italy, Austria, Poland, Estonia, Greece, and the Czech Republic). Two workshops were conducted in each country, featuring different participant samples and engaging a total of 245 citizens. All workshops were held online, except for those in Italy, allowing us to include participants from diverse regions within each MS and ensuring the collection of country-specific insights. The hybrid approach of combining in-person and online workshops balances the social benefits of “community building” with accessibility. In-person sessions foster collaboration and engagement through face-to-face interactions, while online workshops overcome geographical barriers, reduce logistical risks, and lower costs. This dual strategy combines the strengths of both formats to create an inclusive and comprehensive participatory approach.

The participatory workshops address Objectives #1 and #2 of the ToR by evaluating the proposed labels of Prototype 1 for suitability and clarity, generating evidence to support the design of Prototype 2, and experimenting with different variations to gather citizen feedback. Emphasizing co-creation, the workshops actively involved citizens as collaborators, valuing their lived experiences to develop innovative and effective concepts through interactive group exercises. The results of the participatory workshops are presented in Section 4.1.

2.2. Next steps

In the remaining part of the project, the team will complete the other activities under Task 2, including the development of the second prototype and the behavioural experiment with consumers to test the effectiveness of Prototype 2 in facilitating correct waste sorting. The following deliverable is the Second Interim Report, which will contain Prototype 2 – which will be developed based on the findings of the online survey and the participatory workshops – and the detailed implementation and results of the behavioural experiment. Additionally, under Task 3, efforts will focus on triangulating and analysing the quantitative and qualitative data from the various tasks, leading to the final conclusions to be presented in the Final Report. In conclusion, building on the evidence collected, the team will develop the final harmonised waste sorting label system and will deliver (i) General Guidelines encompassing comprehensive information about the labelling system, its structure, functioning, and rules, (ii) three guidelines for three different stakeholder groups (citizens, waste management companies and municipalities, and packaging producers), and (iii) the printable label files.

Errore. L'origine riferimento non è stata trovata. shows the updated GANTT chart of the project, with the remaining activities to be completed. Each cell represents 2 weeks. The number of months is shown in the first line. The blue cells correspond to the original GANTT presented in the technical offer, while the orange cells represent the extended timeline for each of the activities.

In particular, it is noted that:

- The activities related to the **online survey** took significantly longer than initially envisaged in the ToR and the technical offer. The consortium and the JRC will work on the behavioural experiment under Task 2 to avoid similar delays, which could compromise the overall timeline and final deliverables of the project.
- The delay in the development of the survey, however, did not impact the timeline for **Prototype 1**. This first design phase was informed mainly by the desk research and knowledge of the design team (i.e. the JRC design team and contractor's lead designer Sille Krukow). Insights from the citizen survey, citizen workshops, and stakeholder consultation will, however, be considered in the development of the second prototype.
- The deadlines of the **participatory design workshops** were only marginally impacted, as they were conducted within the first half of October.

The development of **Prototype 2** started after an in-person workshop held in Brussels on 27th November with the consortium and the JRC. A draft version of the second prototype, which revises Prototype 1 building on the findings of the (i) citizens survey, (ii) citizens workshops, (iii) stakeholders consultation, and (iv) stakeholders workshop was delivered in January 2025. Moreover, a first draft of the **General Guidelines**, together with producers' and municipalities' guidelines, will be delivered in March 2025.

3. Methodology

In this section, we describe the methods used for the three activities conducted and included in this report. First, we describe how we designed Prototype 1 (section 3.1). Then, we provide a high-level description of the online survey in section 3.2 (geographical coverage, sample characteristics and survey structure), while the full protocol is included in Annex 5.3. Finally, we present our design for the participatory design workshops aimed at gathering views and opinions about Prototype 1 (section 3.3).

3.1. Design of Prototype 1

The design of Prototype 1 is organised into two levels:

- **Level 1: The System Design**, which describes the meta labels, colours for different types of waste fractions and which materials require labels.
- **Level 2: The Visual Design**, which describes specific label designs, colour selection, icon design and specific wording related to each material.

These aspects ensure that the prototype addresses both the structural and visual requirements for effective consumer guidance, adaptability to different waste management systems, and compliance with the PPWR.

The prototype itself is meant to be applied to both packaging items and waste receptacles. It aims to apply a harmonised labelling system across European countries applicable to the various separate waste collection systems, particularly the separation and commingling logic and practices and other elements currently in place in MS.

The design of the initial prototype has not been informed by the results of the online survey, as planned, as these were unavailable at that time. Instead, **the design is primarily theory-driven, relying on extensive desk research and the expertise of the consortium members and consulted expert stakeholders.** Part of the desk and related research is outlined in the inception report and the European Commission's publication *Setting the Scene for Harmonised Waste-Sorting Labels in the European Union* (Bruns et al., 2024).¹ The design of Prototype 1 is the outcome of an iterative consultation among the study team, the JRC and the external expert advisor Ann Thor, who led the development of the Nordic pictogram scheme on several key elements, including the naming conventions, icons, and colour choices for each waste fraction. Additionally, the prototype incorporates insights from the qualitative evaluation conducted by the JRC and its Contractors.² These evaluations guided the ongoing development of the project.

3.1.1. System design

This subsection describes the structural and conceptual elements of Prototype 1, including the starting point for the first prototype, the regulatory alignment, its material focus, requirements, and the hierarchical levels of granularity in waste fractions.

¹ <https://publications.jrc.ec.europa.eu/repository/handle/JRC135860>

² These evaluations were carried out in the context of the evaluation assessment criteria activity conducted as part of the inception report by the groups of experts, one from each of the consortium organizations: JRC, Open Evidence, Politecnico di Milano, and Krukow.

3.1.1.1. Starting Point and Regulatory Alignment

The starting point for the design of Prototype 1 is the Nordic waste sorting labelling system by EUPicto (Figure 1). This choice was driven by the fact that the Nordic System aligns with the requirements of the provisionally agreed Packaging and Packaging Waste Regulation (PPWR), which mandates the use of identical labels on packaging and waste receptacles to facilitate consumer disposal through symbol matching (recital 64 and recital 66 of the provisionally agreed PPWR). This feature is a key distinction from the waste sorting labels previously evaluated by the consortium and the JRC, none of which use matching labels to communicate sorting instructions. Instead, these labels typically indicate the (country-specific) waste destination on the packaging.

The Nordic pictogram scheme also presents an exception to the absence of a harmonised waste sorting labelling scheme across EU MS. EUPicto is an initiative founded by four Nordic municipal waste associations to own, develop, distribute, and administer a system of international waste management pictograms that facilitates environmentally friendly handling of waste and reuse of products. It is a voluntary labelling system implemented first in Denmark in 2017, then introduced identically (with a few changes according to the law on waste sorting) in Sweden, Norway, Iceland, and Finland. In the future, Latvia, Lithuania and Estonia are looking to expand the project to the Baltic countries.^{3,4}

The overall graphical aspects of the labels in Prototype 1 build on the Nordic system and closely align with those established by this initiative. The Nordic system is regarded as successful based on its voluntary adoption across Denmark, Sweden, Norway, Finland, and Iceland⁵. Official evaluations, such as the study commissioned by Avfall Sverige⁶ demonstrated measurable improvements in waste sorting behaviours. For example, the introduction of the Nordic pictogram system in Swedish households led to a reduction of residual waste by up to 26%, with corresponding cost savings of 25.6%, particularly when combined with behavioural nudges. The system's design, incorporating clear and intuitive pictograms, standardized use of colours, and modular adaptability, aligns closely with the design criteria outlined in the JRC study "Behavioural Insights for Waste-Sorting Labels in the European Union".⁷ This study emphasizes clarity, consistency, and adaptability as core principles of effective waste-sorting labels, underlining their consumer appreciation and operational efficiency. These principles are satisfied by the Nordic system and informed the holistic approach used to develop Prototype 1.

Figure 1 Nordic pictogram system example: symbols for fractions

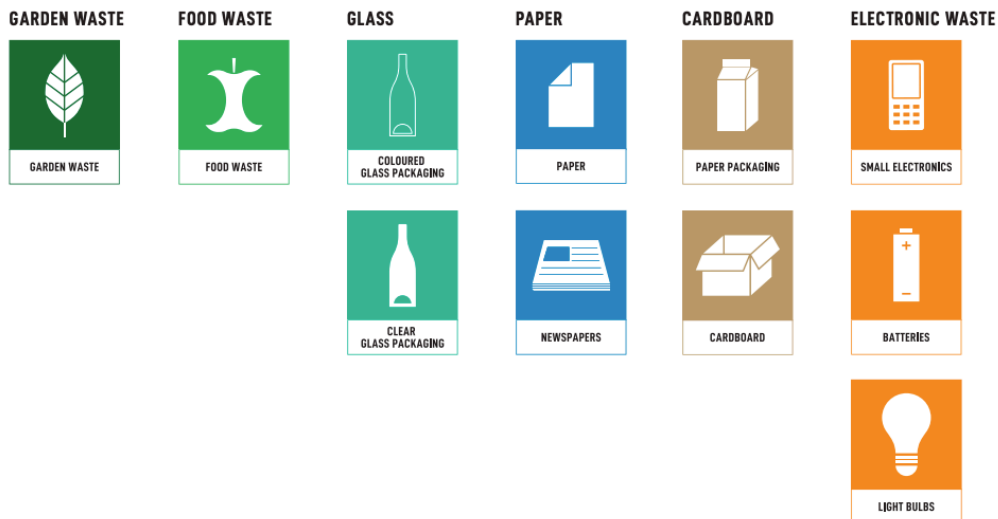
³ <https://www.eupicto.com/about-the-pictogram-system/>

⁴ <https://norden.lv/en/projects/sustainable-development/adaption-of-the-danish-pictogram-system-in-baltic-countries/>

⁵ As of January 2022, 94 out of 98 municipalities have implemented the system, as well as more than 200 users such as manufacturers, festivals, supermarkets, and packaging producers. In 2023 it has also been made mandatory to use the pictogram scheme for kerbside collection. In Sweden, 200 municipalities and 400 producers, property owners, and others have implemented the system. In Norway, 13-14 municipalities and several large producers have started implementing pictograms on packaging.

⁶ <https://www.avfallsverige.se/in-english/common-symbols-for-waste-sorting/>

⁷ <https://publications.jrc.ec.europa.eu/repository/handle/JRC134206>



Source: EUPicto

The visual concept of the Nordic system (example in Figure 1) is developed to ensure flexibility and alignment with various waste management systems. The system consists of three units: symbol, colour and type of material, which can be combined to suit local requirements in a modular fashion. The waste labelling scheme is designed to be adaptable because while the symbols are identical across countries and meant to remain unchanged over time, the scheme has also been developed to keep room for the system to be adapted according to user needs. As a result, more symbols and fractions can be added should new requirements arise. Moreover, the labels are applicable to both packaging and receptacles.

The Nordic system complies with the PPWR requirements on multiple levels:

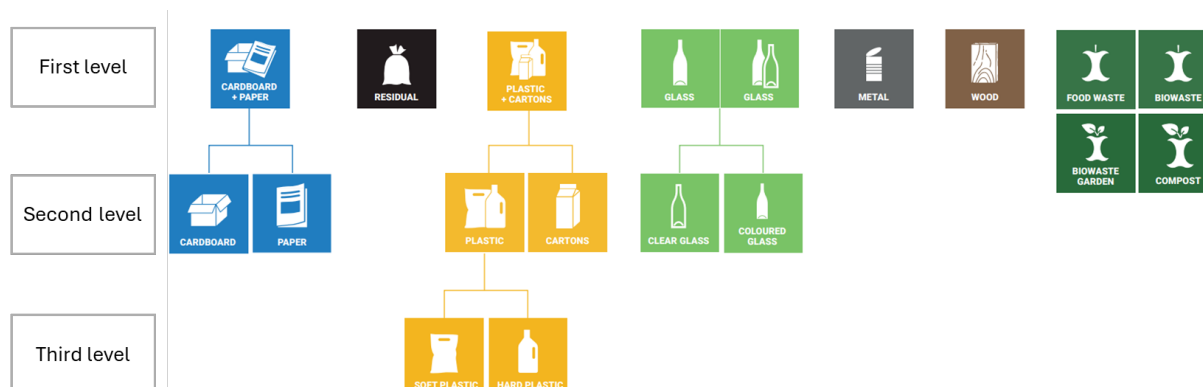
1. It is **material-based**, ensuring that its labels focus on the material composition of the packaging, which is a requirement of the Packaging and Packaging Waste Regulation (recital 64).
2. It employs a **matching** system that applies identical labels on packaging and waste receptacles (recitals 64 and 66 of the PPWR), thus allowing consumers to match the symbols for the purpose of disposal.
3. Its application across multiple countries highlights its flexibility and adaptability. This international applicability demonstrates its potential to contribute to the broader goals of the PPWR, creating a unified and efficient framework for packaging and waste management systems.

3.1.1.2. Hierarchical Levels of Granularity

Prototype 1 illustrated below builds on the Nordic system. It differentiates packaging waste into **seven fractions**. This level of granularity was identified as an appropriate starting point and incorporates minimum separate waste collection requirements as defined in Directive 2008/98/EC (the Waste

Framework Directive, WFD):⁸ **paper & cardboard, residual, plastic & cartons⁹, glass, metal, wood, and biowaste.**¹⁰

Figure 2 Design and hierarchical structure of labelling Prototype 1 – three levels of waste fraction granularity and their application.



Source: Authors' elaboration

To enhance clarity and usability, the prototype is structured on three levels, with each level addressing the specific needs of different users and contexts described below.¹¹ The three levels were deemed necessary to balance the competing needs for usability, flexibility, and precision in waste sorting. Broad categories at Level 1 ensure that the labelling system remains accessible to a wide range of users, particularly in regions with basic waste sorting infrastructure. At the same time, Levels 2 and 3 allow for progressive granularity, enabling the system to adapt to varying national and regional contexts and evolving waste management technologies.

1. **First level:** This level introduces broad waste categories, such as paper & cardboard, residual, plastic & cartons, glass, metal, wood, and biowaste. It is designed for receptacles where key materials are commingled. For example, a single label for "plastic & cartons" might suffice in a system where these materials are collected together.
2. **Second level:** At this level, certain categories are further divided, providing additional specificity. For example, "cardboard & paper" is split into separate categories for cardboard and paper, while "plastic & cartons" is divided into plastic and cartons. Similarly, "glass" is separated into clear glass and coloured glass. These subdivisions are supported by the introduction of more specific labels, offering a finer definition of the waste fractions. This level is particularly useful in regions where waste management systems require higher granularity to improve recycling quality or where local regulations demand more detailed material separation. Packaging companies might

⁸ It should be noted that the granularity of EU harmonised waste sorting labels, referring to which materials need to receive a distinct label, depends on several factors. First and foremost, the system as defined by the provisionally agreed Packaging and Packaging Waste Regulation is based on materials. Thus, each separate material should receive its own label. However, other factors need to be considered, such as the increased level of cognitive effort required by users to use and understand more labels, existing waste separation schemes in EU MS, the impact of citizen commingling/separation on recycling quality, the local automatic sorting capabilities, and clear definitions for material categories. These factors need to be considered in the process of specifying the granularity of the harmonised labelling system.

⁹ The term "cartons" refers to fibre-based composite materials, such as beverage cartons (e.g., Tetrapak). This wording was chosen as it aligns with the terminology used in the Nordic system and is likely to be more intuitively understood by consumers, given its association with commonly recognized items like beverage cartons.

¹⁰ Note that additional waste fractions, such as electronic waste, may be incorporated in future iterations of the prototype.

¹¹ To see a selection of on-bin and on-product examples of Prototype 1, refer to Section 5.1 of the Annex.

adopt this level for products targeted at countries with stricter recycling protocols or for products where the material distinction could impact the recycling process, such as clear versus coloured glass.

3. **Third level:** This level depicts the highest granularity, breaking down categories like “plastic” into subcategories such as soft plastic and hard plastic. This is intended for highly advanced waste management systems with automatic sorting capabilities or specialized recycling facilities. Packaging companies might use this level for products made of mixed plastic types or where precise material identification is critical for recycling quality. For example, a company selling products in a region with sophisticated recycling technology might benefit from providing detailed labels to match the local system's requirements.

Labels according to the above levels of granularity can correspondingly be applied to waste receptacles based on national or local sorting rules. By incorporating multiple levels, the prototype supports a modular approach, accommodating countries or regions with diverse waste management capabilities while laying the groundwork for future harmonisation. Additionally, the differentiation accounts for the cognitive load on users: households or businesses can adopt the level that best aligns with their local practices, avoiding confusion or excessive complexity in systems that do not require high granularity, while still enabling the labelling system's functionality. Future iterations of the prototype may include further expansions or adjustments to waste fractions, such as additional packaging materials or material fractions beyond packaging waste, such as electronic waste, ensuring the system remains adaptable and forward-looking.

3.1.2. Visual design

This subsection focuses on the visual aspects of Prototype 1, including colours, pictograms, naming conventions, and scalability.

3.1.2.1. Pictograms

The pictograms in Prototype 1 were designed to strike a balance between clarity, intuitive recognition, and alignment with existing waste sorting practices. Different styles of pictograms were selected for different materials to cater to their specific visual associations and consumer expectations. In some cases, we developed meta-labels that combine two related materials (e.g., cardboard and paper) under a single label. To ensure consistency and facilitate easier recognition for users, the pictograms used on the meta-labels are the same as those featured on the respective single labels. This approach allows users to identify the materials intuitively based on the familiar pictograms, improving the clarity and usability of the waste sorting labels.

- **Cardboard and Paper:** The label for “cardboard and paper” includes pictograms for both of its components. Perspective icons were used to depict recognisable items (e.g., a box for cardboard), aiming to ensure clarity and quick identification. This choice reflects a need for users to associate these fractions with common, everyday objects.
- **Plastic and Cartons:** As many EU MS commingle plastics and fibre-based composite packaging (beverage cartons), a meta-label including plastic and cartons was designed to reduce complexity. Icons for “plastic & cartons” include sub-pictograms for plastic bottles, beverage cartons, and other plastic materials. The aim was to capture the diversity within this fraction while simplifying identification.
- **Glass:** A flat, front-facing bottle icon style was used for both clear (no filling) and coloured (white filling) glass, making the distinction between the two types salient. The glass meta-label was

designed in two different versions to be tested with users, one depicting both types of glass, and another one depicting only the empty bottle icon. The choice was informed by the need to differentiate between subcategories (clear and coloured glass) without overwhelming the user.

- **Metal and Wood:** For metal, we used a flat pictogram, while for wood a perspective one. Both provide a neutral, easily recognizable icon.
- **Biowaste Variants**¹²: The biowaste category employs variations (e.g., food waste, biowaste garden, compost) with icons representing versions of a crunched apple. These icons were tested for effectiveness in participatory workshops, focusing on clarity and user understanding (see Section 4.1).

The use of perspective icons versus flat icons reflects an effort to tailor the design to material-specific considerations. While perspective icons are more visually detailed, they may require higher cognitive effort or pose specific printing challenges. Flat icons offer simplicity and uniformity, and are more straightforward to print but might lack immediate recognisability for some fractions.

3.1.2.2. Colours and meta fractions

The colour scheme was designed to align with the majority of established colour-waste associations in EU MS while addressing the lack of internationally or European-wide harmonised standards.

This selection is based on the first survey conducted by the JRC, which identified the colours most commonly associated with each type of waste material across different EU MS.¹³ While there are no internationally harmonised standards, the prototype references commonly used schemes from countries like Denmark, Sweden, and Germany, among others, to ensure alignment with user expectations and existing practices where possible.

Although the colour scheme for the first prototype was developed without direct input from the ongoing consumer survey, the survey includes questions specifically addressing citizens' familiarity with colour associations for different materials. These responses will inform the design of the second prototype, providing more robust evidence to refine the alignment of colour schemes with user expectations and intuitive sorting behaviour.

A key challenge was that each colour could only be assigned once, which required careful prioritisation. In some cases, no single colour emerged as a clear choice, while in others, different countries used different colours for the same material, complicating efforts to achieve consistency.

For certain fractions, such as metal and wood, the colours align directly with the Nordic system (dark grey for metal and brown for wood) (See Figure 3). However, significant changes were made to other fractions to improve consistency with colour associations observed across EU MS.

- **Plastic:** The original purple colour used in the Nordic system was changed to yellow, as this colour is frequently associated with plastic waste in several EU countries.

¹² This category is relevant for packaging materials, i.e., compostable packaging.

¹³ For more information, see: https://policy-lab.ec.europa.eu/news/harmonising-waste-sorting-labels-across-eu-2023-05-02_en#:~:text=Here,%20at%20the%20EU%20Policy%20Lab%20we%20set%20up%20a

- **Residual Waste:** This fraction retains its Nordic colours—black for residual waste—given their strong recognition and alignment with consumer expectations.
- **Glass:** This fraction matches the existing EU colour scheme for glass.
- **Metal and Wood:** Colours align with the Nordic system, using dark grey for metal, to match the colour of metal materials, and brown for wood, ensuring consistency with established practices.
- **Biowaste:** A different shade of green from the Nordic system was selected to match general EU colours related to food waste.

It should be noted that composite materials in this prototype are covered by the “cartons” fraction, which currently refers only to fibre-based composite materials. Plastic- or glass-based composites are not reflected in this design. Future prototypes might need to account for these materials as well, an insight drawn from stakeholder consultations, although this might not be needed if these composites are commingled with the main material. These consultations also highlighted challenges associated with composite packaging, including country-specific thresholds for defining the main component of composites, which may diverge from the EU threshold of 5% (e.g., in Germany).

Figure 3 Colour scheme of the first prototype

Colour Scheme of the First Prototype



The Nordic Waste Labelling Meta Fraction Colour



Cross European Colour Schemes



Source: Authors' elaboration

3.1.2.3. Naming and adaptability

The naming conventions reflect a deliberate effort to balance technical accuracy with public understanding. For some labels, the tension between regulatory compliance (material-based definitions) and user-friendliness remains a key challenge, particularly for complex materials like fibre-based composite packaging that includes layers of different materials and the technical term is not commonly used or known by consumers. For other labels, such as metal and wood, the choice of colour and terminology is relatively straightforward as they correspond directly to the material itself. However, some potential for confusion remains, as the labels currently apply exclusively to packaging items. For example, the label "wood" could be unclear to users who may not immediately associate it with wooden packaging. While terms like "wooden packaging" could provide greater clarity, they may be too lengthy and inconsistent with the material-focused approach of the overall labelling system.

The term “**residual waste**” was chosen as it is widely used across MS, although other terms such as “mixed waste”, “non-recyclable” or “refusal” are also common. Unlike the other labels, it holds a distinct

status as it does not identify a specific material but rather represents the leftover fraction where packaging or materials that do not fit any of the other categories are disposed of.

The naming of the **“plastic & cartons”** category reflects a deliberate effort to balance material identification with public understanding. During consultations within the work team, it was acknowledged that while labels must accurately refer to and identify materials, they also need to be easily understood by citizens. For this reason, the term “cartons” was chosen as it aligns with commonly understood language, particularly for fibre-based composite packaging such as beverage cartons. However, this approach presents challenges. Not all beverage cartons are made from the same material, and using a single label for such packaging might create inconsistencies with the material-based requirements of the provisionally agreed Packaging and Packaging Waste Regulation (PPWR). These shortcomings highlight the inherent tension between technical accuracy and user-friendliness, which the development of the prototype seeks to address. As part of the iterative process, these challenges are being critically assessed in collaboration with project team experts to inform the development of a second prototype. Further refinement and expert input will be essential to align naming conventions with both regulatory requirements and practical user needs.

Figure 4 Prototype 1 – Plastic & cartons fraction and cardboard & paper fraction



Source: Authors' elaboration

For the **“biowaste” label**, the prototype offers four variations: “biowaste”, “food waste”, “biowaste garden”, and “compost” (see Figure below). These variations differ in both the naming¹⁴ and the design of their corresponding icons. Their purpose is to test in the participatory workshops which terms and icons are most effective in facilitating the proper sorting of different types of bio-waste and compostable packaging. Naming variations like “compost” and “biowaste garden” aim to capture different regional terminology to be tested in workshops with citizens and stakeholders. There is a potential confusion between ‘biowaste’ terminology and bio-based (compostable) packaging materials, as with one label consumers would not know how to make a difference between home composting and industrial composting. This issue is further explored in the stakeholder consultations conducted by the JRC.

The focus on biowaste specifically reflects its growing policy importance and the significant consumer confusion surrounding this category, particularly with the increasing relevance of bioplastics, which include biobased and compostable packaging. Unlike other materials, compostable packaging requires distinct clarification as may be co-collected with other bio-waste, but in most cases, the word “compostable” applied on packaging refers to industrial compostability rather than home compostability (unless a specific request for home compostability is adopted by one specific Member State, as stipulated in the PPWR, article 9). This distinction is critical for compliance with the provisionally agreed Packaging and

¹⁴ It is also important to consider the requirements of the PPWR directive, which states that the “compostable” label should clearly indicate that the material is not home-compostable (unless the Member State so requires) and should not be discarded in nature.

Packaging Waste Regulation (PPWR). Both industrially and home compostable packaging must not be discarded into nature.

Biowaste labels are also required in a waste sorting labelling scheme aimed at packaging waste because packaging and packaging waste increasingly include compostable materials. As compostable packaging is designed to enter biowaste streams in industrial composting facilities, it is essential to provide clear labels that direct consumers to dispose of such packaging correctly. Without proper guidance, consumers may mistakenly sort compostable packaging into residual waste. Similarly, in the case of industrially compostable packaging (which will be the condition ordinarily foreseen by the PPWR, unless a Member State adopts a specific requirement of packaging to be home compostable) they may mistakenly attempt to compost it at home. Such mistakes may lead to contamination of waste streams or ineffective management, or even increasing littering in natural settings (sea, woodlands, countryside, etc). Therefore, the inclusion of biowaste labels aligns with the broader goal of ensuring that all biowaste, and different types of packaging waste, including compostable materials, are disposed of in the appropriate waste fraction. As a result, naming variations for biowaste were prioritized in the participatory workshops to identify terms and icons that most effectively facilitate accurate sorting behaviour. This issue has also been explored in stakeholder consultations conducted by the JRC.

Figure 5 Prototype 1 – Biowaste naming variations



Source: Authors' elaboration

Furthermore, the prototype includes two alternative designs for the **"glass" label**, differing only in the icon used (see Figure below). The reason for the two different kinds of icons for glass is due to the visual and for some citizens, intuitive difference between clear and unclear glass. These alternatives are evaluated during the workshops to determine which option is clearer and more intuitive for the user. The decision to provide alternative icons for glass stems from the need to address the specific challenges associated with this category. Glass waste is often differentiated into clear and coloured glass, as is the case in the current prototype design, where these fractions are treated separately.

The evaluation of these alternatives during the participatory workshops allows for testing how well users understand the general concept of a "glass" meta-label in relation to its clear and coloured subcategories. This process is critical to ensure that the final design effectively supports both high-level sorting (e.g., all glass) and finer distinctions (e.g., clear vs. coloured glass) in waste management systems.

Figure 6 Prototype 1 – Glass fraction



Source: Authors' elaboration

In addition, the icon from the Nordic Scheme for wood has been redesigned from showing a detailed icon of different kinds of furniture to instead showing a piece of wood in material form. Furthermore, the color from the Nordic Scheme wood label has been modified from being slightly green/brown to making it a warm tone of brown, hence more relatable to the material of wood. These changes have been made to enhance visual clarity, particularly at smaller sizes.

Figure 7 Prototype 1 – Wood fraction














Source: Authors' elaboration

3.2. Participatory Design Workshops

This section describes the methodology used for the 12 participatory design workshops conducted to test Prototype 1 with citizens. These workshops were designed to engage a diverse range of citizens from 6 selected Member States (MS). The countries involved were Italy, Austria, Poland, Estonia, Greece and the Czech Republic. For each country, we carried out two workshops with different samples of participants from the respective countries, involving a total of 245 citizens. The selected countries reflect the diversity of the EU in terms of recycling rates, how citizens commonly sort their waste, population characteristics, and existing approaches to waste sorting labelling¹⁵. Since all workshops, except those held in Italy, were conducted online, we were able to engage participants from various regions within each Member State, ensuring the collection of country-specific insights. The objective was to gather their feedback on the prototype through their individual views and gather citizen needs and insights on a very granular level about the designed waste sorting label system.

Table 1 below compares the colours and systems of the home countries of citizens involved in the workshops indicating potential conflicts between the proposed labelling system and their current one.

Table 1 Waste Fractions, colours and systems in place across workshop countries

Prototype	 COLOURED GLASS	 CLEAR GLASS	 FOOD WASTE	 OTHER BIOWASTE	 PAPER	 CARDBOARD	 BEVERAGE CONTAINERS	 METAL	 PLASTIC	 RESIDUAL
Italy										

¹⁵ For further details see: <https://publications.jrc.ec.europa.eu/repository/handle/JRC135860>

	COLOURED GLASS	UNCOLOURED GLASS	FOOD WASTE	OTHER BIOWASTE	PAPER	CARDBOARD	BEVERAGE CONTAINERS	METAL	PLASTIC	RESIDUAL
Austria	Amenity sites	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Green with 3 circles	Red with 3 circles	Red with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Deposit Refund Schemes	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Green with 3 circles	Red with 3 circles	Red with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Door-to-door / curbside pick-up	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Green with 3 circles	Red with 3 circles	Red with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Drop-off / collection points	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Green with 3 circles	Red with 3 circles	Red with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Home composting	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Green with 3 circles	Red with 3 circles	Red with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
Poland	Amenity sites	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Deposit Refund Schemes	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Door-to-door / curbside pick-up	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Drop-off / collection points	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Home composting	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
Estonia	Amenity sites	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Deposit Refund Schemes	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Door-to-door / curbside pick-up	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Drop-off / collection points	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
	Home composting	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Yellow with 3 circles	Black with 3 circles
Greece	Amenity sites	Blue with 3 circles	Blue with 3 circles	Brown with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Blue with 3 circles	Blue with 3 circles	Green with 3 circles
	Deposit Refund Schemes	Blue with 3 circles	Blue with 3 circles	Brown with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Blue with 3 circles	Blue with 3 circles	Green with 3 circles
	Door-to-door / curbside pick-up	Blue with 3 circles	Blue with 3 circles	Brown with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Blue with 3 circles	Blue with 3 circles	Green with 3 circles
	Drop-off / collection points	Blue with 3 circles	Blue with 3 circles	Brown with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Blue with 3 circles	Blue with 3 circles	Green with 3 circles
	Home composting	Blue with 3 circles	Blue with 3 circles	Brown with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Blue with 3 circles	Blue with 3 circles	Green with 3 circles
Czech Republic	Amenity sites	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Orange with 3 circles	Yellow with 3 circles	Black with 3 circles
	Deposit Refund Schemes	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Orange with 3 circles	Yellow with 3 circles	Black with 3 circles
	Door-to-door / curbside pick-up	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Orange with 3 circles	Yellow with 3 circles	Black with 3 circles
	Drop-off / collection points	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Orange with 3 circles	Yellow with 3 circles	Black with 3 circles
	Home composting	Green with 3 circles	Green with 3 circles	Brown with 3 circles	Brown with 3 circles	Blue with 3 circles	Blue with 3 circles	Orange with 3 circles	Yellow with 3 circles	Black with 3 circles

Source: Authors' elaboration based on European Commission, 2024

The outcomes of the workshops, together with the other research activities, will inform the design of Prototype 2. In the context of participatory workshops, testing refers to the process of evaluating prototypes with citizens to gather insights on their usability, effectiveness, and overall user experience. Testing is a critical phase in the process, allowing creators and developers of solutions to identify potential issues, assess design decisions, and ensure the solution meets user needs and expectations before finalising or launching it.

3.2.1. Design and preparation

Each workshop was designed to engage approximately 20 participants, with a duration of 4 hours. Experienced facilitators, who had prior experience in conducting design-driven participatory workshops and engaging citizens, facilitated all sessions. Citizens were selected according to a set of diversity criteria to ensure that the sample groups mirrored the diverse composition of the general population within the engaged MS.

The workshops were designed to collect individual opinions and insights on how the systems currently in place in the various countries might affect the efficiency and functionality of the new system and shed light on potential requirements regarding the introduction of a new system.

Specifically, the workshops aimed to:

- Evaluate the suitability and understandability of the proposed labelling system.
- Generate insights and evidence to support the design of EU-harmonised waste sorting labels that are understandable, appreciated, and effective.
- Inform and contribute with evidence to the design of the harmonised waste sorting labelling system proposal.
- Actively involve citizens in the development of the prototype, co-create with them and generate innovative concepts.

All workshops actively involved citizens as collaborators in the design process, rather than simply collecting feedback or imposing ideas. After an initial review of the labels, participants engaged in an interactive group exercise focused on co-design. This approach valued the diverse expertise of participants, based on their lived experiences, daily needs, and challenges, making them part of the design process of the system.

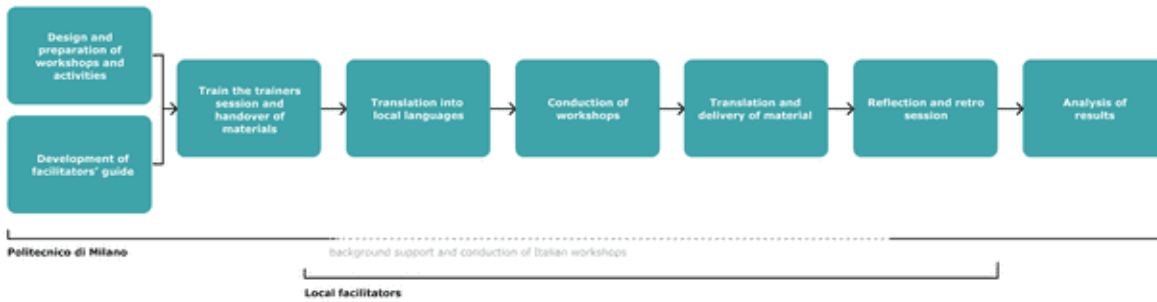
This process went beyond gathering feedback to uncover unmet needs and frustrations, helping improve the waste labelling prototype for better usability and appeal. Addressing *pain points* (i.e., challenges or obstacles users face) was key to identifying critical insights and collaboratively creating solutions that meet real needs, ensuring user-centred and effective outcomes.

The workshops were set up to follow the same structure, ensuring uniformity and comparability of results. Considering the importance of language and cultural aspects, the workshops were delivered in each country's local language by two local facilitators.

The two workshops in each country were run by the same facilitators, with the Italian sessions run by the team of the Department of Design of the Politecnico di Milano, who designed the workshop format, and a total of ten facilitators managing sessions across the remaining five countries. The facilitators were selected based on their experience in workshop facilitation and familiarity with design thinking and co-design methodologies to ensure the collaborative and interactive aspect in all sessions. Their backgrounds included experience and expertise in the fields of service design, applied design thinking, workshop facilitation, creative problem solving, concept testing and user-centred design.

Figure 9 illustrates the process of development and the handover between Politecnico di Milano to the local facilitators, as well as the feedback loop following the conclusion of the workshops.

Figure 8 Process of citizen workshops and responsibilities



Source: Authors' elaboration

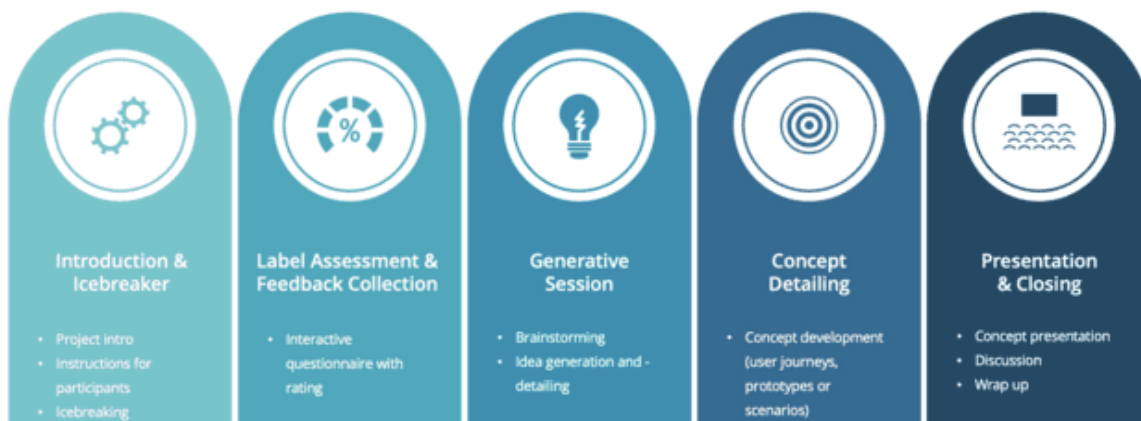
3.2.1.1. Workshop structure and development for online and in-person settings

The materials for the workshops were developed centrally by the team from Politecnico di Milano to ensure the uniformity of the holistic format.

With 10 of 12 workshops being held in an online setting, the activities were developed for an online setting and then adapted for the two in-person workshops in Italy. The rationale behind incorporating a hybrid approach of in-person and online workshops is grounded in the recognition of both the social benefits of "community-building" and the practical advantages of "online accessibility." In-person sessions foster community-building by enabling face-to-face connections and dynamic interactions among participants, which nurtures a stronger sense of collaboration and engagement. Conversely, online workshops ensure accessibility, overcoming geographical constraints and accommodating a diverse range of participants, in addition to reducing logistical complexities and overall costs. This dual strategy combines the community-building strengths of in-person sessions with the inclusivity and flexibility provided by online platforms.

Figure 10 below summarises the structure of the workshop. The following subchapters describe each building block of the workshops, detailing their scope, the activities carried out and tools utilised, as well as their outcomes.

Figure 9 Building blocks and activities of the citizen workshops



Source: Authors' elaboration

1. Introduction and Icebreaker

The short introduction included general information about the project and its aims, giving participants context and encouraging their engagement in the interactive part of the workshop by highlighting the importance of their contribution.

Furthermore, participants were introduced to the overall concept of having a unified system across the European Union that would entail having the same labels attached to packaging components and bins in a matching system.

A short icebreaker was used to onboard people to WooClap - the tool employed for the following label assessment - and start the conversation around the waste sorting topic. WooClap is an interactive platform designed to enhance audience engagement during presentations, lectures, and workshops. It allows for real-time interaction by integrating various types of interactive questions, polls, and rating exercises. An example of such an interaction is shown in **Figure 11**.

The open icebreaker question used was “Which item do you always struggle to dispose of and why?”, thus triggering first reflections on participants’ own needs, pain points and behaviours.

2. Label Assessment

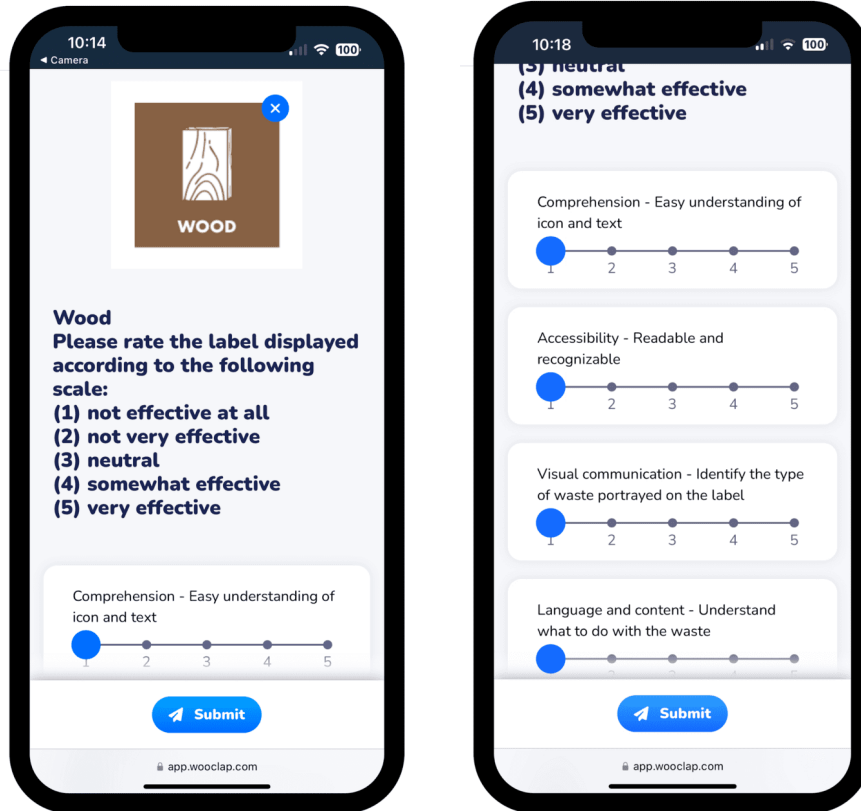
For the assessment of labels, participants could access the assessment either on their phone or desktop and were asked to rate the label according to the dimensions listed in Table 2.

This activity was designed to capture unbiased, individual citizen perspectives. Seeing the labels for the very first time and being asked to rate anonymously and individually, they expressed their personal and spontaneous perception, facilitating the collection of data on various dimensions of each label, ultimately influencing their overall interpretation. Participants saw the complete labels in colour with icon and text (in English, mentioning that the final labels would be translated in the local languages).

Additionally, closely examining the prototype label by label, participants gained an overview of the entire labelling system and entered all subsequent activities with a good understanding of the prototype and its nuances.

An open question for each label gathered participants’ first impressions of the label and allowed space for first discussions, reflections as a group and exchange of opinions and ideas. This idea worked very well in the in-person setting and was amended after the first online workshop in Austria, with facilitators taking a more active role and inviting citizens to voice their ideas in addition to the inputs on WooClap.

Figure 10 Example of participants’ view on a WooClap assessment question



Source: Authors' elaboration

Table 2 Analytical dimensions and types of question for the label assessment

Scale	Dimension	Description	Method
Individual label	Comprehension	How easy is it to understand the text and the icon of the label?	5-point Likert scale
	Accessibility	How readable and recognizable is the content of the label?	5-point Likert scale
	Visual communication	How clear is it, which type of waste is portrayed on the label?	5-point Likert scale
	Language and content	How clear is it from the label what to do with the waste displayed?	5-point Likert scale
	Matching expectations	How well does the label match your expectation of how this kind of waste should be portrayed?	5-point Likert scale
	Coherence and clarity	Do the icon and text provide clear and consistent information?	5-point Likert scale

	Socio-cultural interpretation	What do the colour, icon and text on the label mean to you? What do you think you should throw according to this label? What is your general impression of this label?	Open question
Overall labelling system	Consistency	How consistent is the visual style of all labels?	5-point Likert scale
	User-friendliness	How easy to understand is the labelling system?	5-point Likert scale
	Information hierarchy	How well does the labelling system organize information about the waste type and what to do with it?	5-point Likert scale
	Choice and motivation	Do the labels encourage you to sort your waste the right way?	5-point Likert scale
	Integration with packaging design	How well do the labels fit with the packaging on which they should be applied?	5-point Likert scale
	Overall impression	What is your general impression of the labelling system?	Open question
	Problems and risks	What are problems or weak points that you see?	Open question
	Positive aspects and opportunities	What do you like about it?	Open question

Source: Authors' elaboration

3. Generative Session

In the Generative Session of the workshops, participants worked in small groups of around 5 people to brainstorm and envision concepts for an improved waste sorting system and improvements for Prototype 1.

The aim was to gather ideas on how to make the waste sorting labels more understandable, appreciated, and effective.

"How might we..."-questions were posed to the groups to facilitate the brainstorming. "How might we" questions encourage open-ended, optimistic, and collaborative thinking. This phrasing frames challenges as opportunities, inviting a range of ideas without fear of judgment. It balances structure with flexibility, helping the groups to stay focused on the user's needs while exploring a variety of solutions.

In addition, the three questions listed below were intended to support citizens in thinking beyond the single label and taking a more systemic view. To improve understanding and underline the call to action, the “How *might* we” was adapted to “How *can* we...”:

- *How can we make waste labels more intuitive?*
- *How can we encourage people to care more about proper waste disposal through labelling?*
- *What elements from other successful systems (e.g., food, clothing, safety) could inspire waste labelling innovations?*

After generating as many ideas as possible, each group had to select one promising idea or group of ideas to develop into a more detailed concept.

To support the decision-making process, a prioritisation matrix was provided to help roughly assess the potential impact and the implementation feasibility of different ideas. The selected idea was then further detailed by the group describing the initial problem, the ideated solution, its objectives and a first draft of how such a solution would work.

Figure 11 Ideation templates for the generative session on a Miro board



Source: Authors' elaboration

4. Concept detailing

The subsequent step of the workshops allowed the previously formed groups to continue their idea development and make more detailed considerations on how to transform their ideas into viable concepts.

Participants were then directed to a more development-oriented phase with hands-on activities. They were asked to choose a format for their co-design activity: either developing alternative label designs or customer journeys.

Customer journeys are visual or narrative representations of the steps a user goes through when interacting with a product, service, or system. They map out each stage of a customer's experience, from their initial awareness of a product or service to their decision to purchase, use, and potentially advocate for it. The journey includes various moments when a customer interacts with a product or system, whether directly (like purchasing in a store) or indirectly (such as seeing an advertisement).

The formats were distinct yet complementary options, providing groups with the flexibility to choose one of the two options based on their preferences, expertise, or perceived relevance to their objectives. The flexibility during the concept development allowed for a diverse array of outputs across all workshops,

acknowledging the variability in participants' skill sets and ensuring the exploration of diverse creative possibilities within the waste sorting label system project.

- **Alternative label designs:** This activity concentrated on generating new visual representations and layout configurations for the waste sorting labels. By delving into the creative design process, participants were invited to propose novel label designs to enhance clarity, user appreciation, and effectiveness. They could generate diverse design concepts exploring variations in layout, colour schemes, and symbolic elements, contributing to the evolution of the labelling system's visual identity. This option offered a tangible and visual output that could serve as a direct refinement of Prototype 1.
- **User Journey:** In this activity, participants mapped the end-to-end experiences users might undergo when engaging with the waste sorting labels. Generating visual representations of the entire user journey, including interactions, decision points, and the overall user experience, they provided a holistic understanding of label functionality within the waste management process. This option involved a deeper exploration of the labels in the context of their use within the broader waste management system.

5. Presentation and discussion

The last part of the workshop was dedicated to the reporting and discussion of the outputs generated in the larger group. It is built upon the inputs provided by the participants, fostering a constructive setting for reflection and interaction. The primary objective was to gather additional insights and feedback from participants, complementing the data collected during the earlier stages of the workshop. The facilitators guided the discussion, encouraging participants to share their perspectives on the generated concepts to enrich the understanding of participants' preferences, needs, and expectations, providing valuable input for the iterative design process.

Throughout all the activities, participatory design played a crucial role in integrating bottom-up perspectives, prioritising citizens' needs, and addressing gaps left by traditional top-down approaches. Despite participants lacking formal design expertise, their contributions in co-design activities provided valuable insights and suggestions related to their needs, significantly contributing to the overall refinement of the waste sorting labelling system.

To fully leverage and exploit the opportunities for co-design activities and ensure consistency and comparability of results, a structured process was established to enable the local facilitators to execute the workshops according to the methodology described in this chapter.

3.2.1.2. Enablement of facilitators and training of the trainers

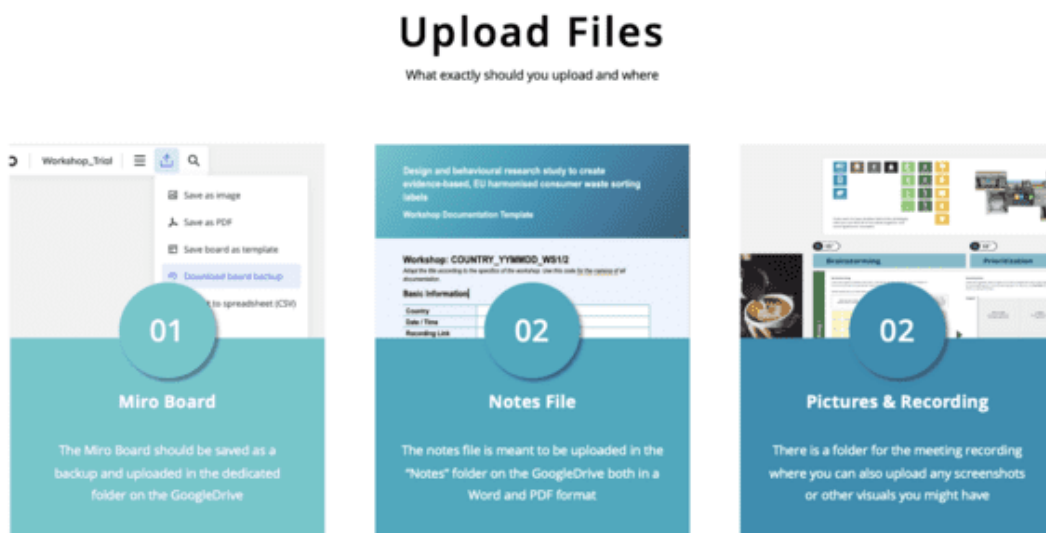
The ten local facilitators were trained to deliver the workshops according to the methodology and to gather impressions and insights on the attention points raised around the prototype. There were two facilitators for each of the participating Member States: Austria, Poland, Estonia, Greece and the Czech Republic. The workshops in Italy were conducted by the group from Politecnico di Milano, which also developed the workshops and trained the other facilitators. The prepared templates and materials were shared with the facilitators in advance, followed by a detailed train-the-trainers session to provide further instructions and allow for discussions and questions. The materials included:

- **Facilitators' guide:** The digital guidebook for all facilitators of the workshops provided a step-by-step guide with background on the project, the preparation of the workshops, their conduction, and the translation and delivery of the produced material (see example **Figure 13**).

- **Workshop slides:** A slide deck to be used to introduce participants to the project and explain to them the single activities of the workshop.
- **WooClap:** A ready-made questionnaire for the label assessment activity, including all rating dimensions and visuals of the labels in the correct order.
- **Miro Board:** The template for the generative session and concept development included an introductory video to onboard participants to the tool and all the elements needed for the single groups to ideate during the generative session and prepare their concepts.

All activities and templates (Slides, WooClap, Miro Boards) were prepared in English and translated into the local languages by the facilitators themselves to support the set-up according to the workshop structure described in chapter 3.2.1.1 and ensure uniformity of workshop conduction and data collection.

Figure 12 Impressions from the Facilitators' Guide



51

Source: Authors' elaboration

The 'Train-the-trainers' session was designed to prepare the facilitators — already experts in facilitation, team leading and co-design — to effectively and uniformly conduct the workshops. The session was run by the team from Politecnico di Milano, supported by Open Evidence, to equip all facilitators with the knowledge and materials needed to deliver the content confidently and effectively to their target audiences.

Facilitators were previously provided with the materials for the workshop, and the session itself guided them through a sample agenda, starting from the project context and walking through all activities, attention points, how to make the best use of resources provided, adapt them as needed, and ensure they are accessible to their target audience.

The process of facilitator enablement had a series of objectives:

- **Consistency:** Ensures that all trainers deliver the same content and messages, promoting uniform standards across all workshops and comparability of results.

- Scalability: Allowing the autonomous conduction of workshops by facilitators in the local languages and management of the resources with only little additional support like an initial tech check and the count of participants before the start of each workshop.
- Empowerment: Enable and empower facilitators to confidently deliver the sessions and be well prepared for questions from participants to maximise impact.

3.2.1.3. Participants & recruiting

The participants for each workshop (245 in total) were recruited to ensure diversity, capturing a broad range of perspectives and yielding comprehensive, relevant, and broadly applicable testing outcomes. This diversity introduced varied experiences and viewpoints, helping to identify potential barriers and challenges that may otherwise be overlooked.

Although the participant count was relatively small compared to the total population, the selection aimed to reflect the real-world demographic likely to interact with or be affected by the prototype. This approach ensured that feedback was representative of a wider population, enabling the prototype to meet the needs of all citizens, not just a narrow subset.

Diversity also fostered creativity, as collaboration among individuals from different backgrounds led to innovative ideas and new solutions. This inclusivity mitigated biases and blind spots, resulting in fairer, more objective testing outcomes that could benefit the community.

Particularly important was addressing the needs of people with varying abilities, digital literacy, accessibility requirements, and language preferences. This inclusivity ensured the labelling system could be designed to be accessible and usable for everyone.

The following diversity criteria were applied when recruiting participants:

- Age
- Gender
- Place of Origin (both within the country of the workshop and beyond)
- Demographics (capital, city, town, rural areas)
- Educational background
- Socioeconomic background
- Diverse abilities and inclusion of persons with disabilities with a specific focus on visual impairments

Overall, 245 participants were recruited for the workshops with the splits shown in Figure 14, according to the mentioned criteria:

Figure 13 Statistics of citizens' workshop participants

Gender



Female: 50,38%
 Male: 49,23%
 Non-binary/other: 0,38%

Demographics



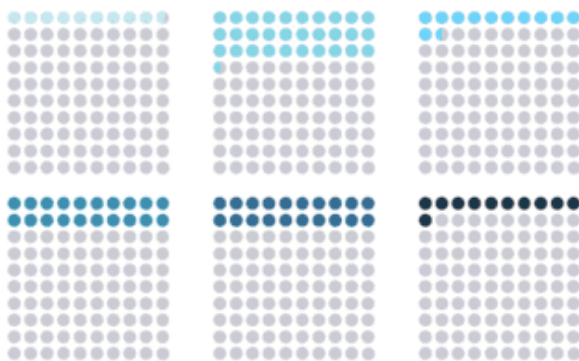
Big city / capital: 26,92%
 City, not specified: 33,08%
 Small city: 13,08%
 Village or small town: 26,92%

Age Groups



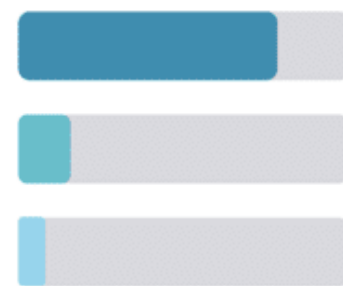
18-30 years old: 28%
 31-45 years old: 28%
 46-60 years old: 27%
 60+ years old: 17%

Educational background



Primary or secondary education: 9,61%
 Highschool diploma: 31,53%
 Vocational Training / Apprenticeship: 11,53%
 University degree, not specified: 19,62%
 Higher Education, not specified: 16,56%
 Master Degree / Postgraduate / PhD: 11,15%

Accessibility



No impairments: 78,03%
 Visual impairment: 15,61%
 Physical impairment: 06,36%

Source: Authors' elaboration

3.2.2. Execution of the workshops

The series of workshops started with two in-person workshops carried out in Italy, followed by a short break for a few days to complete the material translation and set up of the workshops for all the online settings.

Starting with Austria, each pair of facilitators held workshops with participants from their country over two consecutive days, applying the same methodology with a new set of participants each time.

After the conclusion of the workshops, a reflection and exchange session was held among all facilitators. This session provided an opportunity to come together and collectively reflect collectively on common themes, differences, and the overall conduction of the workshops.

The outcomes of this session kicked off the elaboration of results.

3.2.3. Elaboration of results

The results were analysed following the structure of activities of the workshops, considering the various kinds and formats of input delivered by the facilitators after the conclusion of all workshops. details the materials delivered for each of the activities and how the output was analysed.

Table 3 Workshop materials and outputs for analysis

Activity	Materials	Output
Label Assessment	WooClap extract with quantitative rating data and written feedback for each label Facilitators' notes	Qualitative and contextual feedback on various dimensions of individual labels and the overall labelling system. Additional qualitative feedback to enrich the assessment results from open questions and discussion.
Generative Session	Miro board, translated into English language with all notes and content produced by participants Completed canvases (prioritisation matrix & idea card) Facilitators' notes	Diverse ideas for improving Prototype 1, enhanced clarity, appreciation, and effectiveness of waste sorting labels. Range of creative concepts generated.
Concept Development	Miro board, translated into English language with all notes and content produced by participants Completed canvases (alternative label designs and/or user journey) Facilitators' notes	Tangible and visual outputs reflecting various aspects of the labelling system in a visual re-design of the labels or a visual journey of a citizen to illustrate the novel concept
Presentation of concepts and general discussions	Facilitators' notes Workshop recordings	Additional insights and feedback from participants and considerations from the in-group activities are to be considered in the iterative design process

Source: Authors' elaboration

Throughout the earlier phases of the project, a series of topics emerged, including hypotheses formulated by the project team on themes and **issues to be examined with particular attention** during the workshops. These topics were explored without directly guiding participants toward them, allowing insights to arise organically.

- **Compostable materials, compostable paper and plastics:** Uncertainty around how citizens currently distinguish compostable materials and how they are perceived. Verify whether the labelling clearly distinguishes compostable materials from other waste types, ensuring users can easily identify compostable paper and plastics for proper disposal.
- **Country-specific knowledge:** Evaluate how the system incorporates country-specific and local regulations and guidelines, ensuring labels align with country-specific waste management

standards and are easily understood by residents in different regions. Assess cultural differences, risks and opportunities.

- **Multi-component packaging:** Assess whether the labelling system guides users on handling packaging with multiple materials (e.g., plastic and paper), helping them separate components for accurate disposal. Understand current practices and difficulties when disposing of multi-component packaging.
- **Interrelation of waste sorting labels and other labels on packaging:** Examine how waste sorting labels interact with existing product labels (like nutritional or other information, recycling symbols or material indications) to prevent confusion and improve clarity on disposal requirements.
- **Deposit Return Systems:** Investigate existing deposit return systems, their usage, and perceptions. Assess the system's integrability, ensuring it aligns with deposit return schemes, ensuring labels clearly indicate items covered by such programs and provide information on deposit redemption points.
- **Colours and distinction of colours:** Test that colours used in labelling are perceived as distinct, universally recognised, and accessible, including for users with colour vision deficiencies, to support quick and accurate waste sorting.
- **Information needed (communication & campaigns):** Assess the additional information and educational campaigns required to support label understanding. Identify any communication gaps that could hinder correct disposal behaviours, including the format, how information should be provided, and the perception of communication about waste disposal and recycling.
- **Waste Sorting labels on receptacles and packaging:** Reflect on the connection of packaging and receptacle and the necessary elements for recognisability. Evaluate the effectiveness of sorting labels on waste receptacles, ensuring they clearly indicate which waste type belongs in each bin to simplify user sorting. Verify how packaging labels can provide unambiguous sorting instructions, guiding consumers on where each type of waste should be discarded according to the material.
- **Multi-country labelling:** Test if the labelling system can adapt across countries, accommodating various waste management practices while maintaining clear, universal symbols and instructions.
- **Accessibility and Inclusivity:** Assess the labelling system's accessibility and usability for vulnerable groups, such as the elderly and individuals with disabilities, to ensure it meets diverse needs.
- **Receptacles, home organisation and apartment buildings:** Examine how well the labelling system supports waste separation in home environments, considering the number of receptacles needed and the dynamics in shared spaces like apartment buildings.

The single points are picked up again in the final part of the analysis reflecting on the workshop results through each of the lenses.

3.3. Online Survey

This section describes the methodology used for designing and conducting an online survey with ~800 participants from each of 21 EU MS (N=16,380 in total). It presents the survey structure, the geographical distribution and sample characteristics, as well as the main quality measures adopted in the data collection.

3.3.1. Survey structure

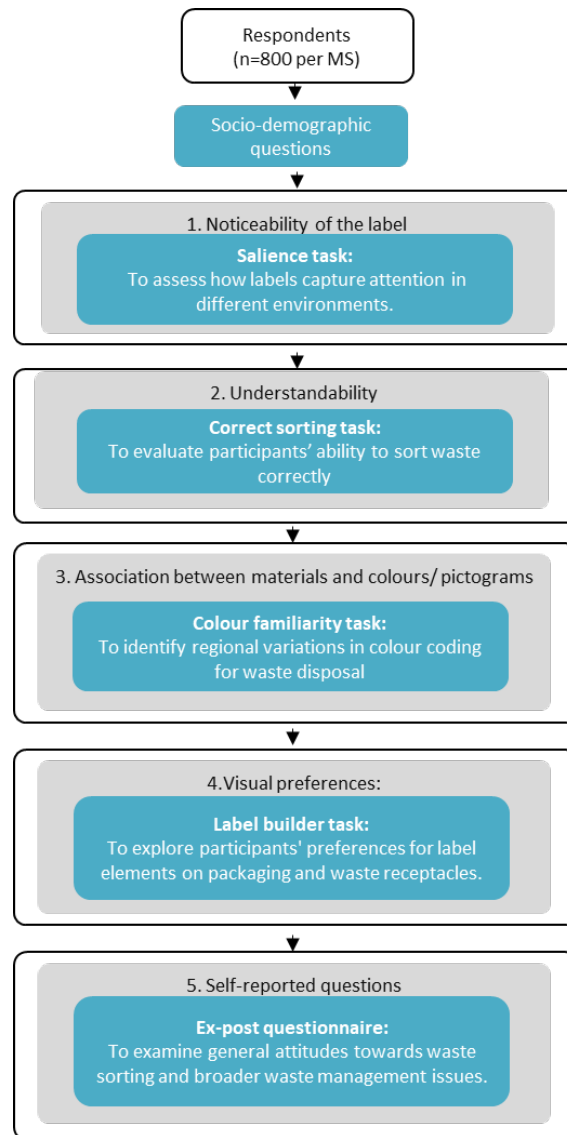
According to the ToR, the objective of the survey is to (i) evaluate various aspects of the Nordic and other relevant pictogram systems, (ii) systematically collect perspectives, preferences, and feedback regarding label elements on participants, and (iii) investigate how key label elements impact key consumer perceptions and reactions.

To meet these objectives, the survey is divided into different sections that address the research questions related to Objectives #1 and #2, as outlined in

Figure 15.

For a more detailed description of the online survey, refer to Section 5.3 of the Annex. This section provides an in-depth explanation of each part of the survey, including its objectives, key dependent and independent variables, and the experimental process for each task. It describes the treatment variations applied (both within- and between-subjects) and outlines the key outcome variables and question types used in the study.

Figure 14 Online survey flowchart



Source: Authors' elaboration

The first section of the survey focuses on collecting **socio-demographic information** from participants. These questions are designed to capture gender, age, country of residence, education, type or residence, metropolitan area, and monthly income. The primary goal of this section is to ensure that the sample is representative of the population across these variables (see Section 5.3.1)

Next, the **Salience task** is used to assess how different label elements impact the noticeability of waste sorting labels. Participants complete a task designed to measure the salience of different waste sorting labels. The primary objective is to understand how different label elements influence noticeability. Noticeability is evaluated by estimating participants' likelihood to point to waste sorting labels in the images presented when asked to identify the elements that they believe are the most important in helping them sort waste. Specifically, this involves tracking whether participants click on the waste sorting label(s) shown on each image at least once, among all clicks combined. This measure helps determine whether people notice the label. For a detailed explanation of how noticeability is operationalised and measured, including specific dependent variables, please refer to Section 5.3.3. Noticeability was measured in different experimental treatments. The varied label elements include text presence (labels with or without text indicating the material), label colour (black and white vs. primary colours), presence of other labels (Green Dot label, SUP, Triman Logo vs. no additional label), and bin-label colour matching (whether the

label colour matches the colour of the corresponding bin). The rationale behind these treatments is supported by findings from the literature review conducted by the JRC¹⁶, which highlights the significance of colour, text, and label presence for waste sorting effectiveness. On the other hand, the consideration of bin-label colour matching reflects the practical challenge of maintaining various bin colours across countries, as changing them would incur significant costs and inconvenience.¹⁷ These factors are systematically varied across the different images presented in the task, as detailed in Table 31 in Section 5.3.3. Participants are shown, in random order, three product images and one bin image, and are required to click on the waste sorting labels of each image as quickly and as accurately as possible. The requirement for accuracy and speed were communicated to participants in the instructions. For examples of images of products related to the salience task, please refer to Figure 105 in Section 5.3.3. For examples of the visual representation of the packaging experimental treatments refer to Figure 104 in Section 5.3.3. This task addresses Research Question 5 and is used to determine if labels effectively capture attention across different environments. Please refer to Section 5.3.3 for details.

The **Correct sorting task** aims to evaluate participants' ability to correctly sort waste in different experimental environments thanks to the waste sorting labels applied to both bins and packaging. This task is intended as a matching exercise, where participants match on-pack labels with the corresponding receptacle labels. Each participant makes 10 sorting decisions, which are shown to them in random order. Participants can choose to dispose of the entire product in a single receptacle or to separate its components into separate bins, if the product packaging consists of more than one material. If they choose to dispose of materials separately, they are presented with a follow-up interface displaying again the image of the product and focusing on each of its components to sort. For each component, participants are required to select the most appropriate bin based on the provided labels.¹⁸ The images used to show the contextualised labels in this task were designed to vary systematically in key label features to evaluate their impact on sorting accuracy. Specifically, the treatment variations include:

1. **Label Colours:** Labels were presented in one of two different colour schemes—black and white or primary colours. The primary colours are those of the Nordic scheme (e.g., purple for plastic, green for glass).
2. **Presence of Text:** Some labels included text explicitly describing the material (e.g., "Plastic" "Glass"), while others were presented without text. This variation assesses whether text facilitates sorting accuracy, particularly in cases of colour mismatches.
3. **Presence of Other Labels:** Additional labels such as the "Green Dot" or "Triman logo" were included on some packaging. This variation examines whether the presence of multiple labels disturbs participants' ability to focus on and correctly interpret the waste sorting label.
4. **Presence of Component Pictograms:** Some labels included pictograms that indicate how to sort each individual components of the product (e.g., a cap or bottle), while others did not. This

¹⁶ <https://publications.jrc.ec.europa.eu/repository/handle/JRC134206>

¹⁷ <https://op.europa.eu/en/publication-detail/-/publication/037cdea9-b2be-11ef-acb1-01aa75ed71a1/language-en>

¹⁸ For instance, for a product with a bottle and a cap, the participant would see the following prompts:

Cap: "You have indicated that different parts of the product packaging need to go in separate bins. Please select the appropriate disposal bin for the cap. Note that you can enlarge the image by clicking on it."

Bottle: "You have indicated that different parts of the product packaging need to go in separate bins. Please select the appropriate disposal bin for the bottle. Note that you can enlarge the image by clicking on it."

variation tests whether component-specific icons improve comprehension for sorting products with multiple parts.

5. **Colour Match/Mismatch Between Bin and Label:** The colour of the label on the product was either matched or mismatched with the colour of the corresponding disposal bin. The colour mismatch condition explicitly considers regional differences in waste sorting practices across EU MS. By incorporating participants' self-reported colour-material associations (from the Colour Familiarity Task, see Section 5.3.4), the study accounts for variations in performance due to alignment or misalignment between experimental labels and local conventions.

For examples of images of products related to the understanding task, please refer to Section 5.3.4. This task addresses R.Q.5 and R.Q.6 as it measures participants' comprehension of waste sorting labels and evaluates the effect of waste sorting labels on participants' ability to sort waste correctly. Sorting accuracy is operationalised as the proportion of correctly sorted components relative to the total number of components in each product. Participants receive a full score if all components are placed in the appropriate bins, partial credit if only some components are sorted correctly, and no credit if none are correctly sorted. This approach ensures that sorting performance is assessed consistently across various levels of the product complexity. Please refer to Table 33 in Section 5.3.4 for further details.

The **Colour familiarity task** is used to identify regional differences in colour coding for waste disposal and control for colour familiarity in the salience and understanding tasks. Participants answer questions to indicate the colours they typically associate with different types of waste materials.

The **Label Builder Task** is used to identify participants' preferences for label elements, respectively for packaging and waste receptacle labels. For each label element, participants could select their preferred option from the following categories while always having the option to indicate they do not know or do not have a preference. The elements and available options are:

1. **Colour of the label:** Participants could choose between colour labels (colour palette) or black-and-white labels.
2. **Presence of text:** Participants could choose whether they prefer to have text indicating the waste material on the label or not.
3. **Language of the text:** Participants could select whether they preferred the text to appear in their own language or another commonly understood language or both.
4. **Inclusion of a material identifier:** Options included labels with or without material codes (e.g., PAP 22 for paper).¹⁹
5. **Presence of a QR code:** Participants could choose labels with or without a QR code linking to additional information.
6. **Use of multi-component pictograms:** Participants could choose whether there are, in addition to waste sorting labels, pictograms indicating which material is each of the components of a product (e.g., cap and bottle) made of, or not.

¹⁹ Commission Decision 97/129/EC (28 January 1997) established a voluntary system for identifying packaging materials to facilitate waste sorting. In November 2023, the European Parliament adopted the Packaging and Packaging Waste Regulation (PPWR), making this system mandatory and introducing clearer labeling and packaging design requirements to improve recycling rates and reduce material complexity (Recital 74).

Please refer to Section 5.3.6 for more details on the Label Builder task.

The **Ex-post questionnaire** is used to explore general attitudes towards various aspects related to waste sorting and the broader context of waste management. It serves two purposes: (1) to provide covariates for analysing results from other tasks and (2) to offer standalone insights into participants' attitudes, behaviours, and perceptions regarding waste sorting and waste sorting labels. The questionnaire covers six distinct areas:

1. **Salience, Understanding, Attractiveness, and Utility of Waste Sorting Labels:** Participants are asked about the importance, visibility, comprehensibility, attractiveness, and consistency of waste sorting labels on both product packaging and waste receptacles.
2. **Motivations, Opportunities, and Abilities (MOA):** Drawing from the MOA framework, questions explore participants' personal motivations, perceived opportunities, and self-reported confidence in their ability to engage in proper waste sorting practices.
3. **Environmental Responsibility and Impact:** Participants are asked about their perceived responsibility for reducing environmental impact through waste sorting and their beliefs about the extent to which individual actions (such as proper sorting) can address larger environmental challenges.
4. **Perceived Barriers and Community Support:** Questions focus on difficulties encountered in sorting waste in their country, the availability and quality of waste sorting facilities, and the types of support or incentives participants commonly encounter, such as financial rewards, feedback mechanisms, or information campaigns.
5. **Social Norms:** This section investigates participants' views on socially accepted standards and expectations regarding waste sorting, as well as their perceptions of others' behaviours and attitudes. For example, questions ask participants to estimate the importance their peers place on waste sorting, revealing potential gaps between personal beliefs and perceived societal norms.
6. **Familiarity with and Use of QR Codes:** Participants are asked about their experience with scanning QR codes, including frequency and specific use cases. This explores the potential accessibility and usage of QR-coded labels as it is often found that QR codes are appreciated overall but actually little used (Gaudeul and Krawczyk, 2023).²⁰

This section addresses R.Q.1, focusing on perceived challenges and needs related to waste sorting labels, and R.Q.4, by examining self-reported satisfaction with the current waste sorting systems in participants' countries. For detailed questions and answer options, refer to Section 5.3.7 for details.

Task order rationale. The structure of the survey was carefully designed to minimize potential biases and priming effects, ensuring the validity and reliability of participant responses. The socio-demographic questions were positioned at the beginning to collect essential background information before participants engaged with the tasks and to screen out participants. Following this, the salience task (measuring noticeability) and the correct sorting task (measuring understandability) were placed early in the survey to capture participants' instinctive, unprimed reactions to the labels. This ordering ensured that these

²⁰ Gaudeul, A. and Krawczyk, M., Using QR codes to access food information: a behavioural study with European consumers, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/358391, JRC134602.

responses were not influenced by later questions, which asked participants about their preferences, beliefs and perceptions of waste sorting and waste sorting labels (overall and design elements).

3.3.2. Geographical coverages and quotas

Table 4 outlines the geographical distribution of countries included in the online survey, grouped by region. This geographical distribution ensures a broad representation of different parts of Europe, covering Western, Southern, Northern, and Eastern Europe.

Table 4 Online survey – Geographical coverage

Geographical area	Online survey
Western Europe	Austria, Belgium, France, Germany, Ireland
Southern Europe	Greece, Italy, Portugal, Malta, Spain
Northern Europe	Denmark, Estonia, Lithuania, Latvia, Sweden, Finland
Eastern Europe	Czech Republic, Poland, Romania, Slovakia, Hungary

Source: Authors' elaboration

To ensure that the sample is representative of key variables and, the survey targets specific quotas. Quotas are used as a means to achieve a certain level of representativeness of the sample by ensuring that selected characteristics are proportionally reflected in the sample as they are in the target population. These quotas are divided into two categories: hard quotas and soft quotas. Hard quotas are strictly enforced, requiring the sample to match the exact proportions defined for these categories. In contrast, soft quotas were used to monitor the overall distribution within the sample and we allowed for more flexibility to enhance fieldwork feasibility, particularly when targeting difficult-to-reach groups such as people living in rural areas or low-income people. Overall deviations of up to $\pm 10\%$ were considered acceptable for soft quotas. Table 5 below outlines the categorization and composition of the quotas used in the survey. Each quota is aligned with the demographic composition of the population in the respective countries, based on the official Eurostat and United Nations Statistics Division (UNSD).

Table 5 Online survey – Quota composition

Quota	Type of quota	Quota composition	Source
Gender	Hard	Male/Female	Eurostat
Age	Hard	18-24, 25-34, 35-44, 45-54, 55-64, and 65+	United Nations Statistics Division (UNSD)
Urban/Rural	Soft	Urban/Suburban/Rural	United Nations Statistics Division (UNSD)

Education	Soft	Primary/Secondary/Tertiary	Eurostat
Income	Soft	First quartile/Second quartile/Third Quartile/Fourth Quartile	Eurostat

Source: Authors' elaboration

3.3.3. Quality measures

The online survey includes several measures to exclude potential bots and low-quality respondents, such as participants identified as speeding (with a cut-off time of 5 minutes). It also features two attention-check questions with clear instructions for participants on how to respond. In addition, any participant who completes the survey faster than the 5th percentile of the pilot duration distribution and fails at least one attention check is excluded, except for those aged over 70. Participants who fail both attention checks are immediately removed, and their slot is filled by a new respondent. In addition, a qualitative review of open-ended responses is conducted to exclude any participant providing offensive text; identified participants are not included in the dataset and are replaced by new participants.

4. Conclusions

In this section we present the main findings from the participatory design process and the online survey.

4.1. Participatory design workshops

The results from the participatory design workshops with citizens are based on the input gathered from 245 participants during 12 workshops conducted in 6 different countries. Given the relatively small number of citizens engaged compared to the online citizen survey, the results are to be seen with a qualitative focus and complement the quantitative survey findings. The inclusion of rating exercises and quantitative measures in the participatory design workshops aimed to stimulate participants' reflections and identify differences and gaps between countries. Combined with the results of the survey, the data collected from the workshops aims to offer useful insights to inform and steer the development of Prototype 2.

4.1.1. Country Insights

The following section details the key insights from each country, as emerged during the conversations throughout the session, including the rating exercises and the concept development. It highlights the main topics that participants repeatedly discussed when reflecting on waste labels, related systems, and processes.

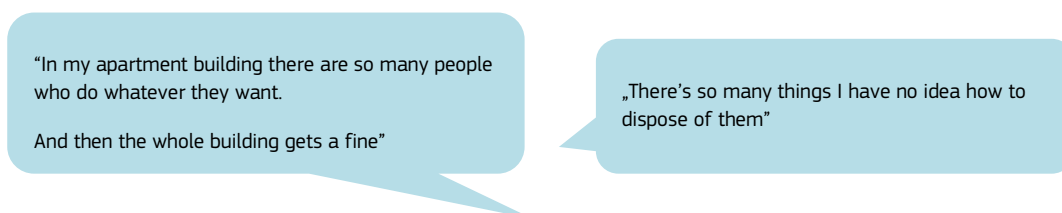
All insights are framed from a citizen's perspective. In the following subchapters, which assess the single activities, a more neutral approach towards the analysis is adopted.

4.1.1.1. Italy

The first two workshops were conducted in person in Milan at Politecnico di Milano. The in-person format provided an opportunity for participants to engage in direct discussions and reflect on waste sorting and individual behaviours.

A frequent topic of discussion was the regional disparities in regulatory frameworks, as well as the number of containers and sorting practices, which differed significantly from region to region and even municipality to municipality in Italy. Participants noted that this variation substantially increased the difficulty of learning the system and adapting practices accordingly. Additionally, the lack of education and awareness on recycling practices was discussed, acknowledging the complexity of the system and pointing out the existence—or complete absence—of information, particularly about handling composite packaging, i.e. packaging made from multiple components that cannot be separated easily by consumers or contaminated packaging and how to dispose of them correctly. **Figure 16** and **Figure 17** provide direct and tangible examples of insights gathered during the workshops.

Figure 15 Voices from Italy: Reflections from participants on country specificities



„I just moved to a different municipality, even within the same region – and suddenly all the rules were different. That’s absurd”

Source: Authors’ elaboration

- **Communicating the after-effects of recycling:** A recurring topic during the discussions was the insufficient public communication on how the Italian recycling system works and the unseen efforts that sustain it. For instance, glass is not separated by citizens, because special sorting machines handle it during the recycling process. However, many citizens are not aware of this and assume glass is not being recycled properly anyway.
- **Incentives and fines:** Participants reflected on the existing system of fines in Italy²¹ applied for improper sorting, discussing its efficacy and expressing a need for more positive incentives to encourage citizens to sort their waste correctly. They emphasised the importance of motivating citizens with mainly positive incentives, particularly as they adapt to a new labelling system. In parallel, participants discussed how in several municipalities, the current system can unfairly penalise entire groups of people, particularly those living in apartment buildings. For example, when a sorting mistake is made by a single unit, the lack of tracking mechanisms prevents to spot the responsible person and thus the fine from being attributed to the responsible individual, resulting in all residents in the building being fined collectively. This was seen as a significant flaw in the system, discouraging collective compliance and creating frustration among residents.
- **Technology:** New technologies, such as QR codes, mobile applications, and Near Field Communications (NFCs), were frequently mentioned as potential tools to make waste sorting more intuitive, easy and accessible.
- **Education:** Education was a prominent topic, especially regarding current practices. Participants noted that waste sorting is typically learned at home—or not at all. Non-native speakers and immigrants often struggle due to the lack of accessible information, highlighting the need for more inclusive educational initiatives.

Figure 16 Participants designing new labels during the first workshop in Italy

²¹ https://www.mase.gov.it/pagina/recycling-and-waste-management#sanctions_regime



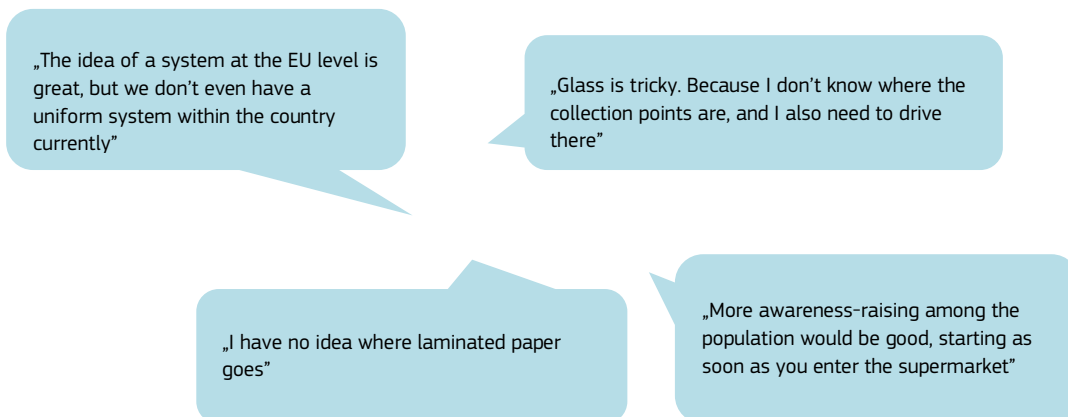
Source: Authors' elaboration

4.1.1.2. Austria

The Austrian workshops engaged participants across two online sessions. Among the participants, three reported non-specified visual impairments. After an initial warm-up session to build comfort in the workshop setting, vivid discussions emerged and continued through the generative session and the concept development phases.

Among the current practices and country-specific characteristics highlighted were the fact that glass disposal is not integrated into the home waste disposal system in Austria, and glass needs to be taken to special containers located in public spaces. Also, biowaste containers are not available in all regions and municipalities across the country, which often results in biowaste being disposed of as residual waste when home composting is not an option. Confusion frequently arises when dealing with composite packaging or items contaminated with food, as participants struggle to determine the correct disposal method. **Figure 18** and Figure 19 provide examples of direct and tangible insights gathered during the workshops.

Figure 17 Voices from Austria: Reflections from participants on country specificities



Source: Authors' elaboration

The points below illustrate the main insights and recurring themes gathered by the facilitators:

- **Availability of bins:** Participants emphasised the critical need to increase recycling bin availability in public spaces. They proposed replacing individual garbage cans with multiple bins

designated for waste separation, which they believed would significantly enhance community awareness about recycling and help reduce residual waste.

- **Best practices in other countries:** Participants highlighted the value of learning from countries and contexts that recycle well and have in place successful recycling systems, especially Nordic countries like Sweden or Denmark. They thought that studying these practices and adapting them locally, would help create better systems that engage communities and improve sustainability efforts.
- **Communicating the after-effects of recycling:** A strong desire emerged to understand the fate of waste after disposal. Participants encouraged manufacturing companies to provide transparent and uniform reporting on packaging, which they saw as essential for an effective waste management system. Many expressed disenchantment with the overly optimistic portrayal of recycling, calling for a realistic understanding of the process and its actual environmental impact.
- **Consistent labelling between packaging and containers:** Participants reinforced the need for consistent labels on packaging to indicate the correct disposal receptacle. They agreed with the key characteristic of the proposed standardised waste system, with labels that maintain a uniform format for easy identification, simplifying the waste disposal process for consumers, and enhancing understanding regardless of location.
- **Corporate Responsibility:** Participants felt that companies need to step up and take the lead on sustainability by reducing packaging and selecting sustainable materials. If businesses focus on this, citizens could be more motivated to recycle, making a much bigger impact together. Seeing companies making efforts to produce products with sustainable materials is specifically identified as a source of motivation and a pathway to a better future.
- **Education and technology:** A common thread is the importance of educating consumers about recycling and waste management. Suggestions included turning packaging into a learning tool and launching information campaigns to help people understand their role in sustainability and why it matters. Educating citizens about the labelling system is essential for increasing recycling participation. Participants also proposed using technology, such as QR codes, to provide instant access to waste management information, helping individuals recognise how to dispose of items correctly.
- **Incentives and fines:** Participants suggested introducing fines for non-compliance with recycling regulations, especially in shared living spaces, to drive accountability. They also proposed pairing fines with positive incentives, such as return programs, to foster a culture where everyone feels accountable and motivated to recycle.
- **Inclusivity:** The incorporation of braille on packaging labels was proposed to ensure accessibility for individuals with visual impairments, promoting responsible recycling practices for all community members.
- **Simplicity:** Participants stressed the importance of connecting the symbols on the packages to the bins to make recycling a no-brainer. They noted that when the process is straightforward and user-friendly, with people knowing where to toss their waste, more people are likely to participate (thus purporting a positive link between capability and motivation).

Figure 18 Participants presenting their concept during the first workshop for Austria



Source: Authors' elaboration

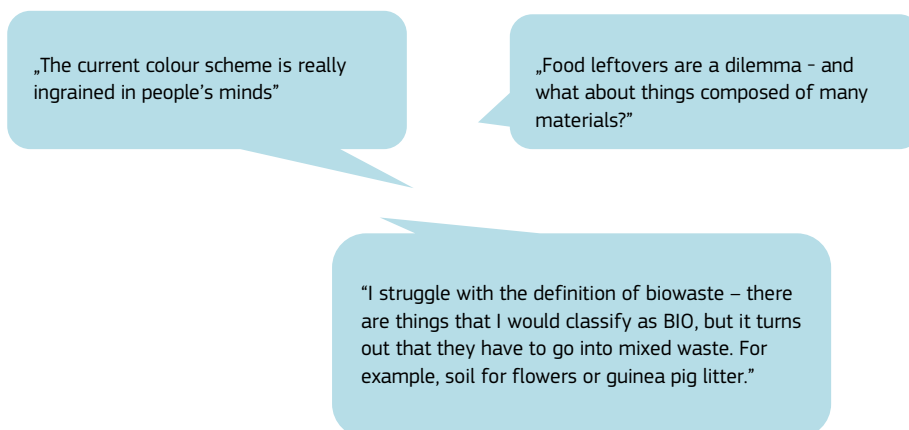
4.1.1.3. Poland

Generally, the labels were very well received during the two Polish workshops, and much of the discussion focused on how to introduce a new system, how it differs from the current one, and the potential risks or challenges of the transition.

Participants highlighted several specific aspects of the current system. First, they noted a strong cultural association between certain colours and materials (see **Figure 20**). The alignment of the new system with these associations, such as yellow for plastic, was well received. However, small deviations, such as the use of brown for biowaste, were immediately criticised.

Cartons and other composite materials packaging types frequently lead to incorrect sorting due to confusion about their disposal. In addition, a significant issue with the current system is the inconsistency between the labels on packaging and those on bins, making sorting not intuitive and unnecessarily complex. Figure 20 and **Figure 21** provide examples of direct and tangible insights gathered during the workshops.

Figure 19 Voices from Poland: Reflections from participants on country specificities

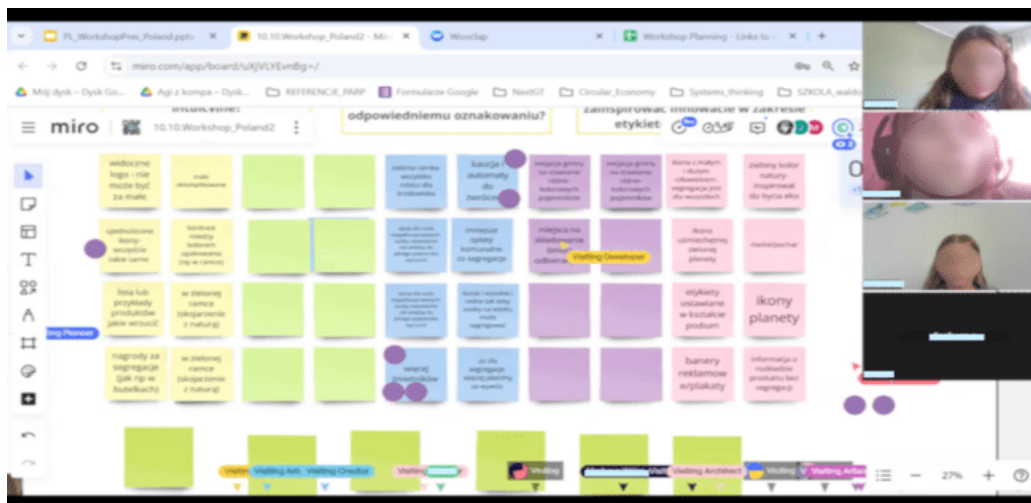


Source: Authors' elaboration

The points below illustrate the main insights and recurring themes gathered by the facilitators:

- **Simplicity:** Participants expressed concern that the proposed label system might become more complicated or detailed, especially regarding the number of bins or receptacles required for separate collection in homes or common areas in buildings. Many participants did not distinguish packaging labels and bin labels in this context. They tend to stick to the existing 5-fraction system that was introduced in Poland some time ago, which is still relatively new and was communicated effectively²². There was notable resistance to further changes to this system.
- **Managing Change:** Existing labels for materials such as plastic, paper, and metal, are perceived as familiar, simple, and well-received. Participants pointed out that any new and unfamiliar labels, or significant changes, need to be communicated clearly and made accessible to ensure adequate education and adoption of the new system.
- **Cost of introduction:** Participants frequently voiced concerns that additional labels could lead to increased costs for sorting with lots of municipalities having to invest in additional resources and machinery. This concern caused indignation in conversations and was often accompanied by frustration from individuals, particularly considering the required contribution also by individuals (to buy new, additional bins) and the space constraints posed by sorting bins in homes and shared spaces. The "Wood" label was a particular point of contention, drawing strong criticism for potentially adding unnecessary complexity and cost.
- **Education:** The importance of clear information and education about the new system was a recurring theme. Participants stressed that an effective educational campaign is critical to ensuring successful implementation and widespread adoption.
- **Technology:** Participants proposed numerous ideas for leveraging technology. Common suggestions during the ideation phase included scanning apps or automatic bins to make the process more intuitive and user-friendly.

Figure 20 A group from Poland brainstorming on new concepts



²² The Polish system includes glass, plastic and metal, paper, bio-waste, and mixed waste as main fractions, see also Rogowska, J., Piątkowska, K., & Głowacz, Z. (2024). Societal Involvement in Household Waste Sorting Behavior in the Context of the Circular Economy: A Case Study of Poland. *Sustainability*, 16(5), 1841. <https://doi.org/10.3390/su16051841>

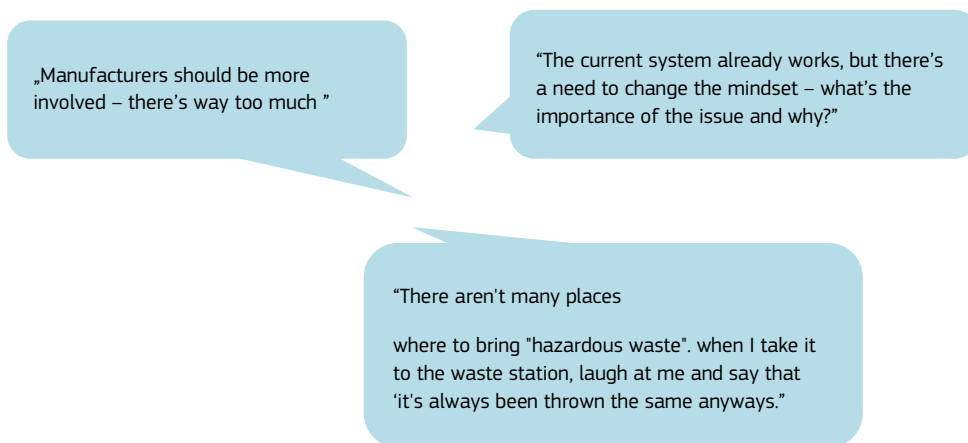
4.1.1.4. Estonia

During the two workshops with Estonian participants, the overall mindset towards the system was very positive. Participants discussed opportunities to integrate the proposed system into the current one and how to ensure it is widely understood and accessible.

A topic raised multiple times was a widespread myth in Estonia that all waste is mixed during the waste management process. This perception has led to significant mistrust and loss of motivation among the population to sort waste correctly.

The current label system was often mentioned as a functioning and well-designed example. The following Figures provide examples of direct and tangible insights gathered during the workshops.

Figure 21 Voices from Estonia: Reflections from participants on country specificities



Source: Authors' elaboration

- **Accessibility and inclusivity:** Participants emphasised that the waste sorting system should be intuitive, accessible, and visually clear. They suggested adding accessibility features, such as Braille, to enhance and ensure inclusivity for all users.
- **Availability of bins:** Discussions extended beyond the labelling system to include concerns about the availability of appropriate bins. Participants raised questions about how the system would function if the correct containers were not nearby and how users might react in such situations. Ensuring the sufficient availability of bins in public spaces was seen as a critical factor for success.
- **Managing Change:** Participants stressed the importance of thoroughly introducing the new system, especially given the notable differences between the prototype and the current system.
- **Colours:** The groups generally discussed which colours would be most inclusive and accessible for all users, suggesting higher contrasts and a wider diversity of colours. There was also debate about how labels should be designed to remain functional on black-and-white packaging.
- **Detailed Instructions:** While participants appreciated the clarity of single icons and texts, they stressed the need for detailed instructions accompanying the bins. These instructions should specify what can and *cannot* be disposed of in each container. The residual waste category

raised the most questions, ranging from what should go into it to what the icon should depict. Similarly, biowaste is confusing regarding the differences between home-compostable and industrially compostable waste and how to deal with the differences.

- **Simplicity:** The group stressed the need for a solution that simplifies daily life rather than adding a burden. Although they acknowledged the potential of reward and fine systems, participants agreed that the wide adoption of a new system would be extremely challenging even with a rewarding system, if it required significant additional effort from citizens.
- **Technology:** Participants advanced suggestions for the inclusion of digital support, such as QR codes or an app with sorting guidelines, working as interactive solutions to provide real-time guidance on complex items.

Figure 22 Citizens expressing their difficulties with recycling during an icebreaker activity in an Estonian workshop



Source: Authors' elaboration

4.1.1.5. Greece

The lively conversations during the Greek workshops mirrored the deep engagement of participants and their motivation to think out of the box, going beyond label contents to communication campaigns, system changes and responsibilities.

The most discussed issue with the current waste disposal system was the lack of education—not only on how to separate waste, but on the importance of recycling in general. Participants repeatedly highlighted the need for marketing, campaigns and educational measures targeted at both children and adults, which stood out throughout both workshops. Figure 24 and **Figure 25** provide examples of direct and tangible insights gathered during the workshops.

Figure 23 Voices from Greece: Reflections from participants on country specificities



“A system for waste sorting needs to be usable even for children.”

“People don’t want to spend time separating waste.”

Source: Authors’ elaboration

- **Campaigns:** Participants proposed information campaigns highlighting the consequences that society will face if we do not recycle. They suggested showing the negative effects of waste mismanagement without scaring the population. The approach was identified as a strong driver towards better recycling practices without causing anxiety. A closely related topic was around making the connection between recycling and the urgent need for action for climate and our future.
- **Corporate and political responsibility:** An emerging idea focused on the impact of political decisions and the responsibilities of system leaders. Participants suggested a recurring campaign to report on the impact of implemented measures and regularly update the public on achieved results and milestones, building trust and accountability.
- **Country Adaptation:** Participants reflected on the need of adapting the system to the specific context and language of each country, namely in terms of language of the text. Participants pointed out how important the local language would be for effective labels, but also voiced concerns for non-native speakers and tourists and suggested bilingual versions.
- **Education:** School-based education was seen as a key driver for fostering good waste-sorting habits from a young age. Participants advocated for a long-term educational strategy to embed recycling practices deeply and ensure sustainable, lifelong behaviours among citizens.
- **Material of labels:** Participants discussed the use of resilient and durable materials on bins to ensure long-term sustainability and readability of the icons.
- **Language:** The most frequently expressed need was for labels to be provided in both Greek and English to ensure accessibility for all citizens, including non-native speakers—also considering the impact of tourism on waste recycling results.
- **Personalisation:** Participants recommended tailoring information and advertising campaigns to the different target groups to address different needs and concerns and speak to them effectively. One specific idea that emerged was a campaign aimed at debunking urban legends about recycling.
- **Rewards:** A national rewards system was identified as a strong lever for integrating new practices. Participants stressed that it should be implemented across the entire country, including rural areas, to ensure widespread adoption and impact.

Figure 24 An AI-generated visualisation of a sorting concept created by a Greek participant



Source: Authors' elaboration

4.1.1.6. Czech Republic

As in many of the preceding workshops, the concluding two sessions in the Czech Republic, revolved around a broader conversation about the entire ecosystem of waste sorting and recycling ecosystem, combined with an in-depth reflection on the proposed labelling system.

A recurring theme during the two workshops was the lack of trust and transparency citizens feel towards the current waste management system. This mistrust causes frustration and diminishes motivation to participate in proper waste sorting. Participants highlighted the need for simplicity and clear communication to support and incentivise correct sorting behaviour.

Figure 25 Voices from the Czech Republic: Reflections from participants on country specificities

"I don't know what happens to the waste when I throw it away."

"I'd love a sorting system that will evoke that we are all in the same boat, on the same planet"

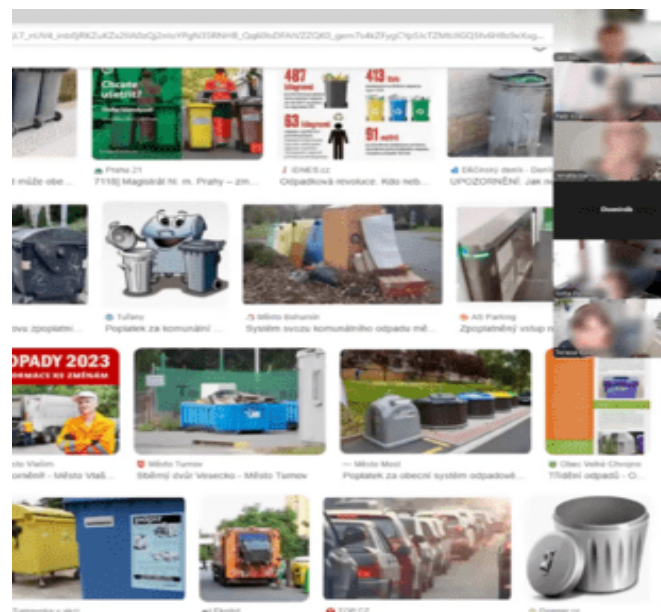
"Maybe produce less waste from the start? It bothers me that you buy a comb and you get a book of instructions in 30 languages. Couldn't you print it on a QR code for people to find.."

Source: Authors' elaboration

- Instructions:** Participants frequently mentioned difficulties with composite- or dirty packaging. While single-material packaging is clear, combinations of materials or dirty packaging were mentioned as a cause of confusion and insecurities. Current instructions on packaging often use multiple recycling signs, but it is unclear where to throw it or whether it requires to separate pieces of the package. Participants noted a lack of a centralised resource (shop/app/website) where people can find detailed guidance on which packaging/waste belongs in which bin, how much (if at all) it is necessary to separate materials from each other, or if/when cleaning is required. Additionally, the existence of municipality-specific regulations adds to the confusion, as rules vary from place to place.

- **Corporate and political responsibility:** Participants reported inconsistent information from workers at the waste yards, with some workers providing conflicting answers to the question where to dispose of specific items like paint cans or porcelain. Some participants expressed frustration about having a collection vehicle loading mixed waste containers, even when separated containers were inside. Participants called for greater transparency and information/education on how the overall waste sorting system and infrastructure work.
- **Simplicity: The concept of meta-labels did not resonate strongly with participants.** Many expressed concerns that the system of sorting could become more complicated with countries taking the opportunity of introducing the new system to separate some waste types further and create a system that is more demanding in terms of time, space at home, and space for additional containers on the streets. Participants noted that current container capacity and the frequency of waste collection are already insufficient.
- **Colour:** Participants agreed that all label colours could be bolder, brighter, and more distinct. For example, the blue colour for paper and cardboard waste is very bland and pale, kind of blue grey. The colour does not always ensure sufficient contrast (yellow). On a positive note, participants appreciated colours that naturally reflect the type of material/waste, such as brown for wood and grey for metal.

Figure 26 A group from the Czech Republic conducting live desk research during the idea generation phase



Source: Authors' elaboration

The qualitative impressions from the workshops reported above offer a first overview of the frequently discussed topics and key insights from the sessions. These themes are mirrored and recognisable also in the concepts developed during the second part of the workshop.

4.1.2. General insights

In this section, the outcomes of the single activities of the workshop series are detailed. These results were elaborated according to the methodology.

The first activity, label assessment, provides direct feedback on the developed labels for prototype 1, while the subsequent generative session and concept development delve into participants' suggestions for improvement and their newly developed solutions. These are clustered by topics and recurring themes. In the final part of this chapter, the specific attention points, along with the corresponding results and insights, are reported.

During the icebreaker activity, citizens reflected on items they always struggle to dispose of showing some patterns across countries.

Citizens struggle with items made from mixed materials like drinking cartons or less common items that do not have dedicated containers but need to be transported to collection points like oil or batteries.

The first activity of rating the single labels resulted in a score for each of the labels and for the system overall.

To gain an unbiased and individual understanding of participants' views of the label prototypes, participants were asked to rate the labels at the beginning of the workshop upon seeing them for the first time. After rating each label, conversations were engaged, allowing participants to share and discuss first impressions and ideas. This process was carried out for all individual labels of the prototype concluding with an overall assessment of the set of labels as a system.

The assessment employed 5-point Likert scale (1=Not at all; 5 = Extremely), prompting participants to position themselves along a discrete scale and included specific open questions to gather in-depth and contextual insights—for example, to identify potential socio-cultural misinterpretation of specific icons.

Each label was evaluated according to the dimensions detailed further in the methodology section; the short explanations below were the ones attached to each of the assessment questions for participants.

- **Comprehension** - Easy understanding of icons and text
- **Accessibility** - Label is readable and recognisable
- **Visual Communication** - Identify the type of waste portrayed by the pictogram
- **Language & Content** - Understand what to do with the waste
- **Matches expectations** – Alignment with how this kind of waste is typically portrayed
- **Consistency** - Icon and text are coherent and provide consistent and clear information

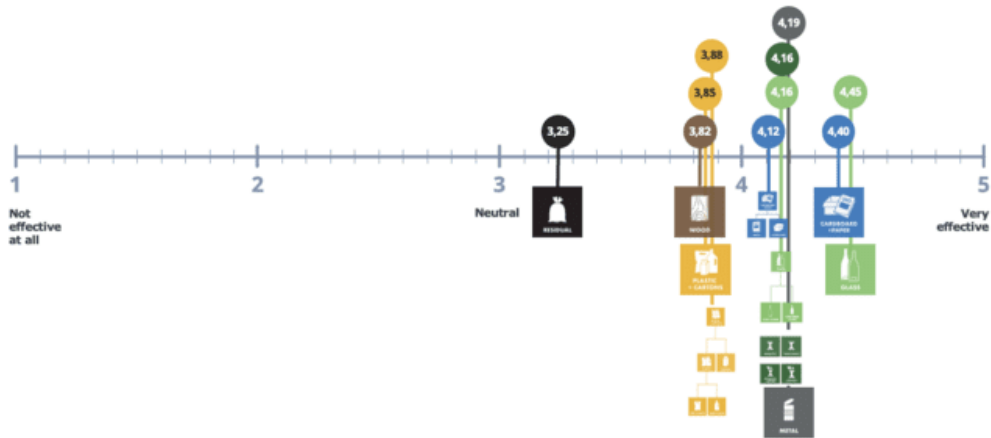
The assessment for the individual labels reveals that the highest-rated labels were those for combined glass and combined cardboard + paper, which resonated most with participants and created the least confusion.

Conversely, the label for residual waste received the lowest ratings across all dimensions. Participants frequently criticised the very neutral or even negatively perceived colour, the general icon, and the text, which were deemed not being comprehensible.

In the comment section there are plenty of ideas and suggestions not related to packaging exclusively suggesting that citizens went beyond the packaging concept in their considerations. It was mentioned various times that a system like this would have to work for the entire waste sorting system both in public and in households and therefore participants suggested changes of icons and text to support other and more generic use cases.

Figure 28 illustrates the overall rating for each label across all workshops and sets them in relation to each other.

Figure 27 Overall rating results per label for all rating dimensions



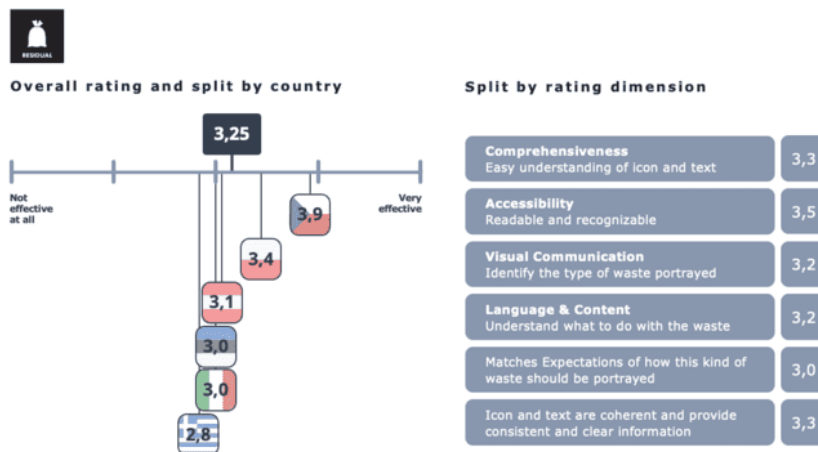
Source: Authors' elaboration

4.1.2.1. Residual Waste

The label for residual waste received the lowest ranking overall throughout most of the countries and dimensions. Numerous comments highlighted issues with the colour and the icon.

Figure 29 below reports the overall ranking, along with a country-wise and dimension-wise breakdown of the ratings.

Figure 28 Rating results for the residual waste label



Source: Authors' elaboration

Table 6 summarises the most common comments and criticisms related to the colour, icon, and text, as the main visual elements of the label. It also includes frequent comments, suggestions for improvements, and other remarks.

Table 6 Key comments from all workshops for the residual waste label

Colour	Icon	Text	General impression
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<p>The colour black is generally associated with mixed or undifferentiated waste, but some users find it negative or confusing. Black is seen as "sad," "negative," or "associated with toxic or non-recyclable waste."</p> <p>Some users recommend using a different colour scheme, like a white background with a black bag, or adding a bright border to enhance visibility.</p> <p>Many users associate black with non-recyclable items but find it too dark or unclear for quickly recognising the type of waste.</p>	<p>Most users understand the bag icon as representing a "catch-all" or mixed waste concept. However, a few note that the icon is overly generic and could be mistaken for plastic or other categories.</p> <p>Some recommend adding small symbols within the bag, like food scraps or other common mixed items, to clarify its purpose.</p> <p>While the icon mostly conveys a general disposal bag, some feel it resembles other objects (e.g., "Santa's gift bag") or could be made more cartoonish for improved recognition.</p>	<p>Users express the need for the label text to be clear and preferably in their local language. Terms like "residual" may be confusing, and labels such as "mixed waste" or "household waste" could be clearer.</p> <p>Some comments suggest the text be larger, more prominent, or placed at the top for easier reading, especially in small formats.</p> <p>Explicit text, such as "non-recyclable" or "mixed waste," would help users immediately recognise what should go into this bin.</p>	<p>Users generally find the label somewhat understandable but lacking in clarity. It effectively indicates a disposal bin, but some feel it could be clearer in expressing what should or shouldn't go in.</p> <p>The label could be improved by inverting colours, adding specific items inside the icon for context, or making the icon and colour scheme more vibrant to distinguish it from other waste categories.</p> <p>The black colour gives a somewhat gloomy impression. A few users recommend a more colourful or cheerful design to improve the overall look while still conveying the "mixed waste" message.</p>
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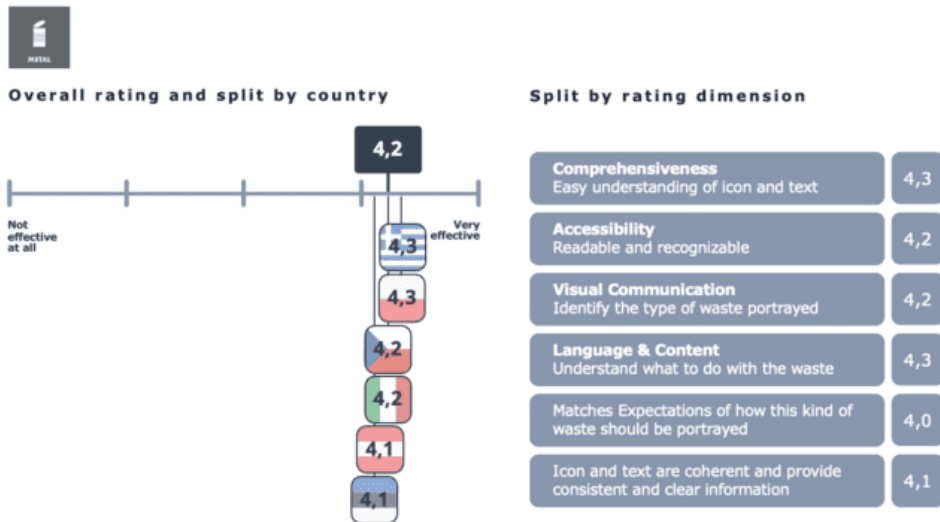
Source: Authors' elaboration

4.1.2.2. Metal

The label for metal received a relatively high ranking overall, with most participants finding it clear and easy to understand. However, some participants offered suggestions for improvement, particularly regarding the icon and colour, as noted in their comments.

Figure 30 below reports the ranking overall, the split by country and rating dimension.

Figure 29 Rating results for the metal label



Source: Authors' elaboration

Table 7 summarises the most common comments and criticisms related to the colour, icon, and text, as the main visual elements of the label. It also includes frequent comments, suggestions for improvements, and other remarks.

Participants went beyond the assessment and consideration for packaging labels only, but reflected on how the label could work universally within a holistic waste sorting system.

Table 7 Key comments from all workshops for the metal label

Colour	Icon	Text	General impression
<p>Grey is associated with metal and is generally well-received.</p> <p>Some suggestions for a lighter shade of grey, or even metallic or silver, to make the association clearer</p> <p>Concerns that it resembles the colour used for undifferentiated waste, which could cause confusion.</p> <p>A few comments mention that grey could be dull or neutral and prefer a more colourful label for metal, some suggesting blue (though it's often used for paper)</p>	<p>The can icon is widely understood to represent metal, but many feel that it only conveys a specific type of metal. Suggestions included adding other metal items (like bolts, screws, or wires)</p> <p>A few users recommended adding a tab on the can or using a more recognisable shape (e.g., an open tin can) to improve recognition</p> <p>Some pointed out that while the can is recognisable, the label doesn't make it clear whether all metals (like</p>	<p>The term "metal" is generally considered clear and universally understood, though some users suggested additional clarification on what types of metal are acceptable</p> <p>A few comments noted that including multiple languages, especially for tourists, would be helpful</p> <p>It was mentioned that there could be better labelling for mixed or composite materials that combine metal with other substances (e.g., metal with plastic or paper)</p>	<p>Most found the label understandable, there were concerns about the potential overlap with undifferentiated waste due to the colour. Some users felt the label could be more attention-grabbing</p> <p>There's also a recurring request for better clarity on whether items beyond cans (e.g., larger metal objects, spray cans, or items made from different metal alloys) can be disposed of in this bin</p> <p>Expanding the label to include other metal objects or clarifying instructions on handling</p>

	cutlery, scrap metal, etc.) are acceptable		composite materials would improve overall clarity
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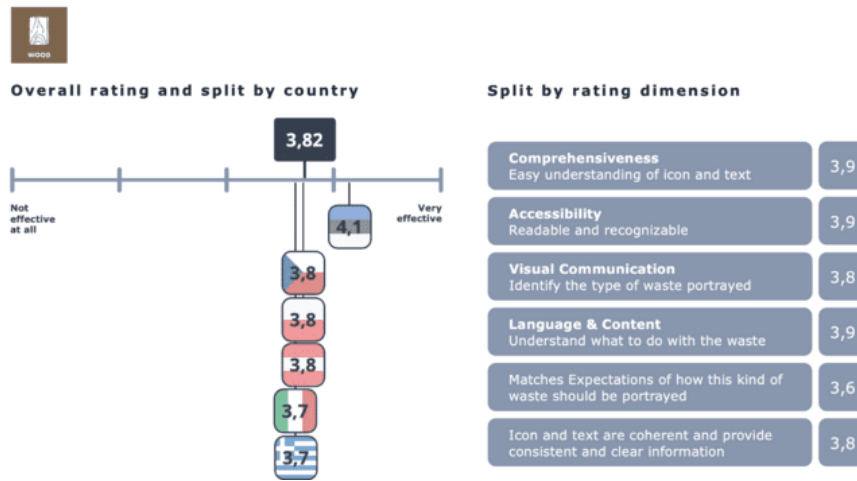
Source: Authors' elaboration

4.1.2.3. Wood

The label for wood was mostly positively received by participants. However, many noted that wood is not currently part of household waste collection in most countries, therefore making it a newly introduced category. This novelty prompted additional commentary about the need for clear communication and education to support its integration into the waste sorting system.

Figure 31 below reports the ranking overall, the split by country and rating dimension.

Figure 30 Rating results for the wood label



Source: Authors' elaboration

Table 8 summarises the most common comments and criticisms related to the colour, icon, and text, as the main visual elements of the label. It also includes frequent comments, suggestions for improvements, and other remarks.

Table 8 Key comments from all workshops for the wood label

Colour	Icon	Text	General impression
<p>The brown colour is widely associated with wood and natural materials, making it intuitive for most people</p> <p>Some users suggest a brighter or lighter shade of brown to improve visibility and avoid</p>	<p>The icon is somewhat understandable, especially when paired with text.</p> <p>Many recommend using a more recognisable symbol, such as a tree trunk, round cut logs, or branches, instead of the current plank-like depiction, which some</p>	<p>The text is generally clear and helps in understanding the label, especially for native speakers</p> <p>Some users suggest including translations (English) or larger text for better readability</p>	<p>Users propose adding specific elements like tree rings, green leaves, or garden branches to clarify the type of wood waste allowed (e.g., raw, treated, or furniture)</p> <p>Ambiguity about what items are acceptable (e.g., treated wood, furniture, plywood,</p>

<p>confusion with residual- or bio-waste</p> <p>A few comments mention that the current brown shade might be too dark or ashy, leading to potential misunderstandings</p>	<p>mistake for books or other items</p> <p>The icon lacks clarity on its own, with users finding it abstract or unrelated to household and packaging wood waste</p>	<p>Without the accompanying text, the icon alone often fails to convey the intended message</p>	<p>branches). Suggestions include adding more descriptive elements or instructions for size and type restrictions</p> <p>While the label is somewhat effective overall, there's still a lack of clarity to avoid misinterpretation.</p>
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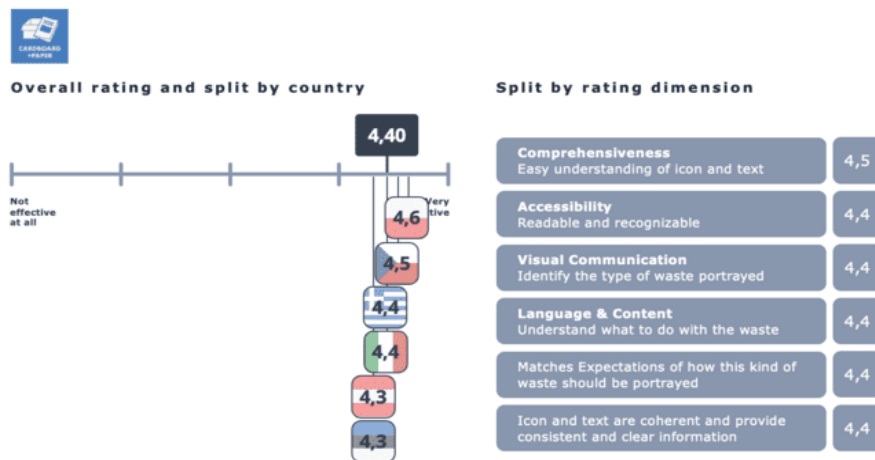
Source: Authors' elaboration

4.1.2.4. Cardboard and Paper

The label for cardboard and paper received very positive ratings and feedback from participants, mentioning its proximity to their current systems and the intuitive recognition of the waste fraction displayed.

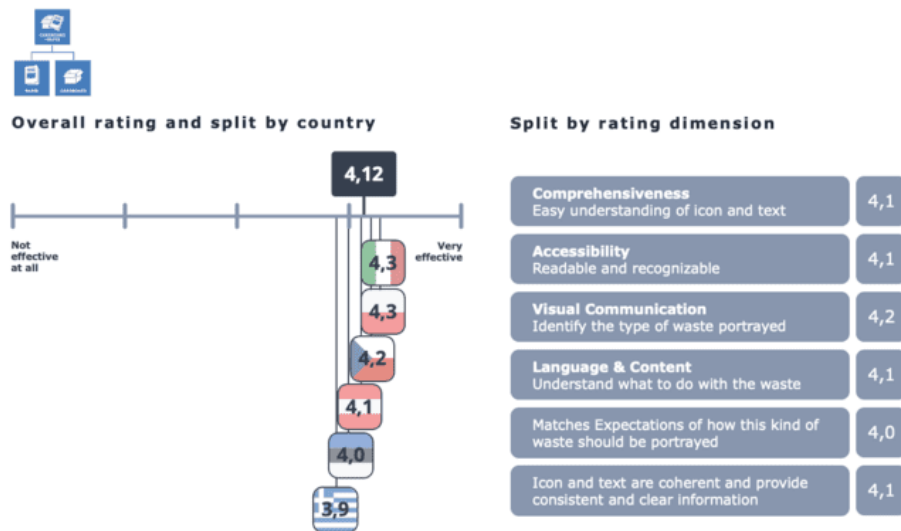
For the rating exercise, participants first assessed the combined label for cardboard and paper, followed by an evaluation of the separate labels for these fractions. This allowed for insights into how participants perceived the combined versus divided versions. Figure 32 and Figure 33 below report the ranking overall, the split by country and rating dimension.

Figure 31 Rating results for the paper and cardboard (combined) label



Source: Authors' elaboration

Figure 32 Rating results for the paper and cardboard (divided) label



Source: Authors' elaboration

Table 9 summarises the most common comments and criticisms related to the colour, icon, and text, as the main visual elements of the label. It also includes frequent comments, suggestions for improvements, and other remarks referring both to the combined and split version of the paper and cardboard label.

Table 9 Key comments from all workshops for the paper and cardboard label

Colour	Icon	Text	General impression
<p>The colour doesn't intuitively remind of paper or cardboard, but it's perceived as visually pleasant</p> <p>Brown or beige might be a better colour choice to represent cardboard and paper.</p>	<p>Separating the icons for paper and cardboard makes them clearer and easier to understand</p> <p>The cardboard icon is less clear, especially when partially obscured by the paper icon in the combined label</p> <p>The paper icon looks like a book or magazine, which might not clearly represent all paper types</p>	<p>The text is clear and helps make the label understandable, especially when the icons alone might not be enough</p> <p>Including translations (e.g., English) or larger text would improve accessibility</p> <p>The text clarifies what can be thrown away but doesn't address edge cases like greasy or laminated paper</p>	<p>It's unclear whether paper and cardboard should always be separated or go into the same bin</p> <p>Additional guidance is needed for ambiguous items like glossy magazines, stapled paper, or contaminated cardboard</p> <p>A single combined label might be simpler and avoid confusion compared to separated icons.</p>

Source: Authors' elaboration

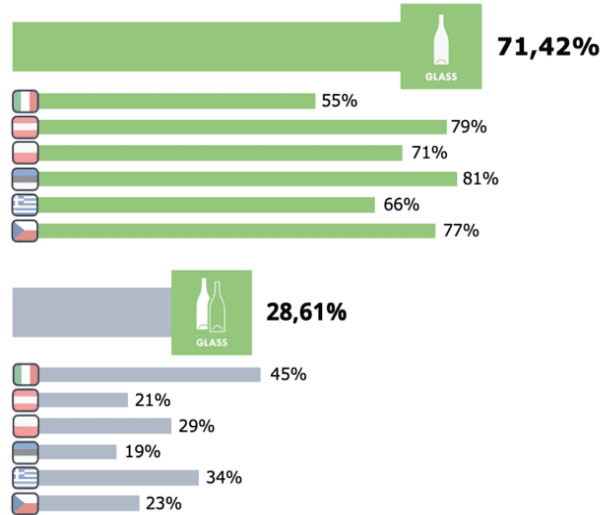
4.1.2.5. Glass

The glass label was among the highest-rated labels overall, with participants appreciating its clarity and facilitated comprehension.

As part of the exercise, two alternative designs for the glass label were presented, and participants were asked to indicate their preference between the two options shown in Figure 34. Similarly, the rating exercise was split into two parts: participants first evaluated the combined label for glass, followed by the separate labels for plastic and cartons.

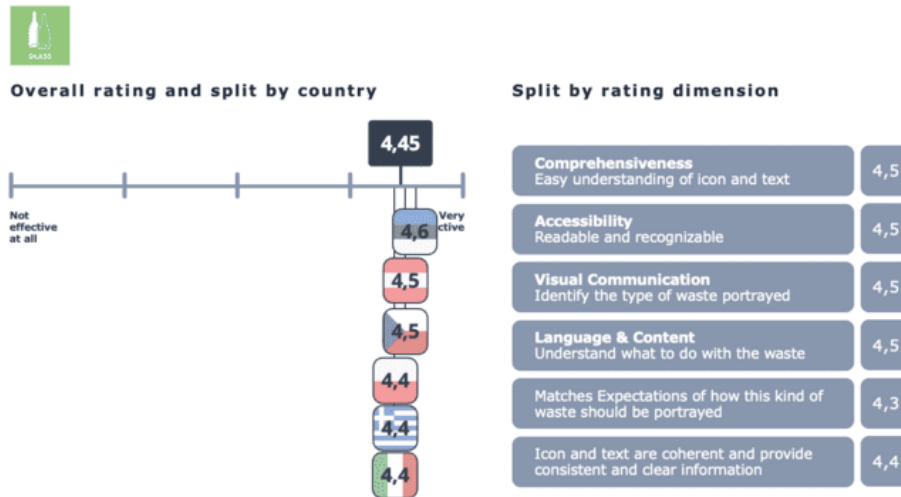
Figure 35 and Figure 36 below report the ranking overall, the split by country and the rating dimension.

Figure 33 Preference for glass label – ranking



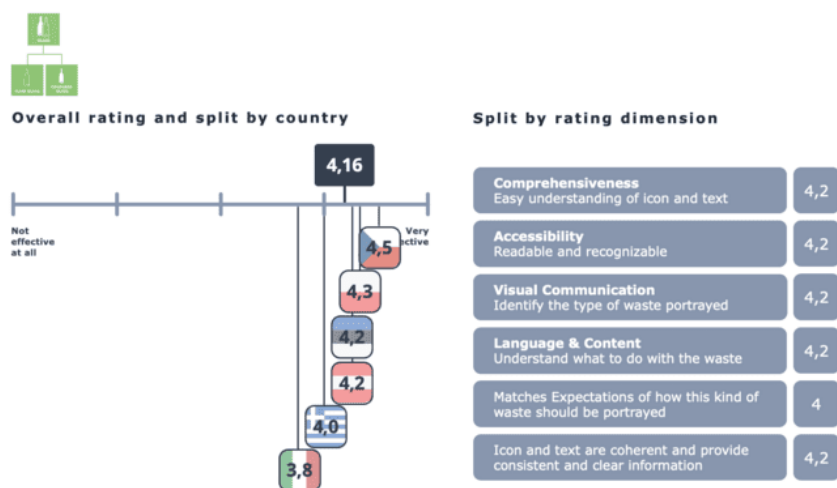
Source: Authors' elaboration

Figure 34 Rating results for the glass (combined) label



Source: Authors' elaboration

Figure 35 Rating results for the glass (divided) label



Source: Authors' elaboration

Table 10 summarises the most common comments and criticisms related to the colour, icon, and text, as the main visual elements of the label. It also includes frequent comments, suggestions for improvements, and other remarks referring both to the combined and split versions of the glass label.

Table 10 Key comments from all workshops for the glass label

Colour	Icon	Text	General impression
<p>Green is generally associated with glass and fits well, though some suggest darker or lighter shades</p> <p>The green colour could confuse some, as it might be associated with eco or bio waste instead of glass</p>	<p>The icons are clear when separated but can cause confusion when combined, especially regarding the purpose of the two bottles</p> <p>The bottle shapes and styles suggest only wine or beverage bottles, excluding jars or other glass items</p>	<p>The text clarifies the distinction between clear and coloured glass, which may not be obvious from the icons alone</p> <p>Without text, the icon could be misunderstood as referring to full versus empty bottles</p>	<p>There is uncertainty about whether all glass items (e.g., jars, mirrors) can be thrown away or just specific ones like bottles</p> <p>Many users feel separating clear and coloured glass is unnecessary and could complicate recycling efforts.</p> <p>Adding more shapes or clearer distinctions for other types of glass (besides bottles) would improve clarity and inclusivity</p>

Source: Authors' elaboration

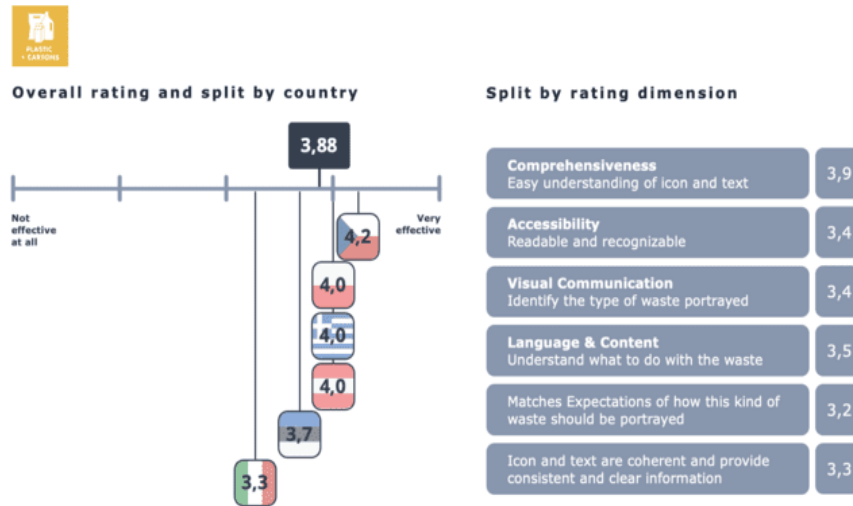
4.1.2.6. Plastic and Cartons

The plastic and carton labels were positively rated overall, but the especially the more complex division of the different kinds of plastic appeared potentially confusing and difficult to comprehend.

The rating exercise for these labels was split into two parts: participants first evaluated the combined label for plastic and cartons, followed by the separate labels for each.

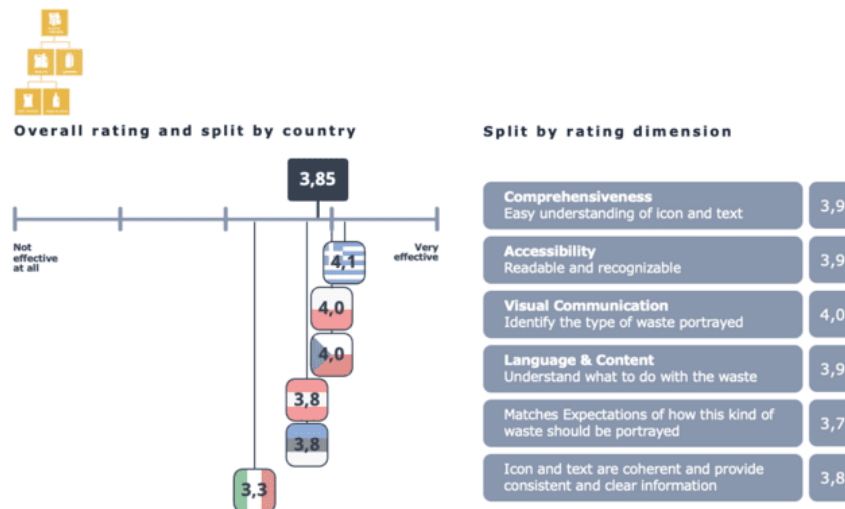
Figure 37 and Figure 38 below report the ranking overall, the split by country and the rating dimension.

Figure 36 Rating results for the plastic and cartons (combined) label



Source: Authors' elaboration

Figure 37 Rating results for the plastic and cartons (divided) label



Source: Authors' elaboration

Table 11 summarises the most common comments and criticisms related to the colour, icon, and text, as the main visual elements of the label. It also includes frequent comments, suggestions for improvements, and other remarks referring both to the combined and split versions of the plastic and carton labels.

Table 11 Key comments from all workshops for the plastic and cartons label

Colour	Icon	Text	General impression
Yellow is widely associated with plastic	The inclusion of Tetrapak is confusing,	Explicitly stating 'Tetrapak' in the text	Separating waste into so many subcategories

<p>recycling and is a logical choice for this label</p> <p>The darker or ochre tone is less familiar or intuitive; a brighter or more vibrant yellow would be better."</p> <p>The colour is generally suitable but could create confusion for visually impaired individuals or in regions with different current colours.</p>	<p>as many people associate it with paper rather than plastic. Labelling it clearly as 'Tetrapak' or 'beverage cartons' would help</p> <p>Soft and hard plastics are not easily distinguishable by the current icons, and additional examples like plastic bags or PET bottles could improve clarity</p> <p>The icons are generally clear, but the inclusion of multiple subcategories makes the label feel overloaded and potentially confusing</p>	<p>instead of 'cartons' would avoid confusion with cardboard or paper</p> <p>The text needs to be larger and more prominent to ensure readability and clarity</p> <p>Descriptions like 'plastic and packaging' or 'beverage cartons and plastic' are more intuitive and should replace overly technical terms</p>	<p>feels overwhelming and impractical for many households</p> <p>The inclusion of Tetrapak under plastic needs to be better communicated, as this is a shift from traditional recycling rules in some areas</p> <p>Adding product-specific icons like juice or milk cartons, detergent bottles, or plastic bags could make the label more relatable and easier to understand</p>
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Source: Authors' elaboration

4.1.2.7. Biowaste

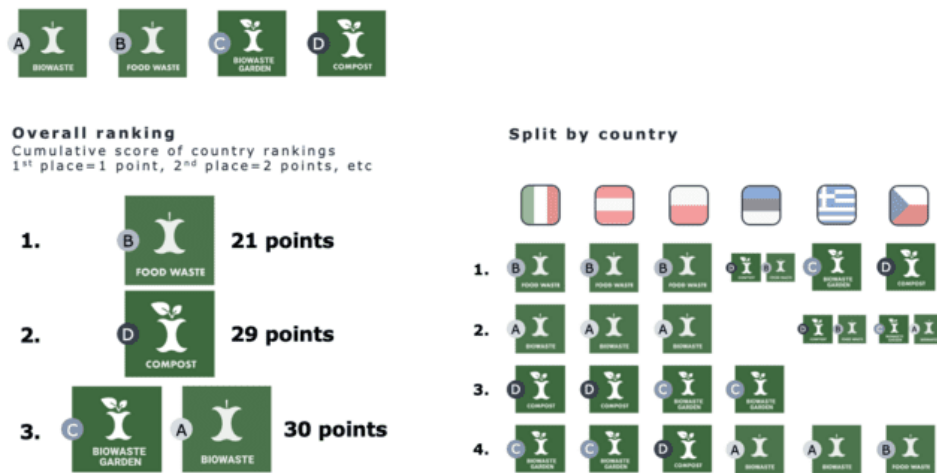
The biowaste label was widely discussed for its colour. Some participants suggested that it should be brown to better align with conventional colour associations, as it currently shares the same colour group as the glass icon, causing confusion.

Another frequently raised topic was the definition of biowaste, with participants questioning whether it should include larger items such as leaves and other waste from garden waste.

As part of the exercise, participants were presented with four alternative designs for the biowaste label. An additional question asked them to express their preference among these four options, which are analysed in Figure 39. Fewer points indicate a higher ranking and therefore an option that was preferred by users.

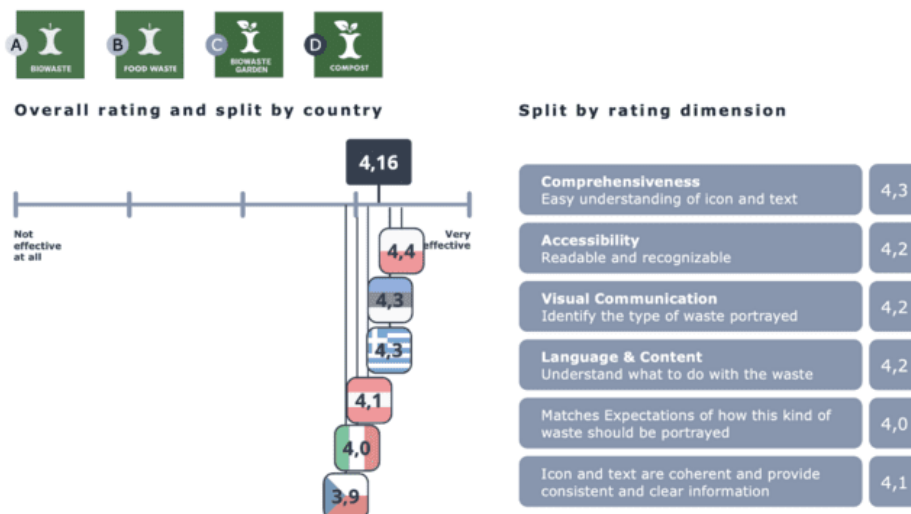
Figure 40 below reports the ranking overall, the split by country and rating dimension.

Figure 38 Preference for biowaste label – ranking



Source: Authors' elaboration

Figure 39 Rating results for the biowaste label



Source: Authors' elaboration

Table 12 displays an overview of the most common comments and critics related to the colour, icon, and text as the main visual elements of the label together with other frequent comments and improvement suggestions. Despite the high ranking of the label with the food waste text, a frequent suggestion was to not use the term food waste in the text. This could be caused by the fact that most participants on the icon and the label during the rating and then started reflecting on more complex elements like the text during the open question eventually suggesting alternatives.

As for other labels assessed previously, some participants went beyond the packaging application of the labels, for example when reflecting on the icon, arguing, that the system would need to universally work for other household applications as well.

Table 12 Key comments from all workshops for the biowaste label

Colour	Icon	Text	General impression
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<p>Green is associated with nature and bio-waste, but there's a potential for confusion with glass bins, especially if both use green tones. Many suggest brown as a more universally recognised colour for compost or bio-waste</p> <p>Some users recommend lighter or brighter shades to improve visibility and distinguish it better from other waste categories</p> <p>For many, green is intuitive for organic waste, but for regions where brown is standard, this could create misunderstandings</p>	<p>The apple core is widely recognised but insufficient to represent the full range of bio-waste.</p> <p>Suggestions include adding other elements like leaves, vegetable scraps, or additional food items (e.g., banana peels or onion skins) for clarity</p> <p>There's ambiguity about whether the icon includes garden waste like leaves and branches or only food scraps, which needs to be clarified visually or in the text.</p> <p>Many users suggest improving the apple core design, such as making it more realistic, adding bite marks, or including leaves, but caution against overly complex visuals</p>	<p>"Organic waste" or "compost" are preferred terms as they are more universal and intuitive than others. For example "food waste" was mentioned as too limiting as not all compostable waste is necessarily food</p> <p>The label should specify whether garden waste is included alongside food waste, as the term "organic" could imply either or both</p> <p>Clearer instructions or examples in the text are needed, such as listing items like "fruit, vegetable scraps, and yard clippings" to reduce ambiguity</p>	<p>Adding more diverse icons or combining multiple elements (e.g., an apple core, leaves, and a fishbone) could better represent the variety of bio-waste items</p> <p>Better distinction between bio-waste and other categories like glass or garden waste is needed, both in colour and iconography</p> <p>Education and guidance are essential, including public awareness campaigns or labelling systems on packaging, to ensure people understand what qualifies as bio-waste</p>
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Source: Authors' elaboration

4.1.2.8. Label System

After rating each label individually, participants were asked to evaluate the entire system, focusing on the interrelation of the individual labels.

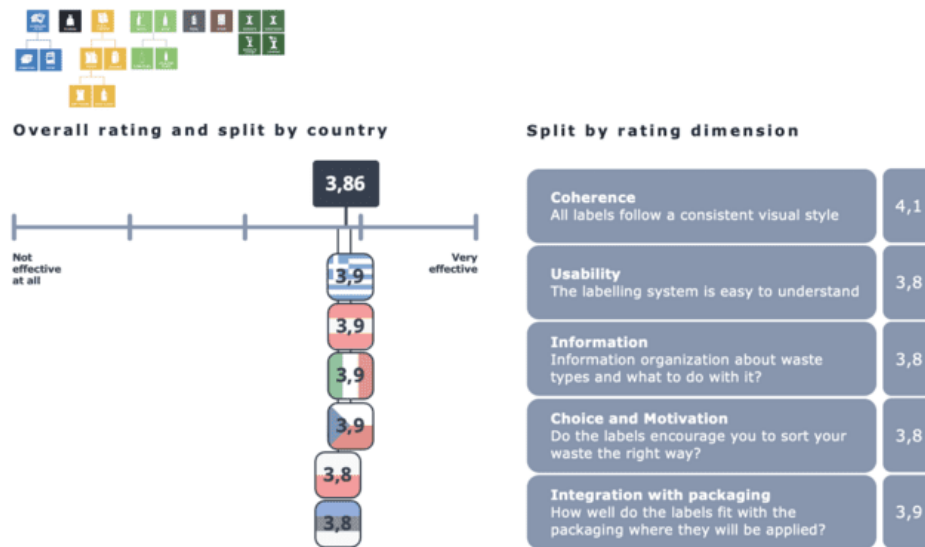
The dimensions for the label system-wide assessment differed from those used for the single-label evaluation to better capture the systemic idea and prompt participants to reflect on the interaction of the various labels and their collective functionality within a unified system. The assessment prompted participants to consider how the labels relate to one another and how they would operate as part of a cohesive system.

- **Consistency** - All labels follow a consistent visual style
- **User-friendliness** - The labelling system is easy to understand
- **Information** - How well does the labelling system organise information about the waste type and what to do with it?
- **Choice and motivation** - Do the labels encourage you to sort your waste the right way?

- **Integration with packaging** - How well do the labels fit with the packaging on which they should be applied?

Figure 41 below reports the ranking overall, the split by country and the rating dimension for the full labelling system.

Figure 40 Rating results for the full labelling system



Source: Authors' elaboration

Table 13 displays an overview of the most common comments and critics related to the overall impression of the labelling system in its entirety and the relation between the different labels. Specific risks or identified problems and positive aspects are listed separately.

Table 13 Key comments from all workshops for the full labelling system

Overall impression	Risks and Problems	Positive Aspects
<p>Clarity and Simplicity: Many users find the labels generally clear and understandable but suggest that simplicity should be prioritised to avoid confusion, especially with too many subcategories or overly detailed icons.</p> <p>Colours and differentiation: The colours are often appreciated but need better differentiation for similar categories. For example, green for bio-waste and glass can be confusing, and</p>	<p>Complexity and Overwhelming Number of Categories: Many users feel the system has too many labels or subcategories, making it difficult to implement at home, especially in limited spaces like small kitchens. The level of granularity might discourage people from sorting waste altogether.</p> <p>Confusing Colours: Colour choices for certain categories are problematic, such as the overlap between green for bio-waste and glass, or brown and black for residual waste. This can lead to confusion, especially for visually</p>	<p>Clarity of Design: The labels are widely praised for their minimalist and intuitive design, making them easy to understand. The combination of icons, text, and colours simplifies sorting, and the clear fonts enhance readability.</p> <p>Colour Coding: The use of distinct colours to differentiate waste categories is highly appreciated. Grouping similar items by colour aids quick identification and enhances the system's usability, especially</p>

<p>suggestions for brown for bio-waste are common.</p> <p>Icons and Representations: Icons are described as helpful but sometimes unclear or insufficient, such as for bio-waste or wood. Users suggest adding more specific and relatable imagery, such as banana peels for bio-waste or screws for metal.</p> <p>Consistency across Systems: A recurring suggestion is to make the system consistent across regions and languages. This includes standardising colour codes and terms like "Tetrapak" or "bio-waste" for broader understanding.</p> <p>Overwhelming Complexity: The system's level of detail is appreciated but often described as too complex, which could discourage people from sorting waste properly. Simplification or fewer categories might improve usability.</p> <p>Educational Component: Users frequently emphasise the need for public education to accompany the labels. This includes clear guidance on what to throw where and potentially integrating educational materials for children and adults.</p> <p>Positive Overall Impression: Despite suggestions for improvement, the overall impression is positive, with many users believing the system is on the right track and praising its potential for improving recycling habits.</p>	<p>impaired individuals or in regions with different recycling colour codes.</p> <p>Unclear or Insufficient Icons: Icons for some waste types, like bio-waste, wood, and metal, are not sufficiently clear or representative. Suggestions include using more relatable symbols, such as a banana peel for bio-waste or screws for metal, to make the categories more intuitive.</p> <p>Inconsistent or Non-Standardised Systems: A lack of standardisation across regions or municipalities leads to confusion. Different countries or cities may use distinct sorting rules, making some labels ineffective or unfamiliar. Harmonising terminology and visuals is critical for success.</p> <p>Lack of Education and Awareness: Insufficient public education and guidance on how to use the labels is a major barrier. Users highlight the need for campaigns, detailed instructions, and possibly a digital solution (e.g., QR codes or apps) to clarify what can be thrown in each bin.</p>	<p>when colour-coding aligns with established standards.</p> <p>Consistency and Uniformity: The labels are seen as consistent in style and design, with uniform graphics and colours across categories. This approach fosters a sense of cohesion and ensures the system feels modern and professional.</p> <p>Educational Potential: The labels are viewed as an effective starting point for educating people about recycling. Their simplicity makes them suitable for all age groups, including children, and the universal design across countries makes them easier to teach and adopt globally.</p> <p>Practicality and Usability: The inclusion of both text and icons enhances comprehension, even for those unfamiliar with recycling practices or specific categories. The visual and textual combination ensures accessibility across language barriers, helping individuals correctly identify and sort their waste.</p>
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Source: Authors' elaboration

4.1.2.9. Concepts developed

Following the rating exercise, participants engaged in a generative session consisting in an ideation phase and a concept development phase aimed at orienting thinking towards solutions and improvement ideas.

Participants were divided into groups for these hands-on sessions.

Starting from an open brainstorming on solutions, they started prioritising their ideas and selected one concept per group to then develop further into a concept, either by shaping alternative designs or developing a customer journey to illustrate it. This approach allows for diverse outputs, enriching the overall exploration of creative possibilities within the waste sorting label system project.

The concepts developed covered a wide range of topics, dimensions of impact, and ways of engagement. Six recurring themes emerged when clustering the ideas:

Ecosystem

24 of the 50 developed concepts addressed the actors and processes of the ecosystem around waste sorting like stakeholders, industries or the organisation of waste disposal in public spaces. It was often combined with re-design considerations for labels and educational measures to raise awareness. The frequent involvement of ecosystem-related aspects underlines the broader thinking of citizens and their awareness of the complexity of implementing such a system.

Label re-design

19 of the 50 developed concepts re-designed the labels or suggested changes for the visual design across text, icons, colour or other additional visual elements. The re-design of the labels was in nearly all cases proposed together with one of the other dimensions not relying solely on visual changes, but for example, adding technological aspects or suggesting changes in the ecosystem to increase impact.

Accessibility

11 of the 50 concepts addressed accessibility for vulnerable groups and beyond. Suggestions across most of the concepts included Braille text, attention to colour-blindness for colour selection and self-explanatory icons, as well as adding textual descriptions in two languages (local language and English). These concepts were often paired with a re-design of the labels or educational measures and campaigns.

Technology

10 of the 50 concepts incorporated technological aspects, with common proposals including QR codes and mobile applications.

Other ideas mentioned included NFCs and smart technologies to enhance waste sorting efficiency.

Education

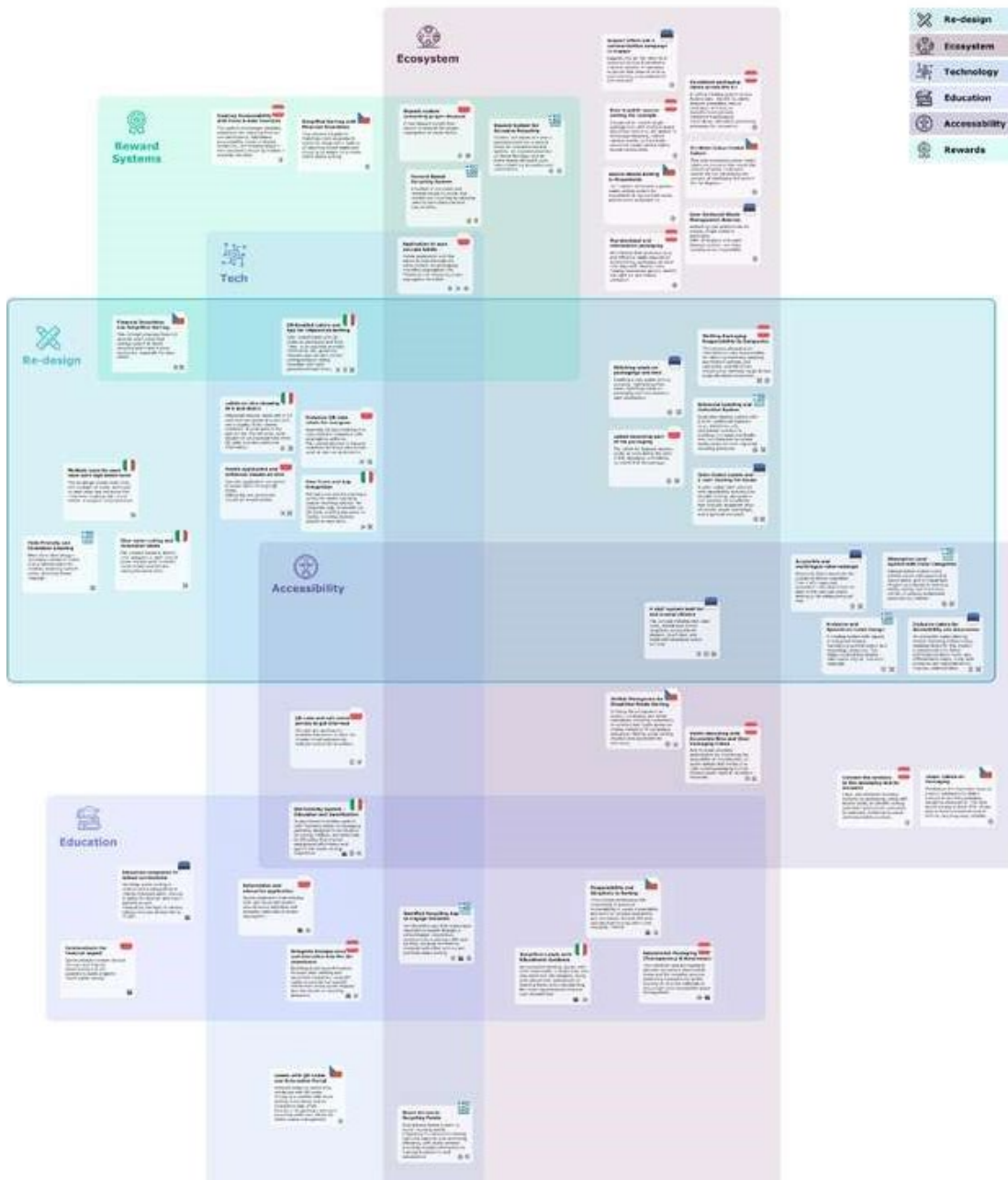
9 of the 50 concepts highlighted educational aspects, such as learning about labels and the importance of waste sorting education, for example by insertion into school curriculums. Frequently, the educational measures were integrated into the concepts in combination with new technologies or broader changes in the ecosystem.

Reward Systems

7 of the 50 concepts involved rewarding mechanisms for encouraging positive behaviour and proper sorting of waste for recycling. Most of them include financial incentives, especially in the beginning of introducing the new waste sorting system to support the adoption and raise awareness step-by-step.

Figure 42 displays the concepts clustered by topics addressed showing the relevance of not only designing the labels, but considering and innovating the surrounding ecosystem, making waste sorting accessible to the entire population, educating citizens early on and continuously and considering reward systems for positive behaviour.

Figure 41 Concepts clustered by topics addressed

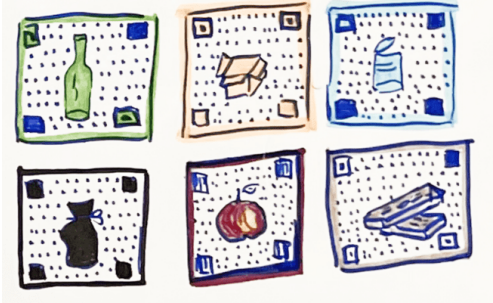


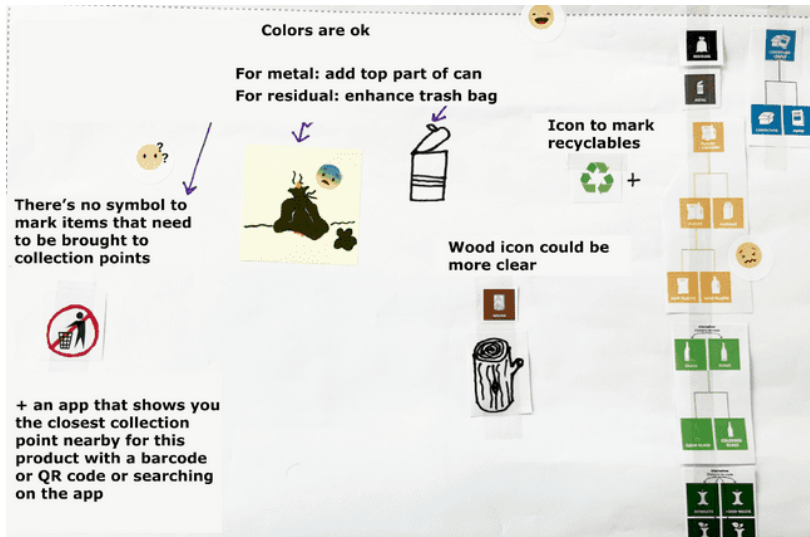
Source: Authors' elaboration

To access the full image, you can follow this [link](#).

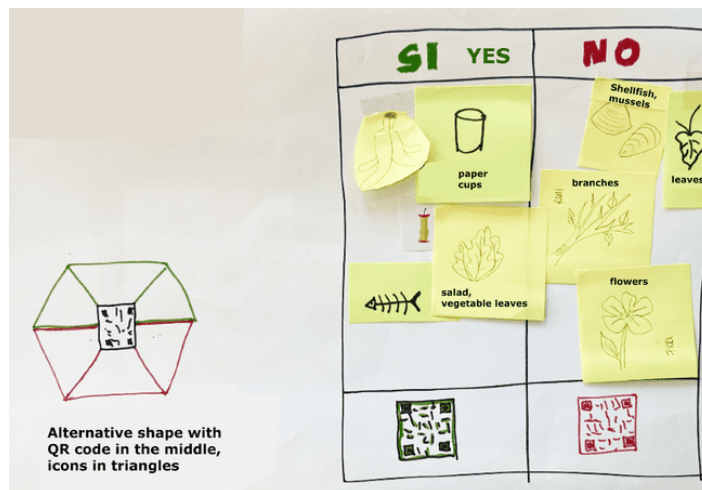
All concepts are listed with a short description in Table 14, the concepts that involve the re-design of the label system or include specific considerations on the visuals contain a more detailed description and a visual of how participants envision their design.

Table 14 Detailed list of developed concepts

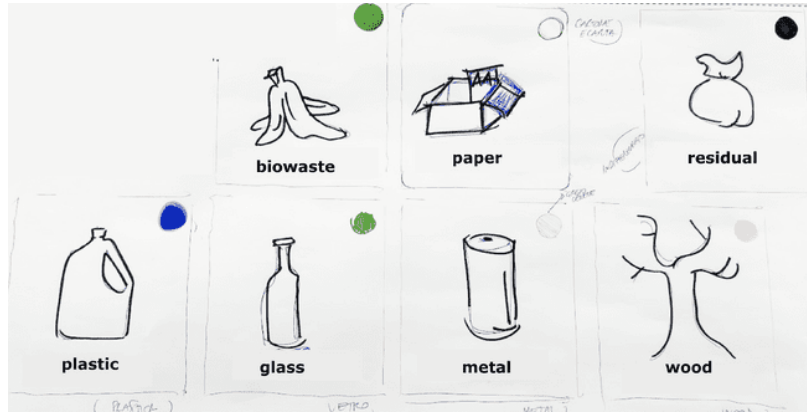
Concept Title	Description	Tags / Topics	Country - ID
QR-Enabled Labels and App for Interactive Sorting	New label design with integrated QR-codes on packaging and bins. The link to an app provides information and guidance; frequent app use and correct sorting behaviour are being rewarded with small government incentives.	Technology Reward Systems Re-Design	IT1
			
Simplified Labels with Educational Guidance	An accessible labelling system with clear colour codes, a single icon, and one-word text per category, along with educational instructions on cleaning items and understanding the recycling process to improve user engagement	Education Ecosystem	IT2
New Icons and App Integration	Refined icons and introduction of a symbol for items requiring special recycling stations. An integrated app, accessible via QR code, guides users to nearby recycling stations specific to each item.	Technology Re-Design	IT3



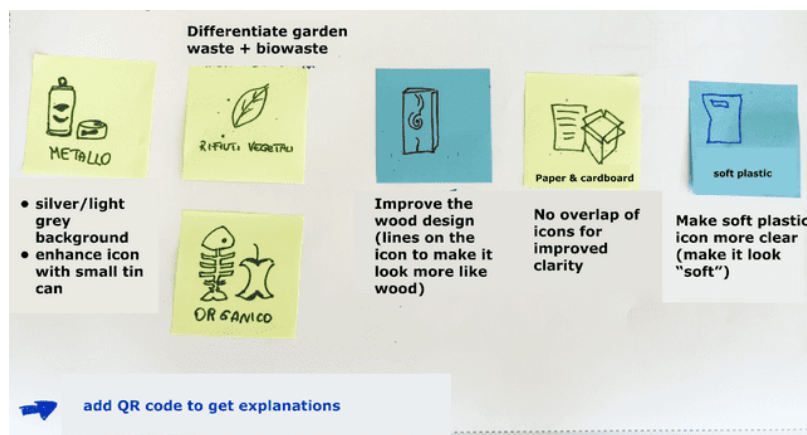
<p>Kid-Friendly System with Education and Gamification</p>	<p>The straightforward labelling system with matching labels on packaging and bins, designed to be intuitive even for young children, is enhanced by QR codes that provide educational information and gamify the waste sorting experience.</p>	<p>Education Accessibility Technology</p>	<p>IT4</p>
<p>Labels on bins showing dos and don'ts</p>	<p>Octagonal-shaped labels with a QR code and composed of green and red triangles. Green shows examples of what goes in the specific bin, the red ones, what should not be disposed here while the QR code provides additional information.</p>	<p>Re-Design Technology</p>	<p>IT5</p>











<p>Clear colour-coding and minimalist labels</p>	<p>The concept entails a distinct colour assigned to each type of waste marked with a coloured round sticker and the bin having the same colour.</p>	<p>Re-Design</p>	<p>IT6</p>
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<p>Tracking users' behaviours to incentivise</p>	<p>The QR code-based system tracks user's behaviours and assigns points for correct sorting showing users the amount of waste they produce to incentivise more sustainable behaviour.</p>	<p>Technology Education Reward Systems</p>	<p>IT7</p>
<p>Multiple icons for each label with high detail-level</p>	<p>The re-design shows more than one example of waste portrayed on each label and enhances the minimalist drawings with more details to support comprehension</p>	<p>Re-Design</p>	<p>IT8</p>



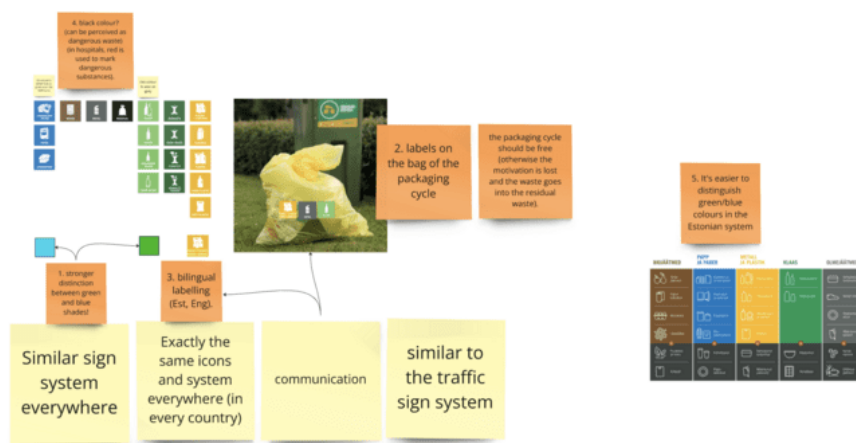
<p>Standardised and informative packaging</p>	<p>The solution commits industry and public sector entities to entirely standardised packaging symbols that are perfectly identical with signs on disposal bins. This helps consumers to quickly identify the right bin and reduce confusion.</p>	<p>Ecosystem</p>	<p>AUS1</p>
<p>Empowering Citizens with Labels and Education</p>	<p>The proposal includes improvement suggestions for the label prototype combined with educational campaigns on the environmental benefits of recycling. To support and further establish correct practices, a bottle deposit system is introduced.</p>	<p>Education Re-Design Ecosystem</p>	<p>AUS2</p>

<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="background-color: #ffffcc; padding: 5px; border: 1px solid black;">Icons should be made more colourful</div> <div style="background-color: #f08080; padding: 5px; border: 1px solid black;">Shape should be square with simple wording</div> <div style="background-color: #ffcc99; padding: 5px; border: 1px solid black;">Colours should match the barrel lids</div> <div style="background-color: #ffffcc; padding: 5px; border: 1px solid black;">Fractions needed: Paper/cardboard Plastics Glass Organic waste Wood Residual waste</div> </div>			
Educational Packaging (Transparency & Awareness)	The initiative proposes to add additional information on packaging to educate consumers about waste types and the recycling process after disposal. In this way it promotes transparency on the journey of recycled materials to encourage more responsible waste management.	Education Ecosystem	AUS3
Shifting Packaging Responsibility to Companies	The concept commits companies to take responsibility for reducing the quantity of packaging materials, adopting eco-friendly options, and complying with EU-driven initiatives to minimise waste before products reach consumers	Ecosystem Re-Design	AUS4
<p>What category (paper, plastic, etc.) is required? What colours would you assign? What shape should the labels have?</p> <p>Think about pictograms and texts: What wording would you use? What symbol would you choose?</p> <ol style="list-style-type: none"> Prerequisite: Law or specifications for companies Categories: Paper/cardboard (red), plastic (yellow), organic (green or brown), glass/coloured glass (light blue), aluminium (silver), residual waste (black), Shapes: Square (possibly diamond/circle/outline of dustbin). Phrasing: German, short words. <div style="display: flex; justify-content: space-around; align-items: center;">         </div>			
Creating Accountability with Fines & Best Practices	The system encourages recycling compliance by imposing fines on non-participants, addressing accountability issues in shared residences. It draws from existing similar models in countries like Italy.	Reward Systems	AUS5
Consistent packaging labels across the EU	Manufacturers are committed to provide transparent and clear information on all kinds of packaging. Together with the unified labelling system across the EU, disposal processes and practices are simplified for consumers.	Ecosystem	AUS6

Bins in public spaces setting the example	All single public garbage bins are replaced with containers for waste separation to set the new standard. This is meant to encourage citizens and promote consistent waste sorting habits across communities while raising the recycling rate for municipal waste from day one.	Ecosystem	AUS7
Public Recycling with Accessible Bins and Clear Packaging Codes	Increased number of recycling bins in public spaces and introduction of corresponding strongly colour-coded packaging to boost recycling and help citizens to easily identify recyclable materials.	Accessibility Ecosystem	AUS8
Integrate transparency and education into the bin experience	QR codes are added to the new labels to provide additional information and transparency on the full recycling process. In this way, citizens are educated to boost recycling participation.	Education Technology	AUS9
Connect the symbols to the packaging and be inclusive	Braille is added to the labels to make instructions accessible to everyone, fostering inclusive and responsible practices for waste sorting.	Accessibility	AUS10
Labels becoming part of the packaging	The waste labels are fully integrated into the packaging concepts instead of just being printed as a small square. A significant part of the packaging is colour-coded according to the colour of the appropriate label (see visual below: participants suggested to colour a part of the entire item with the associated colour of the waste fraction – in this case a bottle with the colour red).	Ecosystem Re-Design	PO1
			
Application to scan barcode labels	A mobile application with a function to scan existing barcodes on products to be provided with recycling information. Scans and other searches for information are saved in the app and rewarded to incentivize citizens to inform themselves.	Technology Ecosystem Rewards	PO2
Inclusive QR code labels for everyone	Integration of a QR code into colour-coded labels linked to an application providing information for waste disposal.	Accessibility Technology Re-Design	PO3

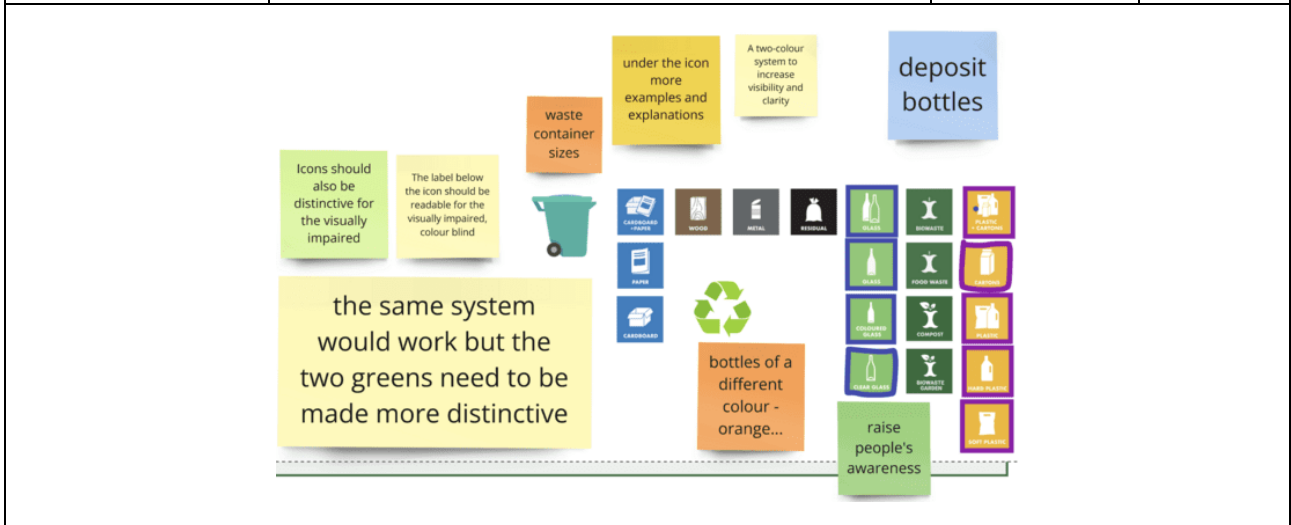
	The coloured element is thought especially for those who do not want or cannot use applications.		
Informative and educative application	A mobile application that includes both additional information around waste collection and recycling processes and contains instructions for users on how to properly segregate.	Education Technology	PO4
Communicate the financial aspect	Communication system around the cost and financial disadvantages of not separating waste properly – “don’t waste money”.	Education	PO5
Mobile application and enhanced visuals on bins	Prominent and large applications of the labels onto bins with an integrated QR code or NFC. The connected mobile application provides all detailed information on waste separation.	Technology Re-Design	PO6
<p>What categories (paper, plastic, etc.) are needed? What colours would you assign? What shape should the labels be? Think also about icons and text: 1. What wording would you use? 2. Which icon would you choose?</p>			
Deposit system rewarding proper disposal	Introduction of a new deposit system for most plastic, glass and metal packaging. The deposit amount varies based on the production cost of the packaging to convey packaging costs to users and enhance the recycling rates especially for high-priced packaging.	Reward Systems Ecosystem	PO7

QR code and call centre service to get informed	Embedded QR code on the labels and set up of a call centre for citizens to call and ask for information. In this way, multiple options for information and education are provided.	Accessibility Technology	PO8
Support offers and a communication campaign to engage	A commercial campaign to convey the value of sorting, informing about correct practices and motivate. Creating of an info helpline to support frustrated or insecure citizens	Ecosystem	EST1
Education integrated in school curriculums	Teaching waste sorting in schools and kindergartens to change mindsets early, making it easier for children and reach parents through their kinds. Integrating the topic in various subjects of the school curriculum that are already being taught.	Education	EST2
Accessible and multilingual label redesign	Re-design of the prototype changing the colours to facilitate distinction and make them more accessible. The text is added in two languages for additional inclusivity and accessibility for non-native speakers.	Accessibility Re-Design	EST3



Matching labels on packaging and bins	Ensuring the precise and perfect matching of packaging labels and bin committing industry and public entities. Highlighting the enhanced user satisfaction and -friendliness in the new scenario with clear and matching labels.	Ecosystem	EST4
User-Centred Waste Management Journey	Introduction of new standards in the packaging industry towards single-material packaging holding manufacturers responsible. Offer of well-organised and hygienic disposal options for citizens.	Ecosystem	EST5
Inclusive Labels for Accessibility and Awareness	Ensuring full accessibility for visually impaired and colour-blind people with a change in colour for some labels. Optimising sizes of containers and bins adding	Accessibility Re-Design	EST6

	examples of accepted waste and, if necessary, explanations.		
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A 360° system built for and around citizens	The concept includes a re-design of some icons to enhance clarity for all kinds of citizens including children. To facilitate access to collection points, it is ensured that sufficient parking spots are available to ensure easy access by car and hazardous waste services are expanded.	Ecosystem Accessibility Re-Design	EST7
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Colour-Coded Labels and a User Journey for Reuse	A colour-coded label redesign with recyclability indicators to simplify sorting. To foster the full ecosystem of recycling, regular transports for specific waste types are set up, accessible drop-off points are established, and repair workshops are organised.	Ecosystem Re-Design	EST8
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<p>Child-Friendly and Consistent Labelling</p>	<p>Re-design of icons retaining the colours of prototype 1 to improve understanding especially for children. Text is added in two languages for improved comprehension among adults.</p>	<p>Re-Design</p>	<p>GR1</p>
<p>Reward System for Inclusive Recycling</p>	<p>A national system introducing an environmental tax or deposit on items like bags that is refunded upon return. Reward system for sorted waste being brought to collection points to foster participation and learning.</p>	<p>Reward System Ecosystem</p>	<p>GR2</p>
<p>Alternative Level System with Clear Categories</p>	<p>Re-design of the system redefining categories and colours together with a variable shape of labels. Enhancement of icons and bilingual text for more inclusivity.</p>	<p>Accessibility Re-Design</p>	<p>GR3</p>

1. **Categories: paper, plastic, wood, fabric, food, glass, metal**
2. **Colours: for wood-brown, for metal-grey, for paper-blue, for fabric-red, for plastic-blue, for food-green dark, for glass-yellow.**
3. **The labels must be square and round.**
4. **Icons are tricky because they do not represent and do not categorize. A child cannot understand the icons.**
5. **The text should be both in english and greek**

Smart Access to Recycling Points via App and Sensors	<p>Identification and real-time monitoring of recycling points through an application.</p> <p>Recycling points can be located, and the capacity of bins is communicated real-time to optimise efficiency. The information is also provided on public screens to improve accessibility and convenience.</p>	Ecosystem Technology	GR4
Enhanced Labelling and Collection System	<p>Expansion of the labelling system with bins for additional materials (e.g., medicines, oil) with an addition of bilingual text and Braille for all labels. Establishment of centralised collection locations in apartment buildings. Commitment to improved municipal waste collection and following recycling processes.</p>	Ecosystem Re-Design	GR5

- We should have containers for more materials like medicines, oil, etc.
- We need one location in the buildings to keep the bins.
- Blue colour for paper and brown for composting
- English and greek context but also braille
- A municipal system that collects waste often
- A better system in Municipalities for the recycling process
- Rectangular or square shape for the icons.
In composting we want the apple with the leaves.
- Bins for wood waste, especially in rural areas

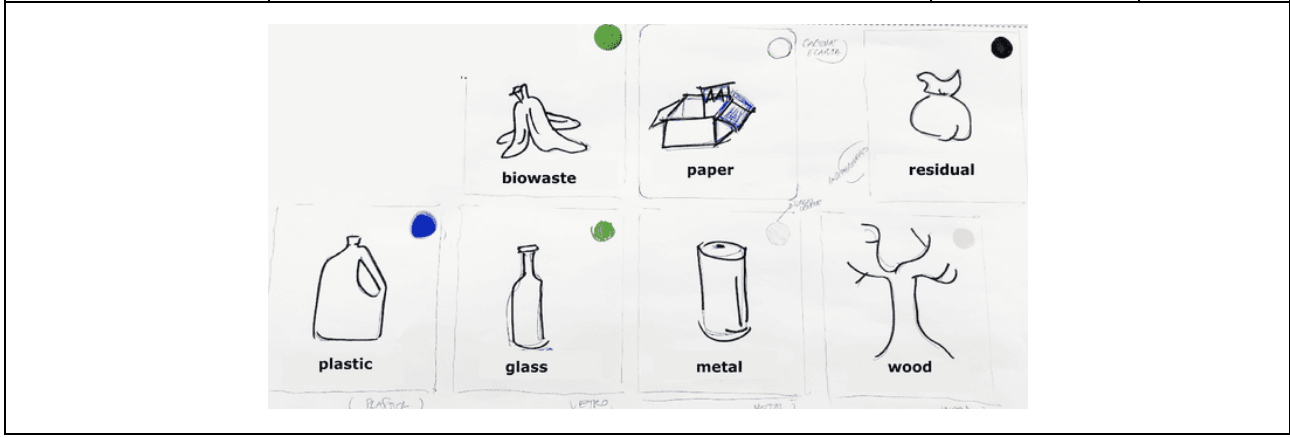
Inclusive and Specialised Label Design	<p>Re-design of the labelling system with square or octagonal shapes, maintaining current colours, and expanding categories. The design incorporates Braille, bold capital English, and local language.</p>	Accessibility Re-Design	GR6
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- The categories mentioned and the additional bins for
1) Clothes 2) Batteries 3) Light bulbs 4) Electrical Appliances
- Square or octagon
- We liked the selected colours
- We would like to see a separate label with a triangle for fragile or dangerous products
- Use of braille
- Bold capital English and the language of the respective country
- For wood we would like an icon that looks like a branch, for light we want some kind of lamp, for electrical appliances we want some kind of device characteristic and for clothes a blouse.

Gamified Recycling App to Engage Students	An interactive app that encourages students to recycle through a school-based competition, accessible through a QR code on bins, allowing students to compete with other schools and promote waste sorting.	Technology Education Ecosystem	GR7
Reward-Based Recycling System	A system of discounts, special offers and other rewards based on points to incentivise citizens to recycle.	Ecosystem Reward System	GR8
Labels with QR Codes and Interactive Waste Portal	Adding a QR code on the labels applied to waste bins. The codes link to a website with more detailed sorting instructions and an interactive map of bin locations to support users and provide additional details for better waste management.	Technology	CZ1
EU-Wide Colour-Coded Labels	Commitment of packaging manufacturers to enhance the colour-coding on their products to facilitate the identification of the waste type and match it to the corresponding bin.	Ecosystem	CZ2
Larger Labels on Packaging	Mandatory minimum label sizes on product packaging to clearly indicate where the packaging should be disposed of. The label occupies at least 20% of one side or have a minimum size of 4x3 cm to ensure visibility.	Accessibility	CZ3
Unification of Pictograms for Simplified Waste Sorting	Ensuring the consistency in icons and colours enhanced by communication across all media, including TV campaigns and press to make waste sorting intuitive and accessible for everyone while raising awareness.	Accessibility Ecosystem	CZ4
Financial Incentives and Simplified Waste Sorting	Simplification of the overall sorting system and small financial rewards for correct behaviour to boost recycling and introduce the new system.	Reward Systems	CZ5
Simplified Sorting with Financial Incentives	Re-design of icon system for bins. Charging the disposal of residual waste based on its weight to promote the improvement of sorting done by individuals and the reduction of overall amount of waste produced.	Re-Design Reward Systems	CZ6



Promoting Responsibility and Simplicity in Sorting	Communication- and promotion campaign around the new waste labelling system emphasising the importance of personal responsibility to increase awareness and motivation.	Education Ecosystem	CZ7
Gastro-Waste Sorting in Households	Introduction of waste sorting systems used in the restaurant business for households to reduce food waste and improve sustainability.	Ecosystem	CZ8





Source: Authors' elaboration


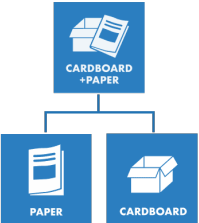
4.1.3. Key takeaways

All the main points of criticism, improvement suggestions, and ideas from all workshops and activities are gathered for each label in Table 15 divided by the initially introduced dimensions of evaluation to allow a distilled overview of insights on what participants suggested across all citizen workshops.

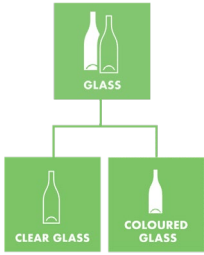

The results for the labelling system are elaborated in a separate table (Table 16).

Table 15 Synthesis of insights for the individual labels

Label	Comprehension	Accessibility	Visual communication	Language & Content	Expectations	Coherence & Clarity
	<p>Not clear, what type of waste is being portrayed</p> <p>Suggestion to include specific items</p>	<p>Icon not recognisable (perceived as general or not recognised as trash bag)</p> <p>Colour too dark</p>	<p>Black perceived as negative</p> <p>Unclear what goes in there and what does not</p> <p>Does not incentivise waste separation ('can throw anything')</p>	<p>'Residual' not clear for most countries</p> <p>Local language is key here</p>	<p>Expectation of better instructions and the definition of residual waste</p>	<p>Insecurity on the definition of residual waste</p>
	<p>Easy to recognise</p> <p>Unclear if other types of metal, like screws or cutlery, are included</p>	<p>Contrast and shapes easy to recognise</p> <p>Colour too close to residual waste</p> <p>Text and icons should be larger and more visible</p> <p>Translations and universally recognisable icons for international users</p>	<p>Single icon creates insecurity if only for one or several types of metal</p> <p>Grey resonates with metal</p> <p>Adding elements like a tab, dents, or crumples to make it more recognisable as can</p> <p>Additional symbols, like bolts, screws, or</p>	<p>'Metal' universally understood</p> <p>Local language still important</p> <p>Label should specify if it includes all metal objects or just metal packaging like cans</p> <p>Text should include instructions for cleaning or emptying items</p>	<p>Aligns with user expectations</p> <p>Ambiguity about what types of metal are included beyond cans</p> <p>Better represent the diversity of metal waste, like wires or larger scrap items</p>	<p>Clear for cans</p> <p>Other types of metal?</p> <p>Needs more specificity to avoid confusion about non-can metal waste</p> <p>Text and icon combination strong</p> <p>Colour similarity to undifferentiated waste detracts from clarity</p>

			other metal objects, for broader range of recyclable metals			
	<p>The type of wood that can be disposed of is unclear (e.g., untreated vs. treated wood).</p> <p>Understandable that it refers to wood, but the icon doesn't perfectly fit the intended meaning—it could look like a book or a plank.</p>	<p>Brown might not very distinguishable for visually impaired people; brighter shades or contrasting colours would help</p> <p>Colours, like green and brown are too similar for visually impaired</p> <p>Text in multiple languages would be more inclusive</p>	<p>Icon looks like a crumpled milk carton or a book—round logs or tree images for better representation</p> <p>Wood texture pattern is clear, could be more realistic</p> <p>Icon simple but doesn't visually represent all types of wood waste</p>	<p>Adding clearer text like 'wood waste' or 'all wood products' would avoid confusion</p> <p>The label is understandable if the text is included</p> <p>The term should specify if it includes treated wood, furniture, or chipboard</p>	<p>Image could better match expectations by depicting items like logs or branches</p> <p>People are used to taking large wooden items like furniture to recycling centres, so it's unclear if they belong in this bin</p> <p>Label matches expectations for wood disposal but doesn't specify, if it includes small household items</p>	<p>Colour and text are consistent and logical, but the icon is not immediately clear</p> <p>Design is cohesive, but the icon needs refinement for better clarity and alignment with other labels</p> <p>Specific differentiation between bulky wood items and smaller scraps</p>
	<p>Icons very clear, making it easy to understand what should be thrown away</p> <p>Paper and cardboard grouped together very clear; the distinction</p>	<p>Adding multiple languages/English to make labels more inclusive</p> <p>Colour choice could cause confusion for colourblind individuals;</p>	<p>Some expect a more neutral colour like white or beige to better represent the materials</p> <p>Overlap of icons isn't as clear; visual</p>	<p>Text and icons together help clarify what belongs in each bin</p> <p>Specifying exclusions, like greasy or</p>	<p>Blue often associated with paper; shade criticised as too grey</p> <p>Aligns well with recycling habits, separation of paper</p>	<p>Consistent design, easy to recognise and understand</p> <p>Division into separate categories clear and logical, might add complexity to sorting</p>

	could be confusing for some items like pasta boxes	suggestions for a higher contrast or distinct tones	separation could improve recognition	adhesive-laden cardboard More explicit wording e.g. 'clean paper and cardboard only'	and cardboard uncommon Integration of edge cases, like magazines with staples or laminated paper needed	
	<p>Icon is clear</p> <p>Terms like 'carton' can be confusing, as they are associated with cardboard rather than plastic</p> <p>Separation of soft and hard plastic is difficult to understand</p>	<p>Need to account for regional differences in terminology—e.g., use of 'Tetrapak' instead of 'carton'</p> <p>Larger icon / text and more contrast to be accessible to visually impaired users</p> <p>Multilingual labels for inclusivity and understanding across regions</p>	<p>Yellow generally associated with plastic</p> <p>Icons sometimes too detailed and confusing for users</p> <p>Adding images of common items like milk cartons or detergent bottles for relatability</p> <p>Subcategories (soft and hard plastic) perceived as visually overwhelming</p>	<p>Specify exclusions and add instructions (clean or separate items)</p> <p>Additional text explaining common items (e.g., juice cartons, laminated packaging)</p>	<p>Yellow widely recognised for plastic</p> <p>Combining Tetrapak with plastic resonates, but some regions currently recycle them with paper</p> <p>Clear guidance on less common items like mixed-material packaging</p>	<p>Overall design is cohesive</p> <p>Separation of subcategories like soft and hard plastic creates complexity</p> <p>Consistent in style</p> <p>Logical and structured</p> <p>Variety of icons could confuse users unfamiliar with detailed waste separation</p>

	<p>Clear for glass disposal, but distinction between clear and coloured glass not always well understood</p> <p>Adding more shapes, like jars or other glass items for improved clarity</p>	<p>Green colour works for glass, but might not be accessible for colour blind individuals</p> <p>Multilingual labels or clearer text would ensure better inclusivity for users from different backgrounds</p>	<p>Two bottles sometimes interpreted one as full and empty</p> <p>Single, unified label for all glass types might simplify the message</p> <p>Icons could better differentiate different glass waste types (bottle and jar)</p>	<p>Text helps clarify that both clear and coloured glass are included, but terms need clear definitions</p> <p>Text specifying common items to enhance understanding</p> <p>Indicate conditions for glass disposal (e.g. bottles without caps)</p>	<p>Green aligned with user expectations, though some areas use different standards</p> <p>Could better represent the full range of glass waste, like cookware or broken mirrors</p>	<p>Design cohesive and visually clear, but the distinction coloured / clear glass could be more explicit</p> <p>Unified labels for all glass types might lack detail for specific waste</p> <p>Overall clarity is good, but icons and text could better address less common scenarios</p>
	<p>Adding more symbols like leaves, a fishbone, or vegetable scraps to improve clarity</p> <p>Specify whether it covers food waste only or includes garden waste</p> <p>Terms like 'organic waste' or 'compost' are clearer and more</p>	<p>Green colour could be mistaken for glass recycling</p> <p>Suggesting brown for organic waste</p> <p>Multilingual labels or clearer text would ensure better inclusivity for users from different backgrounds</p> <p>Icon and text need to be large and clear</p>	<p>More realistic depiction of apple with added bite marks or complementary symbols</p> <p>Include a variety of items like banana peels, leaves, or onion skins to better represent the scope</p> <p>Darker green or brown background to</p>	<p>Clearly specify exclusions, such as cooked food, bones, or other animal waste</p> <p>'Compostable waste' or 'bio-waste' to align better with international practices</p> <p>Text needs to clarify if garden clippings, branches, or other green waste are included</p>	<p>Green colour is commonly associated with organic waste</p> <p>Some suggestion for brown colour</p> <p>Mix of food and garden waste requires clear communication</p> <p>Lack of guidance on less common waste types, like biodegradable</p>	<p>Design is cohesive</p> <p>Additional symbols or text to clearly outline what belongs in the bin</p> <p>Use of green for organic waste is logical but risks overlap with other categories like glass</p>

	universal than 'food waste,'	enough for visually impaired users	differentiate from others, especially glass		packaging or small garden waste	
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Source: Authors' elaboration

Table 16 Synthesis of insights for the labelling system

Consistency	User-friendliness	Information	Choice and motivation	Integration with packaging
<p>Unified Design: Consistent and minimalist design enhances clarity and familiarity</p> <p>Standardised Colours: Distinct, logical, and universally understood colours (e.g., yellow for plastic, green for organic) ensures immediate recognition; care to avoid overlaps (e.g., green for glass and organic, grey shades for metal and residual)</p> <p>Harmonisation Across Systems: Best possible alignment with existing practices towards standardisation</p>	<p>Simplicity is Key: Not too many labels or categories together, labels should focus on essential categories and avoid unnecessary granularity</p> <p>Clear Differentiation: Icons and colours must distinctly separate waste types to reduce confusion (e.g., organic vs. glass, soft vs. hard plastics).</p> <p>Adaptability for Different Contexts: Consideration of the diverse settings like household space, public waste collection ensuring practicality in diverse settings</p> <p>Complexity: Subcategories make the system harder to understand and use</p>	<p>Icon and Text Combination: Both icon and text should be universally understandable even across language barriers</p> <p>Guidance on Preparation: Labels should provide clear instructions on waste preparation (e.g., rinse cans, remove labels), either directly or via additional information (e.g., QR codes).</p> <p>Visibility: Large text and icons with high contrast for readability, for visually impaired users or low-light conditions</p> <p>Ambiguity in Icons: Some icons not immediately recognizable or intuitive, such</p>	<p>Educational Potential: Clear, engaging labels encourage and foster a habit of waste separation.</p> <p>Motivational Design: Appealing graphics and colours that align with eco-friendly themes</p> <p>Avoiding Overcomplication: A system that feels overly burdensome risks reducing user participation. Keeping it simple and intuitive is crucial to maintaining motivation.</p> <p>Unclear Benefits: Without understanding the environmental impact of proper sorting, users might not</p>	<p>Label Placement: Prominent placement on product packaging to ensure visibility and avoid confusion.</p> <p>Clear Alignment with Waste Bins: Packaging labels matching the corresponding bin in colour, iconography, and text</p> <p>Consideration for Complex Packaging: For multi-material packaging, labels should clearly indicate how to separate components or guide users toward specific bins (e.g., "dispose of cap separately")</p> <p>Insufficient Placement and Visibility: Labels on packaging are often too small, poorly placed, or hard to find,</p>

	<p>Space</p> <p>Constraints: Practicality is questioned in scenarios requiring multiple bins, which may not be feasible in small or shared spaces</p>	<p>as the apple core for organic waste or the can for general metals, which may not convey the full scope of acceptable items</p>	<p>feel incentivized to participate actively</p>	<p>reducing their utility for consumers</p>
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Source: Authors' elaboration

The topics identified as special points of attention are further detailed here, enriched with insights from the discussions, opinions, problems and solutions that surfaced during the workshops.

The topics are not tied to individual labels but rather consider the ecosystem, its actors, responsibilities, and the processes and dynamics surrounding waste disposal and recycling.

Compostable materials, compostable paper and plastics

Compostable materials were often discussed about the compostability of certain materials and the amount of compostable waste that can be processed within household systems versus industrial composting.

One frequent example here is garden waste, such as leaves and branches, which is often produced in large volumes and requires specialised handling.

Industrial composting was highlighted frequently as a responsibility of companies, with discussions on how the overall system should incentivise composting and recycling and hold industries responsible for their practices.

Compostable packaging, especially considering the prominence of the packaging topic for the workshops, was not something frequently mentioned or considered by citizens. Sustainable packaging was important for most groups, but without considering compostable packaging specifically.

Country-specific knowledge

Country-specific habits and practices were often brought up in the context of implementing a unified system across Europe. The most important aspect was the association of colours with certain types of waste (e.g. yellow for plastic), which is ingrained in users' minds and behaviour. A secondary aspect more discussed is regional specificities concerning the division of certain types of waste, such as Tetrapak or mixed materials, which are often confused due to unclear or inconsistent rules that vary by region within a country.

Interrelation of waste sorting labels and other labels on packaging

The presence of other labels on the packaging was mentioned mainly when discussing the clarity of the labels, noting the need for waste-sorting labels to be prominent, as simple as possible, and sufficiently large. Citizens expressed concern that they could interfere with or be confused with existing labelling systems, such as the Nutri score.

Deposit Return Systems

Deposit return systems were frequently mentioned as examples of best practices and potential models to target for a future system. Some of the concepts developed included such systems, for example for plastic bottles and glass. One key point the discussions shed light on was the necessity for sufficient recycling stations, and their availability even in rural areas and regions, ensuring they are accessible without placing excessive effort on users.

Colours and distinction of colours

Overall, the colour scheme was positively perceived. Doubts were expressed on two specific aspects: whether yellow can allow sufficient contrast, and if the use of two green labels (for glass and biowaste) would allow sufficient distinction or rather potentially confusing.

The need for communication & campaigns

The currently available information and communication were criticised in most workshops. The fact that information and awareness campaigns were frequently picked as topics to work on in groups highlights that this topic is important to many citizens. Insecurities and uncertainty around proper disposal methods for certain items were a recurring theme. The often-limited availability of information on recycling stations and recycling system dynamics, along with the perceived lack of interest in politics and industry is recognised as a source of frustration. Participants mentioned it as one reason for a lack of interest and motivation in recycling and effective waste sorting. Many missed the communication on the recycling dynamics beyond the individual levels, how the current system works, how items are precisely being recycled or not and the reasoning behind decisions.

To design effective communication campaigns around waste sorting, the importance of striking a balance between emphasizing individual responsibility and acknowledging systemic limitations was mentioned frequently. Campaigns should:

- **Empower Citizens Without Overwhelming Them:** Participants highlighted the significance of citizen sorting in reducing waste and conserving energy while being realistic about its limited impact on the broader waste challenge. This ensures that messages remain both motivating and honest.
- **Clarify Myths About Waste Processing:** Some suggested addressing common misconceptions, such as the belief that citizen sorting is unnecessary because sorting plants handle everything. Explaining how sorting plant process waste could demystify these beliefs and reduce reliance on large-scale sorting facilities.
- **Promote Mutual Responsibility Between Producers and Consumers:** In some of the concepts, citizens are encouraged to reflect on their purchasing choices, such as avoiding products with excessive packaging, while holding producers accountable for sustainable packaging solutions.
- **Leverage Innovative Tools:** Ideas sparked around the incorporation of Gen AI tools like ChatGPT into campaigns to engage citizens interactively to challenge misconceptions about waste sorting could help individuals explore and correct their own beliefs, fostering a deeper understanding of their role in the system.

Ultimately, campaigns should foster informed, balanced perspectives, empowering citizens to act while advocating for systemic changes that amplify their efforts.

Waste Sorting labels on receptacles and packaging

For receptacles, the most frequent need is for big and clear labels including, when necessary, additional information on the waste fraction (bottles without caps, pre-cleaned containers) and items that do not belong in that bin, even though users might assume it (no oily pizza boxes in paper/cardboard). Especially during the transition phase and in public spaces, intuitive labels with extra guidance (on packaging and/or on receptacles) can help users to better and more effectively sort their waste.

Concerns were raised about unifying labels that require aligning all regional systems, as this could lead to misinterpretation if users assume they know the system without realising the existence of regional differences (agreement on what goes in biowaste, residual, etc).

For packaging labels, participants stressed the importance of making them visible. Moreover, when using multiple labels, it needs to be clear whether packaging components need to be separated and, if so, in which way.

Multi-country labelling

Participants generally supported the idea of implementing a universal labelling system but raised concerns given the current variation in labels and colours across countries. They also noted significant differences in waste management systems (e.g., collection, automatic sorting after collection, preparation for recycling, recycling), which could make alignment complex and costly.

Accessibility and Inclusivity

Having included citizens with visual and physical impairments allowed them to highlight the challenges they face with the current system. Some individuals stepped forward during the workshops disclosing their impairment and the problems it was causing for them. Others, including those without impairments, expressed empathy and advocated for the needs of vulnerable groups, such as children and the elderly, pointing out the necessity to consider them when developing new concepts and evaluating the current prototype. Accessibility and inclusivity were some of the most frequent themes appearing in the new concepts designed by citizens, reflecting a commitment to unified design principles across countries.

Receptacles, home organisation and apartment buildings

This topic sparked significant discussion, especially concerning the divided labels. Participants expressed concerns about the space required for multiple containers in households, which could take up space and complicate recycling practices. Apartment buildings were mentioned as aggregators of residents from varied backgrounds, with varying waste-sorting behaviours and perceptions. In this way, the common larger containers that are often part of apartment buildings become a potential for conflicts, highlighting the need for clear rules to set expectations and help align behaviours.

4.2. Online Survey

Here are the main findings from the online survey in the following sections:

- **Analysis approach:** A description of the conducted analysis and the results presented in this report.
- **Sample Description:** A comprehensive overview of the survey sample, including demographic breakdowns by gender, age, education level, income, housing type, and area of residence.
- **Salience Task:** An assessment of how label elements (colour, text, other labels, and matching/mismatching colours) impact participants' attention to waste sorting labels on product packaging and waste receptacles.
- **Understanding Task:** An examination of participants' ability to correctly sort waste materials into the appropriate bins. The analysis considers the effects of label elements: colour, text, pictograms, and matching receptacle colours.
- **Label Builder Task:** An exploration of participants' preferences for specific label characteristics: preferences for colour vs. black-and-white labels, the inclusion of text, language options, QR codes, and material identifiers.
- **Ex-Post Questionnaire:** Description of participants' self-reported evaluations of waste sorting labels, their motivations, perceived barriers, social norms around sorting, and their interaction with technological features like QR codes. It explores the following factors:
 - Evaluation of labels (importance, visibility, clarity, and suggested improvements),

- Motivation, opportunity, and ability to sort waste,
- Social norms around waste sorting behaviours,
- Barriers to and community perceptions on waste sorting practices. Last, we detail the **implications of the findings for Prototype 2**. This section synthesises key results across the tasks and identifies actionable insights to guide the development of improved waste sorting labels.

4.2.1. Analysis approach

The main findings are in the main text, but the Annex contains additional details including disaggregated results, the distribution of observations per treatment group, and supplementary regression outputs. We also include the results of OLS and Probit regression models used to analyse the impact of various label elements and participant characteristics on key outcomes across salience, understanding, and label-builder tasks. These analyses explore participants' responses to label features while controlling for individual and contextual variables. The regression models incorporate control variables to account for sociodemographic and behavioural factors that may influence outcomes. Specifically, we control for:

- **Age**²³
- **Education**
- **Income quartile**
- **House type** (Private house, Condo/apartment, Shared housing, other)
- **Area lived** (urban, suburban, rural)
- **Country**²⁴
- **Colour blindness, visual impairments, and cognitive difficulties**
- **Mobile device usage** for answering the survey
- **Colour association variables** related to participants' familiarity with associating colours with materials (for the understanding task only).²⁵

The models cluster standard errors at the individual level to account for the potential correlation of observations within participants. The use of OLS provides intuitive, linear estimates. Probit marginal effects are particularly useful for interpreting relationships in binary outcome models, complementing OLS when the linear probability model might be inappropriate.

The interpretation of coefficients differs between OLS and Probit models, reflecting their distinct approaches to analysing data. In OLS models, the coefficients represent the change in the dependent variable for a one-unit increase in the independent variable, assuming a linear relationship. For instance, a

²³ Age was collected in brackets (18–24, 25–34, 35–44, 45–54, 55–64, 65 or more) and treated as a continuous variable in the analysis. The reported coefficients represent the marginal effect of moving from one age bracket to the next (e.g., from 18–24 to 25–34).

²⁴ For ease of presentation, country effects are included in the regression models but not shown in the tables due to the large number of categories.

²⁵ These are used to explore the potential role of pre-existing colour associations in correctly sorting waste. Specifically, these results help identify to what extent the colours used in the bins for the sorting task align with or differ from what participants are familiar with.

coefficient of 0.02 indicates that a one-unit increase in the predictor leads to a 2-percent increase in the dependent variable. Probit models, on the other hand, are specifically designed for binary outcomes (e.g., click or no click). The reported marginal effects from Probit regressions represent the change in the probability of the outcome occurring (e.g., clicking) for a one-unit change in the independent variable, holding other factors constant.

The analyses are structured as follows:

1. **Salience Task Regressions:** These examine the likelihood of clicks on different areas of labels (packaging and bins) as a function of label elements. The dependent click variable is 0 when the participant did not click on the corresponding part of the image, and a value of 1 when the participant did click.²⁶
 - **Understanding Task Regressions:** These analyses test for the influence of label features on correct sorting behaviour and reaction times. The dependent variable of correct sorting is 0 when the participant selected the incorrect receptacle (mono-component products) or divided the waste but correctly sorted zero components (multi-component products). Correct sorting is 1 when the participant selected the correct receptacle (mono-component products) or correctly sorted all components of the product (multi-component products). Correct sorting can also be fractions for multi-component products where the participant chose to divide the waste: 0.5: In dual material products the participant correctly sorted one of the two components,
 - 0.33: In triple material products the participant correctly sorted one of the three components,
 - 0.66: In triple material products the participant correctly sorted two of the three products.
2. **Label builder Task Regressions:** Investigating the impact of sociodemographic characteristics on preferences for label characteristics (i.e., black-and-white vs. colour labels, text inclusion).²⁷
3. **Ex-post questionnaire:** Reporting the self-reported responses to the ex-post questionnaire.

4.2.2. Sample description

The final dataset used for the analysis consists of $N=16,380$ survey responses across 21 EU Member States (mean duration=30.7 minutes; median= 21.5 minutes). Table 17 presents the distribution of responses by country, showing the frequency and percentage of responses from each country as a share of the overall sample.

Table 17. Responses by country

Country	Frequency	%
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²⁶ Multiple clicks on the same label are still counted as 1. These binary values are then averaged across all participants. This approach is appropriate because it focuses on whether the label attracts attention, not the frequency of interaction, which avoids overemphasizing participants who click excessively. It also simplifies interpretation, as the average rate represents the proportion of participants who interacted with the label across conditions.

²⁷ The dependent variables in the label builder task regressions are modelled as a binary outcome, where participants' preferences are coded as 1 if they select a specific label characteristic (e.g., black-and-white vs. colour labels, text inclusion) and 0 otherwise.

Austria	783	4.78
Belgium	727	4.44
Czech Republic	797	4.87
Denmark	787	4.80
Estonia	792	4.84
Finland	807	4.93
France	812	4.96
Germany	775	4.73
Greece	797	4.87
Hungary	822	5.02
Ireland	815	4.98
Italy	731	4.46
Latvia	811	4.95
Lithuania	815	4.98
Malta	707	4.32
Poland	737	4.50
Portugal	648	3.96
Romania	766	4.68
Slovakia	808	4.93
Spain	874	5.34
Sweden	769	4.69
Total	16,380	100.00

Source: Authors' elaboration

The tables below summarise the key demographic variables: gender, age, education level, type of housing, area type, and income distribution. These tables provide an overview of the sample's composition across these categories, presenting the frequency and percentage of respondents within each group. This breakdown provides evidence for representativeness and generalisability. Demographic variables are broken down by country in the Annex, where we include a comparison table that shows how close the sample distributions are to the respective country-specific population distributions (See Table 40 in the Annex).

Table 18. Gender distribution

Gender	Frequency	%
Man	8216	50.16
Woman	8133	49.65
I prefer not to answer	11	0.07
Other	20	0.12
Total	16,380	100.00

Source: Authors' elaboration

Table 19. Age brackets distribution

Age group	Frequency	%
18-24	1558	9.51
25-34	2486	15.18
35-44	2868	17.51
45-54	2816	17.19
55-64	2803	17.11
> 65	3849	23.50
Total	16380	100.00

Source: Authors' elaboration

Table 20. level of education distribution

Completed education	Frequency	%
I did not finish high school	2040	12.45

High school or equivalent	6365	38.86
Bachelor's degree or equivalent	3648	22.27
Master's degree	2005	12.24
Doctorate or equivalent higher degree	344	2.10
Vocational school	1512	9.23
I prefer not to answer	49	0.30
Other	417	2.55
Total	16380	100.00

Source: Authors' elaboration

Table 21. House type distribution

House type	Frequency	%
Private House	8220	50.18
Condo/apartment	5763	35.18
Shared housing	1776	10.84
I prefer not to answer	167	1.02
Other	454	2.77
Total	16380	100.00

Source: Authors' elaboration

Table 22. Area of living distribution

Area type	Frequency	%
Urban	8966	54.74
Suburban	4066	24.82
Rural	3348	20.44
Total	16380	100.00

Source: Authors' elaboration

Table 23. Monthly income quartile distribution²⁸

Income quartile	Frequency	%
First quartile (highest)	4636	28.30
Second quartile	2907	17.75
Third quartile	2978	18.18
Fourth quartile (lowest)	5547	33.86
Missing/Prefer not to answer	312	1.90
Total	16380	100.00

Source: Authors' elaboration

4.2.3. Salience task

The main objective of the **Salience task** is to assess how different label elements impact the noticeability of waste sorting labels. Participants were asked to identify the elements they believed are the most important in helping them sort waste. We operationalised 'Noticeability' as the likelihood of selecting waste sorting labels in the presented image.

We examine the effects of label elements on image clicks along these dimensions²⁹:

1. Colours vs. no colour,
2. Text vs. no text,
3. Presence vs. absence of other labels on product packaging,
4. Matched vs. mismatched variations of receptacles on waste labels.

In the Annex, we present the disaggregated (by product type or by receptacle label) results only when we find a statistically significant effect ($p < .05$) at the aggregated level. This is done to better understand which of the variations drive the significant results found at the aggregate level. Finally, we show the impacts of label elements on reaction times in the Annex (see Table 52 and Table 53 in the Annex).

Overall clicks

- On the **product images**, participants click most commonly on the waste sorting label (64.6%), followed by clicking on an unrelated area of the product (39.4%). Secondary labels "Greendot", "Triman", and "SUP" received less attention (9.4%, 8.4%, and 15.9%, respectively). Interestingly,

²⁸ The income quartiles were calculated to account for purchasing power parity. [Eurostat's ilc_di01 indicator](#) provides the cut-off points for income quartiles, dividing the population into four equal groups based on income distribution.

²⁹ Participants are evenly distributed across conditions (see Table 42 and Table 43 in Annex).

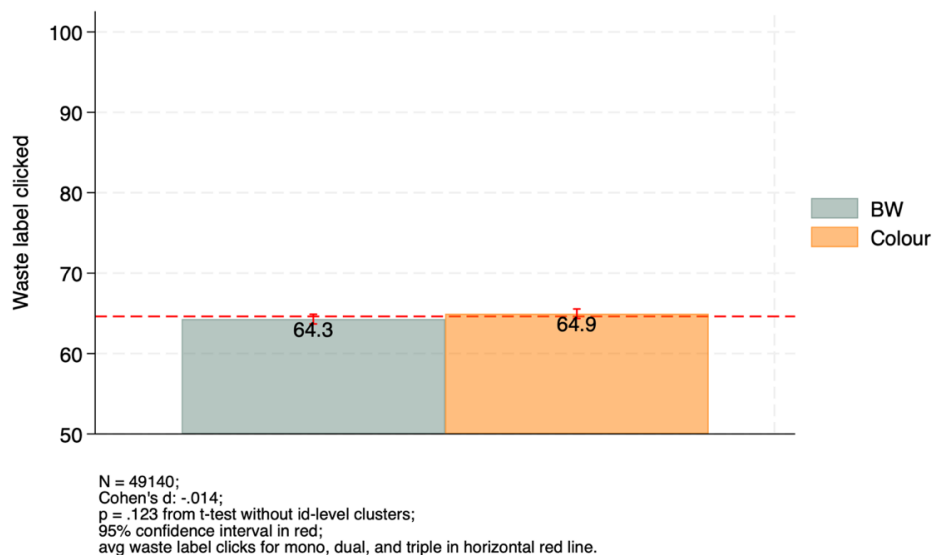
participants in France and Belgium, where the Triman is used more commonly, demonstrated greater use of the Triman to sort waste (14.0%), compared to the sample excluding France and Belgium (7.9%). See section 5.4.4.2 in the Annex.

- On the **receptacle images**, participants most often clicked on the plastic/metal receptacle sign (77.6%), followed by the paper receptacle sign (69.8%). The least clicked labels were biowaste (44.5%) and residual waste (47.7%). For distributions of clicks on all image areas, see Figure 107 - Figure 120 in the Annex).
- On average, participants click more frequently on the bin images compared to product packaging images (4.4 vs. 2.2 clicks respectively, $p < .001$ in a t -test). This is likely because there were more correct clicks possible in the bin images compared to the packaging images.³⁰

4.2.3.1. Effect of colour

The use of colours does not have a statistically significant impact on the likelihood of clicking on product packaging waste sorting labels (Figure 43 below; Table 45 and Table 46 in the Annex).

Figure 42. % Impact of colour on likelihood to click on packaging waste sorting labels - mono, dual, and triple component packaging

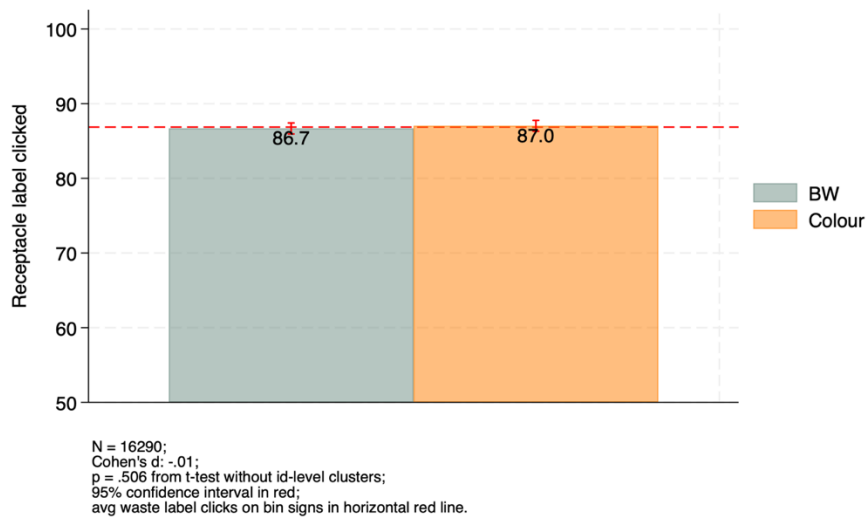


Source: Authors' elaboration

Similarly, **the use of colour does not have a statistically significant impact on aggregate receptacle waste sorting label image clicks, defined as clicking on any of the plastic/metal, paper, biowaste, or residual waste labels** (Figure 44 below). However, colour does significantly increase clicks on the waste sorting label on the bin where the biowaste label is affixed, with a small positive effect of 4.4 percentage points ($p < 0.001$. See Table 47 in Annex).

Figure 43: % Impact of colour on aggregated receptacle waste sorting label clicks

³⁰ In the Annex, we describe a further breakdown of the average number of clicks by product type and conditions (Table 16).



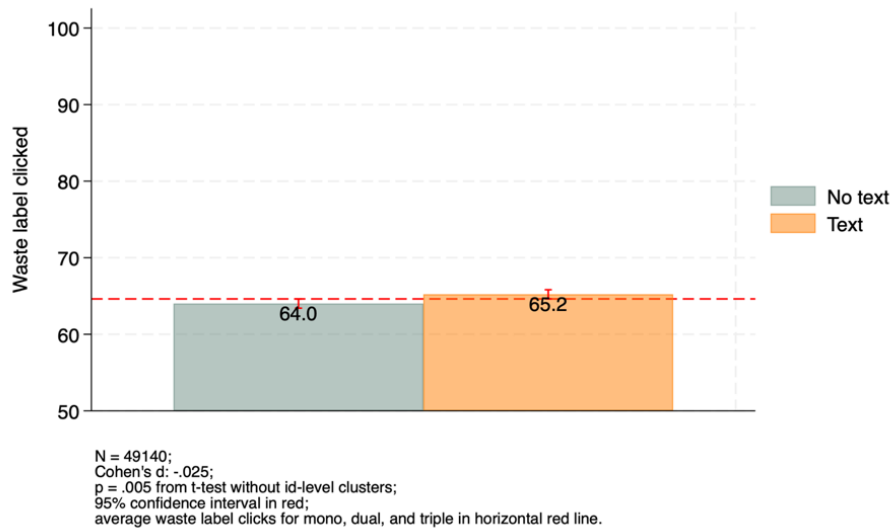
Source: Authors' elaboration

4.2.3.2. Effect of text

The inclusion of text mentioning the relevant material (in the country-specific language) significantly increases the likelihood of clicking on the packaging waste sorting label by 1.2 percentage points (65.2% with text vs. 64.0% without text, $p = .005$, Figure 45; Table 45 in the Annex). As shown in Figure 121 in the Annex, this effect is driven by the mono-products, where text has a small, significant positive effect on click likelihood on the waste label ($p < 0.001$). For dual and triple-material products, the effect is not statistically significant. The significant effect of text for mono-material products suggests that text enhances the salience of waste sorting labels when the product's material composition is simpler and more intuitive to process. However, the absence of significant effects for dual and triple-material products indicates that text information may be less impactful when multiple materials are present.

The inclusion of text significantly reduces the number of clicks on the Greendot by 1 percentage point, corresponding to a small effect ($p < .01$; Table 45 in Annex). While we cannot state with certainty why this is the case, one possible explanation could be that the text draws more attention to the waste sorting label, away from other labels like the Greendot.

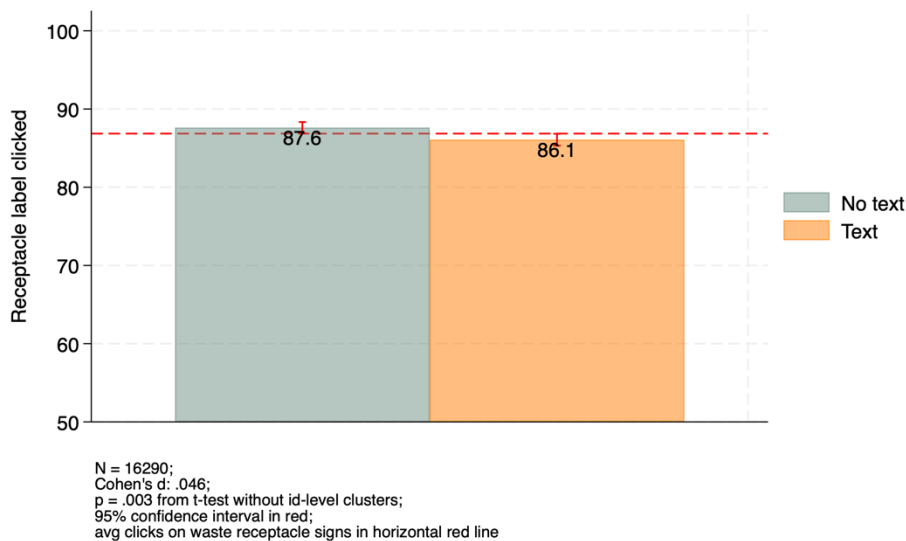
Figure 44: % Impact of text on waste sorting label clicks – mono, dual, and triple



Source: Authors' elaboration

In contrast, **the inclusion of text significantly lowers the likelihood of clicking on the receptacle waste sorting labels, resulting in a small negative effect** (87.6% without text vs. 86.1% with text, $p = .p = .003$, see Figure 46). As previously explained, in Figure 46 we aggregate clicks on any of the receptacle labels of interest: plastic/metal, paper, biowaste, and residual waste. This finding is mainly driven by clicks on the plastic/metal sign, for which the inclusion of text has a small but significant negative effect of lowering clicks by 1.8 percentage points ($p < .01$; see Table 47 and Figure 82 in Annex).

Figure 45: % Impact of text on receptacle waste sorting label clicks



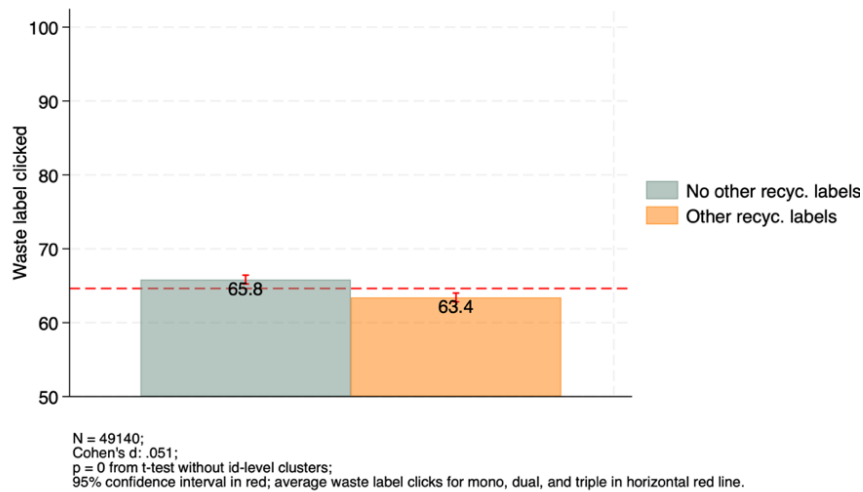
Source: Authors' elaboration

4.2.3.3. Effect of other labels on packaging waste sorting label clicks

The inclusion of other labels (i.e., Greendot, Triman, and SUP) has a small but significant negative effect on the number of clicks on packaging waste sorting labels, reducing them by 2.4 percentage points (65.8% without other labels vs. 63.4% with other labels, $p < .001$, Figure 47). All three product types, mono, dual and triple, show this trend, with the strongest effect (though still small in

size) in the mono products (66.0% without other labels vs. 62.0% with other labels, $p < .001$); see Figure 128 - Figure 130 in Annex. The inclusion of other labels significantly reduces the number of clicks on any other parts of the image shown by 2.1 percentage points, corresponding to a small effect ($p < .001$, Table 45 in Annex). This result is again driven by the mono-product (Table 21 in the Annex).

Figure 46: % Impact of other labels on packaging waste sorting labels – mono, dual, and triple

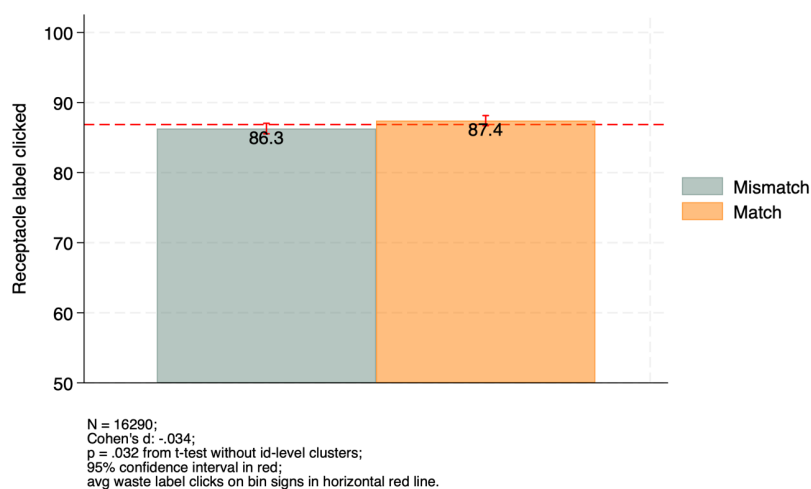


Source: Authors' elaboration

4.2.3.4. Effect of match/mismatch of label and receptacle colours on receptacle waste sorting label clicks

When the label and receptacle colours match, clicks on labels increase by 1.1 percentage points. In other words, colour matching has a positive and significant small effect on clicks (87.4% with matching colours vs. 86.3% with mismatching colours, $p = .032$). This finding is driven primarily by the small positive effect of matching colours between the label and receptacle for paper on label clicks (70.7% with matching colours vs. 68.9% mismatching colours, $p = .01$; Table 47 and Figure 132 in the Annex).

Figure 47: % Impact of matching label and receptacle colours on receptacle waste sorting label clicks



Source: Authors' elaboration

4.2.3.5. Reaction times

None of the label elements on product packaging or waste receptacles significantly impact the reaction time of participants, measured as the time (in seconds) to submit the page in the salience task (Table 52 and Table 53 in Annex).

4.2.4. Understanding (correct sorting) task

The main objective of the **understanding (correct sorting) task** is to understand how different elements of labels impact the ability of participants to correctly sort products into the appropriate receptacle.

In this section, we present the main findings related to the task. We examine in detail the effects of the label elements on product sorting along these dimensions, also described in Table 24³¹:

1. Colours vs. no colour,
2. Text vs. no text,
3. Presence vs. absence of other labels,
4. Presence vs. absence of component pictograms for multi-component packaging, and
5. Match vs. mismatch of waste sorting labels and receptacle colours.

Table 24. Elements varied in each understanding task product type

Product type	Number of products tested	Label elements
Mono	3	Colour/B&W, Text/No text, Greendot/No Greendot, Colour matching/No Matching
Dual	4	Colour/B&W, Text/No text, Greendot/No Greendot, Component pictogram/No component pictogram, Colour matching/No Matching
Triple	2	Colour/B&W, Text/No text, Greendot/No Greendot, Component pictogram/No component pictogram, Colour matching/No Matching
Non-recyclable	1	Text/No text, Greendot/No Greendot ³²

Source: Authors' elaboration

³¹ Participants are evenly distributed across conditions (see Table 54 in the Annex).

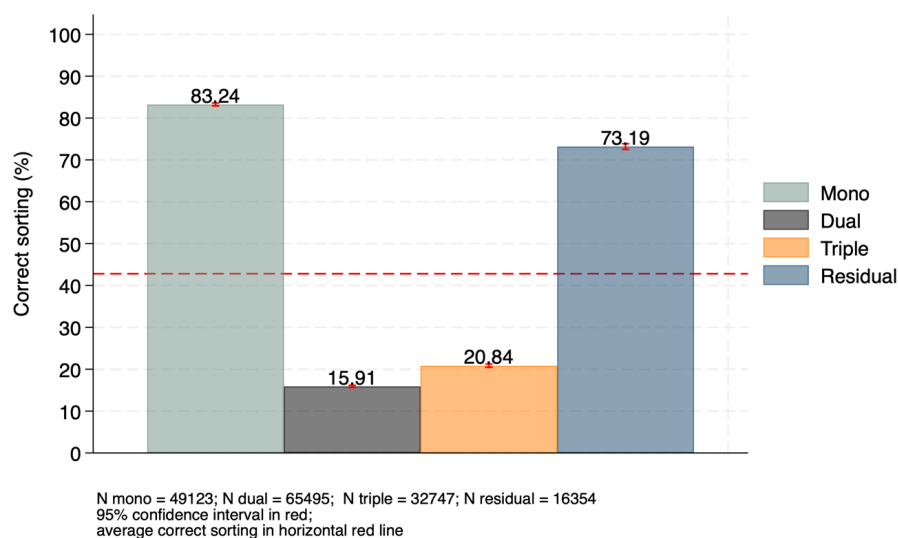
³² Note: There was no variation in colour for non-recyclable labels, as these labels are already presented in black and white.

We present the disaggregated (by product type) results in the Annex only when we find a statistically significant effect ($p < .05$) at the aggregated level. This is done to better understand which of the variations drive the statistically significant results found at the aggregate level.

Correct sorting

On average, waste products were sorted correctly 42.8% of the time. However, the results show a wide variation in correct sorting by product type. **Mono products were sorted correctly 83.2% of the time, while dual and triple material products were sorted correctly 15.9% and 20.8% of the time,** respectively. These results are not too surprising, as correctly sorting multiple components of a product is more challenging and effortful than correctly sorting a single-material item. Figure 49 illustrates the percentage of the sample that correctly sorted items, providing an overview of overall performance and highlighting potential variations across different label and product conditions.

Figure 48. % sample sorting correctly



Source: Authors' elaboration

With regard to **participants' existing colour-material associations and their effects on correct sorting**, we report some interesting findings. Overall, aside from the plastic/metal association, seeing one's existing colour associations on the receptacles improves the ability to correctly sort waste (see Table 56 in the Annex for full results).

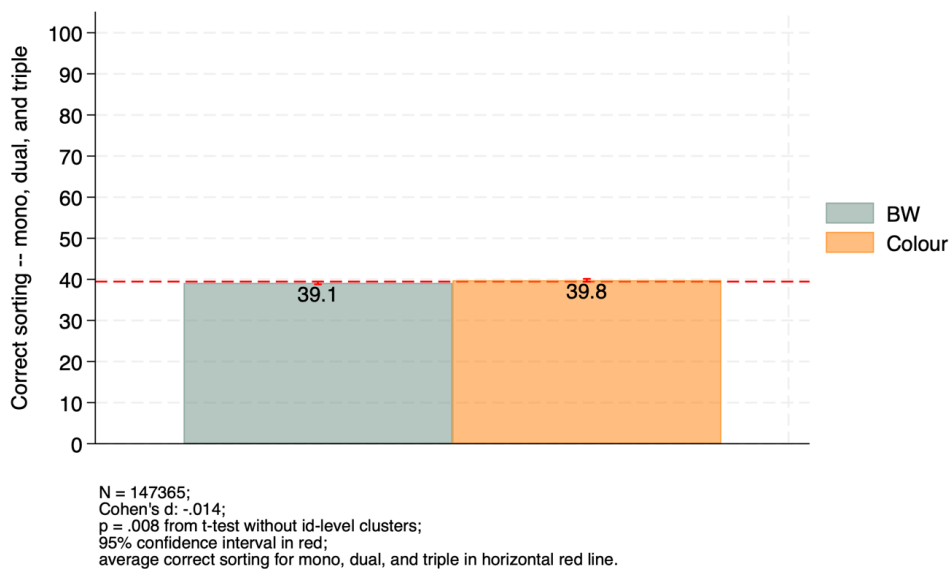
- Participants whose **plastic/metal colour** associations match the receptacle colour in the understanding task are 3.7, 3.2, and 3.8 percentage points less likely to correctly sort the mono, dual, and triple materials, respectively ($p < .001$ in all cases).
- Participants whose **paper/cardboard colour** associations match the receptacle colour are 6.8, 5.6, 8.0, and 5.6 percentage points more likely to correctly sort the mono, dual, triple, and residual materials, respectively ($p < .001$ in all cases).
- Participants whose **glass colour** associations match the receptacle colour are 7.0, 1.4, 2.1, and 3.8 percentage points more likely to correctly sort the mono, dual, triple, and residual materials, respectively ($p < .001$, $p = .014$, $p = .002$, $p < .001$, respectively).

- Participants whose **biowaste colour** associations match the receptacle colour are 5.4, 1.3, 1.9, and 2.6 percentage points more likely to correctly sort the mono, dual, triple, and residual materials, respectively ($p < 0.001$, $p = .018$, $p = .009$, $p = .006$, respectively).

4.2.4.1. Effect of colour

Colour on the waste label on product packaging has a small but significant positive impact on the correct sorting of waste materials (39.8% correct sorting with colour vs. 39.1% correct sorting without colour, $p = .008$, Figure 50), in contrast with the non-significant impact on label clicks. The regression results demonstrate that these **results are driven by mono products** (Table 28 and Figure 94 in the Annex).

Figure 49. % Impact of colour on correct sorting - mono, dual, and triple

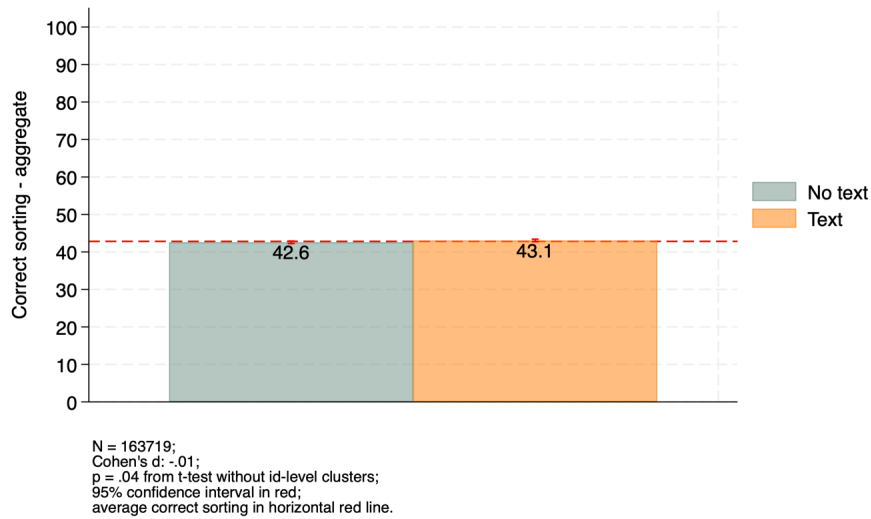


Source: Authors' elaboration

4.2.4.2. Effect of text

The inclusion of text that describes the material on the product packaging increases the correct sorting of waste materials by 0.5 percentage points, a statistically significant effect (43.1% correct sorting with text vs. 42.6% correct sorting without text, $p = .04$, Figure 51). Similarly to the use of colour, this effect is driven by mono products, for which text increases correct sorting by 0.8 percentage points ($p < .05$; Table 28 and Figure 97 in Annex). These positive effects of text on the correct sorting of waste, especially for mono products, are in line with the positive effects of text on the likelihood of clicking on the labels.

Figure 50. % impact of text on correct sorting - aggregate

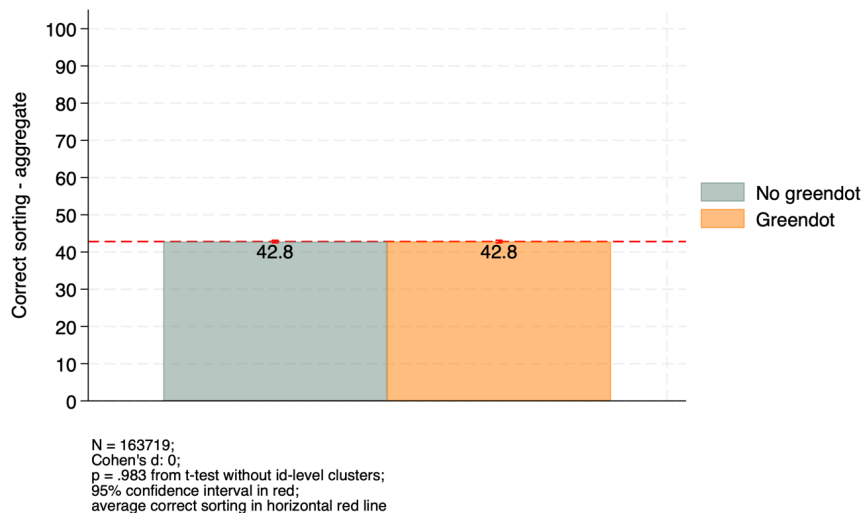


Source: Authors' elaboration

4.2.4.3. Effect of Greendot

The inclusion of the Greendot does not significantly impact the correct sorting of waste materials (Figure 52 below and Table 55 in Annex). However, the salience task results indicate that participants clicked on the Greendot significantly more frequently, suggesting that it drew their attention. This discrepancy may be attributed to the instructions in the salience task, which asked participants to click on elements that help them sort their waste. If participants interpreted the task broadly (e.g., using 'recycling' and 'sorting' interchangeably) they may have clicked on the Greendot as a recycling symbol, even though it does not directly aid sorting accuracy.

Figure 51. % impact of Greendot on correct sorting - aggregate

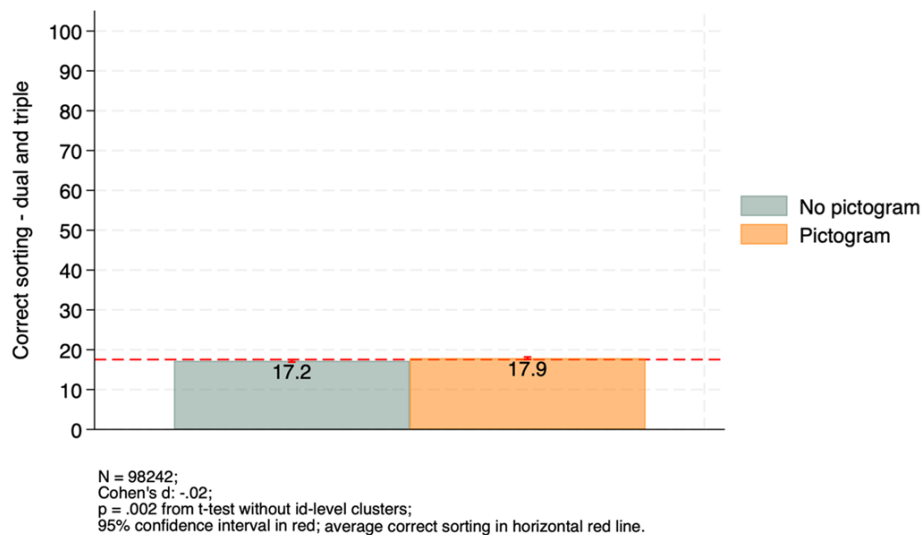


Source: Authors' elaboration

4.2.4.4. Effect of component pictograms

The inclusion of component pictograms for dual- or triple-component products significantly increases the correct sorting of waste materials by 0.7 percentage points (17.9% in component pictogram vs. 17.2% in no component pictogram, $p = .002$). This effect is driven by the dual products, in which the component pictogram increases correct sorting by 0.8 percentage points ($p < .01$; Table 56 and Figure 142 in the Annex).

Figure 52. % Impact of component pictogram on correct sorting - dual and triple

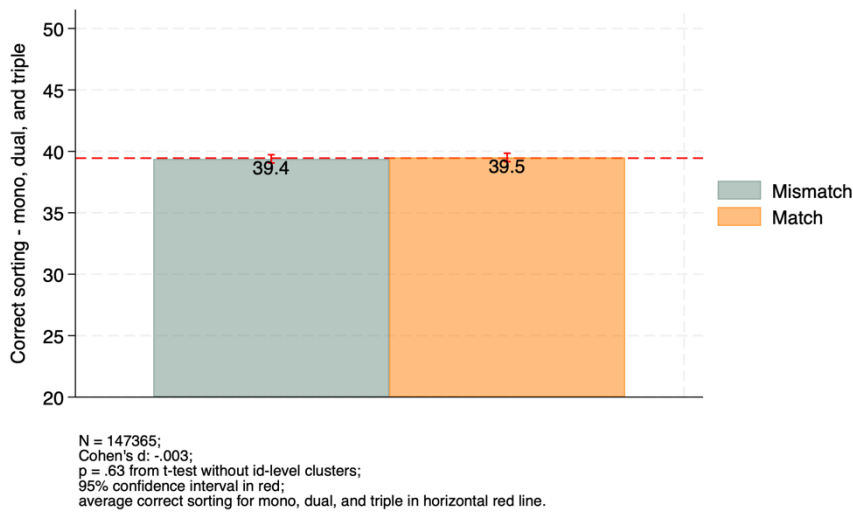


Source: Authors' elaboration

4.2.4.5. Effect of matching label and receptacle colours

While on average we find **no statistically significant effect of matching label and receptacle colours on correct sorting** (Figure 54 below). Regression analysis including controls for additional variables suggests that matching colours significantly reduces sorting accuracy by 5.6 percentage points, corresponding to a small effect ($p < .001$; Table 55 in Annex). This effect holds across mono, dual, and triple materials (Table 56 in Annex). Matching label and receptacle colours reduce sorting accuracy by 8.7, 3.4, and 5.4 percentage points for mono, dual, and triple materials, respectively ($p < .001$ for all). This finding contrasts with the effects found in the salience task, whereby matching label and receptacle colours significantly increased the likelihood of clicking on the label. A potential explanation for this discrepancy is that matching colours may initially draw visual attention to the label, enhancing salience and click likelihood in the salience task. However, during the sorting task, this same colour-based cue may create confusion or misattribution when more deliberate cognitive processing is required to correctly identify the material category. This suggests that colour matching may act as a heuristic shortcut during initial attention allocation but can interfere with accurate material identification when deeper cognitive engagement is necessary.

Figure 53. impact of matching colours on correct sorting - mono, dual, and triple



Source: Authors' elaboration

4.2.4.6. Decision to separate materials

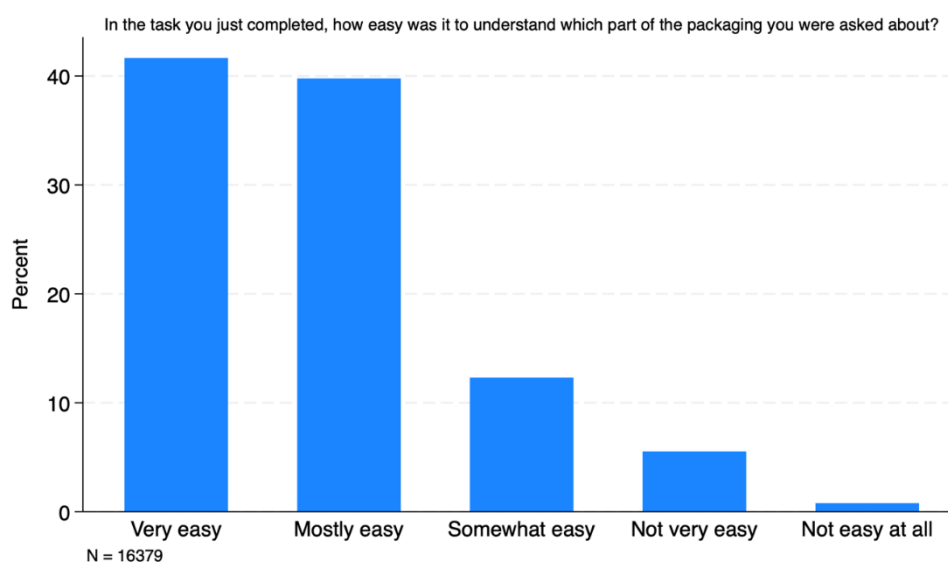
Here we focus on the decision to separate materials, which was correct for dual and triple materials, and incorrect for mono and residual waste materials.³³ Participants chose to separate mono, dual, triple, and residual waste material packaging 1.1%, 22.1%, 27.7%, and 0.9% of the time, respectively. The **inclusion of the component pictograms significantly increases the likelihood of separating into separate receptacles** by 1.2 percentage points ($p < .001$, small effect), irrespective of whether it is correctly or incorrectly separated. **Triple material products are more likely to be separated by 5.6 percentage points than dual material products** ($p < .001$, small effect). Surprisingly, matching the label and receptacle colours significantly decreased the likelihood of separating into separate receptacles by 4.7 percentage points ($p < .001$, small effect; Table 57 in Annex).

4.2.4.7. Clarity of task

Figure 55 below summarises the self-reported perceived clarity of the understanding task. The results indicate that most participants found the task to be at least "Somewhat easy". Fewer than 10% of participants reported finding the task "Not very easy" or "Not easy at all". The Pearson's correlation between ease of understanding (1 = very easy to 5 = not easy at all) and performance in the understanding task is $r = -0.1$, $p < 0.001$. This suggests that participants who more easily understood the task were able to perform better in it. Nevertheless, ease of understanding explains a very small portion of understanding task performance, so this correlation should be interpreted with caution.

³³ Only 1% of observations incorrectly chose to separate into separate bins when asked how they would sort mono component and residual waste materials.

Figure 54. Clarity of understanding task



Source: Authors' elaboration

4.2.4.8. Reaction times

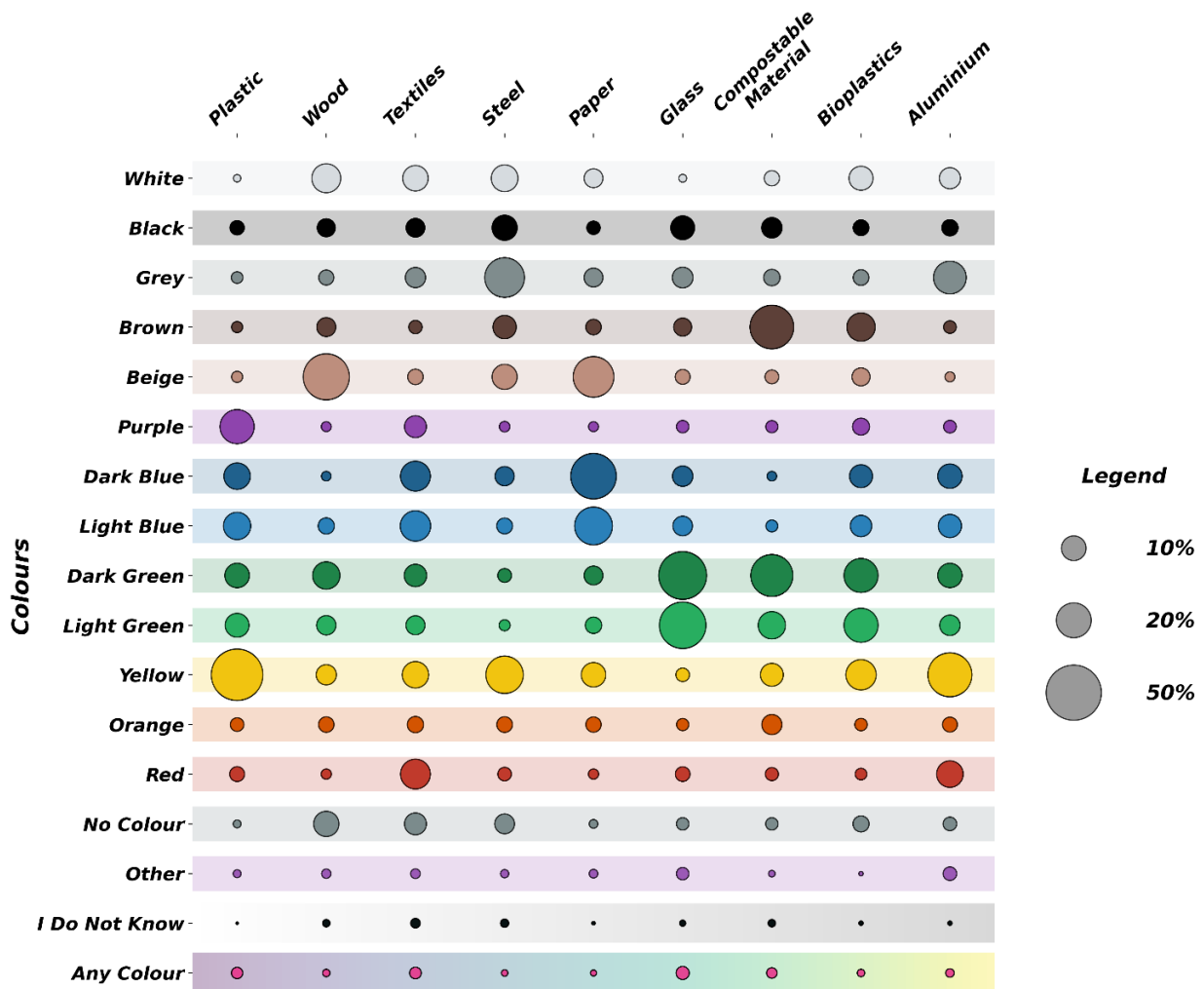
The inclusion of **text significantly increases the time needed to complete the understanding task, with a small effect of 0.91 seconds** ($p < .05$; Table 58 in Annex). As shown in Figure 51, the inclusion of text on packaging improves correct sorting. Therefore, it may be that the increased reaction time is used by consumers to better understand how to sort correctly. None of the other treatment variations, including colour, matching labels, and other labels, had a statistically significant impact on reaction times. However, when splitting into correct and incorrect responses, only the inclusion of the GreenDot increased the response time for incorrect responses by 1.16 seconds ($p < .05$).

4.2.5. Colour familiarity task

In this section, we present the results of the **Colour familiarity task** across various material categories. Participants were asked to identify or associate specific colours with different materials. The materials examined include plastic, wood, textiles, steel, paper, glass, compostable materials, bioplastics, and aluminium.

Overall, results across all materials indicate clear colour associations that suggest participants' familiarity and intuitive understanding of material categories. As shown in Figure 56, several key trends emerge.

Figure 55 Material colour associations



Source: Authors' elaboration

Certain materials are strongly associated with specific colours, indicating clear and consistent preferences and habits among participants:

- **Yellow is the dominant colour for plastics (43.5%)**, with purple (19.1%) as the second most chosen. However, there is a 24.4 percentage point gap between the two, highlighting the clear dominance of yellow.
- **Green (light and dark) is highly associated with glass.** Dark green is the most chosen colour for glass (37.5%), closely followed by light green (35.5%).
- **Brown is strongly linked to compostable materials (31.2%)**, with dark green (28.9%) as the second choice. The gap of 2.3 percentage points suggests both colours are perceived as suitable for compostable material.

For some materials, multiple colours are similarly preferred, showing overlap in participants' perceptions:

- **For textiles, light blue (15.1%) and dark blue (14.6%) are nearly equally chosen**, with red (14.5%) also receiving notable preference. This highlights a lack of strong dominance by any single colour.

- **For paper, dark blue (33.9%) is the dominant choice**, followed by beige (27.1%). The 6.8 percentage point gap reflects a shared association between these two colours.

Residuals and steel, show less dominant colour associations, with preferences distributed across several colours:

- For steel, black (25.8%) and yellow (22.9%) are leading, but white (11.7%) and brown (10.3%) also feature quite prominently. The gap between black and yellow is only 2.9 percentage points, indicating near-equal strength.
- Dark colours like black and grey are consistently linked with residual waste (black: 25.8%, grey: 17.5%) and metals (black: 25.8%, grey: 25.8%), likely due to their association with sturdiness or general waste categories.

Building on the overall trends outlined above, in the Annex (Section 5.4.6) we describe the specific colour associations for individual material categories.

4.2.6. Label builder task

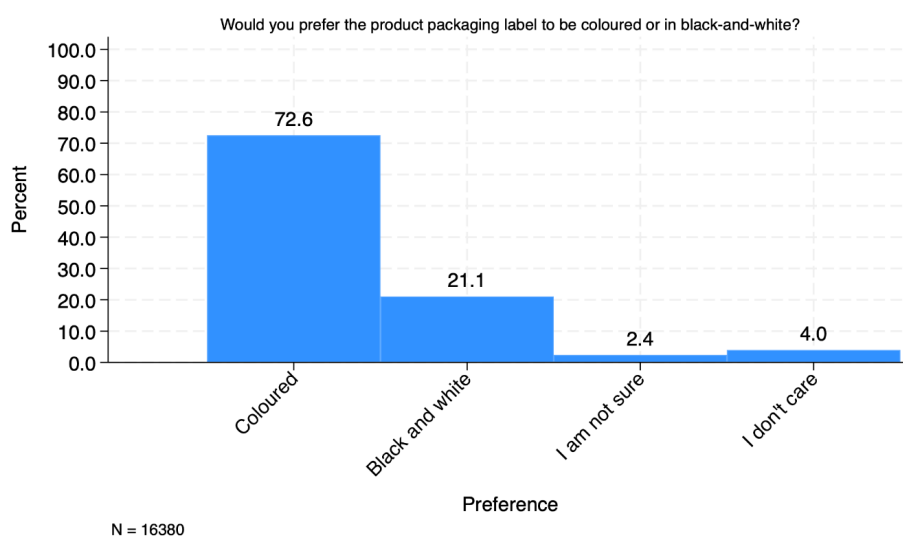
This section summarises participants' preferences and perceptions regarding various aspects of waste sorting labels along these dimensions: label colour, the presence of material text, the language used, material identifiers, the presence of QR codes, and understanding of compostability. Each subsection presents findings for both product packaging labels and waste receptacle labels when appropriate, highlighting key trends and patterns. The graphs illustrate the distribution of preferences, with the y-axis showing percentages and the x-axis displaying the possible response options. Additionally, regression tables provide insights into the sociodemographic characteristics associated with these preferences.

4.2.6.1. Colour preferences

Figure 57 and Figure 58 summarise participants' preferences for colour versus black-and-white labels on product packaging and waste receptacles. Key findings include:

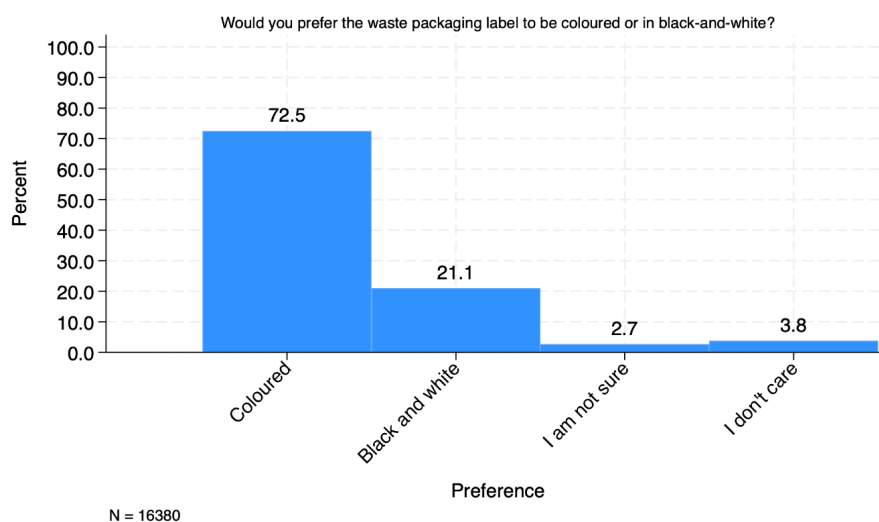
- **Most participants prefer coloured labels, for both the product packaging (72.6%) and waste receptacles (72.5%).**
- Black-and-white labels are preferred by 21.1% of participants for both product packaging and waste receptacles.

Figure 56. Colour preferences on product packaging labels



Source: Authors' elaboration

Figure 57 Colour preferences on waste receptacles



Source: Authors' elaboration

In terms of the sociodemographic characteristics that predict a preference for B&W labels versus coloured labels on product packaging and waste receptacles, the main findings are (see Table 59 in Annex):

- **Age:** Older participants are significantly less likely to prefer B&W labels for both packaging and receptacles, by 0.6 and 0.4 percentage points ($p < .001$ for both), respectively, indicating a stronger preference for colour labels.
- **Education:** Higher education is associated with a slight preference for B&W labels, particularly on waste receptacles (0.6 percentage points, $p < .001$, compared to 0.2 percentage points on packaging, $p < .05$).
- **Income:** Participants in higher-income quartiles are less likely to prefer B&W labels, suggesting a stronger preference for coloured labels. Higher incomes reduce preference for B&W labels by 0.3

percentage points for packaging labels ($p < .01$) and 1 percentage point for receptacle labels ($p < .001$).

- **Housing Type:** Relative to those living in private houses:
 - Participants living in condos/apartments are 2.3 percentage points more likely to prefer B&W labels for packaging labels and 2.1 percentage points for receptacles ($p < .001$).
 - Those in shared housing and other housing types show a reduced preference for B&W labels by 1.2 percentage points for packaging labels ($p < .01$), and 2.4 percentage points for receptacle labels ($p < .001$), indicating a preference for colour labels.
 - Participants in the "Other" housing category are 5.9 percentage points less likely to prefer B&W labels for packaging labels and 8.1 percentage points less likely for receptacle labels ($p < .001$).
 - Respondents who selected "Prefer not to answer" are 7.5 percentage points less likely to prefer B&W labels for packaging labels and 11.5 percentage points less likely for receptacle labels ($p < .001$), also suggesting a preference for colour labels.
- **Area Lived:**
 - Participants in suburban areas are slightly more likely to prefer B&W labels, compared to urban areas, by 1.3 percentage points for packaging labels ($p < .001$) and 0.8 percentage points for waste receptacles ($p < .01$)
 - Those in rural areas are significantly less likely to prefer B&W labels by 2.7 percentage points for packaging labels and 1.2 percentage points for waste receptacles ($p < .001$ for both), indicating a preference for colour.
- **Health-Related Variables:**
 - Participants with colour blindness and visual impairments show a strong preference for B&W labels, likely due to accessibility considerations. For the colour-blind, the preference for B&W packaging labels increases by 9.5 percentage points and 8.2 percentage points for waste receptacle labels ($p < .001$ for both). For the visually impaired, the preference for B&W packaging labels increases by 9.3 percentage points and 6.8 percentage points for waste receptacle labels ($p < .001$ for both).
 - Participants with cognitive difficulties prefer B&W labels for waste receptacles, with an increased preference of 10 percentage points ($p < .001$), but not for product packaging.

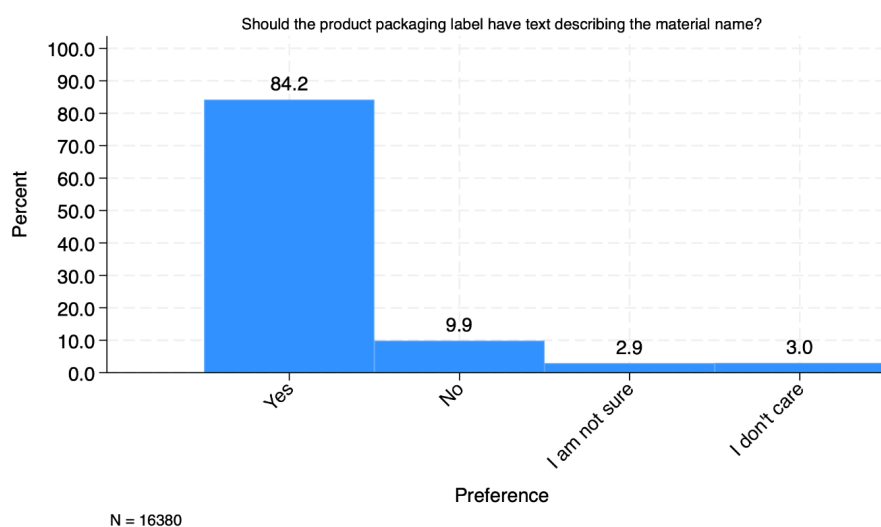
Participants filling out the survey on their mobile phone are more likely to prefer B&W labels both on packaging and receptacles, with effects of 1.1 ($p < .05$) and 2.7 ($p < .001$) percentage points, respectively.

4.2.6.2. Preference for text describing material name

Figure 59 and Figure 60 summarise participants' preferences for including text describing material names on product packaging and waste receptacles. Key findings include:

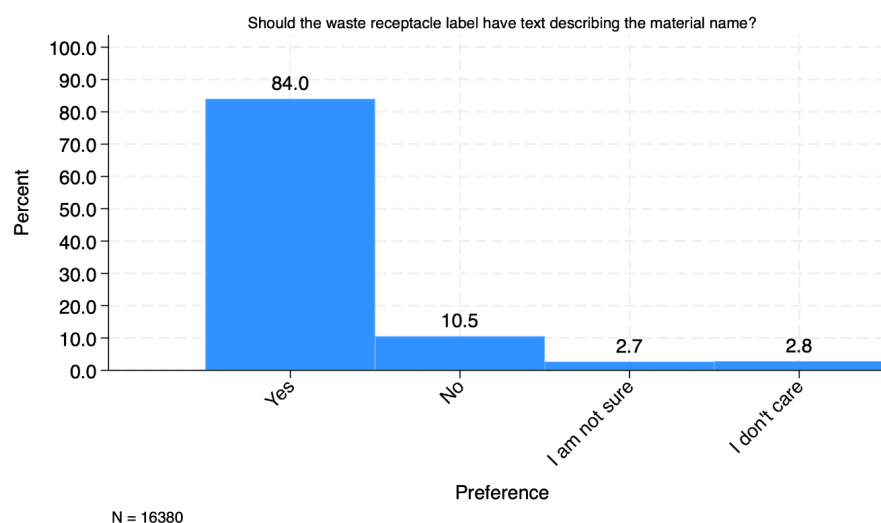
- **Most participants strongly prefer the inclusion of text on labels, with 84.2% favouring text on packaging labels and 84.0% favouring text on receptacle labels.** This suggests that explicitly stating the material the label is referring to is preferred by citizens.
- A smaller proportion of participants prefer no text, with 9.9% for packaging and 10.5% for receptacles, potentially due to preferences for visual simplicity or minimalistic designs.

Figure 58. Text preferences on product packaging labels



Source: Authors' elaboration

Figure 59 Text preferences on waste receptacles



Source: Authors' elaboration

In terms of sociodemographic characteristics that predict a preference for having text describing material on labels on product labels and waste receptacles, the main findings are (see Table 60 in Annex):

- **Age:** Older participants are significantly more likely to prefer labels with text for both packaging and waste receptacles, with preferences increasing by 0.7 and 0.4 percentage points, respectively ($p < .001$).
- **Education:** Higher education levels are associated with a reduced preference for text on packaging and receptacle labels, with preferences decreasing by 0.2 ($p < .01$) and 0.6 percentage points ($p < .001$), respectively.
- **Income:** Participants with higher incomes show a greater likelihood of preferring text on waste receptacle labels only, with preferences increasing by 0.5 percentage points ($p < .001$).

- **Housing Type:**
 - Participants living in condos/apartments show a slight preference for text on packaging labels, with preferences increasing by 0.7 percentage points, respectively ($p < .001$).
 - Those in shared housing are significantly less likely to prefer text on both packaging and waste receptacle labels, with reductions in preference by 4 and 5.7 percentage points, respectively ($p < .001$, for both).
 - Participants in “other” housing types prefer text descriptions on waste receptacles only, with preferences increasing by 2 percentage points ($p < .001$).
- **Area Lived:**
 - Participants in suburban areas show a slight preference for text on packaging labels, with preferences increasing by 0.5 percentage points ($p < .05$).
 - Those in rural areas display mixed results: they prefer text on packaging labels, with an increased preference of 0.5 percentage points ($p < .05$), but show a reduced preference for text on waste receptacles by 1.5 percentage points ($p < .001$).
- **Health-Related Variables:** Participants with colour blindness, visual impairments, and cognitive difficulties show significantly lower preferences for text on both packaging and waste receptacle labels. Colour blindness reduces preference for text by 5 percentage points and 4.4 percentage points for product packaging and waste receptacles, respectively. Visual impairments reduce preference for text by 4.1 percentage points and 4.4 percentage points for product packaging and waste receptacles, respectively. Cognitive difficulties reduce preference for text by 2.7 percentage points and 7.5 percentage points for product packaging and waste receptacles, respectively ($p < .001$ for all).

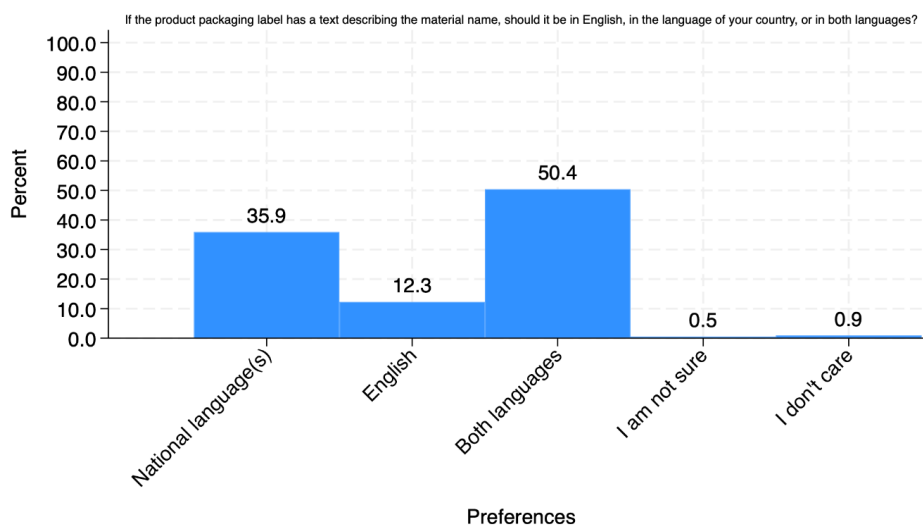
4.2.6.3. Language preferences

Figure 61 and Figure 62 summarise preferences for the language used in the text describing material names on both product packaging labels and waste receptacle labels, for those participants who indicated they wish to have text on the labels. The main insights are:

- **Preference for bilingual labels:** The majority (50.4%) of participants prefer labels in both their national language(s) and English for both packaging and receptacles.
- **National language(s) preference:** 35.9% of participants prefer text only in their national language(s) across both label types, suggesting a significant portion values local language accessibility over English or bilingual options.
- **English-only preference:** 12.3% of participants prefer labels solely in English for both product packaging and waste receptacles.

These findings highlight a preference for having labelling in both the national language(s) and English on both product packaging and waste receptacles. Providing bilingual options can help accommodate the needs of a diverse audience.

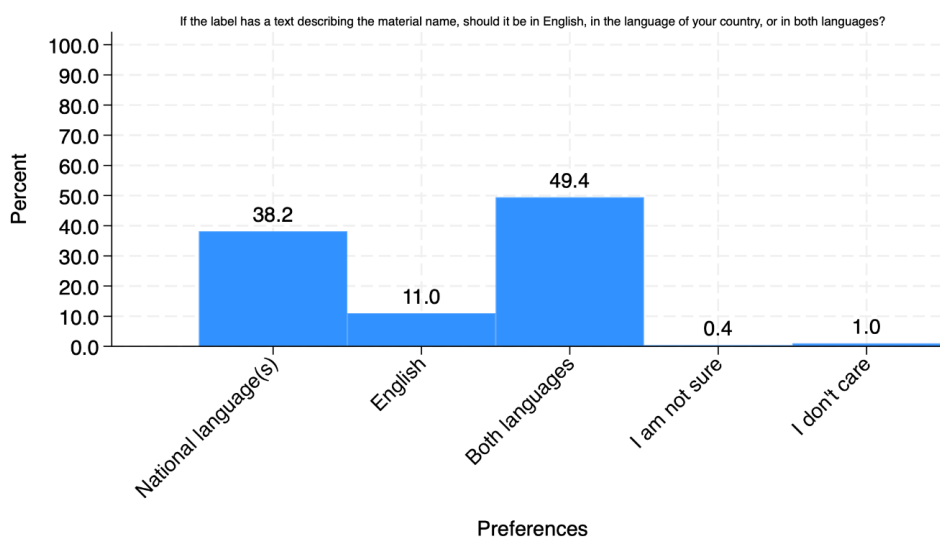
Figure 60 Language preferences on product packaging



N = 13791; note this question was conditional on participants indicating in a previous question that they prefer to see text on the labels

Source: Authors' elaboration

Figure 61 Language preferences on waste receptacles



N = 11175; note this question was conditional on participants indicating in a previous question that they prefer to see text on the labels

Source: Authors' elaboration

We also examine sociodemographic characteristics that predict language preferences on product labels and waste receptacles. Using multinomial logit models and reporting their marginal effects (see Table 61 and Table 62 in Annex), we calculate the likelihood of holding any particular language preference relative to all other possible preferences in the question. The main findings³⁴ are

³⁴ We do not report findings related to the "I am not sure" and "I don't care" selections. These results can be found in the Annex.

- **Age:** Older participants are significantly more likely to prefer labels in the national language only for both packaging and receptacle labels, with preferences increasing by 2.2 and 2.4 percentage points in both cases, respectively ($p < .001$). In addition, for both product packaging and receptacle labels, older participants are significantly less likely to prefer labels in English (-1.3 percentage points, $p < .001$) or in both languages (-1.1 percentage points).
- **Education:** Higher education levels are associated with a 0.8-1.3 percentage point preference increase for labels in English only, for waste receptacles and product packaging, respectively ($p < .001$ in both cases). In addition, higher education is associated with a 0.8 percentage point preference decrease for product packaging labels in the national language only ($p < .01$).
- **Income:** Participants with higher incomes show a greater likelihood of preferring labels in the national language only, for both packaging and receptacles. Preferences increase by 1.6 and 2.1 percentage points, respectively ($p < .001$ for both). In addition, participants with higher incomes show a lesser likelihood of preferring labels in English or both languages, for both packaging and receptacles. Packaging and receptacle preferences for English-only labels decrease by 0.5 ($p < .05$) and 0.9 ($p < .001$) percentage points, respectively. Packaging and receptacle preferences for both languages decrease by 1.1 ($p < .01$) and 1.2 ($p < .001$) percentage points, respectively.
- **Housing Type:**
 - Participants living in condominiums are significantly more likely to prefer both product packaging and receptacle labels in English, with preferences increasing by 3.7 and 2.1 percentage points, respectively ($p < .001$ for both). This same group is significantly less likely to prefer packaging and receptacle labels in both languages, with preferences decreasing by 3.8 ($p < .001$) and 2.7 ($p < .01$) percentage points, respectively.
 - Participants living in shared housing are significantly less likely to prefer packaging and receptacle labels in the national language only, with preferences reducing by 2.8 ($p < .05$) and 6.2 percentage points ($p < .001$), respectively. The same group are significantly more likely to prefer product packaging in English, with a preference increase of 2.6 percentage points ($p < .01$), and waste receptacles in both languages, with a preference increase of 7.0 percentage points ($p < .001$).
 - Those who prefer not to answer the housing question are significantly less likely to prefer the packaging and receptacle labels in the national language only, with preferences decreasing by 9.4 and 11.1 percentage points, respectively ($p < .01$). In addition, this same group is 5.0 percentage points less likely to prefer product packaging labels in English only ($p < .01$), as well as 13.7 percentage points more likely to prefer product packaging labels in both languages ($p < .001$).
 - Participants in “other” housing types are more likely to prefer the national language-only labels for both receptacle and packaging labels, with preferences increasing by 5.8 ($p < .05$) and 7.4 ($p < .01$) percentage points. In addition, they are less likely to prefer English-only product packaging and waste receptacle labels, with preferences decreasing by 4.1 ($p < .01$) and 5.3 ($p < .001$) percentage points, respectively.
- **Area Lived:**
 - Participants in suburban and rural areas are more likely to prefer product packaging and waste receptacle labels in the national language only, with rural residents showing slightly stronger preferences. For suburban residents, national language preferences increase by 2.8 percentage points for packaging and 3.7 percentage points for receptacles ($p < .001$ for both). For rural residents, national language preferences increase by 3.1 percentage points for product packaging and 3.8 percentage points for receptacles ($p < .001$ for both). In

addition, participants in suburban and rural areas are less likely to prefer product packaging and waste receptacle labels in English only. For suburban residents, English language preferences decrease by 3.5 percentage points for packaging and 3.4 percentage points for receptacles ($p < .001$ for both). For rural residents, English language preferences decrease by 2.5 percentage points for product packaging and 4.1 percentage points for receptacles ($p < .001$ for both).

- **Participants completing the survey by mobile phone** are 9.1 and 6.5 percentage points more likely to prefer the product packaging and waste receptacle labels in the national language only ($p < .001$ for both), as well as 5.7 and 4.6 percentage points less likely to prefer product packaging and waste receptacle labels in English ($p < .001$ for both). In addition, these participants are 4.7 percentage points less likely to prefer both languages on product packaging ($p < .01$).
- **Health-Related Variables:**
 - Participants with visual impairments are significantly more likely to prefer labels in the national language only. Their preference for the product packaging increases by 14.0 percentage points and their preference for the waste receptacles increases by 27.4 percentage points ($p < .001$ for both).
 - Participants with cognitive difficulties also show a higher preference for national language-only labels, with preferences for product packaging labels increasing by 17.5 percentage points ($p < .001$) and preferences for waste receptacles increasing by 12.4 percentage points ($p < .01$).

4.2.6.4. Material identifier preferences

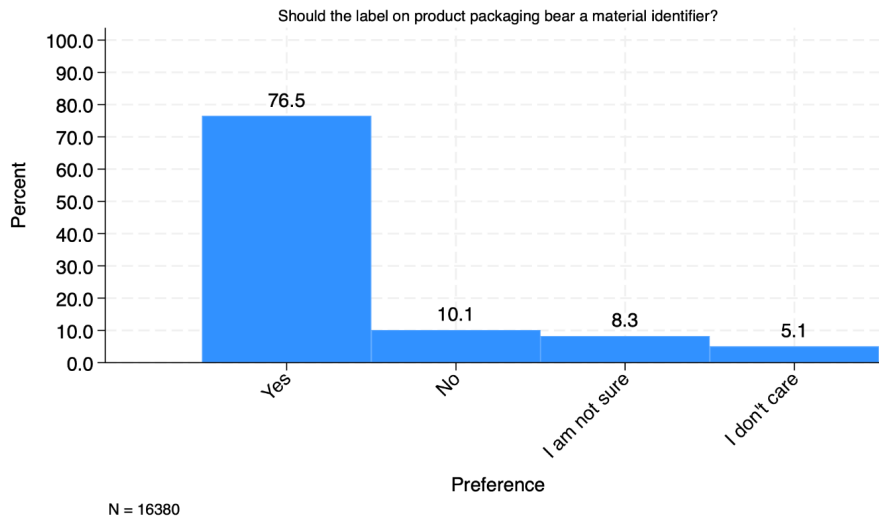
Figure 63 and Figure 64 summarise participants' preferences regarding the inclusion of material identifiers on product packaging and waste receptacles³⁵:

- **A significant majority (76.5%) of participants prefer packaging labels to include material identifiers**, suggesting that having this information is viewed as important by consumers.
- **Preferences for material identifiers on receptacle labels are similarly high**, with 77.2% of respondents favouring the inclusion of material identifiers.
- Only a small percentage of participants explicitly prefer no material identifiers, at 10.1% for product packaging and 9.6% for waste receptacles.

These results indicate a clear demand for material identifiers.

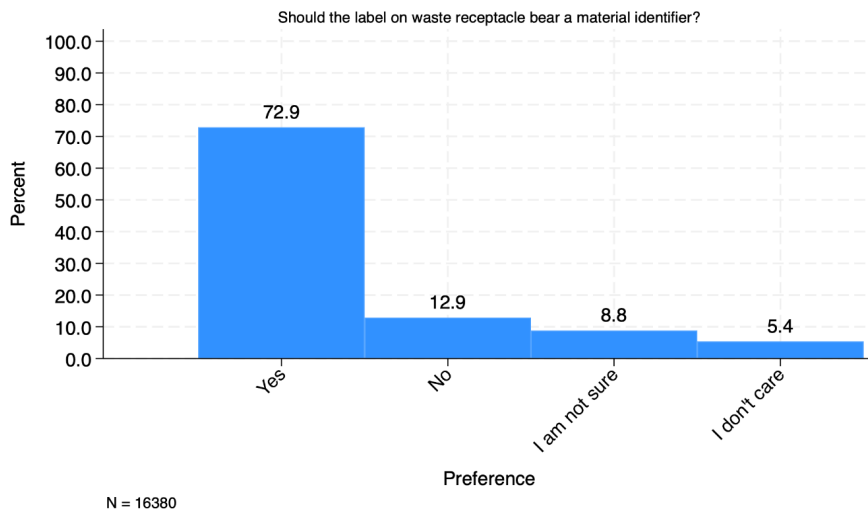
³⁵ The examples provided to participants included specific identifiers such as graphical pictogram "PET 1" for plastic and "PAP 22" for paper, helping to clarify what was meant by "material identifiers".

Figure 62. Material identifier preferences on product packaging



Source: Authors' elaboration

Figure 63. Material identifier preferences on waste receptacles



Source: Authors' elaboration

In terms of sociodemographic characteristics that predict a preference for having material identifiers on packaging and waste receptacle labels, the main findings are (see Table 63 Marginal effects of probit model – sociodemographic controls on preference for material identifier in Annex):

- **Age:** Age does not have a statistically significant effect on the preference for material identifiers on either packaging or waste receptacle labels.
- **Education:** Higher education levels are associated with a reduced preference for material identifiers on receptacle labels, with a decrease of 1.5 percentage points ($p < .001$). No significant effect is observed for packaging labels.

- **Income:** Income quartile does not significantly impact the preference for material identifiers on either packaging or receptacle labels.
- **Housing Type:**
 - Participants living in **condos/apartments** are significantly less likely to prefer material identifiers on both packaging and receptacle labels, with reductions of 4.7 and 6.7 percentage points, respectively ($p < .001$).
 - Those in **shared housing** also show a significantly lower preference, with reductions of 7.1 percentage points for packaging and 7.5 percentage points for receptacle labels ($p < .001$).
 - Participants who selected **“I prefer not to answer”** regarding housing type show a slight increase in preference for material identifiers on packaging labels (6.6 percentage points, $p < .05$), but no significant effect for receptacle labels.
 - Those in **other housing types** have the strongest negative association, with a decrease in preference of 14.2 percentage points for packaging and 20.1 percentage points for receptacle labels ($p < .001$).
- **Area Lived:**
 - Participants in **suburban areas** are significantly less likely to prefer material identifiers on both packaging and receptacle labels, with reductions of 1.8 ($p < .05$) and 2.6 percentage points ($p < .01$), respectively.
 - Those in **rural areas** show an even stronger reduction in preference, with decreases of 3.1 ($p < .001$) and 5.4 percentage points ($p < .001$) for packaging and receptacle labels, respectively.
- **Mobile Status:** Participants who answer the survey via mobile are significantly more likely to prefer material identifiers on packaging labels, with an increase of 4.4 percentage points ($p < .001$). However, no significant effect is observed for receptacle labels.
- **Health-Related Variables³⁶:**
 - Participants with **colour blindness** do not show a statistically significant preference for material identifiers on either type of label.
 - Those with **visual impairments** have a significantly lower preference for packaging labels, with a reduction of 7.9 percentage points ($p < .05$), but no significant effect for receptacle labels.
 - Participants with **cognitive difficulties** show no statistically significant impact on preference for either label type.

These findings suggest that housing type and area of residence are predictors of preference for material identifiers, with those in shared or alternative housing types and rural areas being the least likely to prefer them.

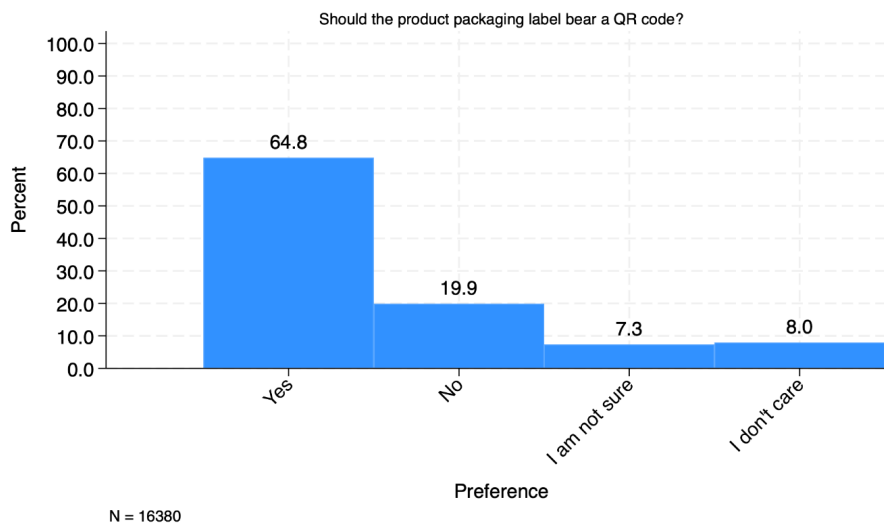
³⁶ The lack of a statistically significant effect among participants with health-related conditions should be interpreted with caution, as the small sample size substantially reduces statistical power. This limits the ability to detect an effect of similar magnitude observed in the broader sample.

4.2.6.5. QR code preferences

Figure 65 and Figure 66 illustrate participants' preferences for including QR codes on product packaging and waste receptacles. The **results suggest that QR codes are generally well-received for their potential to provide supplementary information, though their appeal is somewhat stronger for product packaging than for waste receptacles.** Specifically:

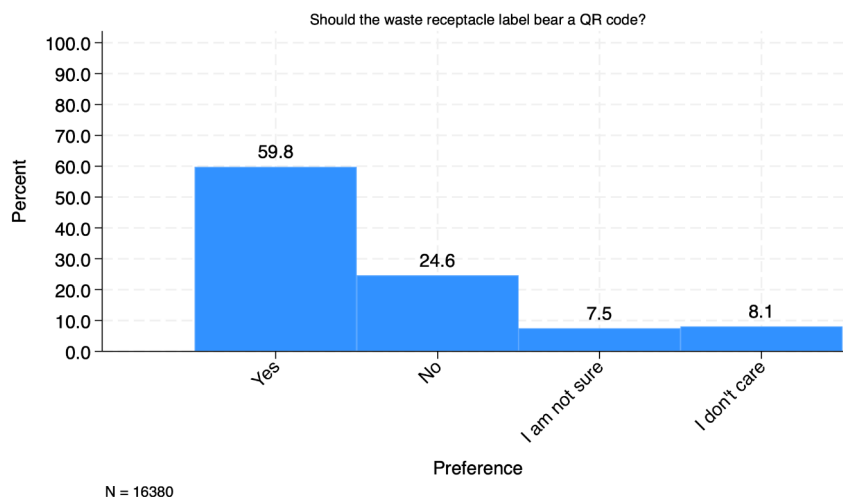
- **Product packaging:** 64.8% of participants prefer labels with QR codes, indicating a strong interest in accessing additional information digitally. Conversely, 19.9% do not prefer QR codes, 7.3% remain unsure and 8.0% are indifferent.
- **Waste receptacles:** A majority of 59.8% prefer QR codes on waste receptacle labels, showing slightly less support compared to product packaging. Those opposing QR codes comprise 24.6% of participants, with 7.5% uncertain and 8.1% indifferent.

Figure 64. QR code preferences on product packaging



Source: Authors' elaboration

Figure 65. QR code preferences on waste receptacle



In terms of sociodemographic characteristics that predict a preference for **having QR codes** on product labels and waste receptacles, the main findings are:

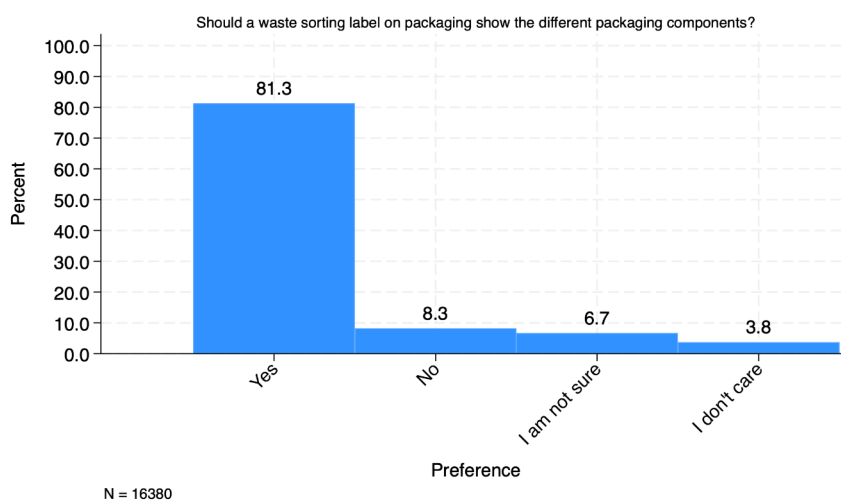
- **Age:** No significant relationship was found between age and preferences for QR codes on either packaging or receptacle labels.
- **Education:** Higher education levels are associated with a reduced preference for QR codes, particularly on receptacle labels. For packaging labels, the preference reduces by 0.8 percentage points ($p < .05$), and for receptacle labels the preference reduces by 1.7 percentage points ($p < .001$).
- **Income:** Participants with higher incomes are significantly less likely to prefer QR codes on receptacle labels, with preferences reducing by 1 percentage point ($p < .01$).
- **Housing Type:**
 - Participants living in condos/apartments are significantly less likely to prefer QR codes for both packaging and receptacle labels, with preferences reducing by 4 percentage points and 6.4 percentage points, respectively ($p < .001$, for both).
 - Those in “other” housing types show a strong aversion to QR codes for both packaging and receptacle labels, with preferences reducing by 21.1 percentage points and 23.2 percentage points, respectively ($p < .001$, for both).
 - No significant preference was observed for participants in shared housing.
- **Area Lived:**
 - Participants in suburban areas are slightly less likely to prefer QR codes, with a stronger reduction in preference for receptacle labels, with preferences decreasing by 2.4 percentage points ($p < .01$).
 - Rural residents are significantly less likely to prefer QR codes on both packaging and receptacle labels, with the effect being more pronounced for receptacles. Preferences are reduced by 5.2 percentage points and 7.9 percentage points, respectively ($p < .001$, for both).
- **Health-Related Variables:**
 - Participants with colour blindness, visual impairments, or cognitive difficulties show no significant differences in their preference for QR codes.

4.2.6.6. Multi-component packaging preferences

Figure 67 illustrates participants' preferences for including a waste sorting label that shows the different packaging components on product packaging:

- **A significant majority, 81.3%, support the inclusion of a label identifying the various components**, indicating a strong preference for detailed sorting guidance.
- Only 8.3% oppose having such a label, while 6.7% are unsure, and 3.8% indicate indifference.

Figure 66. Preference for having a different packaging components pictogram on product packaging



Source: Authors' elaboration

In terms of sociodemographic characteristics that predict a preference for adding a **multicomponent pictogram**, the main findings are (see Table 64 in Annex):

- **Age:** Age does not have a statistically significant effect on the preference for a multicomponent pictogram.
- **Education:** Higher education levels are associated with a greater preference for a multicomponent pictogram, increasing by 1.5 percentage points ($p < .001$).
- **Income:** Income quartile does not significantly impact the preference for a multicomponent pictogram.
- **Housing Type:**
 - Participants living in **condos/apartments** are significantly less likely to prefer a multicomponent pictogram, with a decrease of 2.5 percentage points ($p < .001$).
 - Those in **shared housing** also show a significantly lower preference, with a decrease of 2.8 percentage points ($p < .01$).
 - Participants who selected **“I prefer not to answer”** regarding housing type show a slight but non-significant increase in preference for a multicomponent pictogram (2.1 percentage points).
 - Those in **other housing types** are significantly less likely to prefer a multicomponent pictogram, with a decrease of 5.1 percentage points ($p < .05$).
- **Area Lived:**
 - Participants in **suburban areas** are significantly more likely to prefer a multicomponent pictogram, with an increase of 2.8 percentage points ($p < .001$).
 - Those in **rural areas** also show an increased preference, but the effect is smaller and not statistically significant (1.5 percentage points).

- **Mobile (Survey Completed via Mobile):** There is no statistically significant effect of completing the survey via mobile on the preference for a multicomponent pictogram.
- **Health-Related Variables:**
 - Participants with **colour blindness** do not show a statistically significant preference for a multicomponent pictogram.
 - Those with **visual impairments** have a significantly lower preference, with a reduction of 8.7 percentage points ($p < .05$).
 - Participants with **cognitive difficulties** do not show a statistically significant preference for a multicomponent pictogram.

4.2.6.7. Understanding of “Compostable” vs. “Home compostable”

Figure 68 and Figure 69 illustrate participants' understanding of two terms that can be shown on packaging labels: "compostable" and "home compostable". The first graph focuses on general perceptions of "compostable", which may include home and industrial composting. The correct answer in this first graph is "both home and industrial compostable". The second graph examines interpretations specific to "home compostable". The correct answer to the second question is "home compostable only". Importantly, something that is (industrially) compostable is not automatically home compostable.

Overall, the findings suggest that **while "compostable" is commonly understood as applicable to both home and industrial contexts, "home compostable" is more narrowly interpreted. However, some participants continue to conflate the two terms**, emphasising the need for clear communication and education about compostability labels.

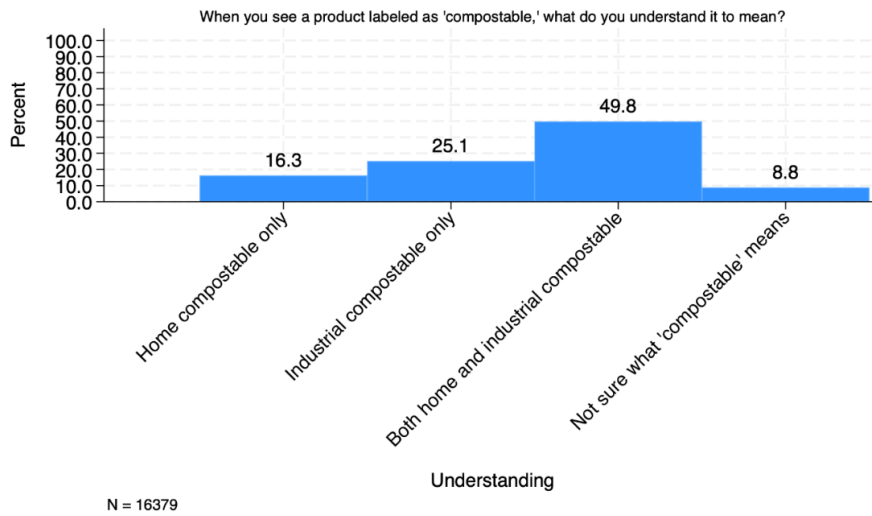
Specifically, for the term **“compostable”**:

- Nearly half (49.8%) of participants associate "compostable" with both home and industrial composting.
- 25.1% of respondents interpret "compostable" as industrial composting only.
- A smaller proportion, 16.3%, believe "compostable" refers exclusively to home composting.
- 8.8% of respondents are unsure of the meaning of "compostable".

For the term **“home compostable”**:

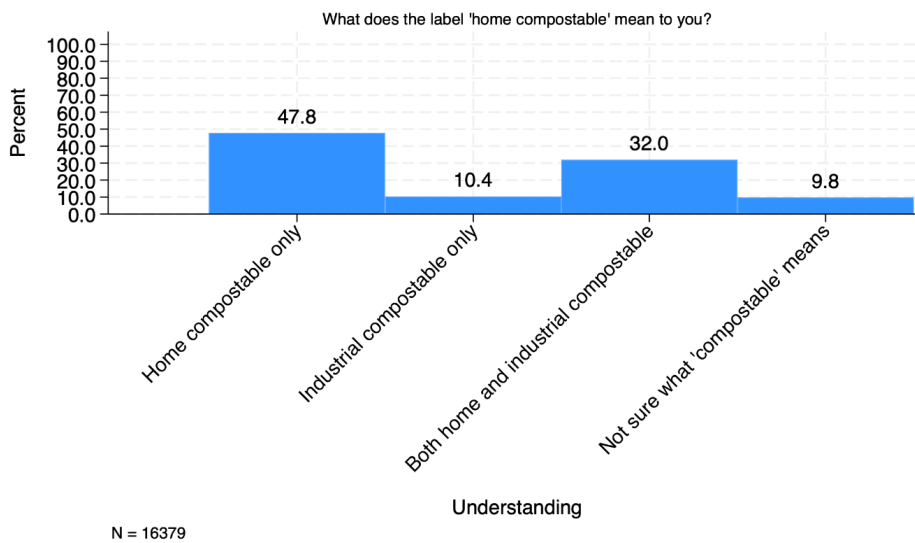
- Slightly less than the majority (47.8%) associate "home compostable" specifically with home composting.
- Around 32.0% interpret it as encompassing both home and industrial composting.
- A smaller group (10.4%) believe it refers to industrial composting only.
- Approximately 9.8% of participants are unsure of its meaning.

Figure 67. Understanding of “Compostable”



Source: Authors' elaboration

Figure 68. Understanding of “Home Compostable”



Source: Authors' elaboration

4.2.7. Ex-post questionnaire

This section presents the results from the ex-post questionnaire. We structure this section into different subsections, which examine questions addressing the evaluation of labels, motivations, barriers, social norms, and the integration of QR codes.

It is important to note that the findings presented in this section are based on self-reported data, which are inherently subject to limitations. Specifically, responses may be influenced by social desirability bias, where participants may overreport positive behaviours or attitudes, such as the importance they place on waste sorting or their confidence in sorting correctly and their motivation to correctly sort to align with perceived social norms. Additionally, given the placement of the ex-post questionnaire towards the end of

the survey, participant fatigue may have also affected the level of detail or engagement in their responses, with this cognitive load potentially varying across individuals depending on factors such as device type (e.g., phone vs. computer), familiarity with numbers and surveys, and time constraints. Readers are thus advised to interpret these findings with caution and consider these limitations in the broader context of the study.

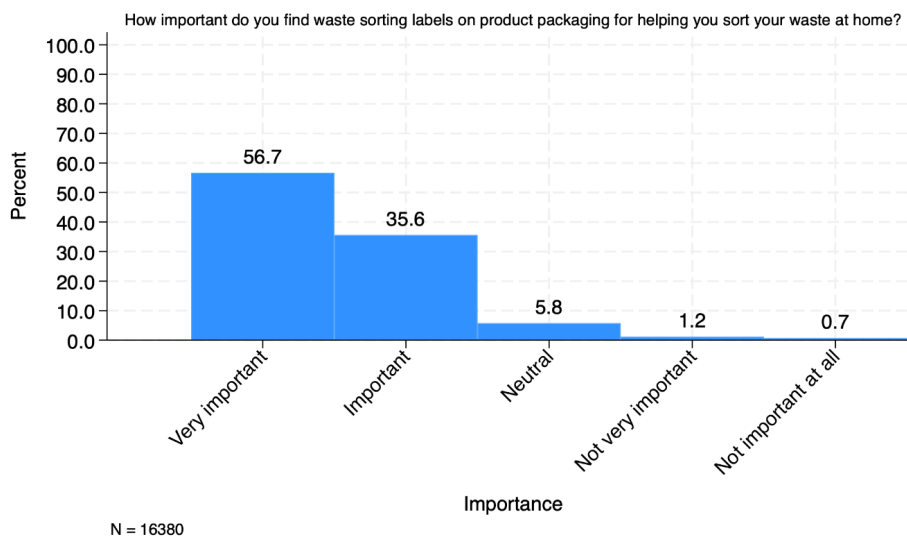
4.2.7.1. Evaluation of existing waste sorting labels

This section summarises the self-reported evaluations of waste sorting labels participants already encounter in their everyday lives without asking them to specify which labels they are referring to while answering the questions. It covers the following aspects: perceived importance, visibility, ease of understanding, comprehensiveness of information, design attractiveness, consistency of placement, consideration during sorting, and suggested improvements. This analysis identifies how participants interact with labels on product packaging and waste receptacles.

4.2.7.1.1. Perceived importance of the label to help sort waste

Figure 70 illustrates participants' perceived **importance of waste sorting labels on product packaging for sorting waste at home**. The majority, 56.7%, rated it as "very important", while 35.6% considered it "important". Only a small portion expressed neutrality (5.8%), with negligible percentages finding it "not very important" (1.2%) or "not important at all" (0.7%).

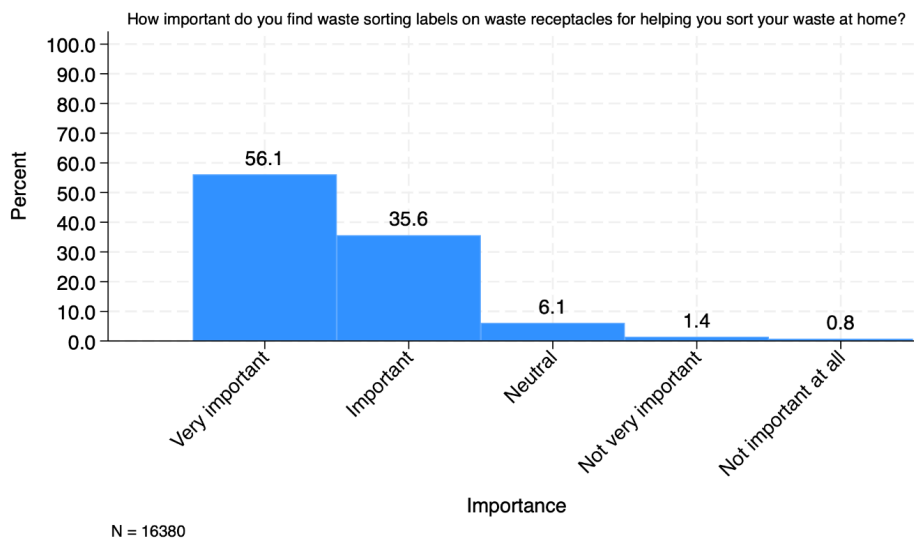
Figure 69. Importance of waste sorting labels on product packaging at home



Source: Authors' elaboration

Figure 71 shows participants' views on **the importance of waste sorting labels on waste receptacles for sorting waste at home**. The majority, 56.1%, considered it "very important", and 35.6% rated it as "important". Neutral responses accounted for 6.1%, while "not very important" (1.4%) and "not important at all" (0.8%) were reported by very few.

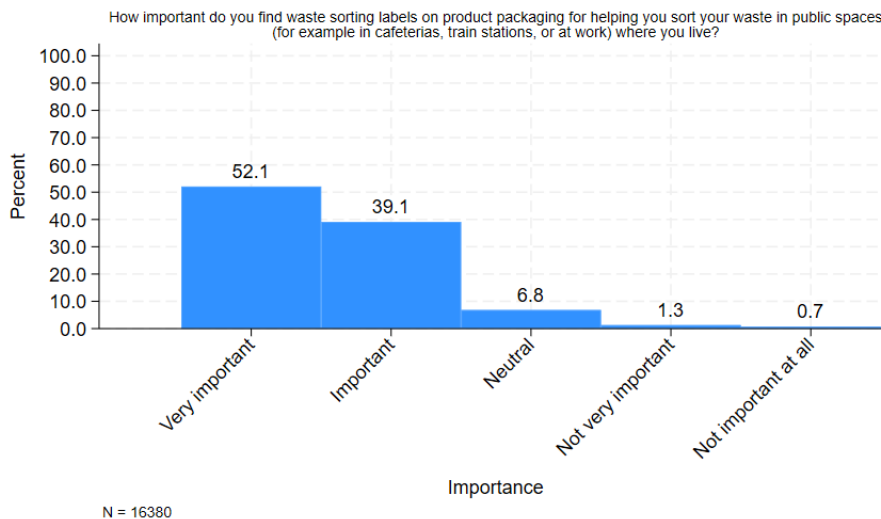
Figure 70. Importance of waste sorting labels on waste receptacles at home



Source: Authors' elaboration

Figure 72 illustrates the **importance participants place on waste sorting labels on product packaging in public spaces**, such as cafeterias or workplaces. More than half, 52.1%, rated it as "very important", with an additional 39.1% selecting "important". Neutral responses were 6.8%, while 1.3% and 0.7% found it "not very important" or "not important at all", respectively.

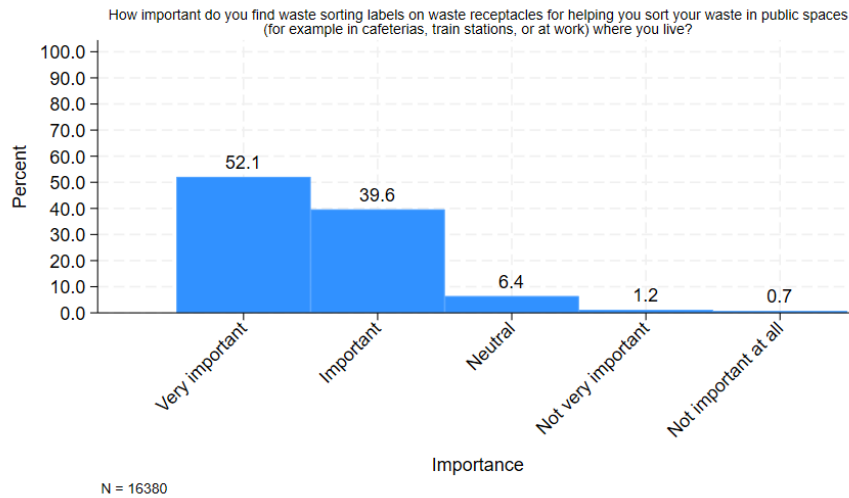
Figure 71. Importance of waste sorting labels on product packaging in public spaces.



Source: Authors' elaboration

Figure 73 highlights participants' opinions about the **importance of waste sorting labels on waste receptacles in public spaces**. The majority, 52.1%, indicated "very important", followed by 39.6% who said "important". Neutral responses were 6.4%, and less than 2% rated it as "not very important" (1.2%) or "not important at all" (0.7%).

Figure 72. Importance of waste sorting labels on waste receptacles in public spaces.



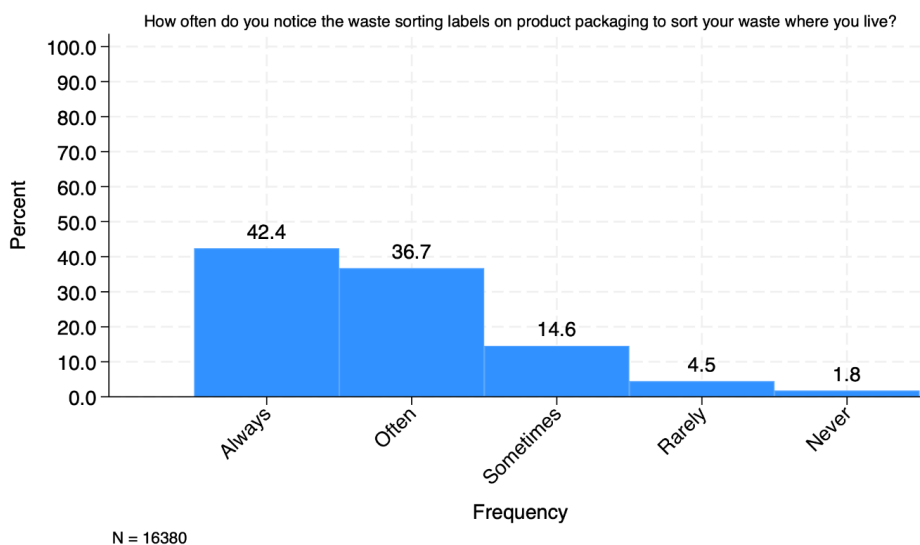
Source: Authors' elaboration

Overall, **across both domestic and public contexts, waste sorting labels on product packaging and waste receptacles are predominantly viewed as important tools for effective waste sorting.** In household settings, slightly more participants rated labels on packaging as "very important" compared to labels on receptacles. In public spaces, similar trends emerged, though there was a marginally lower percentage of participants assigning the "very important" rating compared to home contexts.

4.2.7.1.2. Visibility of the labels

Figure 74 illustrates how frequently participants notice waste sorting labels on packaging in their living areas. A significant proportion of respondents reported "Always" (42.4%) or "Often" (36.7%) noticing these labels. A smaller percentage indicated noticing them "Sometimes" (14.6%), while "Rarely" (4.5%) and "Never" (1.8%) were reported less frequently.

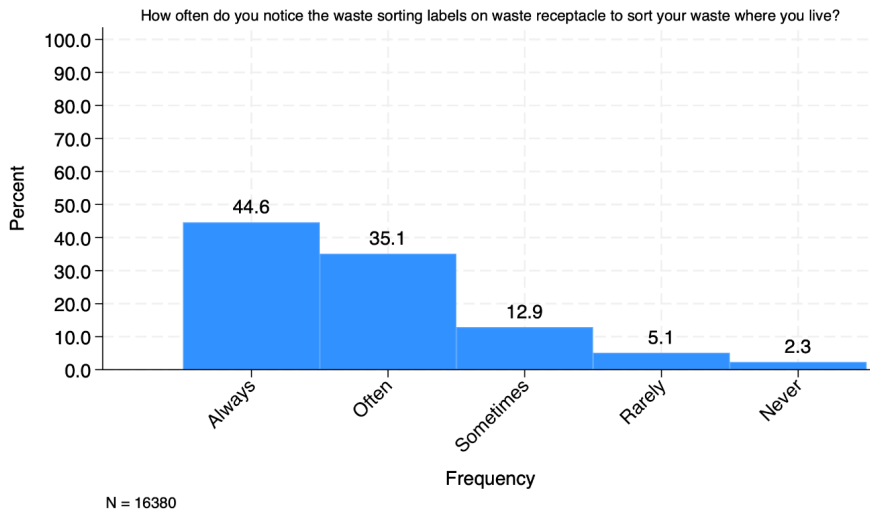
Figure 73 Frequency of noticing waste sorting labels on product packaging



Source: Authors' elaboration

Figure 75 shows how often participants notice waste sorting labels on receptacles in their living areas. The majority indicated "Always" (44.6%) or "Often" (35.1%), with a smaller percentage reporting "Sometimes" (12.9%). Fewer participants stated "Rarely" (5.1%) or "Never" (2.3%) noticing these labels.

Figure 74. Frequency of noticing waste sorting labels on waste receptacles

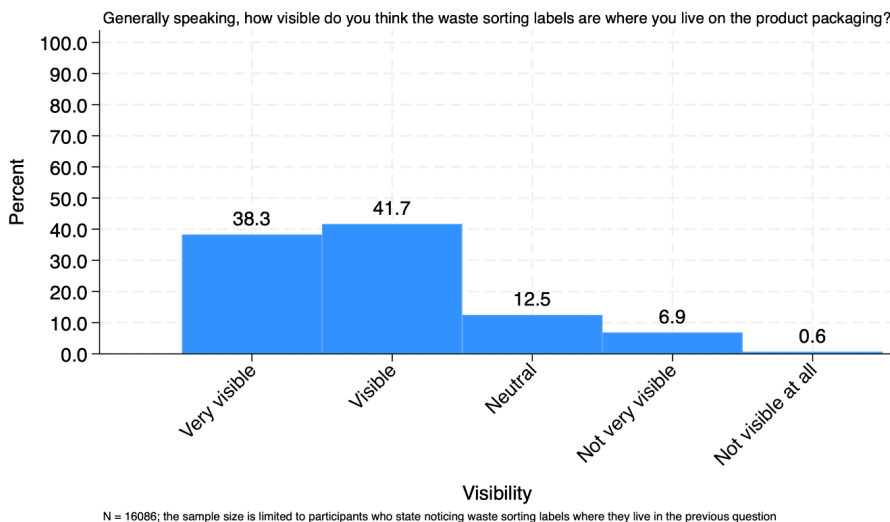


Source: Authors' elaboration

The findings reveal that **participants consistently engage with waste sorting labels, whether on packaging or receptacles**. A majority of respondents report frequently noticing these labels, with "Always" and "Often" being the most selected responses in both cases. Labels on receptacles appear slightly more noticeable than those on product packaging.

Figure 76 shows participants' perceptions of the visibility of waste sorting labels on product packaging. A significant proportion found them "very visible" (38.3%) or "visible" (41.7%), while a smaller segment was "neutral" (12.5%). A minority found them "not very visible" (6.9%) or "not visible at all" (0.6%), indicating that most participants feel these labels are easily noticeable.

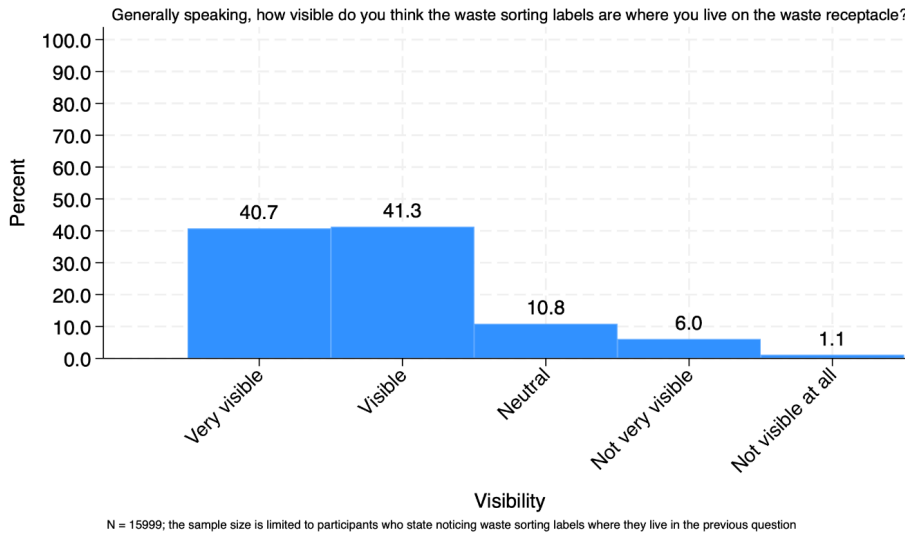
Figure 75. Visibility of waste sorting labels on product packaging.



Source: Authors' elaboration

Figure 77 illustrates participants' views on the visibility of waste sorting labels on receptacles. A majority rated them as "very visible" (40.7%) or "visible" (41.3%), with 10.8% being "neutral". Only a small portion found them "not very visible" (6.0%) or "not visible at all" (1.1%), suggesting a general ease in locating labels on receptacles.

Figure 76. Visibility of waste sorting labels on waste receptacles.



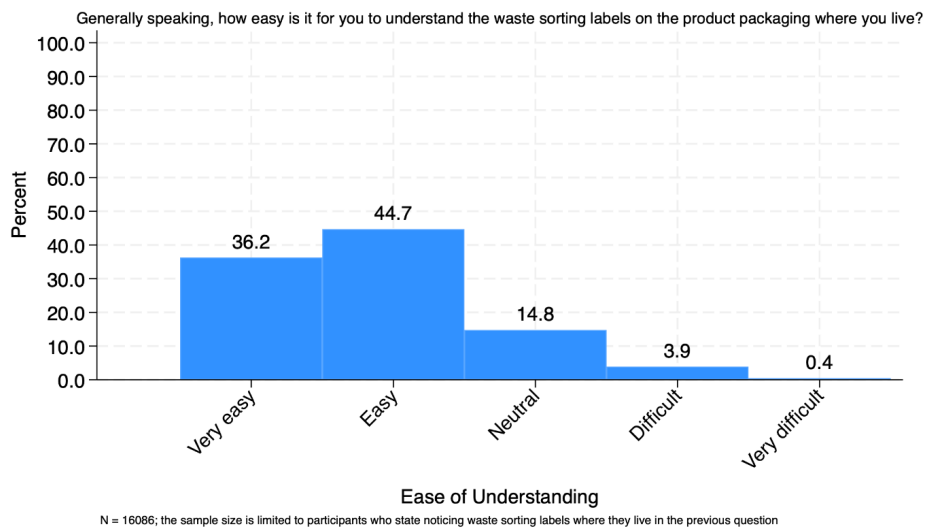
Source: Authors' elaboration

Participants generally perceive waste sorting labels on both product packaging and waste receptacles as visible and accessible, with more than 80% across both categories rating them as either "very visible" or "visible". However, **there remains a small subset of participants who perceive visibility issues, highlighting areas for potential improvement in label placement or design.**

4.2.7.1.3. Ease of understanding of the labels

Figure 78 illustrates participants' perceptions of the ease of understanding waste sorting labels on packaging where they live. The majority found the labels "Easy" (44.7%) or "Very easy" (36.2%) to understand, with 14.8% remaining neutral. Only a small fraction found them "Difficult" (3.9%) or "Very difficult" (0.4%), indicating overall positive perceptions of label clarity.

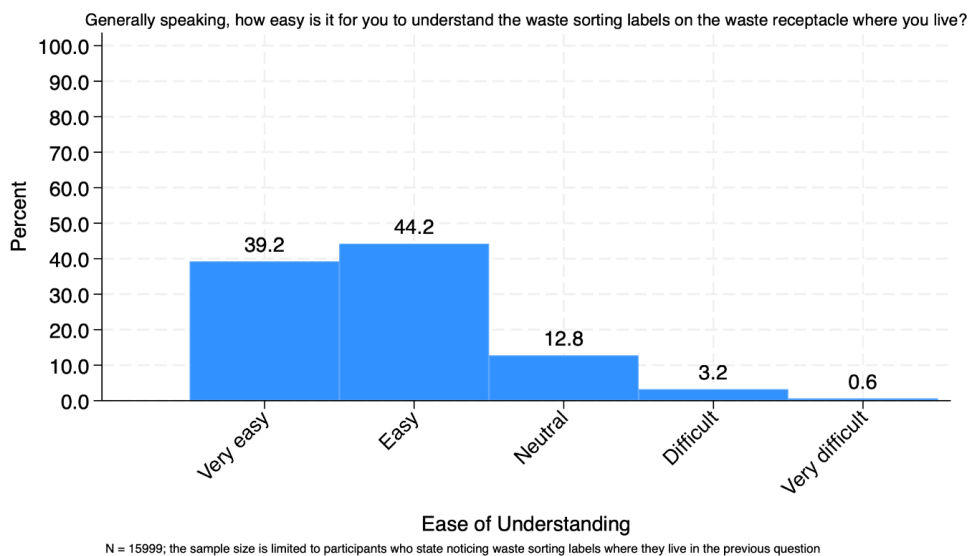
Figure 77. Ease of understanding waste sorting labels on product packaging



Source: Authors' elaboration

Figure 79 presents participants' perceptions of the ease of understanding waste sorting labels on receptacles where they live. Most participants reported the labels to be "Easy" (44.2%) or "Very easy" (39.2%) to understand. A smaller proportion remained neutral (12.8%), while only 3.2% found them "Difficult" and 0.6% "Very difficult", suggesting high clarity of the receptacle labels.

Figure 78. Ease of understanding waste sorting labels on waste receptacles



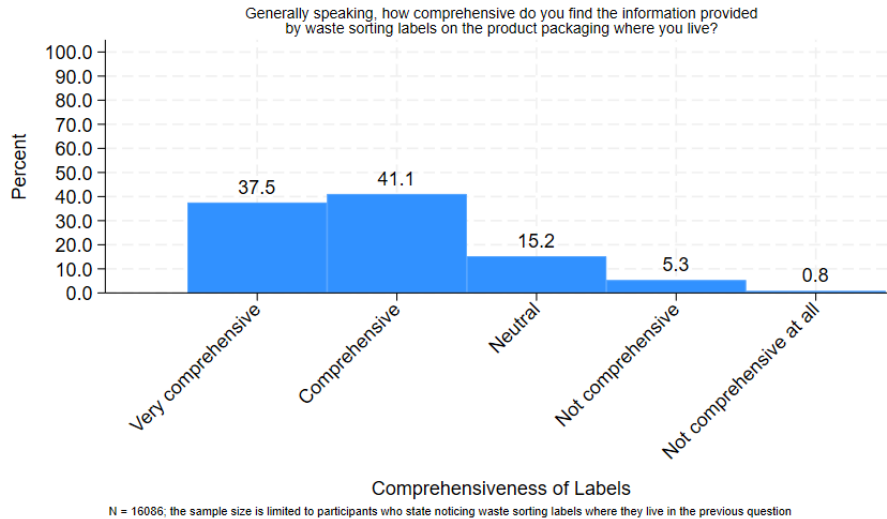
Source: Authors' elaboration

Overall, **the data indicate that participants generally perceive waste sorting labels as straightforward to understand, whether they are on product packaging or waste receptacles.** A clear majority across both categories rated the labels as "Easy" or "Very easy" to comprehend, with minimal reports of difficulty.

4.2.7.1.4. Comprehensiveness of information on the label

Figure 80 shows participants' evaluations of the comprehensiveness of waste sorting labels on product packaging. A combined majority of 37.5% rated them "very comprehensive" and 41.1% "comprehensive". Neutral responses accounted for 15.2%, while 5.3% and 0.8% found the labels "not comprehensive" or "not comprehensive at all", respectively.

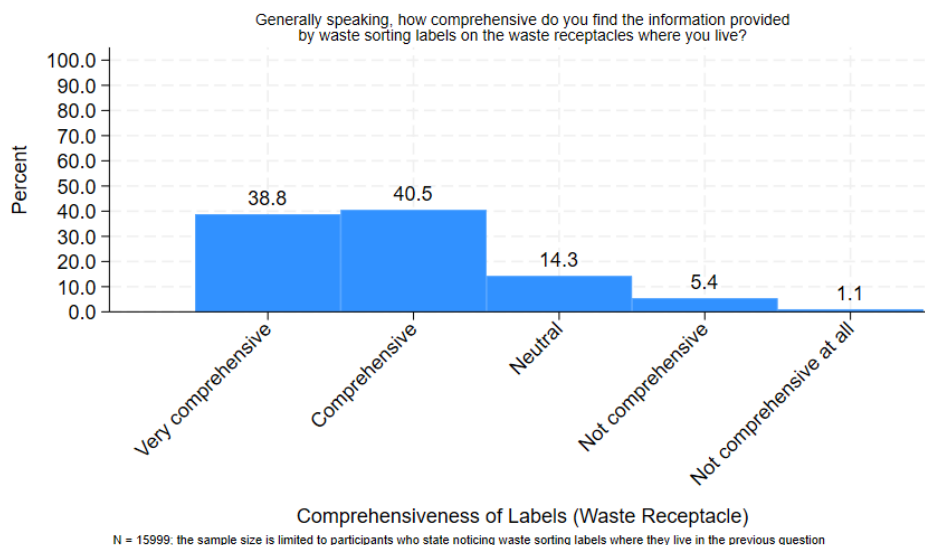
Figure 79. Comprehensiveness of Waste Sorting Labels on Product Packaging



Source: Authors' elaboration

Figure 81 illustrates participants' perceptions of the comprehensiveness of waste sorting labels on receptacles where they live. A majority, 38.8%, found the labels "very comprehensive", while an additional 40.5% described them as "comprehensive". Smaller proportions were neutral (14.3%), and few considered them "not comprehensive" (5.4%) or "not comprehensive at all" (1.1%).

Figure 80. Comprehensiveness of Waste Sorting Labels on Waste Receptacles



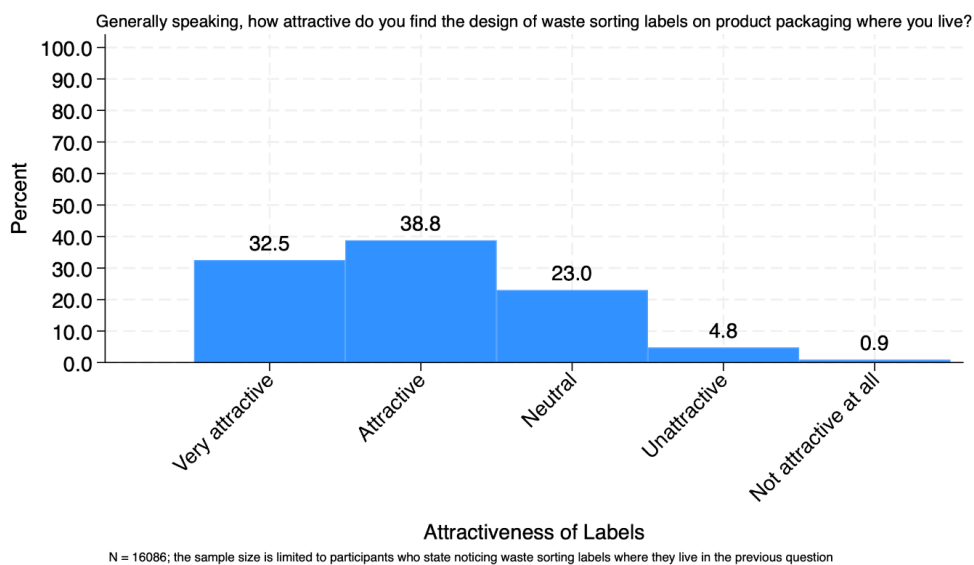
Source: Authors' elaboration

These results highlight that **a majority of participants perceive waste sorting labels on both waste receptacles and product packaging as comprehensive. However, there remains a small proportion who feel the information is limited, indicating room for improvement in label design for better comprehensiveness.**

4.2.7.1.5. Attractiveness of the label

Figure 82 highlights participants' perceptions of the attractiveness of waste sorting labels on packaging. The majority of respondents found the design appealing, with 38.8% rating it as "Attractive" and 32.5% as "Very attractive". Neutral responses accounted for 23.0%, while smaller proportions described the design as "Unattractive" (4.8%) or "Not attractive at all" (0.9%).

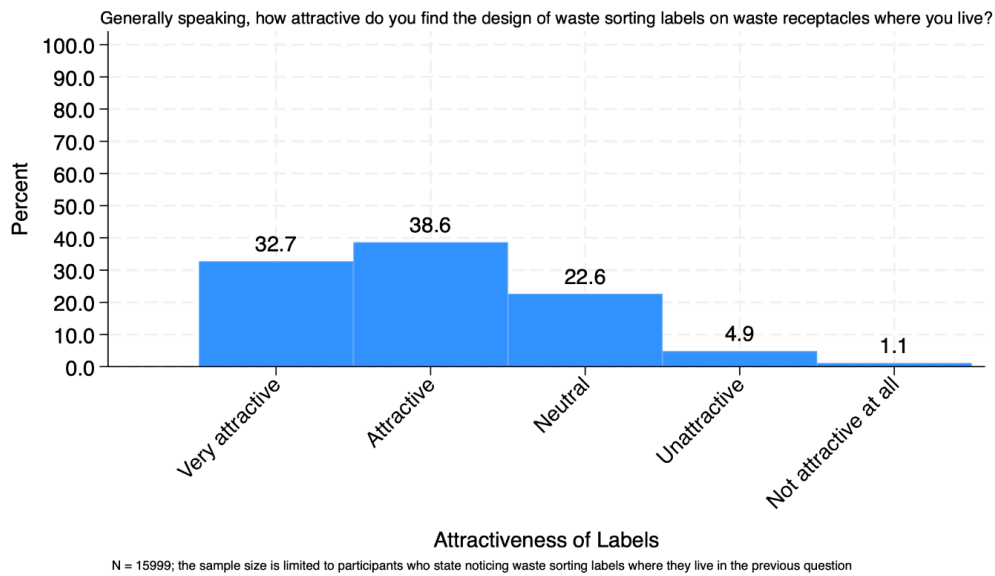
Figure 81 Attractiveness of waste sorting labels on product packaging



Source: Authors' elaboration

Figure 83 illustrates participants' views on the attractiveness of waste sorting labels on receptacles. Similar to packaging, most participants rated the labels positively, with 38.6% considering them "Attractive" and 32.7% "Very attractive". Neutral opinions comprised 22.6%, while 4.9% and 1.1% rated the designs as "Unattractive" and "Not attractive at all", respectively.

Figure 82. Attractiveness of waste sorting labels on waste receptacles



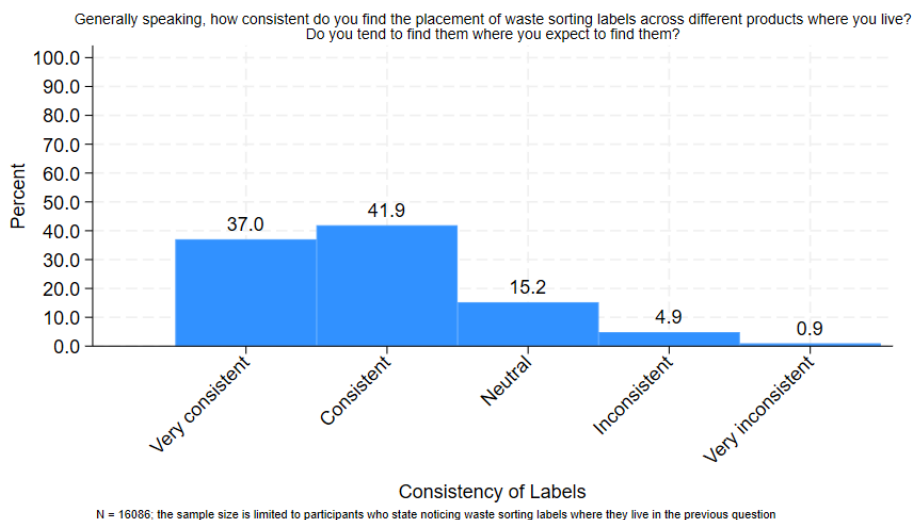
Source: Authors' elaboration

The design of waste sorting labels received broadly positive evaluations, both for product packaging and waste receptacles. However, a notable proportion expressed neutrality, suggesting opportunities for further improvement to make designs more engaging.

4.2.7.1.6. Consistency of placement of the label

Figure 84 illustrates participants' perceptions of the consistency of waste sorting label placement across different products. Most respondents indicated that labels were either "Consistent" (41.9%) or "Very consistent" (37.0%). A smaller portion remained "Neutral" (15.2%), and a minority considered the labels "Inconsistent" (4.9%) or "Very inconsistent" (0.9%).

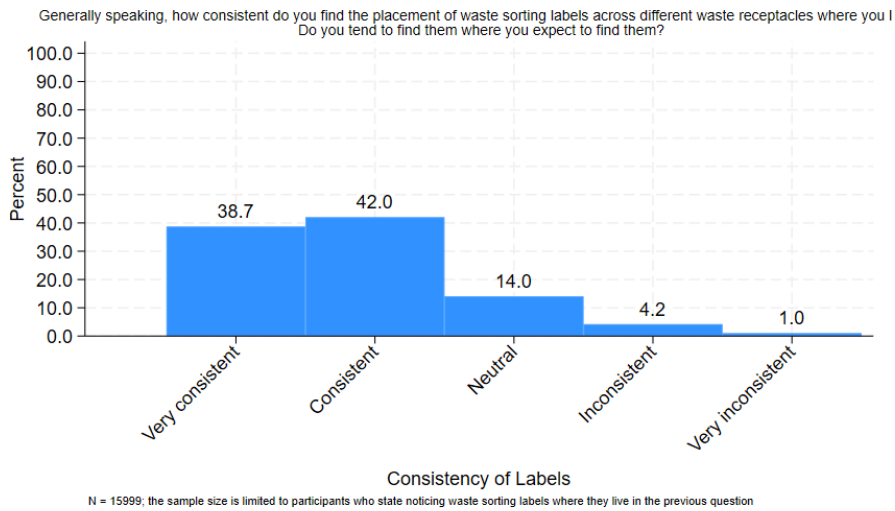
Figure 83. Consistency of waste sorting labels on product packaging



Source: Authors' elaboration

Figure 85 depicts participants' evaluations of the consistency of waste sorting label placement on receptacles. Similar to product packaging, the majority found the labels to be either "Consistent" (42.0%) or "Very consistent" (38.7%). Neutral responses accounted for 14.0%, while "Inconsistent" and "Very inconsistent" were selected by 4.2% and 1.0%, respectively.

Figure 84. Consistency of waste sorting labels on waste receptacles



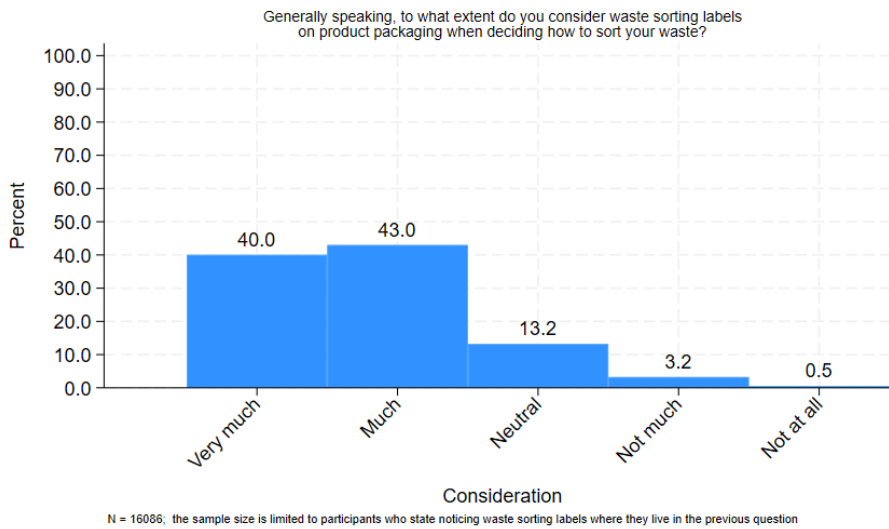
Source: Authors' elaboration

Overall, participants generally perceive the placement of waste sorting labels to be consistent, whether on product packaging or waste receptacles. However, a small percentage of participants noted inconsistencies, suggesting potential areas for improvement in label standardisation across products and receptacles.

4.2.7.1.7. Consideration of the label when deciding how to sort waste

Figure 86 shows the extent to which participants consider waste sorting labels on packaging when deciding how to sort waste. A majority of respondents, 43.0%, answered "Much", while 40.0% chose "Very much". A smaller proportion selected "Neutral" (13.2%), and minimal percentages indicated "Not much" (3.2%) or "Not at all" (0.5%). This highlights the importance of packaging labels in waste sorting decisions.

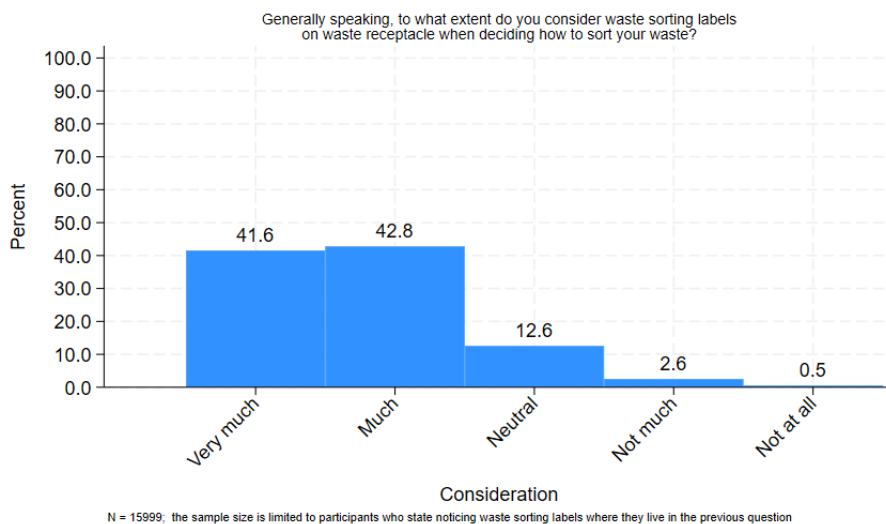
Figure 85 Consideration of waste sorting labels on product packaging



Source: Authors' elaboration

Figure 87 illustrates participants' consideration of waste sorting labels on receptacles when deciding how to sort waste. Responses were largely positive, with 42.8% selecting "Much" and 41.6% "Very much". Neutral responses accounted for 12.6%, while "Not much" and "Not at all" received 2.6% and 0.5%, respectively. These findings underline the importance of waste receptacle labels in sorting behaviour.

Figure 86 Consideration of waste sorting labels on waste receptacles

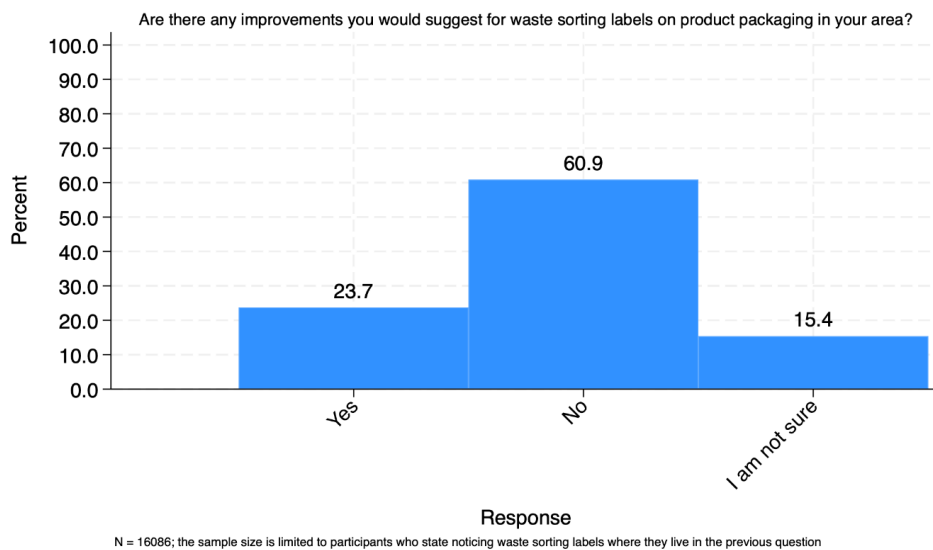


Source: Authors' elaboration

4.2.7.1.8. Improvement of the label

Figure 88 shows participant responses regarding suggested improvements for waste sorting labels on product packaging. While a majority (60.9%) indicated no suggestions for improvement, 23.7% stated they had suggestions. A smaller proportion, 15.4%, were unsure about potential improvements.

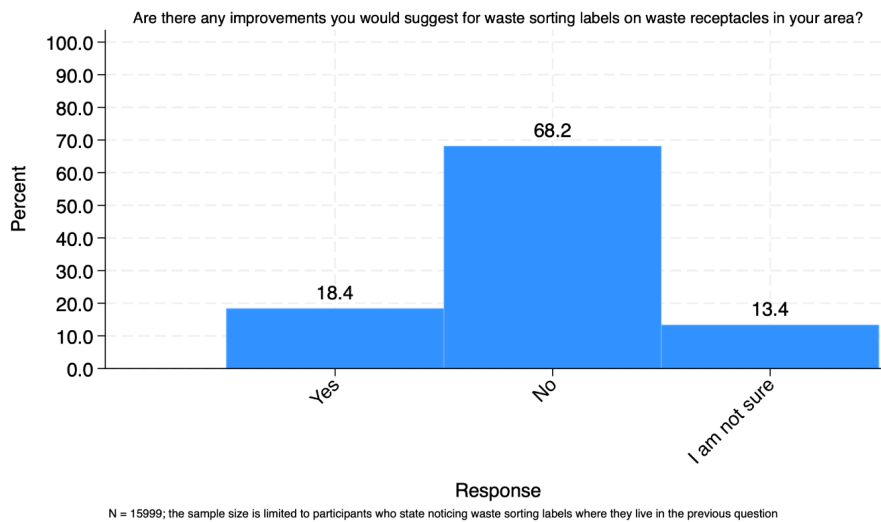
Figure 87. Suggestions for improvements to waste sorting labels on product packaging



Source: Authors' elaboration

Figure 89 presents participant responses concerning suggested improvements for waste sorting labels on waste receptacles. A larger majority (68.2%) indicated no suggestions, 18.4% provided suggestions for improvement, and 13.4% were unsure.

Figure 88. Suggestions for improvements to waste sorting labels on waste receptacles



Source: Authors' elaboration

It is important to note that the absence of suggestions does not necessarily imply satisfaction with the current labels. Participants might not know how to suggest improvements or may have experienced survey fatigue, particularly since this question appeared towards the end of the survey. These factors should be considered when interpreting these findings.

Text analysis. Considering the text responses of those who indicated they had suggestions for improving waste sorting labels, a text analysis conducted with ChatGPT extracted the following main focus areas.

Key areas for enhancement include improving clarity and consistency in labelling,

incorporating multilingual accessibility, using visual aids and technology integration, and promoting sustainability through durable and standardized designs.

Specifically, Table 25 gives an overview of participant feedback, emphasizing specific and actionable areas for improving product packaging labels to facilitate waste sorting.

Table 25. Overview of participant feedback for packaging labels

Dimension	Examples of Participant Suggestions
Clear and Unified Labelling	<ul style="list-style-type: none"> - "Mark clearly what can and cannot be recycled to prevent contamination." - "Labels should specify exactly the type of waste." - "Ensure every package has a clear and visible recycling label." - "Use large and bold fonts to enhance clarity." - "Simplify labelling to make it intuitive for everyone."
Language and Accessibility	<ul style="list-style-type: none"> - "Include text in multiple languages to cater to diverse communities." - "Add Braille for visually impaired users." - "Avoid technical terms and use everyday language." - "Make labels easy to read for older adults." - "Add universal symbols and colours to reduce language barriers."
Visual and Design Improvements	<ul style="list-style-type: none"> - "Use bold colours and contrast to make labels more visible." - "Include icons for every type of recyclable material." - "Provide pictures or diagrams for clarity." - "Highlight the recyclability prominently on the package." - "Use bright colours and large fonts for better visibility in dim lighting."
Technology Integration	<ul style="list-style-type: none"> - "Add QR codes linking to detailed recycling instructions." - "Provide app-based sorting guides via a link." - "Use digital codes to access updated recycling rules." - "Offer augmented reality instructions for sorting practices." - "Include online tutorials accessible through package labels."
Sustainability and Consistency	<ul style="list-style-type: none"> - "Use labels made from biodegradable materials." - "Ensure labels are durable and weatherproof for outdoor bins." - "Standardise recycling symbols and colours across all products." - "Update labels to reflect the latest regional recycling laws." - "Promote sustainability practices through the labelling system."

Source: Authors' elaboration

Figure 82 presents, in the left column, the main areas identified regarding improvement for the receptacle labels, and, in the right column, summaries of statements made by participants, translated into English.

Table 26. Overview of participant feedback for receptacle labels

Dimension	Examples of Participant Suggestions
Clarity	<ul style="list-style-type: none"> - "Clear instructions on what can and cannot be disposed of in each bin." - "Use large, simple text and avoid technical jargon." - "Add images or icons to illustrate waste categories."
Visibility	<ul style="list-style-type: none"> - "Labels should be larger and placed at eye level." - "Use contrasting colours to make labels more readable." - "Ensure labels are visible even from a distance."
Standardization	<ul style="list-style-type: none"> - "Align bin labels with the colours and symbols used on packaging." - "Use the same color-coding system across all regions." - "Standardise labelling to avoid regional inconsistencies."
Multilingual Accessibility	<ul style="list-style-type: none"> - "Include instructions in multiple languages to accommodate diverse communities." - "Use simple symbols and bilingual text for better understanding." - "Add translations in English and other commonly spoken languages."

Durability	<ul style="list-style-type: none"> - "Ensure labels are weather-resistant and do not fade over time." - "Use materials that withstand outdoor conditions." - "Labels should not peel off easily from bins."
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Source: Authors' elaboration

4.2.7.2. Motivation – Opportunity – Ability

This section explores three dimensions of the Motivation Opportunity Ability (MOA) framework which can explain waste sorting behaviours. These dimensions provide insights into the importance participants ascribe to waste sorting (motivation), perceived convenience of performing the task (opportunity), and confidence in their ability to do so effectively (ability). The survey included three questions to explore the three dimensions.

Motivation. Figure 91 illustrates the importance participants place on correctly sorting their waste. Most participants (54.2%) consider waste sorting "very important", followed by 38.8% who find it "important". Only 5.5% remained neutral, while minimal percentages (1.0% and 0.4%) regarded it as "not very important" or "not important at all", respectively. **These findings suggest a strong motivational drive among participants to engage in waste sorting. However, it might be that motivation is overestimated due to the social desirability bias participants may have.**

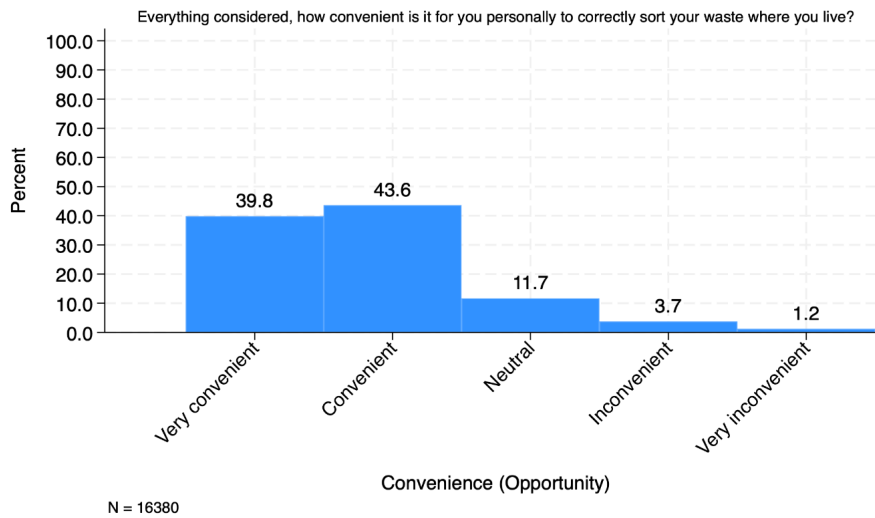
Figure 89. Motivation



Source: Authors' elaboration

The figure illustrates participants' perceptions of the convenience of waste sorting. A significant majority found it either "convenient" (43.6%) or "very convenient" (39.8%). Neutral responses made up 11.7%, while only a small fraction of participants found waste sorting "inconvenient" (3.7%) or "very inconvenient" (1.2%). **These findings suggest that most participants perceive waste sorting as a feasible task in their daily lives.**

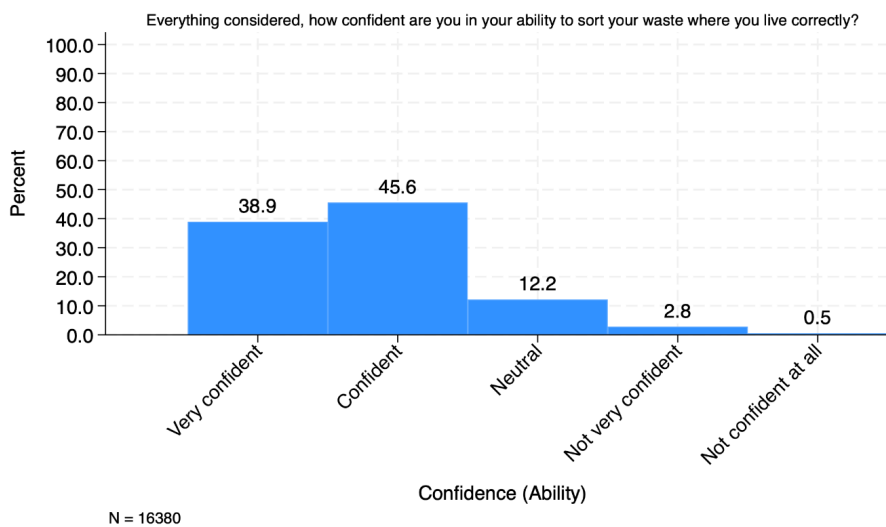
Figure 90. Opportunity



Source: Authors' elaboration

Ability. Figure 93 shows participants' confidence in their ability to sort waste correctly. Most participants reported high levels of confidence, with 45.6% feeling "confident" and 38.9% feeling "very confident". Neutral responses accounted for 12.2%, while lower confidence levels were rare, with only 2.8% "not very confident" and 0.5% "not confident at all". **These results highlight a strong sense of self-efficacy among participants regarding waste sorting.**

Figure 91. Ability



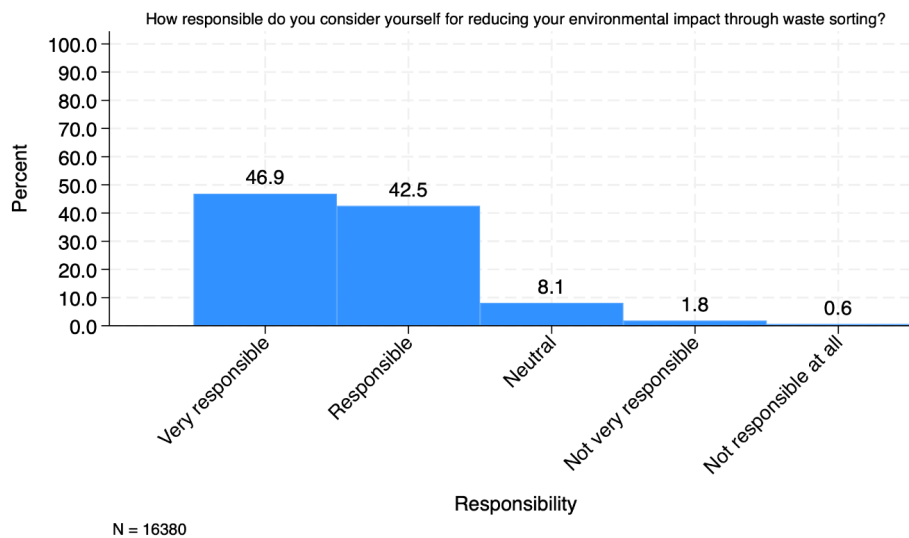
Source: Authors' elaboration

4.2.7.3. Sense of responsibility to reduce environmental impact

This section examines participants' sense of responsibility in reducing environmental impact and their beliefs about the broader impact of individual actions, such as waste sorting, on addressing larger environmental challenges.

Figure 85 illustrates participants' sense of responsibility in reducing environmental impact through waste sorting. The majority, 46.9%, reported feeling "very responsible", while 42.5% felt "responsible", indicating that nearly 90% of participants recognise a significant sense of personal accountability for reducing their environmental footprint. A smaller portion, 8.1%, felt neutral on the matter, with only 1.8% feeling "not very responsible" and 0.6% stating they felt "not responsible at all". **This suggests a strong overall awareness and sense of responsibility among participants regarding their role in environmental impact reduction.**

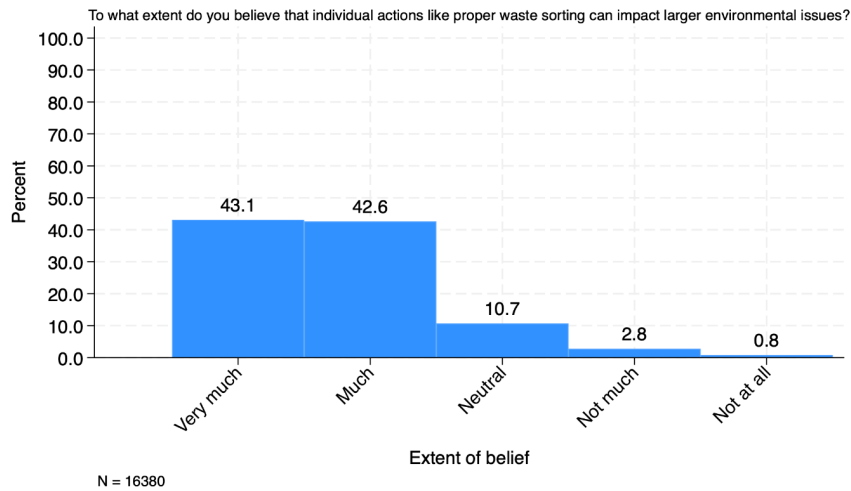
Figure 92. Sense of responsibility in reducing environmental impact



Source: Authors' elaboration

Figure 95 illustrates participants' beliefs about the impact of individual actions, such as waste sorting, on larger environmental issues. A significant majority, 43.1%, responded "very much", and 42.6% indicated "much", demonstrating strong confidence in the efficacy of individual efforts. A smaller portion, 10.7%, expressed neutrality, while only 2.8% and 0.8% selected "not much" and "not at all", respectively. **These results suggest that most participants recognise the broader environmental significance of proper waste-sorting practices.**

Figure 93. Belief in individual actions impacting larger environmental issues.



Source: Authors' elaboration

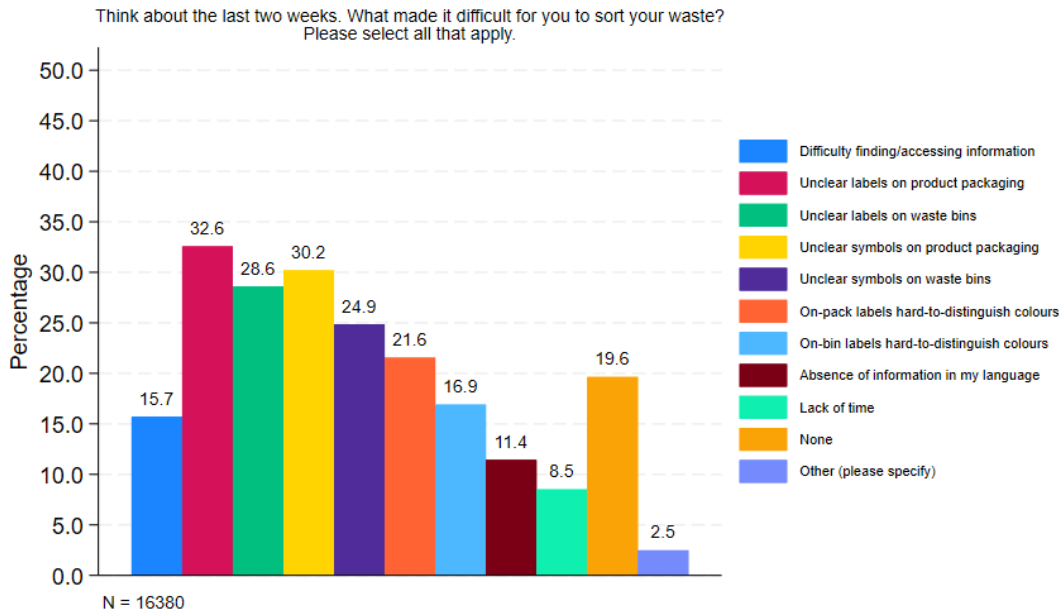
4.2.7.4. Perceived barriers and community-aspects

This section explores participants' perceptions of barriers to waste sorting and the role of the community in supporting these efforts. It examines reported difficulties in sorting waste, the availability of sorting facilities, and the perceived encouragement from local communities to engage in waste sorting practices.

Figure 96 illustrates the distribution of perceived barriers related to waste sorting. **The most reported challenge was "unclear labels on product packaging", cited by 32.6% of participants, followed by "unclear labels on waste bins" (30.2%) and "unclear symbols on product packaging" (28.6%).** These results seem to be at odds with previous findings (see Figure 78 and Figure 79), where participants replied that current labels are generally easy to understand.

Additionally, 24.9% mentioned "unclear symbols on waste bins" as a difficulty. Interestingly, 19.6% of participants reported facing no barriers, while 16.9% struggled with "on-pack labels in hard-to-distinguish colours", and 15.7% found it difficult to find or access information. Less frequently mentioned barriers include "absence of information in my language" (11.4%) and "lack of time" (8.5%), with only 2.5% reporting other unspecified issues. These findings emphasize the need for clear and accessible labelling to alleviate waste sorting challenges.

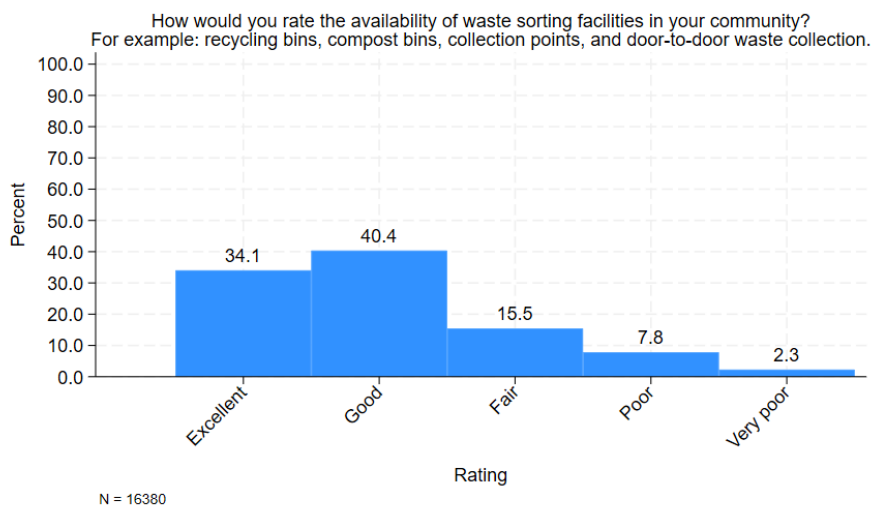
Figure 94. Barriers to waste sorting in the last 2 weeks



Source: Authors' elaboration

Figure 97 illustrates participants' ratings of waste sorting facilities' availability in their communities, including recycling bins, compost bins, collection points, and door-to-door waste collection. Most participants provided positive feedback, with 40.4% rating the availability as "Good" and 34.1% as "Excellent". Meanwhile, 15.5% rated the availability as "Fair", and smaller percentages provided negative ratings: 7.8% rated it as "Poor", and 2.3% rated it as "Very Poor". **These results indicate that most participants perceive the availability of waste sorting facilities positively**, though there is room for improvement.

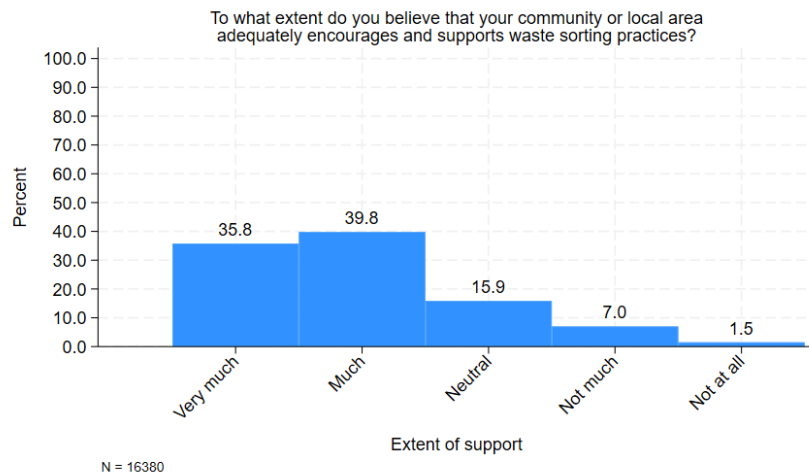
Figure 95. Perceived availability of waste sorting facilities in the community



Source: Authors' elaboration

Figure 98 illustrates participants' perceptions of how well their community or local area encourages and supports waste sorting practices. Most participants expressed positive views, with 39.8% responding "Much" and 35.8% responding "Very much". A smaller group, 15.9%, remained neutral, while 7.0% felt their community provides "Not much" support and 1.5% indicated "Not at all". **These findings suggest that most participants feel their community is supportive of waste sorting efforts, though a minority perceive a lack of sufficient encouragement.**

Figure 96. Perceptions of community support for waste sorting practices



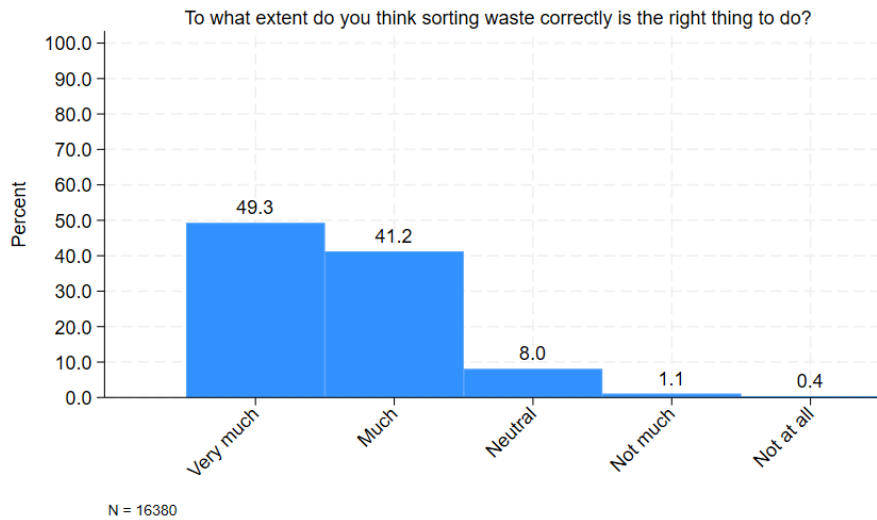
Source: Authors' elaboration

4.2.7.5. Social norms

This section examines participants' perceptions of social norms around waste sorting, focusing on the comparison between personal norms (to what extent waste sorting is the right thing to do for oneself) compared to beliefs about others' personal norms. It highlights discrepancies between individuals' self-perceptions and their beliefs about others, providing insight into the role of perceived norms in shaping waste-sorting behaviour.

Figure 99 shows participants' views on the extent to which they believe sorting waste is the right thing to do, reflecting injunctive social norms around waste management. 49.3%, responded "very much" with an additional 41.2% selecting "much" **indicating a strong consensus that sorting waste is the correct and socially expected behaviour.** A smaller percentage of participants expressed neutrality (8%), while only 1.1% and 0.4% selected "not much" and "not at all" respectively. These results suggest participants strongly support waste sorting as an important practice.

Figure 97. Self-reported waste sorting personal norm

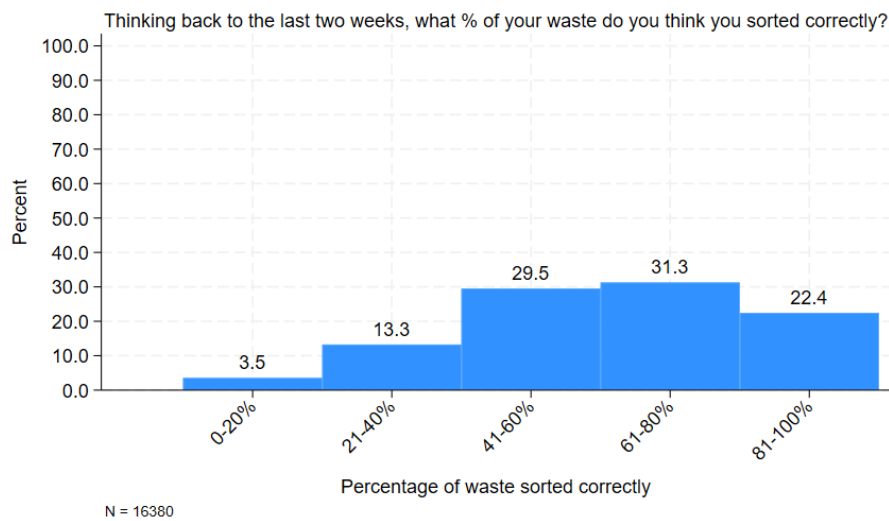


Source: Authors' elaboration

Figure 100 presents participants' self-reported accuracy in waste sorting over the past two weeks. 31.3% of participants estimate that they sorted 61-80% of their waste correctly, with an additional 22.4% reporting 81-100% accuracy. Meanwhile, 29.5% believe they sorted 41-60% correctly, and smaller proportions indicate lower levels of accuracy: 13.3% for 21-40% and 3.5% for 0-20%. **These findings highlight that most participants perceive their waste-sorting efforts as largely accurate, although a still significant share indicates they only sort around half or less of their waste correctly.**³⁷

³⁷While participants in this study report relatively high levels of waste-sorting accuracy (e.g., Almost 54% estimate they sorted at least 61% of their waste correctly), the actual recycling rates across the EU suggest that this self-perception may be overly optimistic. According to the latest Eurostat data (2022), the overall recycling rate in the EU27, excluding major mineral wastes, was 44%. Recycling rates vary by category, with packaging materials achieving the highest rate (65%), followed by municipal waste (49%) and e-waste (32%). This discrepancy underscores the potential gap between perceived and actual waste-sorting accuracy and effectiveness. https://ec.europa.eu/eurostat/databrowser/view/env_waspac_custom_15247151/default/table?lang=en

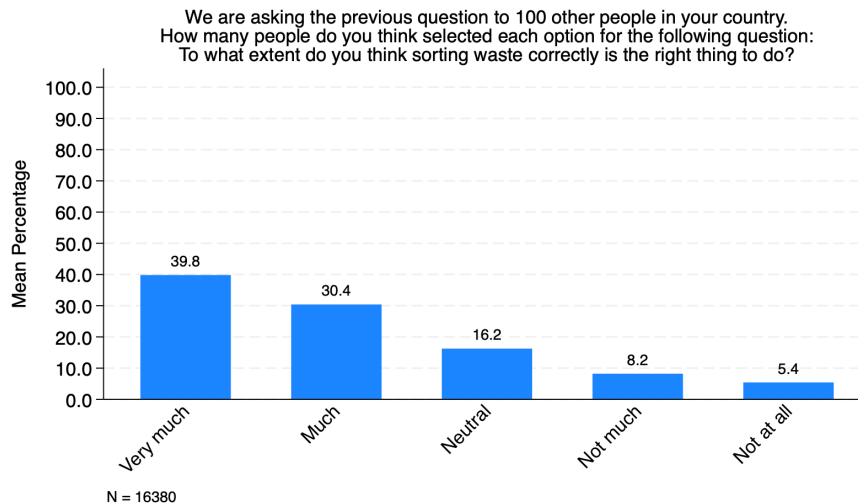
Figure 98. Self-reported accuracy in waste sorting over the past two weeks



Source: Authors' elaboration

Figure 101 shows participants' beliefs about how others perceive the importance of sorting waste. Responses indicate that 39.8% believe others view sorting as "very much" important, while 30.4% think others consider it "much" important. Meanwhile, 16.2% estimate neutrality, and smaller proportions (8.2% and 5.4%) assume "not much" or "not at all" importance, respectively. These results suggest participants perceive other participants to have slightly weaker personal norms regarding waste sorting compared to their own.

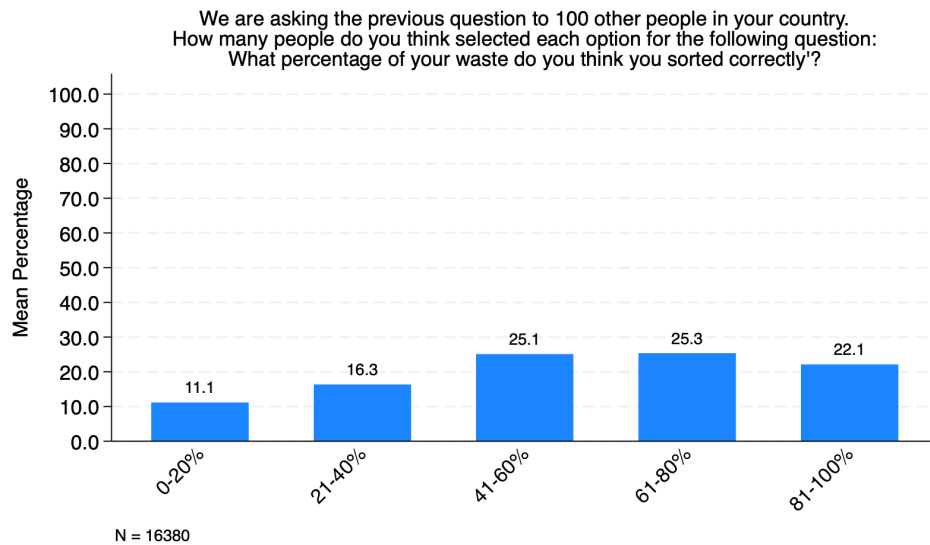
Figure 99. Belief about others' perception of waste sorting importance.



Source: Authors' elaboration

Figure 102 illustrates participants' beliefs about the accuracy of others' waste-sorting efforts over the past two weeks. The highest proportion, 25.3%, believed others sorted 61-80% of waste correctly, followed closely by 25.1% estimating 41-60% accuracy. Smaller percentages anticipated others sorted waste at very high (22.1% for 81-100%) or very low accuracy (11.1% for 0-20% and 16.3% for 21-40%). **These beliefs suggest participants perceive others to be slightly less accurate in waste sorting than they consider themselves to be.**

Figure 100. Estimated accuracy of others in waste sorting over the past two weeks.



Source: Authors' elaboration

Overall, there is an apparent discrepancy between self-reported personal norms and their beliefs about others' norms. While most participants consider waste sorting "very much" or "much" important for themselves (90.5%), they estimate lower personal norms for others (70.2% combined). Similarly, while a significant proportion of participants rate their own waste-sorting accuracy as high (53.7% report 61-100%), they perceive others to be less accurate, with 47.4% estimating similar levels for others.

These results show a divergence where individuals believe they value and are good at waste sorting more than their peers. However, the actual data reveal that many participants perceive waste sorting as important and report high accuracy in their sorting practices, suggesting a pluralistic ignorance effect. This suggests the opportunity for interventions to address misperceptions of social norms to foster collective waste-sorting behaviour.

4.2.7.6. Self-reported waste material sorting

This section summarises the main findings in terms of waste material separation and commingling practices. Table 26 examines participants' self-reported behaviours related to the sorting of different waste materials at home. The focus is on understanding "commingling" — the practice of mixing waste materials. Notably, the rules for separating and commingling waste materials differ within the EU, although the Waste Framework Directive mandates that the following waste materials be collected separately: paper and cardboard, glass, metals, plastics, bio-waste, and textiles. Values for each cell in Table 26 range from 0 to 1, where higher values (highlighted in darker green) indicate more frequent commingling between the respective materials. The main commingling practices are the following:

1. **Cardboard Commingling:** 45% of respondents stated they commingle cardboard with paper which is unsurprising given their similarity in material composition. 11% also reported they mixed it with composite packaging, reflecting that Tetra Pak, a common type of fibre-based composite packaging, is commingled with paper and cardboard in some countries.
2. **Metal and Aluminium Overlap:** Metal and aluminium exhibit significant commingling, with 33% of participants reporting they sort metal with aluminium and 30% of them with aluminium cans. Similarly, for 42% of participants aluminium is mixed with aluminium cans.

3. **Glass Mixing:** Both coloured and uncoloured glass are commonly commingled. Coloured glass is mixed with uncoloured glass by 38% of participants.
4. **Plastic and Composite Packaging:** Plastic is mixed with composite packaging for 22% of participants, with aluminium by 14% of participants and metal by 13% of participants.
5. **Composite Packaging Complexity:** 22% of participants commingle composite packaging (e.g., TetraPak) and 12% with paper.
6. **Wood:** Although wood is less likely to be mixed with other materials, it is sorted with residual waste by 26% of participants; 11% commingle it with composite packaging and 7% with plastic. Also, some participants (8%) report they are not sure how to sort wood.

Table 27. Commingling of waste materials: Self-reported sorting behaviours

	Together with Paper	Together with Cardboard	Together with Metal	Together with Aluminium	Together with Aluminium cans	Together with Coloured glass	Together with Uncoloured glass	Together with Plastic	Together with Composite packaging	Together with Wood	Together with residual waste	I am unsure
Paper	.86	.45	.08	.09	.09	.07	.07	.09	.12	.08	.05	.02
Cardboard		.87	.08	.09	.09	.07	.07	.08	.11	.06	.05	.02
Metal			.82	.33	.3	.07	.07	.13	.09	.04	.04	.03
Aluminium				.81	.42	.08	.08	.14	.11	.05	.05	.03
Aluminium cans					.82	.12	.1	.15	.12	.05	.05	.03
Coloured glass						.84	.38	.09	.09	.06	.05	.02
Uncoloured glass							.85	.13	.09	.06	.05	.03
Plastic								.86	.22	.07	.08	.03
Composite packaging									.86	.11	.11	.05
Wood										.85	.26	.08

Source: Authors' elaboration

Sorting Alone: Participants Sorting Without Commingling. Table 27 below addresses the percentage of respondents who sort each material exclusively (without commingling). These percentages reflect cases where no other materials were selected in conjunction with the specified material.

Table 28. Sorting without commingling

Material	Sorting Alone (%)
Paper	37.1
Cardboard	33.4
Metal	41.3
Aluminium	31.5
Aluminium Cans	32.0
Coloured Glass	39.3
Uncoloured Glass	39.9
Plastic	49.3
Composite packaging	48.1
Wood	52.8

Source: Authors' elaboration

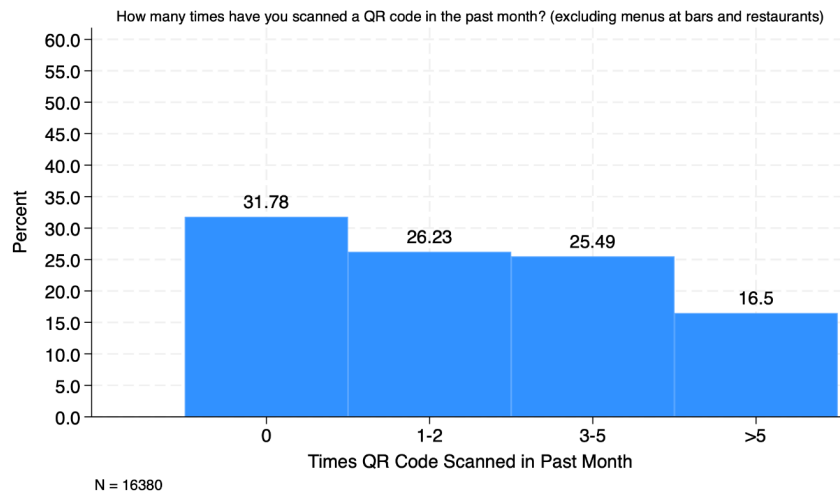
The main findings show:

- **Glass Separation:** The percentages indicate that 39% of participants sort coloured glass exclusively, and 40% sort uncoloured glass exclusively, meaning approximately 40% of participants separate these materials without mixing them with other waste.
- **Higher Sorting Alone for Wood and Plastic:** Over half of the respondents (53%) sort wood exclusively, followed by plastic at 49%.
- **Lower Sorting Alone for Cardboard and Aluminium:** Only around one-third of participants sort cardboard (33%), aluminium (32%), and aluminium cans (32%) exclusively, reflecting higher levels of commingling for these materials.

4.2.7.7. QR code usage

Figure 103 shows the distribution of QR code usage among participants in the past month (excluding menus at bars and restaurants). The largest group, 31.78%, reported not scanning any QR codes in the past month. Among those who did engage with QR codes, 26.23% scanned 1-2 times, 25.49% scanned 3-5 times, and 16.5% scanned more than five times. This distribution suggests a moderate level of QR code engagement, with a considerable portion of participants either not using or using them infrequently (58.1%). Interestingly, while many participants say they want QR codes on labels (refer to subsection 4.2.6.5), their actual usage patterns suggest they don't engage with them as often as they might expect or intend. Alternatively, participants may support QR codes not for their own use but because they believe they would be helpful to others who need them.

Figure 101. QR code usage



Source: Authors' elaboration

4.2.8. Main survey findings and implications for prototype 2

This section summarises the main implications for Prototype 2 based on the evidence collected in the citizen survey.

The **use of colour** on labels demonstrates varying results depending on the context.

- Evidence from colour association tasks, the label builder task, and the ex-post questionnaire indicate that **citizens generally prefer colour-coded labels and specific colour associations for materials**. Self-reported preferences from the label builder task confirm that participants value coloured labels on packaging and receptacles.
- Evidence from the understanding task shows that **colour on package labels slightly improves waste sorting accuracy**.
- However, the use of colours has **limited effects on the saliency of waste labels**. For product packaging waste sorting labels, colours do not significantly influence the likelihood of being noticed. Similarly, for aggregate waste receptacle label clicks, colour does not have a significant impact overall. However, colours do increase the saliency of specific waste receptacle labels, particularly biowaste and residual waste, suggesting that colour can enhance the noticeability of certain types of waste labels.

As regards the **use of text** to indicate the material a label is referring to, **language and material identifier preferences**,

- participants express **strong preferences for labels with text**, often favouring the bilingual option (i.e., national language and English) to enhance usability and accessibility. Additionally, self-reported preferences highlight a demand for more detailed and explicit information, including material identifiers and concise instructions, particularly for labels associated with compostable waste. There is also a strong demand for material identifiers, particularly for multi-material components.
- Evidence from the understanding task shows that **text improves the correct sorting of waste materials**, with a small but significant increase, especially for mono-material products, indicating that text enhances understanding.

- Adding text to packaging **slightly increases the time needed to complete the understanding task**. This suggests that the extra time is spent improving understanding and making better sorting decisions.
- However, **the salience task reveals mixed effects**. On product packaging, the text makes the labels more noticeable. On waste receptacles, adding text reduces salience, particularly for the plastic/metal sign.

The **inclusion of other labels**, such as Greendot and Triman, reduces the noticeability of waste sorting labels in salience tasks, suggesting that these labels distract from the key sorting information provided by waste sorting labels. While the Greendot attracted attention in salience tasks, this increased attention did not translate into improved sorting accuracy in understanding tasks, highlighting its limited utility for aiding waste sorting. These findings suggest that simplifying label designs by reducing or removing non-essential elements like Greendot and Triman can enhance the prominence and effectiveness of waste sorting labels.

Incorporating **component pictograms** for multi-material packaging significantly improved sorting accuracy. Participants were slightly more likely to correctly identify and sort dual and triple-material products when these pictograms were present. Self-reported preferences further confirm the demand for labels that clearly identify individual materials, underscoring the importance of detailed and specific information to support multi-material sorting.

The results indicate that receptacle labels are slightly more salient when the **label and receptacle colours match**. Although this does not improve sorting accuracy on average, but regression analysis including controls for additional variables shows they reduce accuracy by 5.6 percentage points. Despite this counterintuitive result, enhancing colour matching between labels and receptacles might still enhance visibility.

The results reveal clear **colour associations, suggesting** participants' familiarity with colour-coded material categories (see Table 28).

Table 29. Colour associations with colour-coded material categories

Material Category	Associated Colours
Plastics	Yellow
Glass	Green
Compostable Materials	Brown, Dark Green
Paper	Dark Blue, Beige
Metals	Black, Grey
Residual Waste	Black, Grey
Textiles	No consistent association
Steel	No consistent association

Source: Authors' elaboration

Across various tasks, **participants expressed preferences for more detailed and comprehensive labels**, that include for instance material identifiers or QR codes. However, these preferences were not tested in behavioural tasks, highlighting a potential gap in understanding how more information may affect behaviour.

Regarding key findings on **material commingling**, cardboard is mostly sorted with paper but sometimes mixed with composite packaging. Metal and aluminium frequently overlap, though both are often sorted

separately. Coloured and uncoloured glass are commonly mixed, but many participants also sort them separately. Plastic is sometimes sorted with composite packaging, aluminium, or metal, though it is also often separated correctly. The commingling of composite packaging with paper and plastic suggests potential confusion regarding its correct sorting, possibly due to its multi-material composition and cross-country differences in sorting guidelines. Wood is less frequently mixed but still sometimes sorted with residual waste or composite packaging, while some are unsure how to dispose of it.

Social norms play a role in shaping sorting behaviours. Evidence suggests that participants may misjudge how others engage in waste sorting, which can influence their own behaviour. Policy implications include fostering consistent messaging to correct misperceptions and promote alignment with pro-sorting social norms. Incorporating elements that reflect shared societal values, such as the importance of recycling, may further enhance engagement.

The survey provides insights into participants' **perceptions of barriers to waste sorting** and the role of the community in supporting these efforts. The findings indicate that while most participants perceive their communities as supportive of waste sorting and find sorting facilities generally accessible, challenges remain. Unclear labels and symbols on packaging and bins are among the most reported barriers, highlighting the need for clearer and more accessible information. Despite these difficulties, a significant portion of participants do not perceive major obstacles.

The results from the questionnaire inform the three dimensions of the **Motivation Opportunity Ability (MOA) framework** which can explain waste sorting behaviours. The findings suggest that participants generally exhibit a strong motivation to sort waste, perceiving it as an important task. They also find waste sorting to be a convenient activity, indicating that structural or logistical barriers are minimal for most. Additionally, participants expressed high confidence in their ability to sort waste correctly, reinforcing a sense of self-efficacy in performing the task. However, the potential influence of social desirability bias should be considered when interpreting these results.

In conclusion, looking across all the tested elements, text was the strongest predictor of correct sorting behaviour. The evidence consistently shows that labels containing text improved sorting accuracy and saliency more effectively than other elements tested. While coloured labels were generally preferred over black and white labels, the effect of colour on saliency increased and overall accuracy was limited. Meanwhile, component pictograms were particularly useful for multi-material sorting, supporting participants in correctly identifying and sorting complex packaging, especially when materials were difficult to distinguish by appearance alone.

If Prototype 2 prioritises design elements based on their evidence base, the strongest focus should be on:

- Ensuring labels contain clear text as it has a positive effect on correct sorting.
- Incorporating component pictograms for multi-material packaging, as they improved sorting accuracy and were strongly preferred by participants.
- Minimising unnecessary labels (e.g., Greendot, Triman) that distract from essential sorting information.
- Using colour selectively to enhance visibility for specific waste categories (e.g., biowaste and residual waste) while ensuring it does not interfere with comprehension.

Future iterations of the prototype should consider testing the interaction between these elements in more detail. By refining Prototype 2 based on these high-priority findings, the effectiveness of waste sorting labels can be maximised, leading to better sorting outcomes and increased user engagement.

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List of abbreviations and definitions

Abbreviations	Definitions
JRC	Joint Research Centre
MOA	Motivation Opportunity Ability
MS	Member States
OLS	Ordinary Least Squares
PPWR	Product Packaging Waste Regulation
SUP	Single Use Plastic
ToR	Terms of Reference
WFD	Waste Framework Directive

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6. Annexes

6.1. Selection of examples from Prototype 1

On-bin images: home bin + no text



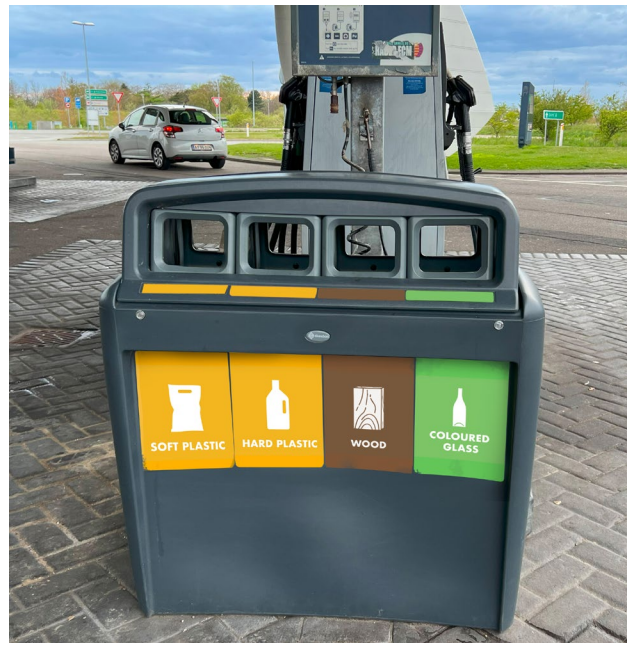
On-bin images: personal outdoor bin + text



On-bin images: home bin + no text



On-bin images: home bin + text



Source: Authors' elaboration

On-product images



On-product images



On-product images



On-product images



Source: Authors' elaboration

6.2. Participatory workshops materials

6.2.1. WooClap Questionnaire Master

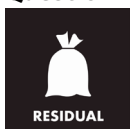
1.

Question

Icebreaker - Which item do you always struggle to dispose of and why?

Answer option

Open Question

2.**Question**

Residual Waste

Please rate the label according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral
- (4) somewhat effective
- (5) very effective

Answer options

Rating on Likert Scale for each dimension:

1. Comprehension - Easy Understanding of icons and text
2. Accessibility - Label is readable and recognisable
3. Visual Communication - Identify the type of waste portrayed on the label
4. Language & Content - Understand what to do with the waste
5. Matches expectations of how this kind of waste should be portrayed
6. Icon and text are coherent and provide consistent and clear information

3.**Question**

Residual Waste

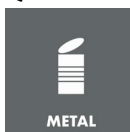
What do the colour, icon and text on the label mean to you?

What do you think you should throw according to this label?

What is your general impression of this label?

Answer options

Open Question

4.**Question**

Metal

Please rate the label according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral
- (4) somewhat effective
- (5) very effective

Answer options

Rating on Likert Scale for each dimension:

1. Comprehension - Easy Understanding of icons and text
2. Accessibility - Label is readable and recognisable
3. Visual Communication - Identify the type of waste portrayed on the label
4. Language & Content - Understand what to do with the waste

5. Matches expectations of how this kind of waste should be portrayed
6. Icon and text are coherent and provide consistent and clear information

5.

Question



Metal

What do the colour, icon and text on the label mean to you?
What do you think you should throw according to this label?
What is your general impression of this label?

Answer options

Open Question

6.

Question



Wood

Please rate the label according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral
- (4) somewhat effective
- (5) very effective

Answer options

Rating on Likert Scale for each dimension:

- 1. Comprehension - Easy Understanding of icons and text
- 2. Accessibility - Label is readable and recognisable
- 3. Visual Communication - Identify the type of waste portrayed on the label
- 4. Language & Content - Understand what to do with the waste
- 5. Matches expectations of how this kind of waste should be portrayed
- 6. Icon and text are coherent and provide consistent and clear information

7.

Question



Wood

What do the colour, icon and text on the label mean to you?
What do you think you should throw according to this label?
What is your general impression of this label?

Answer options

Open Question

8.

Question



Paper and Cardboard (combined)

Please rate the label according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral
- (4) somewhat effective
- (5) very effective

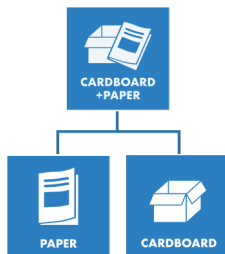
Answer options

Rating on Likert Scale for each dimension:

- 1. Comprehension - Easy Understanding of icons and text
- 2. Accessibility - Label is readable and recognisable
- 3. Visual Communication - Identify the type of waste portrayed on the label
- 4. Language & Content - Understand what to do with the waste
- 5. Matches expectations of how this kind of waste should be portrayed
- 6. Icon and text are coherent and provide consistent and clear information

9.

Question



Paper and Cardboard (divided)

Please rate the label according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral
- (4) somewhat effective
- (5) very effective

Answer options

Rating on Likert Scale for each dimension:

- 1. Comprehension - Easy Understanding of icons and text
- 2. Accessibility - Label is readable and recognisable
- 3. Visual Communication - Identify the type of waste portrayed on the label
- 4. Language & Content - Understand what to do with the waste
- 5. Matches expectations of how this kind of waste should be portrayed
- 6. Icon and text are coherent and provide consistent and clear information

10.

Question



Paper and Cardboard

What do the colour, icon and text on the label mean to you?

What do you think you should throw according to this label?

What is your general impression of this label?

Answer options

Open Question

11.

Question



Plastic and Cartons (combined)

Please rate the label according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral
- (4) somewhat effective
- (5) very effective

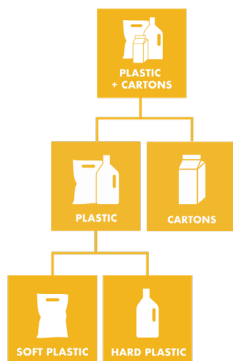
Answer options

Rating on Likert Scale for each dimension:

1. Comprehension - Easy Understanding of icons and text
2. Accessibility - Label is readable and recognisable
3. Visual Communication - Identify the type of waste portrayed on the label
4. Language & Content - Understand what to do with the waste
5. Matches expectations of how this kind of waste should be portrayed
6. Icon and text are coherent and provide consistent and clear information

12.

Question



Plastic and Cartons (divided)

Please rate the label according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral
- (4) somewhat effective
- (5) very effective

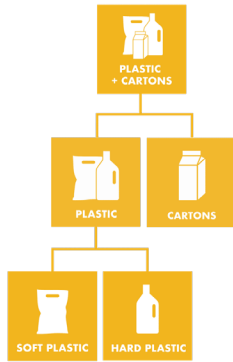
Answer options

Rating on Likert Scale for each dimension:

1. Comprehension - Easy Understanding of icons and text
2. Accessibility - Label is readable and recognisable
3. Visual Communication - Identify the type of waste portrayed on the label
4. Language & Content - Understand what to do with the waste
5. Matches expectations of how this kind of waste should be portrayed
6. Icon and text are coherent and provide consistent and clear information

13.

Question



Plastic and Cartons

What do the colour, icon and text on the label mean to you?

What do you think you should throw according to this label?

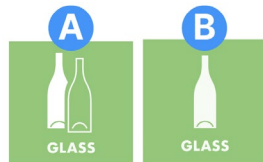
What is your general impression of this label?

Answer options

Open Question

14.

Question



Glass

Sort the label alternatives by your preferences - which one resonates most with you (top) and which one the least (bottom)?

Answer options

Sorting by preference:

Option A

Option B

15.

Question



Glass (combined)

Please rate the label according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral
- (4) somewhat effective
- (5) very effective

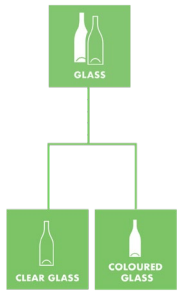
Answer options

Rating on Likert Scale for each dimension:

- 1. Comprehension - Easy Understanding of icons and text
- 2. Accessibility - Label is readable and recognisable
- 3. Visual Communication - Identify the type of waste portrayed on the label
- 4. Language & Content - Understand what to do with the waste
- 5. Matches expectations of how this kind of waste should be portrayed
- 6. Icon and text are coherent and provide consistent and clear information

16.

Question



Glass (divided)

Please rate the label according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral
- (4) somewhat effective
- (5) very effective

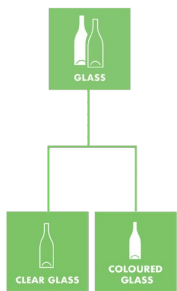
Answer options

Rating on Likert Scale for each dimension:

- 1. Comprehension - Easy Understanding of icons and text
- 2. Accessibility - Label is readable and recognisable
- 3. Visual Communication - Identify the type of waste portrayed on the label
- 4. Language & Content - Understand what to do with the waste
- 5. Matches expectations of how this kind of waste should be portrayed
- 6. Icon and text are coherent and provide consistent and clear information

17.

Question



Glass

What do the colour, icon and text on the label mean to you?

What do you think you should throw according to this label?

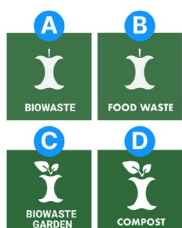
What is your general impression of this label?

Answer options

Open Question

18.

Question



Biowaste

Sort the label alternatives by your preferences - which one resonates most with you (top) and which one the least (bottom)?

Answer options

Sorting by preference:

Option A

Option B

Option C

Option D

19.

Question



Biowaste

Please rate the label according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral
- (4) somewhat effective
- (5) very effective

Answer options

Rating on Likert Scale for each dimension:

- 1. Comprehension - Easy Understanding of icons and text
- 2. Accessibility - Label is readable and recognisable
- 3. Visual Communication - Identify the type of waste portrayed on the label
- 4. Language & Content - Understand what to do with the waste
- 5. Matches expectations of how this kind of waste should be portrayed
- 6. Icon and text are coherent and provide consistent and clear information

20.

Question



Biowaste

What do the colour, icon and text on the label mean to you?

What do you think you should throw according to this label?

What is your general impression of this label?

Answer options

Open Question

21.

Question



Overall labelling system

Please rate the system according to the following scale:

- (1) not effective at all
- (2) not very effective
- (3) neutral

- (4) somewhat effective
- (5) very effective

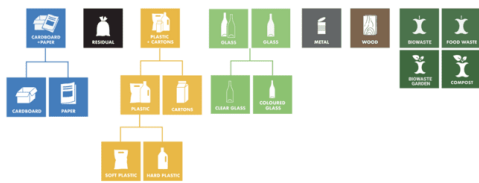
Answer options

Rating on Likert Scale for each dimension:

1. Comprehension - Easy Understanding of icons and text
2. Accessibility - Label is readable and recognisable
3. Visual Communication - Identify the type of waste portrayed on the label
4. Language & Content - Understand what to do with the waste
5. Matches expectations of how this kind of waste should be portrayed
6. Icon and text are coherent and provide consistent and clear information

22.

Question



Overall labelling system

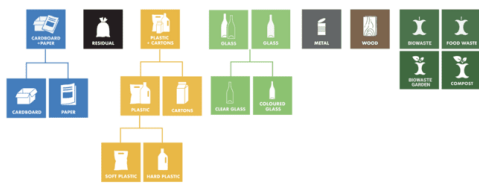
What is your general impression of the labelling system?

Answer options

Open question

23.

Question



Overall labelling system

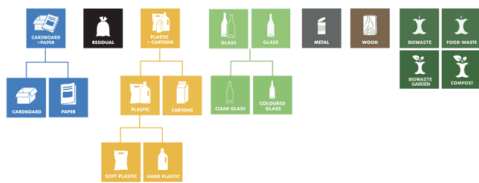
What are problems or weak points that you see?

Answer options

Open question

24.

Question



Overall labelling system

What do you like about it?

Answer options

Open question

Source: Authors' elaboration

6.2.2. Miro Board Template

5"

Miro Intro

Watch me first!

Miro: Better. Easier. For. New. Participants.

The Miro Intro board is divided into five sections:

- Navigation:** Shows how to use the Miro interface, including the toolbar and workspace.
- Basics:** Explains how to create and move sticky notes, and how to use the Miro toolbar.
- Adding content:** Shows how to add images, shapes, and other content to the workspace.
- Finding content:** Shows how to search for content and how to use the Miro toolbar.
- Shortcuts:** Lists various keyboard shortcuts for navigating and editing the workspace.

5"

Group Formation

Group Formation
Take an object to recycle and place it in the correct bin.
Write your name on the post-it next to it by double-clicking on the post-it.
Remember the colour of the bin and your group number, it will help you to find your workspace for the rest of this workshop.

The Group Formation board features a collection of various objects (e.g., plastic bottle, paper cup, metal can, glass bottle, cardboard box) scattered across the workspace. Below the objects are five recycling bins, each labeled with a group number and a material type:

- Group 1:** BIOWASTE (Green bin)
- Group 2:** RESIDUAL (Black bin)
- Group 3:** PLASTIC (Yellow bin)
- Group 4:** METAL (Grey bin)
- Group 5:** CARDBOARD/PAPER (Blue bin)

15"

Brainstorming

Brainstorming
Each participant chooses one colour and starts writing ideas for one concept or how to improve the presented water filter system.
Some questions to think about to help you obtain:

- How can we make it more efficient?
- How can we make it more sustainable?
- How can we make it more user-friendly?
- How can we make it more affordable?
- How can we make it more eco-friendly?
- How can we make it more durable?
- How can we make it more compact?
- How can we make it more portable?
- How can we make it more easy to use?
- How can we make it more easy to clean?
- How can we make it more easy to maintain?
- How can we make it more easy to transport?
- How can we make it more easy to store?
- How can we make it more easy to dispose of?
- How can we make it more easy to recycle?
- How can we make it more easy to repair?
- How can we make it more easy to upgrade?
- How can we make it more easy to customize?
- How can we make it more easy to integrate with other systems?
- How can we make it more easy to scale up?
- How can we make it more easy to scale down?
- How can we make it more easy to scale out?
- How can we make it more easy to scale in?
- How can we make it more easy to scale up and down?
- How can we make it more easy to scale up and out?
- How can we make it more easy to scale up and in?
- How can we make it more easy to scale up and out and in?

10"

Prioritization

Prioritization
Evaluate together which ideas are most valuable for users and might be most suitable to be implemented. This should help you to decide on one idea or a group that you want to pursue your algorithm further. Improving water saving levels.

Impact

High impact	High impact
Low impact	Low impact

Feasibility

High feasibility	High feasibility
Low feasibility	Low feasibility

15"

Idea Detailing

Idea Card
Drag your selected idea here and start it further exploring the problem that it solves and how it works.

IDEA

Algorithm

Challenge addressed

How does it work?

Source: Authors' elaboration

- Answer Options: I did not finish high school - High School or equivalent – Vocational school - Bachelor’s degree or equivalent - Master’s degree - Doctorate or equivalent higher degree - I prefer not to answer - Other

5. Residence Type:

- "What type of residence do you live in?"
- Answer Options: Private house - Condo/Apartment - Shared housing - I prefer not to answer - Other (please specify)

6. Area:

- "How would you best describe the area where you currently live?"
- Answer Options: Urban (metropolis or a city)- Suburban (residential area on outskirts of a city)- Rural (settled place outside a town or city)

7. Household Monthly Income After Tax:

- "What is your household's monthly income after tax?"
- Answer Options: Less than or equal to 200 Euro - 201-400 Euro - 401-600 Euro - 601-800 Euro - 801-1,000 Euro - 1,001-1,200 Euro - 1,201-1,400 Euro - 1,401-1,600 Euro - 1,601-1,800 Euro - 1,801-2,000 Euro - 2,001-2,200 Euro - 2,201-2,400 Euro - 2,401-2,600 Euro - 2,601-2,800 Euro - 2,801-3,000 Euro - 3,001-3,200 Euro - 3,201-3,400 Euro - 3,401-3,600 Euro - 3,601-3,800 Euro - 3,801-4,000 Euro - More than 4,000 Euro - I prefer not to answer

To ensure comparability of socio-demographic data across all participating countries, we implemented harmonization techniques based on Eurostat³⁸ and ISCED classifications³⁹:

- **Household Income:** Reported monthly incomes were converted into country-specific quartiles using Eurostat's national income distribution data. This normalization ensures that participants' income levels are comparable as relative economic positions across countries, regardless of differences in currency or cost of living.
- **Education Levels:** Educational attainment was recoded into standardized ISCED categories:
 - Primary Education (ISCED 0-2): Includes participants who did not complete high school.
 - Secondary Education (ISCED 3-4): Includes high school and vocational education.
 - Tertiary Education (ISCED 5-8): Includes Bachelor’s, Master’s, and Doctorate degrees.

³⁸ Eurostat's `ilc_di01` indicator provides the cutoff points for income quartiles, dividing the population into four equal groups based on income distribution.

³⁹ The levels of education are structured according to the International Standard Classification of Education (ISCED 2011), which provides a comprehensive framework for categorising educational programs and qualifications across countries. For more information see: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_Standard_Classification_of_Education_\(ISCED\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_Standard_Classification_of_Education_(ISCED))

Other variables, such as gender, age, and residence type, are universally applicable and defined consistently. These harmonization efforts ensure robust cross-country comparisons and meaningful analyses.

6.3.2. Introduction and welcome

Participants are shown the following welcome pages with introductory information, translated, as the full surveys, into the respective main language(s) of the country:

Welcome!

This survey is designed to study decision-making and waste-sorting practices. It is done in collaboration with the European Commission Joint Research Centre.

Completing this survey should take a maximum of 20 minutes. Please concentrate and avoid distractions.

The survey

This survey is composed of different parts, each with its own instructions.

No deception

We employ a strict non-deception policy. This means that all information you receive during this survey is truthful. During this survey, we will include two attention checks. You must answer at least one of these correctly to continue the survey. This is to make sure that we get usable data that is informative for us. Please pay sufficient attention to the questions to help us in our research. We sincerely thank you for your effort in advance!

Data privacy statement

The data collected in this survey are treated in accordance with the General Data Protection Regulation (GDPR). No personal information will be shared, published, or kept for longer than necessary for the study period. All responses will be assessed and treated anonymously. Your participation is voluntary, and you have the right to withdraw from the survey at any time without any negative consequences. The collected data will be stored securely and will only be accessible to the research team.

Please know that moving to the next page of the survey means you consent to participate in the study. If you do not consent, you can simply close this page and leave the survey.

Please confirm you are not a robot by clicking on the box below to continue with the survey.

[captcha]

6.3.3. Noticeability of the label (salience task)

The first task of the survey is used to understand how different label elements impact the noticeability of the waste sorting labels. To ensure that participants are familiar with the task and understand the instructions, they are asked to complete a practice task. In this task, all participants were shown one set of 5 images, positioned next to each other, each containing 1 specific object. They are asked to simply click on the object that they like the most, to see how clicks are shown on the image and how they can be changed by clicking on the same place a second time.

Table 29 summarises the main elements of the salience task, i.e., its main objective and the dependent and independent variables.

Table 30 Saliency task – Main features

Saliency task			
Main objective	Understand how different label elements (text presence, colour scheme, contrast) affect the noticeability of labels in realistic contexts.		
<i>Variable type</i>	Variable name	Description	Operationalization
Dependent variables	<i>Noticeability</i>	Accuracy of noticing the specific label, based on the presence of different label features in the image (for both the receptacle and the product packaging images).	Binary variable (0= not area not clicked, 1=clicked) Reaction times (how long does it take to make a decision).
Independent variables	<i>Colour (within-subjects)</i>	The colour scheme used for the waste label (not the colour of the receptacle)	Binary variable (0= Black and white, 1= Colourful)
	<i>Image shown (within-subjects)</i>	Each participant is shown four images: one image of a receptacle (i.e., bins in a station), and three images of a product featuring a WSL, in random order.	0=receptacle image (i.e., bins at a station) 1st product image (i.e., Packaging with one material - Mono) 2nd product image (i.e., Packaging with two materials - Dual) 3rd product image (i.e., Packaging with three materials - Triple)
	<i>Text (within-subjects)</i>	The presence or absence of text (indicating the material) on the waste label	Binary variable (0 = No text, 1 = Text present).
	<i>Presence of other labels (within-subjects)</i>	The presence or absence of the Green Dot label, the SUP and the Triman Logo (only for on-pack label). The SUP additional label and the Triman logo is applicable only to the mono material products. The Green Dot is applicable in mono, dual and triple material products.	For mono products, one out of <ul style="list-style-type: none"> • Green Dot, SUP and Triman logo • No other label For dual and triple products, one out of <ul style="list-style-type: none"> • Green Dot • No other label
	<i>Bin colour matching (within-subjects)</i>	Colour match or mismatch between label and bin (only for on-bin label)	One out of <ul style="list-style-type: none"> • Match: Bin and label are the same colour. • Mismatch: Bin and label are not the same colour.

Source: Authors' elaboration

Task objective

Participants complete a task designed to measure the saliency of different waste sorting labels. The primary objective is to understand how different label elements affect the noticeability of labels in realistic contexts. This task addresses Research Question 5 and is used to determine if labels effectively grab attention in various environments. This task serves two purposes:

1. **For participants:** The task involves identifying elements within an image that participants believe are the most important in helping them sort waste. Participants are shown realistic images of waste bins or product packaging and are asked to click on the relevant label(s) as quickly and accurately as possible.

- Participants interact with four images, each containing waste sorting labels within a visually complex environment, such as bins with a “no litter” sign or packaging with additional icons and branding.
- Their task is to identify the most helpful sorting information.

2. For the study:

The objective is to assess the salience of specific label features by analysing participants' clicks. By systematically altering key label elements (e.g., text presence, colour, contrast), the study examines which design elements most effectively draw participants' attention in realistic settings.

Task description

Participants are instructed to complete the task under the following framing:

- *"You will see several images depicting realistic situations and products. Your task is to click on the elements in the image that you think are the most important in helping you sort your waste. Please click as quickly and accurately as possible, selecting at least one element in each image to proceed."*

Thus, participants are instructed to click on the elements within each image that they think are most helpful for sorting waste. The task is designed to be non-trivial, ensuring that participants must focus on identifying key elements while ignoring irrelevant distractions. To familiarise participants with the task, a practice phase allows them to click on highlighted elements and learn how to modify their selections. This ensures they understand how to interact with the task interface before starting. Participants then view a series of four images in random order, each depicting waste sorting labels in realistic contexts:

- Each participant is instructed to click on the elements within the image that she thinks best help sort waste.
- Each participant views a series of 4 images in a random order.
- Each image contains several background elements, including realistic environments with some distracting information (for example, a “no litter sign” in the waste bin image condition), to ensure the task is not trivial and emulates a realistic setting. In the packaging image condition, distracting elements include other product labels and icons, such as recycling logos, nutritional information, or branding on the packaging, creating a visually complex environment.

One of the four images shows **Public bins in a station**. The picture contains four bins, each designated for a specific type of waste material: plastic/metal, paper/cardboard, residual waste and bioplastics.

Independent variables. We introduce the following *independent variables* that are applied for both the receptacle and the product packaging images. In total, we test 8 variations (See Table 30 for an overview):

1. (within-subjects) Background colour of the waste label (colour used in the WSL vs. black and white).⁴⁰
2. (within-subjects) Waste label's text presence (with vs. without, in the national language) indicating the material.

⁴⁰ The colour of the waste receptacles does not vary. We will control for colour familiarity ex post in the analysis using the results from task 3.

3. (within-subjects) Presence of other labels (Green Dot, Triman, and SUP). Only in on-pack labels.
4. (between-subjects) Colour match or mismatch between label and bin. Only on-bin labels.⁴¹

That is, all contextual elements remain constant, with variations only in the label features on the receptacle and the product packaging. By methodically altering these key label elements and aspects, we can assess the independent impacts of these elements on the salience of the waste label within a realistic context.

Table 31 Salience task – Experimental treatments description for on-bin labels

Image variation	Label Colour	Label text (indicating material – in National languages)	Colour match BIN <>LABEL
1	Black and white	Text	Mismatch
2	Black and white	Text	Match
3	Black and white	No text	Mismatch
4	Black and white	No text	Match
5	Primary colours	Text	Mismatch
6	Primary colours	Text	Match
7	Primary colours	No text	Mismatch
8	Primary colours	No text	Match

Source: Authors' elaboration

- The other three images show product packaging with varying numbers of components:
 1. **Mono.** Cup for beverages (plastic)
 2. **Dual.** Food can with a plastic lid
 3. **Triple.** Medicine packaging (paper box, glass bottle, plastic cap).

There are 8 variations for each image, comprised of black and white versions, with or without text (the packaging labels are consistently in English), and the presence or absence of additional labels. For mono products, these labels include the Green Dot, the Single-use plastics (SUP) symbol, and the Triman logo. Dual and triple component products feature only the Green Dot, as the SUP is specific to certain products. As per the agreement with JRC, the Triman logo was included only when the SUP is present. See Table 31 for an overview of the variations and Figure 104 for the visual representation of the experimental treatments.

41

Table 32 Salience task – Experimental treatments description for on-pack labels

Image variation	Label Colour	Label text (In English)	Other waste sorting label
1	Black and white	Text	None
2	Black and white	Text	Green dot ⁴²
3	Black and white	No text	None
4	Black and white	No text	Green dot
5	Primary colours	Text	None
6	Primary colours	Text	Green dot
7	Primary colours	No text	None
8	Primary colours	No text	Green dot

Source: Authors' elaboration

Figure 102 Salience task – Visual representation of experimental treatments for on-pack labels



⁴² In mono component products, the Green Dot is accompanied by the Triman logo and the SUP.



Source: Authors' elaboration

Dependent variables. This part of the survey aims to understand whether the labels grab attention effectively in different environments. Participants are assessed on:

1. *Accuracy:* their ability to notice labels within realistic contexts. We observe whether the relevant area is clicked or not (binary variable) and the order of clicks to measure the most salient label (e.g., first, second, third, etc).⁴³

General Structure for Participants

- *Variation condition.* For each image, participants are randomly shown a different label variation.
- *Randomised order.* The order of the four images is randomised for each participant to control for order effects.

Table 32 and Figure 105 below show examples of the sequences for two participants, each seeing a specific sequence of images and associated elements.

Table 33 Salience task – Example Participant 1

Image Order	Image Type	Label Colour	Label text	Other labels	Colour match (bin and label)
1	Receptacle	Black and white	Text	--	Yes
2	Product Packaging 1	Black and white	No text	Yes	--
3	Product Packaging 2	Primary colours	Text	No	--
4	Product Packaging 3	Primary colours	No text	Yes	--

Source: Authors' elaboration

Figure 103 Salience task –Example images of Participant 1

1

2

⁴³ While reaction time for individual clicks is not recorded due to software limitations, an overall page submission time is collected. This allows for a comparative evaluation of task completion time across label versions.



3



4



Source: Authors' elaboration



6.3.4. Understandability (Correct sorting task)

Correct sorting task. This task is built to evaluate participants' ability to correctly associate labels with their respective receptacles. This task is intended as a matching exercise (i.e., on-pack label corresponds to the on-receptacle label), reflecting the matching requirement of the PPWR (Article 9) which states that the same label should be placed on the packaging and the receptacle. This task serves two purposes:

1. **For participants:** The task involves deciding how to sort waste correctly. Participants are instructed to examine the labels on product packaging and disposal bins and select the appropriate bin(s) for disposal.
2. **For the study:** The objective is to assess the impact of label elements (e.g., text, colour, and icons) on sorting accuracy, providing insights into the clarity and comprehensibility of waste sorting labels. This task addresses R.Q.5 and R.Q.6, focusing on participants' comprehension of waste sorting labels, their ability to associate labels with correct waste categories, and their capacity to follow sorting instructions accurately.

The table below summarises the main features of this task.

Table 34 Correct sorting task – Main features

Correct sorting task			
Main objective	Understand how different label elements affect the ability of participants to correctly sort products in the correct receptacles.		
<i>Variable type</i>	Variable name	Description	Operationalization
Dependent variables	<i>Correct sorting</i>	Accuracy of selecting the correct bins for a given product	A score ranging from 0 (totally incorrect) to 1 (totally correct). For mono products: 1 if correct, 0.5 if partially correct, 0 if incorrect. For dual products: 1 if both correct, 0.5 if one correct, 0 if incorrect. For triple products: 1 if all three correct, 0.66 if two correct, 0.33 if one correct, 0 if none correct.
	<i>Reaction times</i>	Reaction times in selecting the receptacles, for each product.	Continuous variable in seconds
Independent variables	<i>Material component (within-subjects)</i>	10 products with different material components.	<ul style="list-style-type: none"> • Mono (3 cases) • Dual (4 cases) • Triple (2 cases) • Non-recyclable (1 cases)
	<i>Label Colour (within-subjects)</i>	The colour of the label used.	One out of: <ul style="list-style-type: none"> • Black and white • Coloured
	<i>Presence of text (within-subjects)</i>	Text indicating the material on the label.	One out of: <ul style="list-style-type: none"> • Text indicating the material • No text
	<i>Presence of other labels (within-subjects)</i>	Green Dot label ^{Error! Unknown switch argument.}	One out of <ul style="list-style-type: none"> • Green Dot • No other label
	<i>Presence of component pictograms (within-subjects)</i>	Presence of the component pictograms. They only appear in multi-material products to differentiate the various components of the product.	One out of <ul style="list-style-type: none"> • Component pictogram • No component pictogram
	<i>Bin colour matching (between-subjects)</i>	Colour match between label and bin	One out of <ul style="list-style-type: none"> • Bin and label are the same colour • Bin and label are not the same colour

Source: Authors' elaboration

We operationalise the task such that the search for information is costly, implementing the following two features to provide a more realistic depiction of these choices:

1. **Effort to access label information:** In each decision, participants see 3 images of the different sides of a given product. The waste label is only on one side of the product, ensuring that the search for information is costly by requiring participants to exert an effort to locate the label.
2. **Number of receptacles:** In each decision, participants face 5 receptacles, each designated for a specific waste material. The presence of multiple receptacles increases the complexity of the task relative to simpler scenarios with fewer receptacles or generalised waste categories. This design requires participants to make precise and discerning choices by correctly identifying and sorting materials based on specific label information. The added receptacle variety aims at increasing cognitive load, as participants must evaluate multiple options and match components of the product to their appropriate disposal bins.

The task consists of the following steps:

Step 1. Correct sorting task. Each participant is presented with 10 situations, shown in a random order, in which they must correctly sort a product into the appropriate receptacle(s). In each of the 10 situations, a participant sees one product from three different sides, with one image showing up to three labels applied to the product (depending on the number of components). For each decision, the participants are required to correctly drop the material into the correct receptacle, indicating the receptacle they believe is the most suitable for the product. Firstly, they can choose whether to dispose of the entire product into a single receptacle or to separate different components into separate bins. If they choose the latter, they are secondly presented with additional questions about which bin to use for each component.⁴⁴

The sorting practices are uniform for all participants, meaning the task requires sorting according to the experimental labels provided. For some participants, these sorting practices may align with familiar national systems, while for others, they may not. For example, the label colour for paper is blue, which corresponds to sorting practices in countries such as Germany and Finland but not in Italy or Spain, where paper is typically associated with yellow or other colours. Similarly, the label colour for glass is green, which aligns with practices in Denmark and Belgium but not in the Netherlands, where glass often has no colour-specific association. This uniform system ensures a standardised experimental condition across all participants, though it may vary in its familiarity to individuals based on their local sorting norms

The dependent variable is correct sorting. For example, for a glass bottle with a metal cap, participants should first indicate that the product needs to be disposed of in separate receptacles. They are then asked to choose the appropriate bin for the glass bottle, and then similarly to choose the appropriate bin for the metal cap. The correct sorting for this product would be placing the bottle in the glass bin and the cap in the metal bin. This approach ensures that participants can accurately sort multi-components items and provides an assessment of their sorting abilities. The accuracy of placing components into their correct bins ranges from 0 (totally incorrect) to 1 (totally correct). For mono-component products, the score is 1 if all items are in the correct bin and 0 if all are in the wrong bin. For dual-component products, the score is 1 if both are correctly placed, 0.5 if only one is correct, and 0 if neither is sorted correctly. Triple-component products extend this logic, involving three components, where a score of 1 is achieved when all three are in their correct bins, 0.66 if two are correct, 0.33 if only one is correct, and 0 if none are sorted correctly. This approach provides a consistent way to evaluate sorting accuracy. It ensures that partial

⁴⁴ Familiarity with the used label colours will be controlled for in the analysis.

correctness is acknowledged proportionally, regardless of the complexity or number of components in the product type.

While the task provides valuable insights into participants' ability to sort multi-component items and follow waste sorting instructions, certain limitations must be considered. First, the uniform sorting system used in the task, while necessary for standardisation, may disadvantage participants from countries with significantly different local sorting practices, potentially introducing variability unrelated to the labels themselves. For instance, label colours or sorting conventions that conflict with participants' habitual systems may influence performance. Second, the reliance on a simulated environment, rather than real-world waste sorting scenarios, may limit ecological validity. Participants might behave differently in actual waste sorting situations, where contextual factors such as time pressure, distractions, or access to information could impact decisions.

The tasks include the *independent variables* described below:

1. **Material component (within-subjects variations):** we include 10 products with different material components, which are randomly presented at the subject level. Specifically, as shown in Table 7 below, we include:
 - Mono-material packaging (3 cases);
 - Dual-material packaging (4 cases);
 - Triple-material packaging (2 cases).
 - Materials to be disposed of as residual waste (1 case).
2. **Label colours (within-subjects):** participants see the label either with colour or in black and white.
3. **Presence of text (within-subjects):** participants see the label either with text indicating the material or without.
4. **Presence of other labels (within-subjects):** participants see the label either with the Green Dot label or without.
5. **Presence of component pictograms (within-subjects):** participants see the multi-material product label with a component pictogram or without. See Figure 106 below.
6. **Bin-label colour match/mismatch (between-subjects):** Participants see bins with labels that either match the bin colour or do not match it in all the decisions of the task.⁴⁵

⁴⁵ We note that this will not necessarily be the same matching condition a participant faced in the salience task.

Figure 104. Correct sorting task – Multi-component pictogram



Source: Authors' elaboration

Table 35. Correct sorting task – Overview of product packaging conditions

Situation	Component	Material	Material Example
1	Mono	Plastic	Plastic water bottle
2	Mono	Glass	Glass jar of coffee
3	Mono	Home-compostable plastic	Compostable packaging
4	Dual	Plastic + Glass	Glass bottles with plastic caps
5	Dual	Plastic + Paper	Jar of gravy granules (plastic-lid and cardboard jar)
6	Dual	Glass + Metal	Glass jar with metal lid
7	Dual	Plastic + Metal	Coffee can with a plastic lid
8	Triple	Plastic + Glass + Metal	Medicine packaging (paper box, glass bottle, plastic cap)
9	Triple	Wood + Plastic + Styrofoam	Paper jar with plastic lid and metal film under lid
10	Material (residual waste)	Non-recyclable Metal	Candy wrappers

Source: Authors' elaboration

Table 36. Correct sorting task – Images of product packaging cases

Situation	Component	Product
1	Mono	

2	Mono				
3	Mono				
4	Dual				
5	Dual				



6	Dual				
7	Dual				
8	Triple				
9	Triple				
10	Material (residual waste)				

Source: Authors' elaboration

Source: Authors' elaboration

Receptacle Labels. Alongside the images of the product packaging, there are visual representations of different waste containers, each labelled to indicate a specific waste category. In each decision situation, participants are presented with the following five receptacles: plastic/metal, coloured/uncoloured glass, biowaste, paper/cardboard and residual.

Table 37. Correct sorting task – Example images of colour matching receptacle labels

	Coloured/ uncoloured glass	Biowaste	Paper/ cardboard	Residual
				

Source: Authors' elaboration

Note of colour (in)congruency. In the analysis, we control for colour congruency between the colours used in the images shown and those reported by participants as most familiar with the material, at the individual level. This is important, as it reflects what will happen as the EU labelling system will address the colour of the label, but not the colour of the receptacle, which varies by country. This means that for example, a yellow bin for plastic could end up with a purple label indicating that plastic needs to be discarded in this bin. This approach ensures that our analysis accurately reflects the potential impact of the new labelling system, controlling for individual familiarity, and providing valuable insights into how colour congruency affects the saliency and recognition of waste sorting labels.

6.3.5. Association between material and colour/pictogram (colour familiarity task)

Colour familiarity task. In this task, participants are asked a series of questions to determine the colour they normally associate with each type of waste material. This task helps identify regional differences in colour coding for waste disposal, which is critical for understanding how these differences might affect performance in the Salience Task and the Correct Sorting Task. Specifically, the task measures whether participants' familiarity with certain colours aligns with the experimental labels used in the study, where yellow was used for plastic, green for glass, blue for paper, and brown for biowaste. This enables testing of the hypothesis that alignment between familiar colours and experimental labels may affect performance:

- **For the Salience Task:** Participants who are familiar with a colour convention (e.g., associating yellow with plastic, as it is currently done in e.g., Germany and Belgium) may find the labels for that material more noticeable if the experimental labels match their expectations. Conversely, a mismatch (e.g., purple used for plastic, which is more common in Nordic countries like Sweden) may reduce noticeability due to dissonance or lack of immediate recognition.
- **For the Correct Sorting Task:** Alignment between familiar colours and experimental labels may reduce cognitive load, enabling participants to make faster and more accurate sorting decisions. For

example, using green for glass aligns with practices in Denmark and Italy, whereas this association might be unfamiliar to participants from the Netherlands, where sorting practices often use neutral or less standardised colour coding for glass. Mismatches may increase sorting errors or decision times as participants need to adjust their expectations to the unfamiliar labelling.

By incorporating self-reported familiarity into the analysis, we can control for these effects and distinguish performance differences attributable to the experimental label design from those influenced by participants' pre-existing familiarity with local waste sorting conventions.

Table 38 Colour familiarity task – Main features

Colour familiarity task			
Main objective	Determine the colour participants normally associate with each type of waste material at home. This also has an instrumental value, to control for the difficulty of the subsequent sorting task.		
Variable type	Variable name	Description	Operationalization
Dependent variables	<i>Colour association</i>	Identify the likelihood of a particular colour being associated with a particular waste material.	For each material, a binary variable indicates whether a specific colour is associated with the material (0 = not associated, 1 = associated)

Source: Authors' elaboration

Participants are first presented with the following statement *“Please read the following questions carefully and answer honestly; there are no right or wrong answers.”*

After this, they are presented with the following instructions and answer the questions outlined below: ***“We would like to understand how waste sorting is represented visually in your area. Different places use different colours to indicate how waste materials should be sorted. In the next pages, we will ask you what colour(s) you normally associate with different materials.”***

For each waste material listed, participants are asked to answer the following questions, presented in a random order. Participants can select any of the following that apply: a list of 13 colours (full list provided below), ‘any colour’, ‘I do not know’, ‘No colour’ or ‘Other’. Specifically, Participants are asked: “When disposing of your waste, what colour(s) do you typically associate with [*material*] in your area?”. The [*materials*] included are listed below. For each material, participants were also shown an image of the material to facilitate comprehension.

1. Plastic
2. Paper and cardboard
3. Glass
4. Metal (steel)
5. Metal (aluminium)
6. Wood
7. Bioplastic⁴⁶

⁴⁶ Bioplastic: participants were shown with a short description: “Bioplastics are plastics that are made from renewable resources ('bio-based'), are biodegradable, are made through biological processes, or are a combination of these.”

- 8. Compostable material
- 9. Textiles

The *dependent variables* are the colours that participants associate with each type of waste material. The option from which participants can choose to assign each waste material are: red, orange, yellow, light green, dark green, light blue, dark blue, purple, beige, brown, grey, black, white, or any colour, I do not know, other.

6.3.6. Visual preferences for the label (label builder task)

Label builder task. In this task, participants can indicate the elements they consider important to be included in the waste sorting label. Table 38 summarises the main features of this task.

Table 39 Label builder task – Main features

Label builder task			
Main objective	Indicate the elements participants consider important on the waste sorting label		
Variable type	Variable name	Description	Operationalization
Dependent variables	<i>Elements selected</i>	Likelihood of selecting a given element for a waste sorting label	Binary variable (0= not selected at all, 1=always selected)

Source: Authors' elaboration

Participants are presented with the following questions:

“In this part, we ask you to identify the key elements on the waste labels that you believe help you effectively sort your waste.

A waste label must indicate the material of the product packaging. It must be attached to both the packaging itself and the corresponding waste receptacle (bag, bin, container). And, a waste label must be applicable in multiple countries and regions. These countries and regions may sort waste differently.

When answering the questions, consider different types of packaging and waste receptacles. Examples of types of packaging are beverage bottles, and food containers. Examples of waste receptacles are bins, bags, and containers, both at home and in public spaces.

The *dependent variable* in this task is the likelihood of selecting the elements within each dimension in the building exercise. The goal is to understand participants' preferences regarding label content. This allows us to understand which aspects are deemed most important for enhancing waste sorting practices. These insights will directly inform the development of Prototype 1 and offer design insights that may be beneficial for future workshops and design iterations.

The elements available for consideration include the ones listed below. For each question, participants were shown an image to increase understandability.

1. Would you prefer the label to be coloured or in black-and-white?

	Coloured	Black and white	I am not sure	I don't care
On the product packaging	0	0	0	0
On waste receptacle	0	0	0	0

2. Should the label have text describing the material name?

	Yes	No	I am not sure	I don't care
On the product packaging	0	0	0	0
On waste receptacle	0	0	0	0

3. [conditional on selecting Yes in 2] If the label has a text describing the material name, should it be in English, in the language of your country, or in both languages?

	National languages(s)	English	Both languages	I am not sure	I don't care
On the product packaging	0	0	0	0	0
On waste receptacle	0	0	0	0	0

4. Should the label on product packaging bear a material identifier?⁴⁷

	Yes	No	I am not sure	I don't care
On the product packaging	0	0	0	0
On waste receptacle	0	0	0	0

5. Should the label bear a QR code? This code can be scanned and lead to a website providing additional information on local waste sorting practices.

	Yes	No	I am not sure	I don't care
On the product packaging	0	0	0	0
On waste receptacle	0	0	0	0

6. Should a waste sorting label on packaging show the different packaging components?

	Yes	No	I am not sure	I don't care
On the product packaging	0	0	0	0

7. When you see a product labelled as "compostable," what do you understand it to mean? (Select the statement that best matches your understanding.)

- The product can be composted at home in a backyard compost bin, and not in an industrial composting facility.
- The product can only be composted in an industrial composting facility, and not at home.
- The product can be composted both at home and in an industrial composting facility.

⁴⁷ The question included also examples of these identifiers with the description of PET 1 which specifies the type of plastic, and PAP 22 which shows the type of paper.

- I'm not sure what "compostable" means.

8. What does the label "home compostable" mean to you? (select one)

- The product can be composted at home in a backyard compost bin, and not in an industrial composting facility.
- The product can only be composted in an industrial composting facility, and not at home.
- The product can be composted both at home and in an industrial composting facility.
- I'm not sure what "home compostable" means.

Attention check

At the end of this section, participants are presented with the following attention check question:

This question aims to make sure that you are paying enough attention to the questions we ask you. Please select "Black and white" for the "Product packaging" line.					
	Coloured	Text	No text	Black and white	QR code
Product packaging	0	0	0	0	0

As explained to participants in the introduction, the attention check question serves to ensure that participants are continuing to read the questions of the survey properly. Because no deception is involved in this study, we are transparent about the fact that we are measuring their attention, and we inform them of the exclusion criteria in the introductory section. Specifically, if a participant fails both attention checks, they are automatically excluded from the study and replaced by new respondents. If only one of the two questions is answered incorrectly, the participant remains in the survey, and the variable is included as a control variable in the analysis. Announcing the attention checks at the beginning of the survey may also motivate participants to pay closer attention throughout the survey.⁴⁸

6.3.7. Self-reported questions (Ex-post questionnaire)

Ex-post questionnaire. This section of the survey addresses R.Q.1 as it includes questions addressing perceived challenges in waste sorting and needs related to waste sorting labels. In addition, it investigates the general attitudes toward the waste system. While these questions primarily serve as covariates in the analysis of results for the previous tasks, they are also designed to provide descriptive insights into participants' motivations, opportunities, and abilities, as framed by the Motivation, Opportunity, and Ability (MOA) framework. These findings, including descriptive statistics, are valuable for understanding broader trends and attitudes, and they will be presented in the report alongside the analyses.

This section addresses R.Q.4 as it includes questions exploring self-reported satisfaction with the current systems used in one own's country for both the receptacles and the product packaging. In addition to self-reported questions about attitudes towards labels, we include self-reported behavioural questions and questions related to waste-related norms (i.e., the socially accepted standards, expectations, or rules

⁴⁸ Attention checks in online surveys are generally effective at improving data quality and motivating participants to pay more attention. Studies have found that attention checks can identify careless respondents and exert a motivational influence on answer behaviour (See: *Shamon, H., & Berning, C. C. (2020). Attention check items and instructions in online surveys with incentivized and non-incentivized samples: Boon or bane for data quality?. In Survey Research Methods, Vol. 14, No. 1, pp. 55-77.* MTurk participants tend to perform better on attention checks compared to traditional subject pools (See: *Hauser, D. J., & Schwarz, N. (2016). Attentive Turkers: MTurk participants perform better on online attention checks than do subject pool participants. Behavior research methods, 48, 400-407.*

related to the disposal of waste). We also include questions about beliefs regarding others' behaviours to allow us to measure the gap between beliefs, what respondents actually state, and recycling rates measured in countries. For example, participants might report that they consider waste sorting as very important (e.g., in response to the question: "To what extent do you think sorting waste correctly is the right thing to do?"), yet believe that the majority of others in their community find it less important. This reflects a phenomenon known as "pluralistic ignorance", where individuals overestimate the prevalence of attitudes or behaviours contrary to their own. By comparing participants' self-reported attitudes with their perceptions of others' attitudes and actual recycling rates in their country, this gap highlights potential misalignments in social norms and personal behaviours.

Table 39 summarises the main features of this section. Participants are presented with the following statement "Please read the following questions carefully and answer honestly. There are no right or wrong answers."

Table 40 Ex-post questionnaire

Nr.	Concept	Focus	Survey question and reply options					
Section 1: Saliency, Understanding, Attractiveness, and Utility of Labels								
1	Importance	Home	How important do you find waste sorting labels to help you sort your waste at home?					
				Very important	Important	Neutral	Not very important	Not important at all
			On the product packaging	0	0	0	0	0
			On waste receptacle	0	0	0	0	0
2	Importance	Public spaces	How important do you find waste sorting labels for helping you sort your waste in public spaces (e.g., in cafeterias, train stations, or at work) where you live?					
				Very important	Important	Neutral	Not very important	Not important at all
			On the product packaging	0	0	0	0	0
			On waste receptacle	0	0	0	0	0
3	Saliency	Label	How often do you notice the waste sorting labels to sort your waste where you live?					
				Always	Often	Sometimes	Rarely	Never
			On the product packaging	0	0	0	0	0
			On waste receptacle	0	0	0	0	0
If a participant selects 'always', 'often', 'sometimes', or 'rarely', the following set of questions from section 1 will be asked.								
4	Saliency	Label	Generally speaking, how visible do you think are the waste sorting labels where you live?					
				Very visible	Visible	Neutral	Not very visible	Not visible at all
			On the product packaging	0	0	0	0	0
			On waste receptacle	0	0	0	0	0
5	Understanding	Label	Generally speaking, how easy is it for you to understand the waste sorting labels where you live?					
				Very easy	Easy	Neutral	Difficult	Very difficult
			On the product packaging	0	0	0	0	0
			On waste receptacle	0	0	0	0	0

6	Understanding	Label	Generally speaking, how comprehensive do you find the information provided by waste sorting labels where you live?					
				Very comprehensive	Comprehensive	Neutral	Not comprehensive	Not comprehensive at all
			On the product packaging	0	0	0	0	0
			On waste receptacle	0	0	0	0	0
7	Attractiveness	Label	Generally speaking, how attractive do you find the design of waste sorting labels where you live?					
				Very attractive	Attractive	Neutral	Unattractive	Very unattractive
			On the product packaging	0	0	0	0	0
			On waste receptacle	0	0	0	0	0
8	Consistency	Label	Generally speaking, how consistent do you find the placement of waste sorting labels where you live? Do you tend to find them where you expect to find them?					
				Very consistent	Consistent	Neutral	Not consistent	Very inconsistent
			Across different products	0	0	0	0	0
			Across different waste receptacles	0	0	0	0	0
9	Behaviour	Label	Generally speaking, to what extent do you consider waste sorting labels when deciding how to sort your waste?					
				Very much	Much	Neutral	Not much	Not at all
			On the product packaging	0	0	0	0	0
			On waste receptacle	0	0	0	0	0
10	Improvement	Label	Are there any improvements you would suggest for waste sorting labels on <u>product packaging</u> in your area? (Yes, No, I am not sure)					
			Which improvements would you suggest for waste sorting labels on <u>product packaging</u> in your area? (Open-ended)					
			Are there any improvements you would suggest for waste sorting labels on <u>waste receptacles</u> in your area? (Yes, No, I am not sure)					
			Which improvements would you suggest for waste sorting labels on <u>waste receptacles</u> in your area? (Open-ended)					
Section 2: Personal Motivation, Opportunity, Ability								
11	Motivation	Individual	Everything considered, how important is it to you personally to correctly sort your waste where you live? (Very Important, Important, Neutral, Not very important, Not important at all)					
12	Opportunity	Individual	Everything considered, how convenient is it for you personally to correctly sort your waste where you live? (Very convenient, Convenient, Neutral, Inconvenient, Very inconvenient)					
13	Ability	Individual	Everything considered, how confident are you in your ability to sort your waste where you live correctly? (Very confident, Confident, Neutral, Not very confident, Not confident at all)					
Section 3: Environmental Responsibility and Impact								

14	Responsibility	Environment	How responsible do you consider yourself for reducing your environmental impact through waste sorting? <i>(Very responsible, Responsible, Neutral, Not very responsible, Not responsible at all)</i>
15	Impact	Environment	To what extent do you believe that individual actions like proper waste sorting can impact larger environmental issues? <i>(Very much, Much, Neutral, Not much, Not at all)</i>
Section 4: Perceived barriers and Community Support			
16	Convenience	Barriers	Think about the last two weeks. What made it difficult to sort your waste? Please select all that apply. <i>Difficulty to finding and/or accessing relevant information</i> <i>Unclear labels on product packaging</i> <i>Unclear labels on waste bins</i> <i>Unclear symbols/pictograms on product packaging</i> <i>Unclear symbols/pictograms on waste bins</i> <i>On-pack labels in colours that are hard to distinguish</i> <i>On-bin labels in colours that are hard to distinguish</i> <i>Absence of information in languages I can understand</i> <i>Lack of time</i> <i>Other (please specify): _____</i>
17	Convenience	Others	To what extent do you believe that your community or local area adequately encourages and supports waste sorting practices? <i>(Very much, Much, Neutral, Not much, Not at all)</i>
18	Convenience	Infrastructure	How would you rate the availability of waste sorting facilities in your community? For example: recycling bins, compost bins, collection points, door-to-door waste collection. <i>(Excellent, Good, Fair, Poor, Very poor)</i>
19	Convenience	Encouragement	Which, if any, encouragements of sorting your waste correctly do you commonly encounter where you live? Please select all that apply <i>Financial incentives, such as rewards for sorting correctly</i> <i>Financial disincentives, such as fees for sorting incorrectly</i> <i>Deposit Refund Schemes for certain products, such as plastic bottles</i> <i>Encouraging feedback on correctly sorted waste (for example, from municipalities or waste collectors)</i> <i>Discouraging feedback on incorrectly sorted waste (for example, from municipalities or waste collectors)</i> <i>Offers by producers and retailers to take back waste from bought products (including packaging waste, broken parts, old appliances)</i> <i>Information materials on how to sort correctly (including tips, instructions, recommendations)</i> <i>Information on how much my neighbours sort their waste</i> <i>None</i> <i>Others: Please specify [Text box]</i>
Section 5: Social Norms			
20	Personal Injunctive Norm	Individual	To what extent do you think sorting waste correctly is the right thing to do? <i>(Very much, Much, Neutral, Not much, Not at all)</i>
21	Perceived Social Injunctive Norm	Others	We are asking the previous question to 100 other people in your country. How many people do you think selected each option for the following question? "To what extent do you think sorting waste correctly is the right thing to do?" "Very much" <i>(Very much, Much, Neutral, Not much, Not at all)</i>
22	Personal Behaviour	Individual	Thinking back to the last two weeks, what percentage of your waste do you think you sorted correctly? <i>(<20%, 21-40%, 41-60%, 61-80%, 81-100%)</i>

23	Perceived Social Descriptive Norms	Others	We are asking the previous question to 100 other people in your country. How many people do you think selected each option for the following question? <u>"What percentage of your waste do you think you sorted correctly?"</u> "<20%" "21-40%" "41-60%" "61-80%" "81-100%" (0-100)
Section 6: Questions on QR code			
24	Sorting at home	Individual habits	Matrix question How do you usually sort the following packaging waste materials at home? For each of the following materials: paper, cardboard, metal, aluminium, aluminium cans, coloured glass, uncoloured glass, plastic, composite packaging (like TetraPak), wood, residual waste Participants can select multiple choices from the following list: Together with Paper, together with cardboard, together with metal, together with aluminium, together with aluminium cans, together with coloured glass, together with uncoloured glass, together with plastic, together with composite packaging (like TatraPak), together with wood, together with residual waste, I am unsure.
25	QR code	QR code	"How many times have you scanned a QR code in the past month? (excluding menus at bars and restaurants)" (0 times, 1-2 times, 3-5 times, > 5 times)
26	QR code	QR code	For those selecting more than 0 times, we ask to indicate for which activities they used it "Please indicate for what you used a QR code:" <ul style="list-style-type: none"> • Accessing product information in stores • Participating in contests or promotions • Downloading apps or software • Making payments or transactions • Getting travel information (e.g., timetables, tickets) • Attending events (for entry tickets or event information) • Using services (e.g., bike-sharing, car rental) • Health-related uses (e.g., checking into medical facilities, accessing health information) • Other

Source: Authors' elaboration

At the end of the social norms section, we include the second attention check question.

This question aims to make sure that you are paying enough attention to the questions we ask you. Therefore, please select "Coloured" for the "Waste receptacle" line.					
	Coloured	Text	No text	Black and white	QR code
Product Packaging	0	0	0	0	0

6.3.8. End of survey

Participants were asked about any difficulties they experienced while completing the survey to gather feedback on potential barriers and ensure accessibility of the labels used. This question also serves to provide insights into the frequency of such difficulties across the EU MS participating in the survey, as well as to inform potential adjustments to future label designs or survey methodologies.

1. Difficulties in the survey:

- “Did you experience any difficulties that impacted your ability to answer this survey?”
- Answer Options: No – Yes – I prefer not to say
- If participant selected “Yes”: “Please select any difficulties that apply”
- Answer Options: Colour blindness – Visual impairments – Cognitive difficulties – Technical issues (e.g., slow internet, device problems) – Language barriers – Prefer not to say – Other (please specify)

2. End of survey

“Thank you!”

- “Thank you for your time! Any comments you would like to share with us about this survey e.g., any difficulty you faced?” (open text)
- We thank you for your time. If you want to know more about the project, please click on the following [link](#).

6.4. Online survey results

6.4.1. Exclusions criteria

Exclusion criteria. To create the final dataset, the following exclusion criteria were applied.⁴⁹ A participant who falls within at least one of these categories is excluded from the final dataset⁵⁰:

- Participants who completed the survey on a mobile phone during the pilot phase, before the mobile phone was allowed as a device (i.e., before 31st October). (N=340)
- Participants who are likely bots.⁵¹ (N=2367)
- Participants who answered both attention checks incorrectly. (N=649)
- A qualitative review of open-ended responses was conducted at the end of data collection, and any participant providing offensive text was excluded.
- Incompletes: participants who did not complete the survey. (N=18849)
- Fixed duration limit: participants who completed the survey in less than 5 minutes.
- Conditional limit: Participants who are quicker than the 5th percentile of the pilot duration excluding those aged >70 years and fail at least one attention check.

6.4.2. Demographic breakdown by country

Table 40 provides a detailed breakdown of the survey sample (**bold values**) across various demographic and socioeconomic variables: sex, age brackets, education levels, living area types, and income quartiles. Each column represents the percentage distribution for a specific variable, while the rows detail these percentages for each participating country. Deviations from the reference official statistics (non-bold values) are displayed, allowing for a quick assessment of where the survey sample diverges from the target population. The right-most column shows the overall quota deviation for each country, calculated using absolute values, showing that each country has an average deviation <15%. Similarly, the average deviation for each variable (see bottom row) has been calculated using absolute values. Overall, the sample aligns with the target population, particularly in terms of key categories like gender and general age distribution.

As observed in Table 40, 95% of quotas have a deviation of less than 20%, while only 5% of the quotas exceeded the 20% deviation threshold. Deviations smaller than -20% are primarily seen in primary education quotas (Italy, Portugal, Spain), rural quotas (Belgium, Latvia, Slovakia), and third quartile income quotas (Malta, Slovakia, Spain). On the other hand, deviations greater than +20% are observed in the first quartile income quotas (Belgium, Malta, Slovakia) and urban quotas (Latvia, Slovakia).

⁴⁹ For some of the exclusion criteria the participants were automatically excluded by the software and not recorded in the dataset. Specifically, these are: those faster than 5 minutes, those who answered both attention check incorrectly and those who accessed via mobile phone before mobile phone was allowed as a device.

⁵⁰ We provide an estimate of the number of participants who fall into each exclusion criterion, but note that some participants may fit into multiple categories.

⁵¹ The detection is based on Google's invisible reCaptcha technology. Specifically, respondents with a reCaptcha score of less than 0.5—indicating a higher likelihood of being bots—were removed from the dataset. This score measures the probability that a respondent is human, with values ranging from 0 to 1.

Table 41. Demographic breakdown by country and comparison with official statistics

	Sex (hard quota)		Age brackets (hard quota)						Education (soft quota)			Living area (soft quota)			Income (soft quota)				Average deviat (Absolute values)
Austria	50,32%	49,68%	8,94%	12,77%	16,22%	20,82%	17,62%	23,63%	17,46%	48,40%	34,15%	50,70%	18,01%	31,29%	29,77%	13,02%	27,71%	29,51%	
	1,1%	-1,1%	-0,1%	-4,2%	0,2%	1,8%	0,6%	1,6%	1,2%	-1,8%	0,8%	9,7%	-8,0%	-1,7%	4,8%	-12,0%	2,7%	4,5%	3%
Belgium	55,85%	44,15%	11,14%	17,19%	19,67%	13,62%	18,84%	19,53%	18,34%	36,97%	44,69%	62,59%	25,72%	11,69%	46,68%	12,05%	8,59%	32,69%	
	6,5%	-6,5%	0,1%	1,2%	3,7%	-3,4%	2,8%	-4,5%	-2,5%	-2,8%	5,3%	23,6%	-3,3%	-20,3%	21,7%	-13,0%	-16,4%	7,7%	8%
Czechia	49,31%	50,44%	7,28%	14,68%	19,70%	17,69%	15,81%	24,84%	16,80%	63,12%	20,08%	61,73%	16,69%	21,58%	28,63%	29,14%	12,45%	29,78%	
	0,3%	-0,5%	0,3%	-0,3%	-2,3%	-0,3%	0,8%	1,8%	7,6%	-4,8%	-2,9%	0,7%	2,7%	-3,4%	3,6%	4,1%	-12,6%	4,8%	3%
Denmark	49,68%	50,32%	10,42%	16,39%	15,25%	14,74%	17,03%	26,18%	16,03%	35,87%	48,10%	57,94%	23,89%	18,17%	31,24%	8,83%	33,55%	26,38%	
	0,0%	0,0%	-0,6%	0,4%	0,3%	-2,3%	1,0%	1,2%	-5,9%	-5,6%	11,5%	0,9%	-1,1%	0,2%	6,2%	-16,2%	8,6%	1,4%	4%
Estonia	49,87%	50,00%	9,72%	16,29%	17,30%	16,16%	16,16%	24,37%	14,45%	48,18%	37,37%	57,83%	22,73%	19,44%	21,82%	27,86%	17,97%	32,35%	
	2,5%	-2,6%	0,7%	-0,7%	0,3%	0,2%	0,2%	-0,6%	1,3%	-0,7%	-0,4%	-2,2%	2,7%	-0,6%	-3,2%	2,9%	-7,0%	7,4%	2%
Finland	49,94%	50,06%	9,79%	14,75%	16,48%	13,26%	16,36%	29,37%	3,47%	55,78%	40,75%	48,95%	39,53%	11,52%	34,88%	19,38%	18,38%	27,38%	
	0,5%	-0,5%	-0,2%	-0,3%	0,5%	-1,7%	0,4%	1,4%	-12,3%	8,4%	4,0%	1,0%	3,5%	-4,5%	9,9%	-5,6%	-6,6%	2,4%	4%
France	47,41%	52,34%	9,85%	12,56%	14,53%	16,26%	17,24%	29,56%	7,36%	48,32%	44,32%	39,66%	20,81%	39,53%	26,91%	26,02%	22,32%	24,74%	
	-1,0%	0,8%	-0,2%	-2,4%	-1,5%	0,3%	1,2%	1,6%	-11,9%	5,0%	7,0%	-3,3%	-0,2%	3,5%	1,9%	1,0%	-2,7%	-0,3%	3%
Germany	50,84%	49,03%	10,84%	11,74%	14,19%	18,06%	18,45%	26,71%	4,67%	62,88%	32,44%	40,39%	32,26%	27,35%	28,38%	17,64%	25,07%	28,91%	
	1,6%	-1,7%	1,8%	-3,3%	0,2%	2,1%	2,5%	1,7%	-14,7%	12,3%	2,4%	4,4%	-1,7%	-2,7%	3,4%	-7,4%	0,1%	3,9%	4%
Greece	49,69%	50,06%	9,16%	11,79%	15,81%	17,82%	16,81%	28,61%	18,11%	45,79%	36,10%	67,25%	22,21%	10,54%	17,68%	12,47%	31,81%	38,04%	
	0,8%	-1,1%	0,2%	-2,2%	-0,2%	0,8%	0,8%	0,6%	-4,8%	-1,5%	6,3%	-4,8%	2,2%	2,5%	-7,3%	-12,5%	6,8%	13,0%	4%
Hungary	50,12%	49,88%	10,46%	14,48%	17,88%	18,00%	15,21%	23,97%	18,76%	49,30%	31,94%	54,01%	14,48%	31,51%	25,78%	14,82%	24,78%	34,62%	
	1,9%	-1,9%	1,5%	-0,5%	-1,1%	0,0%	0,2%	0,0%	3,6%	-9,5%	5,8%	-8,0%	4,5%	3,5%	0,8%	-10,2%	-0,2%	9,6%	3%
Ireland	48,47%	51,04%	11,90%	13,37%	18,90%	21,35%	18,90%	15,58%	6,32%	41,37%	52,31%	41,23%	33,37%	25,40%	38,32%	22,45%	20,26%	18,97%	
	-0,9%	0,4%	0,9%	-2,6%	-3,1%	3,4%	4,9%	-3,4%	-8,9%	3,8%	5,1%	4,2%	-0,6%	-3,6%	13,3%	-2,6%	-4,7%	-6,0%	4%
Italy	51,03%	48,97%	5,20%	9,44%	16,01%	20,79%	17,65%	30,92%	14,29%	59,92%	25,80%	44,32%	28,32%	27,36%	21,50%	17,60%	25,11%	35,79%	
	2,2%	-2,2%	-2,8%	-3,6%	0,0%	1,8%	1,7%	2,9%	-23,6%	16,5%	7,2%	-3,7%	2,3%	1,4%	-3,5%	-7,4%	0,1%	10,8%	5%
Latvia	50,43%	49,45%	6,91%	16,28%	16,65%	17,26%	16,65%	26,26%	15,98%	43,14%	40,88%	65,47%	27,99%	6,54%	14,91%	20,80%	22,81%	41,48%	

	4,1%	-4,2%	-0,1%	0,3%	-0,4%	0,3%	-0,4%	0,3%	5,4%	-11,6%	6,2%	25,6%	3,1%	-28,7%	-10,1%	-4,2%	-2,2%	16,5%	7%
Lithuania	50,92%	48,34%	10,92%	15,71%	8,96%	18,04%	18,04%	28,34%	6,69%	47,96%	45,35%	52,88%	25,40%	21,72%	21,10%	27,22%	9,24%	42,45%	
	4,2%	-4,9%	1,9%	-1,3%	-6,0%	1,0%	0,0%	4,3%	-0,3%	-4,0%	4,4%	0,9%	-2,6%	1,7%	-3,9%	2,2%	-15,8%	17,5%	4%
Malta	53,89%	45,83%	9,05%	21,22%	19,80%	9,05%	16,69%	24,19%	38,68%	29,37%	31,95%	43,42%	28,57%	28,01%	45,88%	21,16%	2,41%	30,54%	
	1,3%	-1,6%	0,1%	0,2%	0,8%	-5,0%	1,7%	2,2%	2,9%	-6,3%	3,5%	-20,2%	-5,6%	6,0%	20,9%	-3,8%	-22,6%	5,5%	6%
Poland	49,93%	49,93%	11,80%	19,13%	21,71%	16,55%	16,96%	13,84%	11,82%	51,90%	36,28%	63,64%	12,48%	23,88%	24,96%	21,34%	20,32%	33,38%	
	1,6%	-1,7%	2,8%	1,1%	1,7%	1,6%	1,0%	-8,2%	2,9%	-7,4%	4,5%	-1,4%	-0,5%	1,9%	0,0%	-3,7%	-4,7%	8,4%	3%
Portugal	45,52%	54,32%	11,88%	16,05%	20,06%	21,14%	20,52%	10,34%	11,01%	47,29%	41,71%	50,77%	31,94%	17,28%	9,74%	23,96%	28,12%	38,18%	
	-2,2%	2,1%	1,9%	3,1%	4,1%	4,1%	3,5%	-16,7%	-33,0%	17,4%	15,5%	0,8%	-4,1%	3,3%	-15,3%	-1,0%	3,1%	13,2%	8%
Romania	48,69%	51,04%	9,53%	15,93%	19,71%	19,97%	16,58%	18,28%	9,57%	69,99%	20,45%	74,41%	14,75%	10,84%	27,76%	16,05%	22,76%	33,42%	
	0,1%	-0,3%	0,5%	0,9%	1,7%	0,0%	1,6%	-4,7%	-12,7%	7,7%	5,2%	5,4%	4,8%	-10,2%	2,8%	-9,0%	-2,2%	8,4%	4%
Slovakia	50,37%	49,38%	9,03%	18,19%	21,16%	15,59%	15,84%	20,17%	11,11%	53,44%	35,45%	56,31%	27,10%	16,58%	70,63%	7,56%	2,85%	18,96%	
	1,5%	-1,7%	0,0%	0,2%	0,2%	-0,4%	-0,2%	0,2%	1,4%	-11,5%	10,1%	35,2%	-11,0%	-24,2%	45,6%	-17,4%	-22,2%	-6,0%	10%
Spain	51,95%	47,60%	7,89%	17,96%	21,74%	21,74%	15,10%	15,56%	2,68%	44,34%	52,98%	67,51%	21,40%	11,10%	5,04%	3,17%	4,81%	86,99%	
	2,9%	-3,4%	-0,1%	4,0%	2,7%	2,7%	-0,9%	-8,4%	-35,9%	19,3%	16,5%	4,5%	-0,6%	-3,9%	-20,0%	-21,8%	-20,2%	62,0%	13%
Sweden	49,02%	50,98%	8,45%	13,26%	16,78%	17,04%	15,60%	28,87%	9,14%	54,57%	36,29%	46,29%	35,11%	18,60%	34,90%	21,05%	11,11%	32,94%	
	-1,3%	1,3%	-1,6%	-3,7%	0,8%	1,0%	0,6%	2,9%	-6,1%	12,8%	-6,7%	-4,7%	10,1%	-5,4%	9,9%	-4,0%	-13,9%	7,9%	5%
Total	50,16%	49,65%	9,51%	15,18%	17,51%	17,41%	17,00%	23,39%	12,82%	49,50%	37,68%	54,74%	24,82%	20,44%	28,91%	18,13%	18,57%	34,39%	
Average deviations (Absolute values used)	1,8%	1,9%	0,9%	1,7%	1,5%	1,6%	1,3%	3,3%	9,5%	8,1%	6,2%	7,6%	3,6%	6,3%	9,9%	7,7%	8,3%	10,3%	5,1%

Source: Authors' elaboration

6.4.3. Self-reported survey difficulties

Most participants (15,291, 93.35%) reported no difficulties completing the survey. Among the remaining respondents, 231 (1.41%) selected "Prefer not to answer", and 858 (5.24%) indicated experiencing challenges during the survey.

For those who reported difficulties, Table 41 outlines the specific challenges encountered, including visual, cognitive, technical, or language-related issues, as well as those who reported other unspecified difficulties. The table reflects the percentage of the total sample and the number of respondents who faced these challenges.

Table 42. Self-reported survey difficulties

	Percent of total sample	N
Colour blindness	0.72%	118
Visual impairment	0.75%	123
Cognitive difficulties	1.07%	176
Technical issues	1.77%	290
Language barriers	0.49%	80
Prefer not to say	0.43%	71
Other issues	1.18%	194

Source: Authors' elaboration

6.4.4. Salience task

This section provides a detailed overview of the salience task. The analysis focuses on participants' interactions with packaging and waste receptacle labels across experimental variations. We begin by presenting the distribution of participants (sample sizes) across conditions, followed by a breakdown of click distributions and engagement levels. OLS provides intuitive, linear estimates, which are straightforward to interpret and offer a clear sense of direction and magnitude for the relationships between label features and participants' interactions. On the other hand, Probit regression is specifically tailored for binary outcome variables, such as whether a participant clicks on a label or not. OLS is more reliable for continuous variables, such as reaction times, where linearity is a reasonable assumption. Probit is better suited for analysing binary outcomes, such as click likelihood, as it accounts for the non-linearity in the relationship between predictors and probabilities. By using both models, we ensure robustness and provide a nuanced interpretation of the effects across different types of data. Results are disaggregated where necessary to highlight differences across specific label components and product types. The subsequent subsections analyse the effects of label elements (text, other labels, colours, and matching) on click likelihood and reaction times, using OLS and Probit regression models. Results are disaggregated where necessary to highlight differences across specific label components and product types.

6.4.4.1. Sample sizes by condition

Table 42 and Table 43 summarize the allocation of participants across the different experimental variations. First, we present the distribution of the packaging labels, followed by the distribution of the waste receptacle labels.

Table 43. Experimental treatments sample size for packaging labels

Image variation	Label Colour	Label text	Other label	N	N	N
				Mono	Dual	Triple

1	Black and white	Text	None	2,037	2,045	2,061
2	Black and white	Text	Greendot ⁵²	2,045	2,054	2,046
3	Black and white	No text	None	2,037	2,039	2,080
4	Black and white	No text	Greendot	2,048	2,078	2,049
5	Primary colours	Text	None	2,052	2,042	2,044
6	Primary colours	Text	Greendot	2,039	2,056	2,009
7	Primary colours	No text	None	2,046	2,021	2,048
8	Primary colours	No text	Greendot	2,076	2,045	2,043
Total				16,380	16,380	16,380

Source: Authors' elaboration

Table 44. Experimental treatment sample size for waste receptacle labels

Image variation	Label Colour	Label text (indicating material – in National languages)	Colour match BIN <>LABEL	N
1	Black and white	Text	Mismatch	2,024
2	Black and white	Text	Match	2,022
3	Black and white	No text	Mismatch	2,031
4	Black and white	No text	Match	2,054
5	Primary colours	Text	Mismatch	2,025
6	Primary colours	Text	Match	2,002
7	Primary colours	No text	Mismatch	2,059
8	Primary colours	No text	Match	2,073
Total				16,290

Note: Due to a programming glitch, N=90 participants were not shown the salience task bin images, hence the minor discrepancy in the total sample size. Source: Authors' elaboration

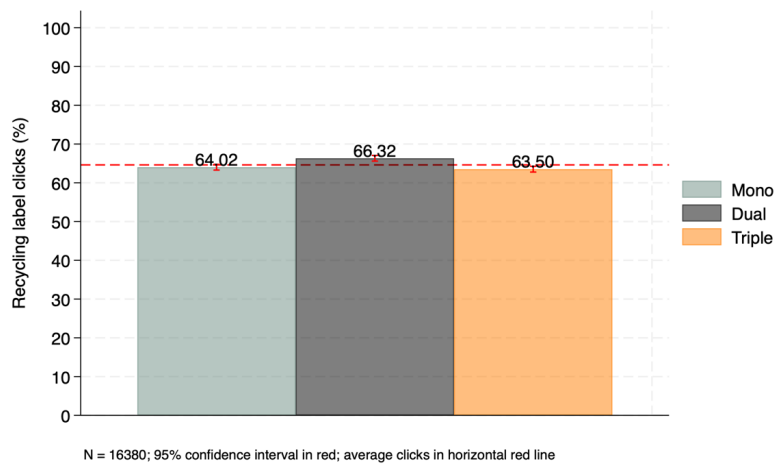
6.4.4.2. Distributions of image clicks

The figures below illustrate the percentage of participants who clicked on various label elements and areas across product packaging and waste receptacle images. These visualizations provide insights into

⁵² In mono component products, the Greendot is accompanied by the Triman logo and the SUP.

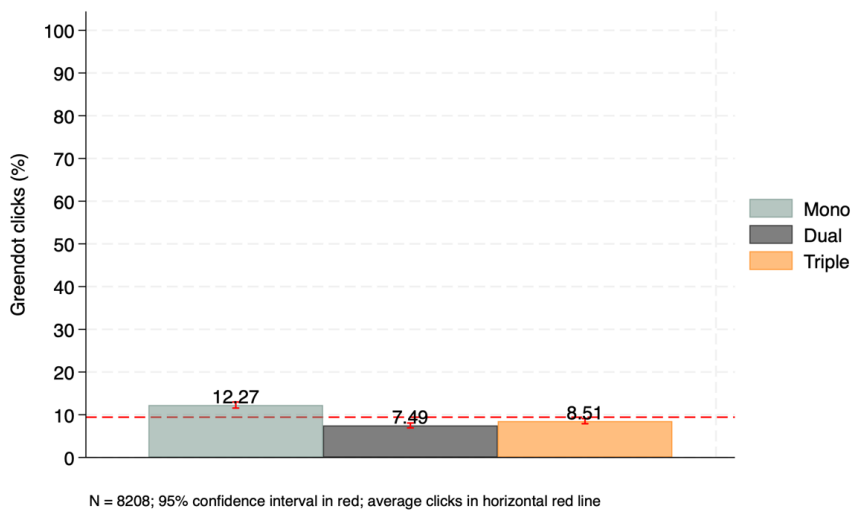
participants' likelihood of clicking, highlighting slight differences in engagement with waste sorting labels, and other areas of interest within the images.

Figure 105. % of sample clicking on the waste sorting labels



Source: Authors' elaboration

Figure 106. % of sample clicking on Greendot



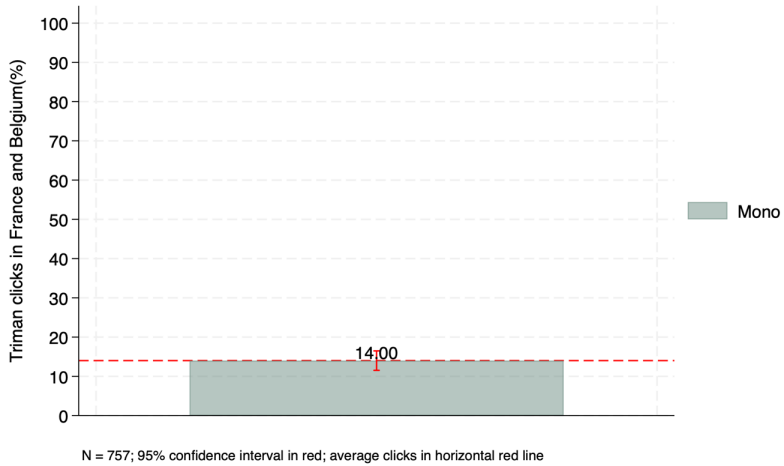
Source: Authors' elaboration

Figure 107. % of sample clicking on Triman⁵³



Source: Authors' elaboration

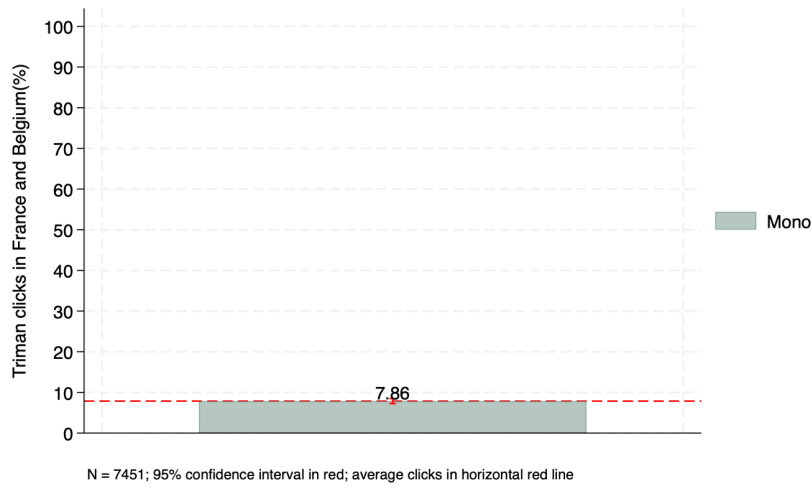
Figure 108. % of sample clicking on Triman in France and Belgium



Source: Authors' elaboration

⁵³ Triman and SUP appear only on mono products.

Figure 109. % of sample clicking on Triman, excluding France and Belgium



Source: Authors' elaboration

Figure 110. % of sample clicking on SUP

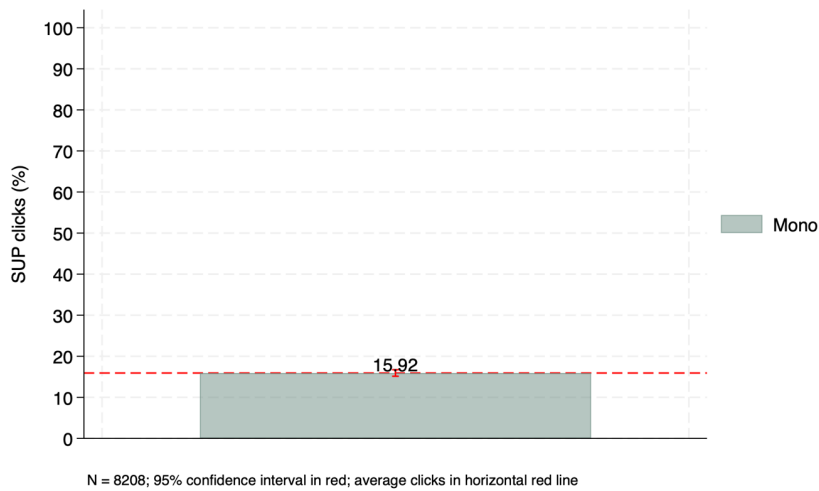
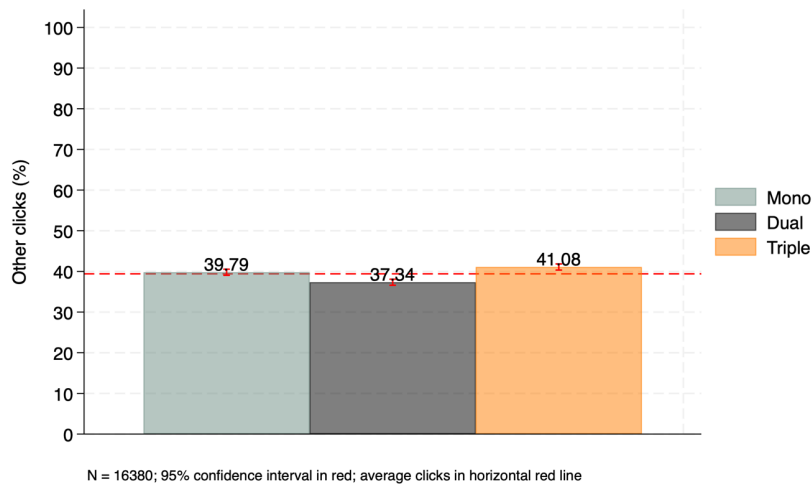
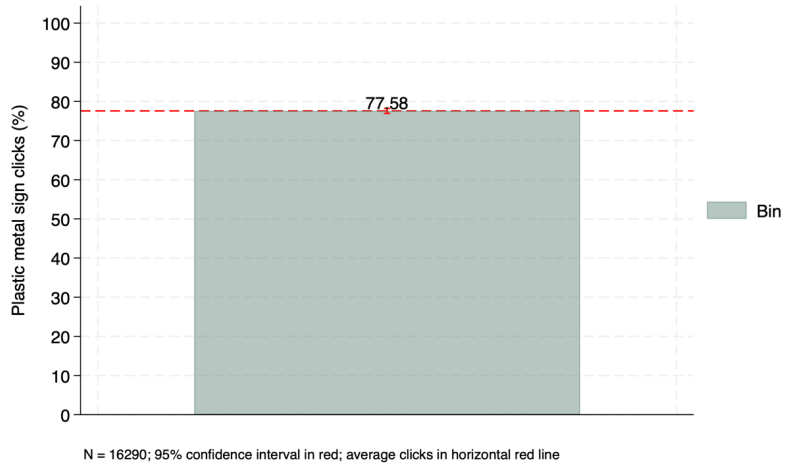


Figure 111. % of sample clicking on other area in product packaging images



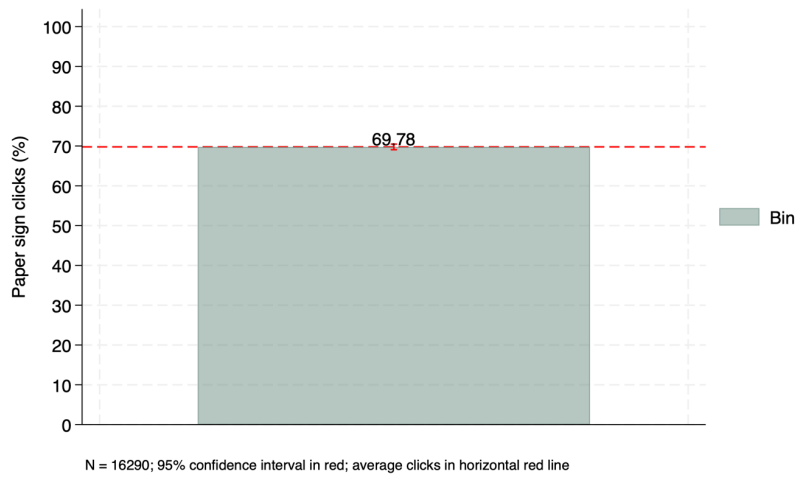
Source: Authors' elaboration

Figure 112. % of sample clicking on plastic/metal sign in receptacle image



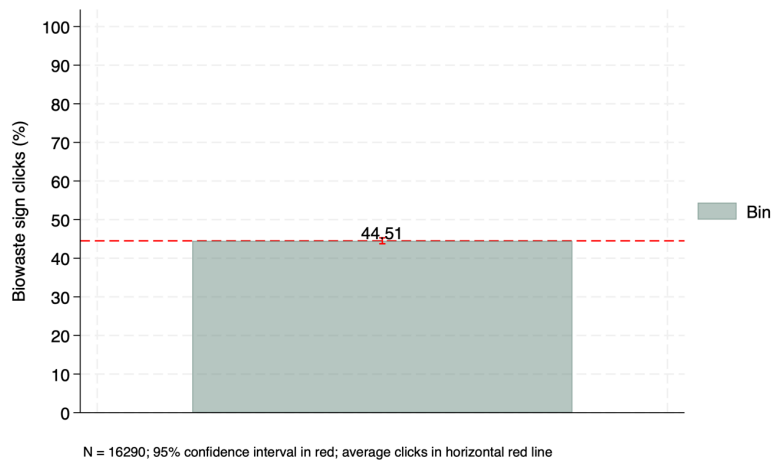
Source: Authors' elaboration

Figure 113. % of sample clicking on paper sign in receptacle image



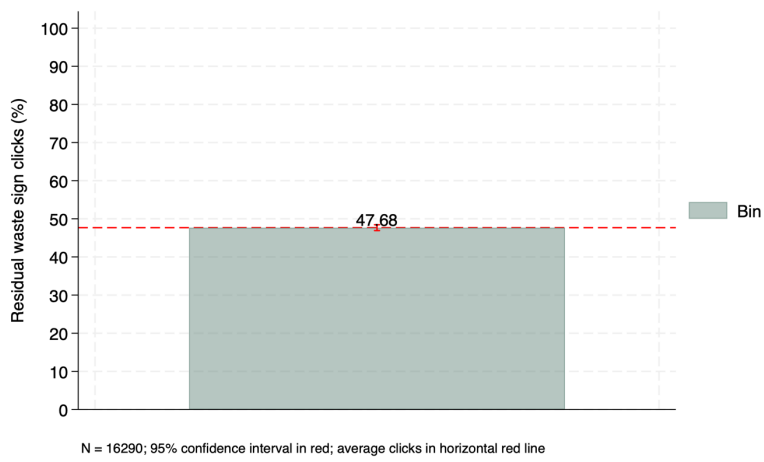
Source: Authors' elaboration

Figure 114. % of sample clicking on biowaste sign in receptacle image



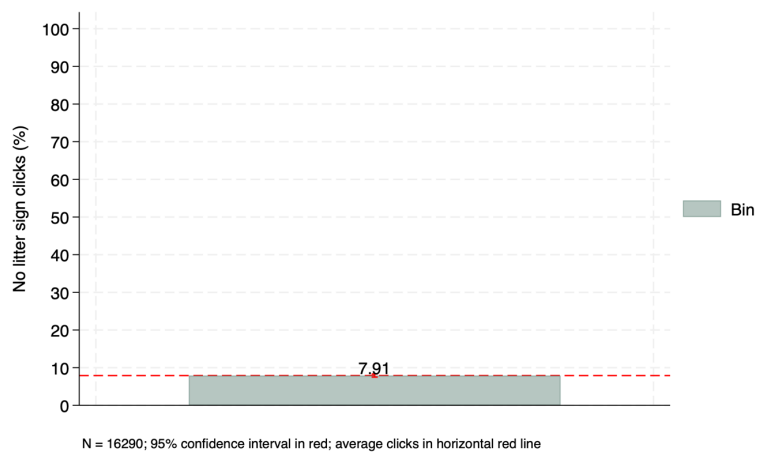
Source: Authors' elaboration

Figure 115. % of sample clicking on residual waste sign in receptacle image



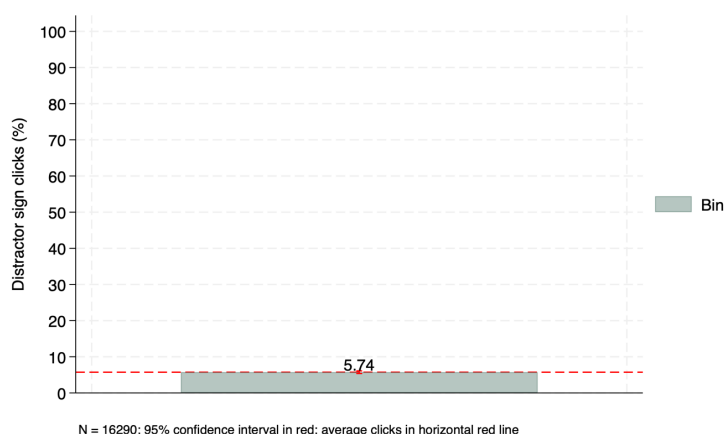
Source: Authors' elaboration

Figure 116. % of sample clicking on no litter sign in receptacle image



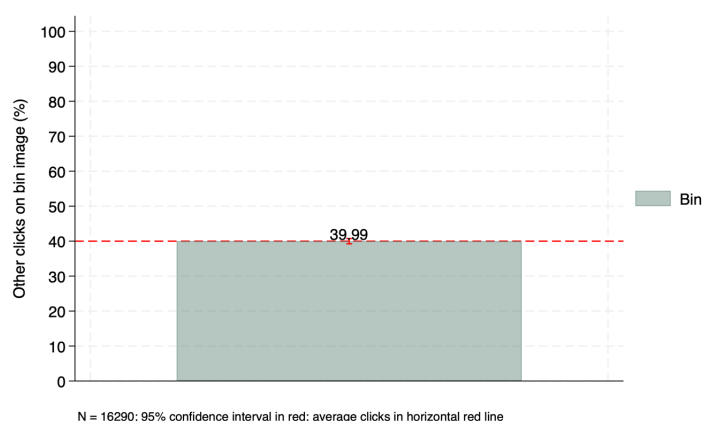
Source: Authors' elaboration

Figure 117. % of sample clicking on distractor sign in receptacle image



Source: Authors' elaboration

Figure 118. % of sample clicking on other area in bin image in receptacle image



Source: Authors' elaboration

6.4.4.3. Average number of clicks

Table 44 presents the average number of clicks per participant across different experimental conditions. Results are reported for product packaging images (mono, dual, and triple material products) and waste receptacle images. The summary compares variations in image characteristics: colour, presence of text, and other labels, providing an overview of participant engagement levels across the conditions.

Table 45. Average number of clicks per participant, by condition

Product		Mean number of clicks	SD
Mono Mean: 1.8, SD: 1.7	B&W	1.8	1.7
	Colour	1.8	1.8
	No Text	1.8	1.7
	Text	1.8	1.7
	No other label	1.7	1.6
	Other label	2.0	1.8

Dual Mean: 2.1, SD: 1.7	B&W	2.1	1.8
	Colour	2.1	1.5
	No Text	2.1	1.8
	Text	2.1	1.5
	No Other label	2.1	1.5
	Other label	2.1	1.8
Triple Mean: 2.6, SD: 1.7	B&W	2.6	1.7
	Colour	2.6	1.8
	No Text	2.6	1.7
	Text	2.6	1.8
	No Other label	2.6	1.7
	Other label	2.6	1.7
Receptacles Mean: 4.4, SD: 2.9	B&W	4.4	2.9
	Colour	4.5	2.9
	No Text	4.4	2.8
	Text	4.5	3.0
	Mismatch	4.4	2.9
	Match	4.5	2.9
Aggregate		2.7	2.3

Source: Authors' elaboration

6.4.4.4. Regressions for salience task

The subsections below summarize the methodological approach and findings for the salience task and its associated outcomes. We first provide an overview of participant allocation across experimental variations, followed by detailed results on participants' interactions with different label types and receptacle images. Specifically:

- **Sample sizes:** We present the distribution of participants across experimental conditions for product packaging labels and waste receptacle labels.
- **Distribution of clicks:** Results are broken down by label elements (e.g., colour, text, other labels) and specific areas where participants clicked on packaging and bin images.
- **Average number of clicks:** We analyse the average number of clicks across experimental variations to assess engagement levels.
- **Impact of label characteristics:** Disaggregated effects of text, other labels, and matching colours on click likelihood and reaction times are presented using OLS and Probit models.
- **Reaction times:** Analysis of time taken to submit the page in response to packaging and receptacle labels, assessed using OLS models.

Packaging label - Impact of label elements on likelihood of clicks

This subsection examines the influence of label elements on participants' likelihood of clicking on different areas of packaging image. The analysis utilizes OLS and Probit regression models to assess the impact of

text, colour, other labels, and other sociodemographic and health-related factors. The models include controls for participant-level and country-specific variations, with standard errors clustered at the participant level.

The results focus on five key areas of packaging labels:

1. Waste sorting label
2. Greendot logo
3. Triman logo
4. SUP (Single Use Plastic) indicator
5. Other areas

The regressions incorporate the following variables:

- Sociodemographic factors: age, education, income quartile, house type (private house, condo/apartment, shared housing, other), and area of residence (urban, suburban, rural).
- Health-related factors: colour blindness, visual impairments, and cognitive difficulties.
- Mobile: mobile device usage for survey completion.
- Country effects: included but not displayed for brevity.

Table 46. OLS - impact of label elements on packaging label clicks

	(1)	(2)	(3)	(4)	(5)
DV: likelihood of clicking (0-1)	Waste sorting label	Greendot	Triman	SUP	Other area
Text	0.012** (0.004)	-0.010** (0.004)	-0.002 (0.006)	0.003 (0.008)	-0.007 (0.004)
Colour	0.006 (0.004)	-0.001 (0.004)	-0.007 (0.006)	0.011 (0.008)	-0.008 (0.004)
Other label	-0.023*** (0.004)				-0.021*** (0.004)
Product = 2, Dual	0.025*** (0.003)	-0.051*** (0.004)			-0.025*** (0.003)
Product = 3, Triple	-0.003 (0.003)	-0.040*** (0.004)			0.013*** (0.003)
Age	-0.027*** (0.002)	-0.009*** (0.001)	-0.010*** (0.002)	-0.012*** (0.002)	0.023*** (0.002)

Education	-0.002	0.013***	0.012***	0.007	0.007*
	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)
Income (quartile)	0.005	0.003	0.004	0.011**	-0.009**
	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)
Area = 2, Suburban	0.010	-0.003	-0.006	-0.039***	-0.027***
	(0.008)	(0.005)	(0.007)	(0.010)	(0.008)
Area = 3, Rural	-0.009	0.023***	-0.001	-0.037***	0.003
	(0.009)	(0.007)	(0.009)	(0.011)	(0.009)
Mobile	-0.332***	-0.074***	-0.080***	-0.062**	0.357***
	(0.013)	(0.010)	(0.015)	(0.019)	(0.013)
Colour blindness	-0.124**	-0.035	-0.051*	0.052	0.129**
	(0.047)	(0.023)	(0.023)	(0.060)	(0.047)
Visual impairments	-0.235***	-0.002	0.035	0.075	0.247***
	(0.042)	(0.025)	(0.041)	(0.062)	(0.041)
Cognitive difficulties	-0.225***	-0.024	-0.050**	-0.040	0.231***
	(0.036)	(0.017)	(0.019)	(0.040)	(0.035)
Constant	0.817***	0.053***	0.062***	0.116***	0.263***
	(0.021)	(0.012)	(0.018)	(0.022)	(0.022)
Observations	46,890	23,461	7,837	7,837	46,890
R-squared	0.081	0.073	0.058	0.051	0.077

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Table 47. Probit marginal effects – impact of label elements on packaging label clicks, incl. covariates

	(1)	(2)	(3)	(4)	(5)
DV: likelihood of clicking (0-1)	Waste sorting label	Greendot	Triman	SUP	Other area

Text	0.012**	-0.009*	-0.003	0.003	-0.007
	(0.004)	(0.004)	(0.006)	(0.008)	(0.004)
Colour	0.006	-0.000	-0.006	0.012	-0.007
	(0.004)	(0.004)	(0.006)	(0.008)	(0.004)
Other label	-0.023***				-0.021***
	(0.004)				(0.004)
Product = 2, Dual	0.025***	-0.053***			-0.025***
	(0.003)	(0.004)			(0.003)
Product = 3, Triple	-0.003	-0.040***			0.013***
	(0.003)	(0.004)			(0.003)
Age	-0.027***	-0.008***	-0.010***	-0.011***	0.022***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
Education	-0.002	0.013***	0.012***	0.007	0.006
	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)
Income (quartile)	0.005	0.004	0.003	0.011**	-0.009**
	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)
house = 2, Condo/apartment	-0.035***	0.014**	0.017*	0.008	0.042***
	(0.007)	(0.005)	(0.007)	(0.009)	(0.008)
house = 3, Shared housing	-0.055***	-0.021**	-0.023*	-0.013	0.036**
	(0.012)	(0.007)	(0.010)	(0.015)	(0.013)
house = 4, I prefer not to answer	0.129***	-0.037	0.005	-0.040	-0.127***
	(0.030)	(0.021)	(0.037)	(0.040)	(0.031)
house = 5, Other	-0.083***	0.049**	0.036	0.028	0.081***
	(0.022)	(0.017)	(0.023)	(0.029)	(0.023)
Area = 2, Suburban	0.011	-0.001	-0.006	-0.039***	-0.028***

	(0.008)	(0.005)	(0.007)	(0.009)	(0.008)
Area = 3, Rural	-0.008	0.023***	0.000	-0.036***	0.003
	(0.009)	(0.006)	(0.008)	(0.011)	(0.009)
Mobile	-0.334***	-0.043***	-0.046***	-0.045**	0.358***
	(0.013)	(0.006)	(0.008)	(0.014)	(0.012)
Colour blindness	-0.118**	-0.048	-0.093	0.053	0.128**
	(0.044)	(0.038)	(0.061)	(0.049)	(0.047)
Visual impairments	-0.229***	0.002	0.044	0.071	0.257***
	(0.043)	(0.027)	(0.036)	(0.048)	(0.047)
Cognitive difficulties	-0.212***	-0.028	-0.069	-0.039	0.225***
	(0.034)	(0.022)	(0.043)	(0.044)	(0.035)
Constant	0.012**	-0.009*	-0.003	0.003	-0.007
	(0.004)	(0.004)	(0.006)	(0.008)	(0.004)
Observations	46,890	23,461	7,837	7,837	46,890

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration

Receptacle label - Impact of label elements on likelihood of clicks

This subsection evaluates the impact of label elements on participants' likelihood of clicking on different areas of waste receptacle image. The analysis employs OLS and Probit regression models to explore the effects of text, colour, and colour matching on attention to specific label areas. The models include a comprehensive set of control variables, ensuring robust analysis. Standard errors are clustered at the participant level, with country effects accounted for but not displayed for simplicity.

The results are organized across seven key label areas:

1. Plastic/Metal sign
2. Paper sign
3. Biowaste sign
4. Bin bag label
5. No litter sign
6. Distractor sign
7. Other areas

The regressions account for the following variables:

- Sociodemographic variables: age, education, income quartile, house type (private house, condo/apartment, shared housing, other), and area of residence (urban, suburban, rural).
- Health-related variables: colour blindness, visual impairments, and cognitive difficulties.
- Mobile: mobile device usage for survey completion.
- Matching variable: whether label and receptacle colours are aligned.
- Country effects: included but not displayed for brevity.

Table 48. OLS - impact of receptacle elements on receptacle label clicks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
DV: likelihood of clicking (0-1)	Plastic / Metal	Paper	Biowaste	Bin bag	No litter sign	Distractor	Other area
Text	-0.018** (0.006)	0.008 (0.007)	0.006 (0.008)	0.010 (0.008)	0.001 (0.004)	0.002 (0.003)	0.007 (0.007)
Colour	-0.003 (0.006)	0.001 (0.007)	0.044*** (0.008)	0.019* (0.008)	-0.007 (0.004)	-0.000 (0.003)	-0.013 (0.007)
match	0.009 (0.006)	0.017* (0.007)	0.005 (0.008)	0.001 (0.008)	0.005 (0.004)	-0.001 (0.003)	-0.001 (0.007)
Age	-0.012*** (0.002)	-0.010*** (0.002)	-0.022*** (0.002)	-0.022*** (0.002)	-0.016*** (0.001)	-0.004*** (0.001)	0.012*** (0.002)
Education	0.001 (0.003)	0.020*** (0.003)	0.010** (0.004)	0.007 (0.004)	0.006** (0.002)	0.006** (0.002)	0.008* (0.004)
Income (quartile)	-0.001 (0.003)	0.006 (0.004)	0.005 (0.004)	0.006 (0.004)	0.004 (0.002)	0.004* (0.002)	0.013*** (0.004)
House = 2, Condo/apartment	0.024*** (0.007)	0.051*** (0.008)	0.049*** (0.009)	0.041*** (0.009)	-0.004 (0.005)	0.013** (0.004)	0.026** (0.008)
House = 3, Shared housing	-0.040*** (0.012)	-0.039** (0.014)	-0.006 (0.015)	0.008 (0.015)	-0.046*** (0.007)	-0.007 (0.006)	-0.002 (0.013)
House = 4, I prefer not to answer	0.063	0.052	0.014	0.056	0.015	0.021	-0.082**

	(0.035)	(0.046)	(0.043)	(0.045)	(0.019)	(0.017)	(0.032)
House = 5, Other	-0.092***	-0.042	-0.062*	-0.059*	-0.007	0.012	0.160***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.018)	(0.015)	(0.028)
Area = 2, Suburban	0.002	-0.002	0.009	0.027**	-0.033***	-0.004	-0.015
	(0.008)	(0.009)	(0.010)	(0.010)	(0.005)	(0.004)	(0.009)
Area = 3, Rural	0.024**	0.022*	0.040***	0.033**	-0.035***	0.005	0.023*
	(0.009)	(0.010)	(0.011)	(0.011)	(0.006)	(0.005)	(0.010)
Mobile	-0.249***	-0.172***	-0.244***	-0.220***	-0.008	-0.004	0.328***
	(0.016)	(0.016)	(0.015)	(0.016)	(0.011)	(0.009)	(0.015)
Colour blindness	-0.116*	-0.118*	-0.098*	-0.155***	0.012	0.065*	0.028
	(0.052)	(0.052)	(0.046)	(0.046)	(0.028)	(0.032)	(0.051)
Visual impairments	-0.121*	-0.049	-0.210***	-0.196***	-0.030	-0.002	0.099*
	(0.049)	(0.049)	(0.038)	(0.042)	(0.023)	(0.022)	(0.048)
Cognitive difficulties	-0.185***	-0.150***	-0.134***	-0.101**	-0.012	-0.012	0.167***
	(0.041)	(0.042)	(0.036)	(0.039)	(0.021)	(0.017)	(0.041)
Constant	0.913***	0.655***	0.489***	0.538***	0.095***	0.014	0.116***
	(0.020)	(0.023)	(0.025)	(0.025)	(0.012)	(0.010)	(0.022)
Observations	15,541	15,541	15,541	15,541	15,541	15,541	15,541
R-squared	0.049	0.040	0.041	0.033	0.043	0.025	0.110

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Table 49. Probit marginal effects - impact of receptacle elements on receptacle label clicks, with covariates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
DV: likelihood of clicking (0-1)	Plastic / Metal	Paper	Biowaste	Bin bag	No litter sign	Distractor	Other area

Text	-0.018**	0.008	0.006	0.010	0.001	0.002	0.008
	(0.006)	(0.007)	(0.008)	(0.008)	(0.004)	(0.003)	(0.007)
Colour	-0.003	0.001	0.044***	0.019*	-0.007	-0.000	-0.013
	(0.006)	(0.007)	(0.008)	(0.008)	(0.004)	(0.003)	(0.007)
match	0.009	0.017*	0.005	0.001	0.005	-0.001	-0.001
	(0.006)	(0.007)	(0.008)	(0.008)	(0.004)	(0.003)	(0.007)
Age	-0.012***	-0.010***	-0.021***	-0.021***	-0.015***	-0.004***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Education	0.000	0.020***	0.011**	0.007	0.008***	0.005**	0.008*
	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)	(0.004)
Income (quartile)	-0.001	0.006	0.005	0.006	0.004*	0.005**	0.013***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)	(0.004)
House = 2, Condo/apartment	0.023**	0.051***	0.049***	0.041***	-0.005	0.012**	0.026**
	(0.007)	(0.008)	(0.009)	(0.009)	(0.005)	(0.004)	(0.008)
House = 3, Shared housing	-0.043***	-0.037**	-0.006	0.009	-0.046***	-0.012*	-0.003
	(0.013)	(0.014)	(0.014)	(0.015)	(0.006)	(0.006)	(0.014)
House = 4, I prefer not to answer	0.054	0.043	0.016	0.057	-0.005	0.019	-0.095**
	(0.032)	(0.039)	(0.045)	(0.045)	(0.024)	(0.024)	(0.036)
House = 5, Other	-0.087***	-0.039	-0.063*	-0.060*	-0.001	0.014	0.155***
	(0.025)	(0.026)	(0.026)	(0.027)	(0.014)	(0.013)	(0.028)
Area = 2, Suburban	0.003	-0.002	0.009	0.026**	-0.032***	-0.004	-0.016
	(0.008)	(0.009)	(0.010)	(0.010)	(0.005)	(0.004)	(0.009)
Area = 3, Rural	0.024**	0.021*	0.040***	0.033**	-0.030***	0.006	0.022*
	(0.009)	(0.010)	(0.011)	(0.011)	(0.005)	(0.005)	(0.010)
Mobile	-0.252***	-0.175***	-0.236***	-0.216***	-0.007	-0.001	0.337***

	(0.017)	(0.017)	(0.014)	(0.015)	(0.007)	(0.006)	(0.016)
Colour blindness	-0.098*	-0.106*	-0.105	-0.166**	0.004	0.046*	0.029
	(0.040)	(0.046)	(0.056)	(0.057)	(0.025)	(0.018)	(0.050)
Visual impairments	-0.100**	-0.047	-0.254***	-0.224***	-0.029	-0.002	0.097*
	(0.038)	(0.044)	(0.057)	(0.056)	(0.031)	(0.021)	(0.048)
Cognitive difficulties	-0.151***	-0.137***	-0.144***	-0.107*	-0.009	-0.007	0.159***
	(0.030)	(0.037)	(0.044)	(0.043)	(0.024)	(0.020)	(0.039)
Observations	15,541	15,541	15,541	15,541	15,541	15,541	15,541

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Impact of label elements on packaging label clicks, by products

This subsection presents the impact of label elements on participants' likelihood of clicking on different areas of packaging images, disaggregated by product types: mono, dual, and triple material products. Probit regression results are provided to explore how label characteristics (text, colour, and other labels) and participant characteristics influence clicking behaviour. Standard errors are clustered at the participant level, and country effects are included but not displayed for ease of presentation. The analysis incorporates the following control variables:

- Sociodemographic variables: age, education, income quartile, house type (private house, condo/apartment, shared housing, other), and area of residence (urban, suburban, rural).
- Health-related variables: colour blindness, visual impairments, and cognitive difficulties.
- Mobile: mobile device usage for survey completion.
- Country effects: included but not shown for simplicity.

The results are organized into three tables, each focused on one product type:

1. **Mono products:** Waste sorting label, Greendot logo, Triman logo, SUP indicators, and other areas.
2. **Dual products:** Waste sorting label, Greendot logo, and other areas.
3. **Triple products:** Waste sorting label, Greendot logo, and other areas.

Table 50. Probit marginal effects – Mono products- impact of label elements on packaging label clicks

	(1)	(2)	(3)	(4)	(5)
DV: likelihood of clicking (0-1)	Waste sorting label	Greendot	Triman	SUP	Other area

Text	0.025***	-0.018*	-0.003	0.003	-0.016*
	(0.007)	(0.007)	(0.006)	(0.008)	(0.008)
Colour	0.010	-0.000	-0.006	0.012	-0.007
	(0.007)	(0.007)	(0.006)	(0.008)	(0.008)
Other label	-0.041***				-0.048***
	(0.007)				(0.007)
Age	-0.023***	-0.008***	-0.010***	-0.011***	0.019***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Education	-0.003	0.012***	0.012***	0.007	0.009**
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)
Income (quartile)	0.005	-0.002	0.003	0.011**	-0.010**
	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
House = 2, Condo/Apartment	-0.020*	0.030***	0.017*	0.008	0.050***
	(0.008)	(0.008)	(0.007)	(0.009)	(0.009)
House = 3, Shared housing	-0.039**	-0.024*	-0.023*	-0.013	0.029*
	(0.014)	(0.012)	(0.010)	(0.015)	(0.014)
House = 4, I prefer not to answer	0.164***	-0.060*	0.005	-0.040	-0.167***
	(0.032)	(0.026)	(0.037)	(0.040)	(0.033)
House = 5, Other	-0.076**	0.052	0.036	0.028	0.069*
	(0.026)	(0.027)	(0.023)	(0.029)	(0.027)
Area = 2, Suburban	0.015	-0.008	-0.006	-0.039***	-0.033***
	(0.009)	(0.008)	(0.007)	(0.009)	(0.009)
Area = 3, Rural	-0.004	0.009	0.000	-0.036***	0.009
	(0.010)	(0.010)	(0.008)	(0.011)	(0.011)
Mobile	-0.268***	-0.077***	-0.046***	-0.045**	0.325***
	(0.016)	(0.010)	(0.008)	(0.014)	(0.016)

Colour blindness	-0.126*	-0.105	-0.093	0.053	0.125*
	(0.050)	(0.063)	(0.061)	(0.049)	(0.052)
Visual impairments	-0.219***	0.045	0.044	0.071	0.260***
	(0.049)	(0.042)	(0.036)	(0.048)	(0.052)
Cognitive difficulties	-0.216***	-0.021	-0.069	-0.039	0.232***
	(0.038)	(0.039)	(0.043)	(0.044)	(0.041)
Observations	15,630	7,837	7,837	7,837	15,630

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Table 51. Probit marginal effects – Dual Products - impact of label elements on packaging label clicks

	(1)	(2)	(3)
DV: likelihood of clicking (0-1)	Waste sorting label	Greendot	Other area
Text	0.005 (0.007)	-0.005 (0.005)	-0.007 (0.007)
Colour	0.002 (0.007)	0.005 (0.005)	-0.009 (0.007)
Other label	-0.014 (0.007)		-0.003 (0.007)
Age	-0.030*** (0.002)	-0.007*** (0.001)	0.027*** (0.002)
Education	0.001 (0.003)	0.016*** (0.003)	-0.001 (0.004)
Income (quartile)	0.003 (0.004)	0.006* (0.003)	-0.006 (0.004)

House = 2, Condo/Apartment	-0.042*** (0.008)	0.011 (0.006)	0.043*** (0.008)
House = 3, Shared housing	-0.069*** (0.014)	-0.006 (0.010)	0.054*** (0.014)
House = 4, I prefer not to answer	0.111*** (0.033)	0.007 (0.035)	-0.102** (0.035)
House = 5, Other	-0.093*** (0.026)	0.056* (0.023)	0.094*** (0.026)
Area = 2, Suburban	0.007 (0.009)	0.000 (0.007)	-0.022* (0.009)
Area = 3, Rural	-0.005 (0.010)	0.029*** (0.008)	-0.006 (0.010)
Mobile	-0.365*** (0.015)	-0.030*** (0.008)	0.373*** (0.015)
Colour blindness	-0.099* (0.048)	0.003 (0.043)	0.122* (0.050)
Visual impairments	-0.261*** (0.047)	-0.077 (0.058)	0.269*** (0.050)
Cognitive difficulties	-0.200*** (0.037)	-0.015 (0.034)	0.213*** (0.039)
Observations	15,630	7,850	15,630

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Table 52. Probit marginal effects – Triple products - impact of label elements on packaging label clicks

(1) (2) (3)

DV:
likelihood of clicking (0-1)

Waste sorting label

Greendot

Other area

	Waste sorting label	Greendot	Other area
Text	0.004 (0.007)	-0.008 (0.006)	-0.000 (0.008)
Colour	0.007 (0.007)	-0.005 (0.006)	-0.006 (0.008)
Other label	-0.015* (0.007)		-0.011 (0.008)
Age	-0.029*** (0.002)	-0.009*** (0.002)	0.022*** (0.002)
Education	-0.003 (0.003)	0.010*** (0.003)	0.009* (0.004)
Income (quartile)	0.005 (0.004)	0.006 (0.003)	-0.011** (0.004)
House = 2, Condo/Apartment	-0.043*** (0.008)	0.002 (0.007)	0.034*** (0.009)
House = 3, Shared housing	-0.056*** (0.014)	-0.033*** (0.009)	0.024 (0.014)
House = 4, I prefer not to answer	0.109** (0.035)	-0.054* (0.024)	-0.112** (0.037)
House = 5, Other	-0.080** (0.026)	0.042 (0.025)	0.081** (0.027)
Area = 2, Suburban	0.011 (0.009)	0.004 (0.007)	-0.027** (0.009)
Area = 3, Rural	-0.016 (0.010)	0.031*** (0.009)	0.006 (0.011)

Mobile	-0.368***	-0.023*	0.376***
	(0.015)	(0.010)	(0.014)
Colour blindness	-0.129**	-0.031	0.138**
	(0.050)	(0.051)	(0.053)
Visual impairments	-0.204***	-0.003	0.241***
	(0.048)	(0.045)	(0.052)
Cognitive difficulties	-0.220***	-0.053	0.233***
	(0.038)	(0.039)	(0.041)
Observations	15,630	7,774	15,630

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Reaction times

This subsection examines the effect of label elements on participants' reaction times, measured as the time in seconds taken to submit pages for tasks involving packaging and receptacle labels. The OLS regression results assess how text, colour, matching elements, and participant characteristics influence completion times. Standard errors are clustered at the participant level, and country effects are included but not displayed for simplicity. The analysis incorporates the following variables:

- Label elements: text, colour, other labels, and matching elements (for receptacle labels only).
- Sociodemographic factors: age, education, income quartile, house type (private house, condo/apartment, shared housing, other), and area of residence (urban, suburban, rural).
- Health-related factors: colour blindness, visual impairments, and cognitive difficulties.
- Device usage: mobile device for survey completion.
- Product type: mono, dual, and triple material products for packaging labels.

The results are presented separately for packaging labels and receptacle labels.

Table 53. OLS - impact of packaging label elements on time to submit page

(1)	
DV: Time (seconds)	Time to submit page
Text	-0.082
	(0.469)

Colour	-0.406
	(0.607)
Other label	-0.791
	(0.606)
Product = 2, Dual	0.472
	(0.477)
Product = 3, Triple	1.655**
	(0.620)
Age	0.433***
	(0.104)
Education	-0.748
	(0.487)
Income (quartile)	0.116
	(0.229)
House = 2, Condo/Apartment	1.091
	(0.745)
House = 3, Shared housing	5.170***
	(1.006)
House = 4, I prefer not to answer	13.184*
	(5.122)
House = 5, Other	0.258
	(0.628)
Area = 2, Suburban	-0.694
	(0.789)
Area = 3, Rural	-0.513
	(0.943)

Mobile	-4.152***
	(1.010)
Colour blindness	-0.220
	(1.812)
Visual impairments	1.246
	(2.006)
Cognitive difficulties	0.526
	(1.212)
Constant	10.051***
	(2.084)
Observations	46,890
R-squared	0.003

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Table 54: OLS - impact of receptacle label elements on time to submit page

	(1)
DV: Time (seconds)	Time to submit page
Text	0.281
	(0.627)
Colour	0.009
	(0.633)
match	-0.630
	(0.633)
Age	0.455**

	(0.142)
Education	-0.059
	(0.259)
Income (quartile)	0.235
	(0.289)
House = 2, Condo/Apartment	0.565
	(0.605)
House = 3, Shared housing	6.201***
	(1.685)
House = 4, I prefer not to answer	0.478
	(3.414)
House = 5, Other	1.404
	(0.783)
Area = 2, Suburban	0.468
	(0.686)
Area = 3, Rural	2.940**
	(1.056)
Mobile	-2.190*
	(0.946)
Colour blindness	-6.047***
	(1.403)
Visual impairments	7.166
	(4.423)
Cognitive difficulties	1.319
	(4.142)
Constant	9.291***

	(1.440)
Observations	15,503
R-squared	0.007

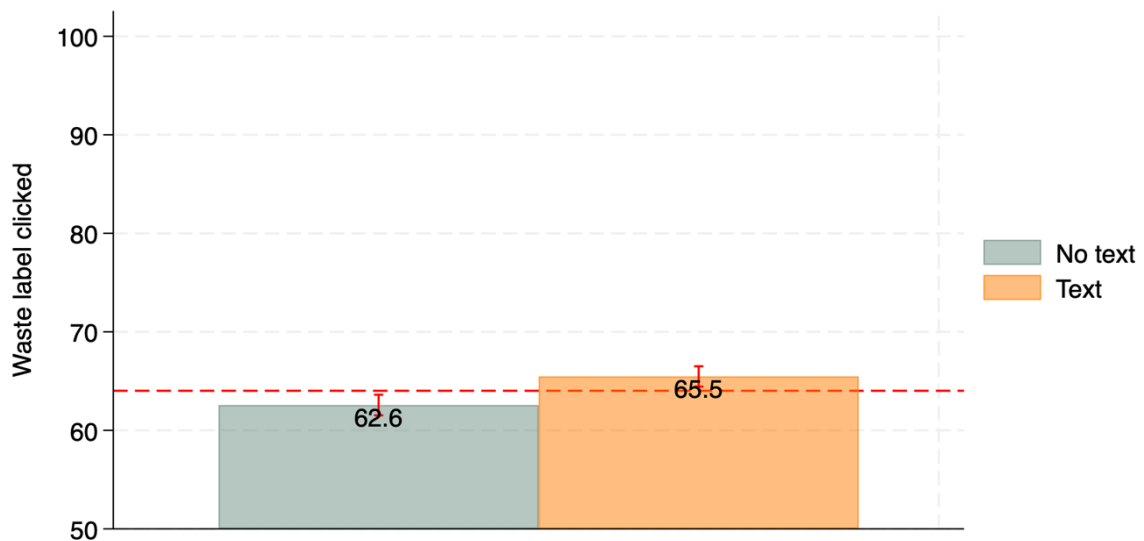
SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

6.4.4.5. Effect of text on product packaging clicks, disaggregated

Given the significant impact observed in terms of how text influences click behaviour, we break down the findings across mono, dual, and triple material product variations to highlight the effect in each condition. The following figures present the disaggregated results of the effect of text on waste label clicks for product packaging.

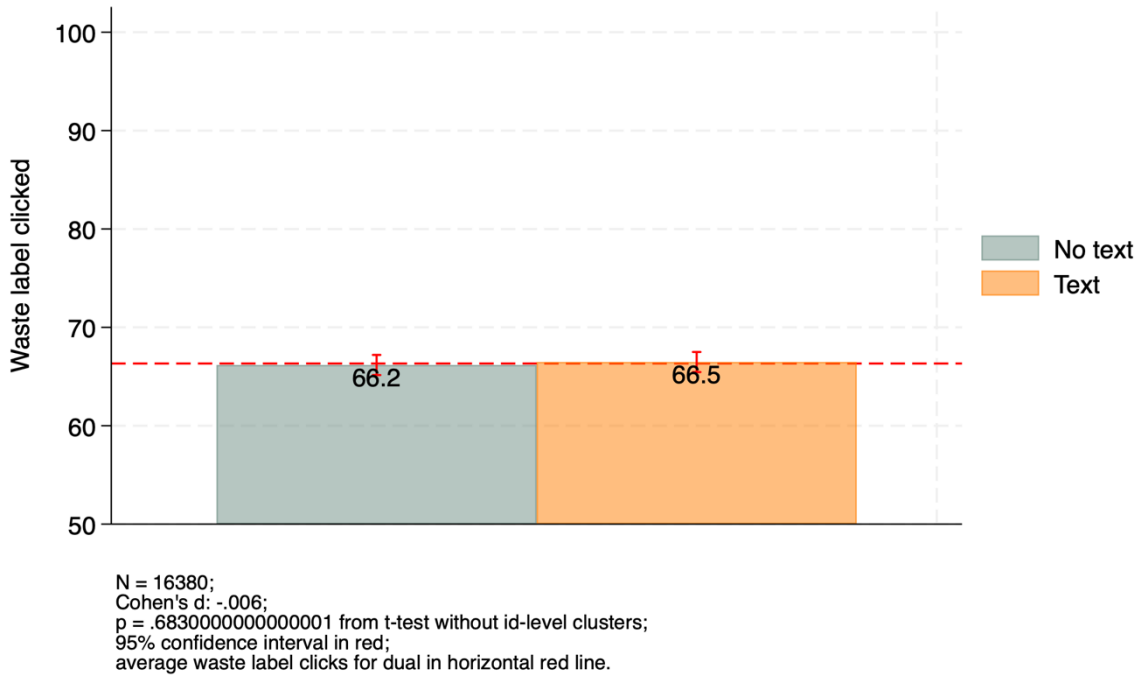
Figure 119. Effect of text on waste label clicks – mono



N = 16380;
Cohen's d: -.061;
p = 0 from t-test without id-level clusters;
95% confidence interval in red;
average waste label clicks for mono in horizontal red line.

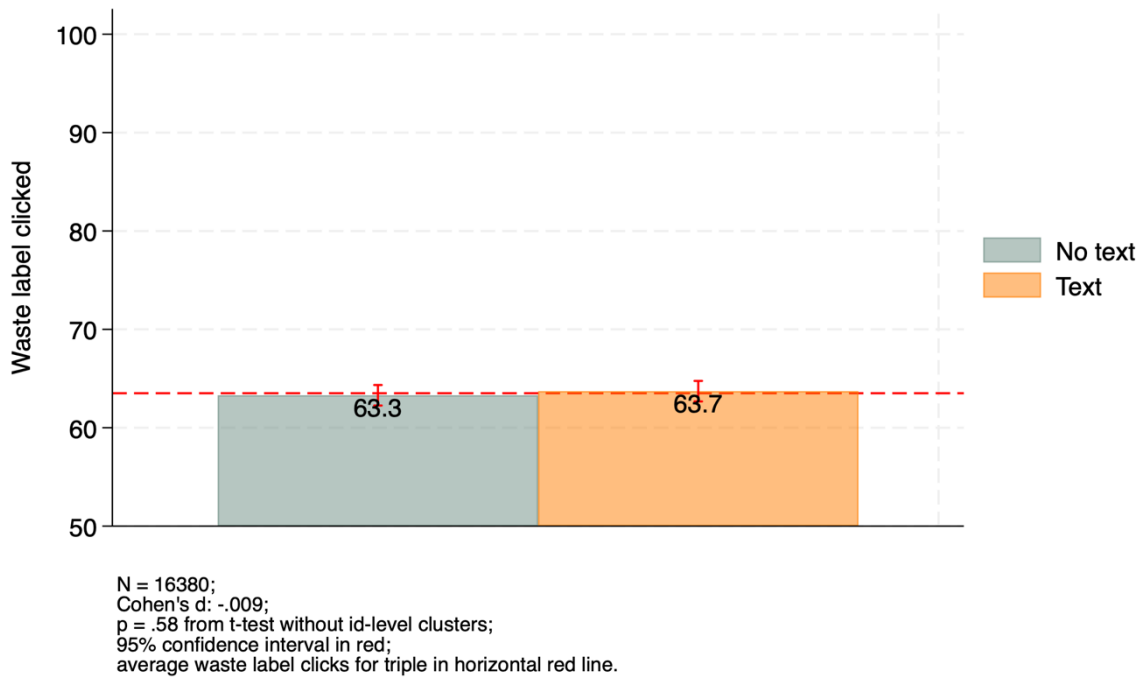
Source: Authors' elaboration

Figure 120. Effect of text on waste label clicks – dual



Source: Authors' elaboration

Figure 121: Effect of text on waste label clicks – triple

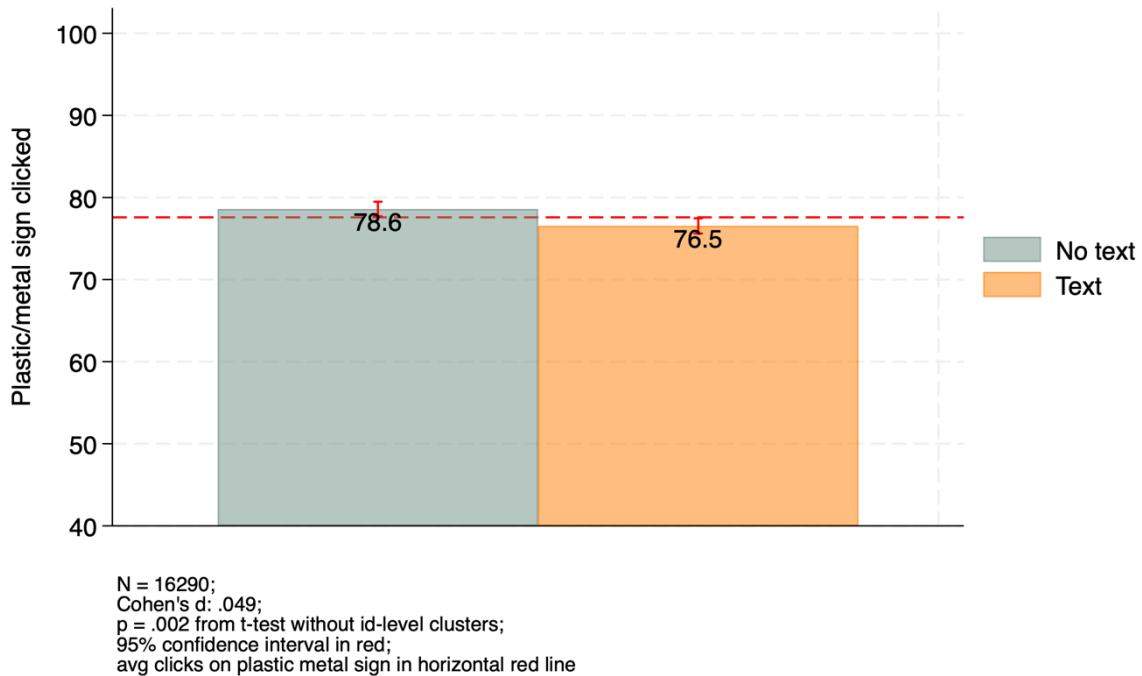


Source: Authors' elaboration

6.4.4.6. Effect of text on waste receptacle sign clicks, disaggregated

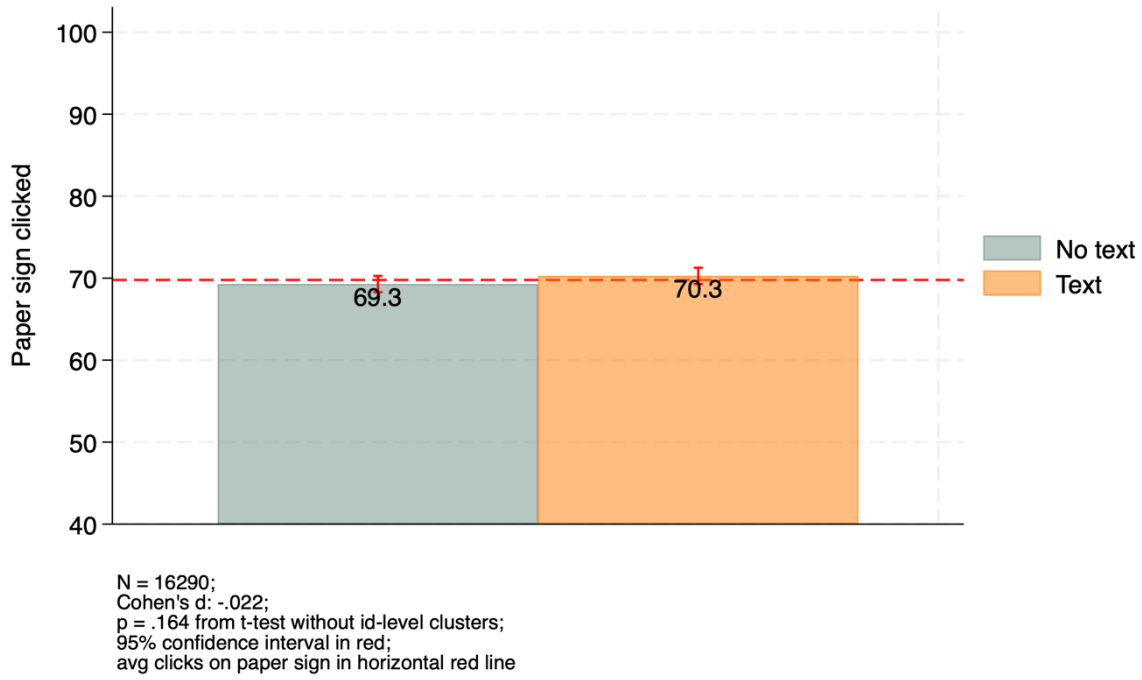
Because we find a significant effect of text on the aggregated waste receptacle sign clicks, we present the disaggregated results, splitting the outcome variable by waste receptacle sign.

Figure 122. Effect of text on plastic/metal sign clicks



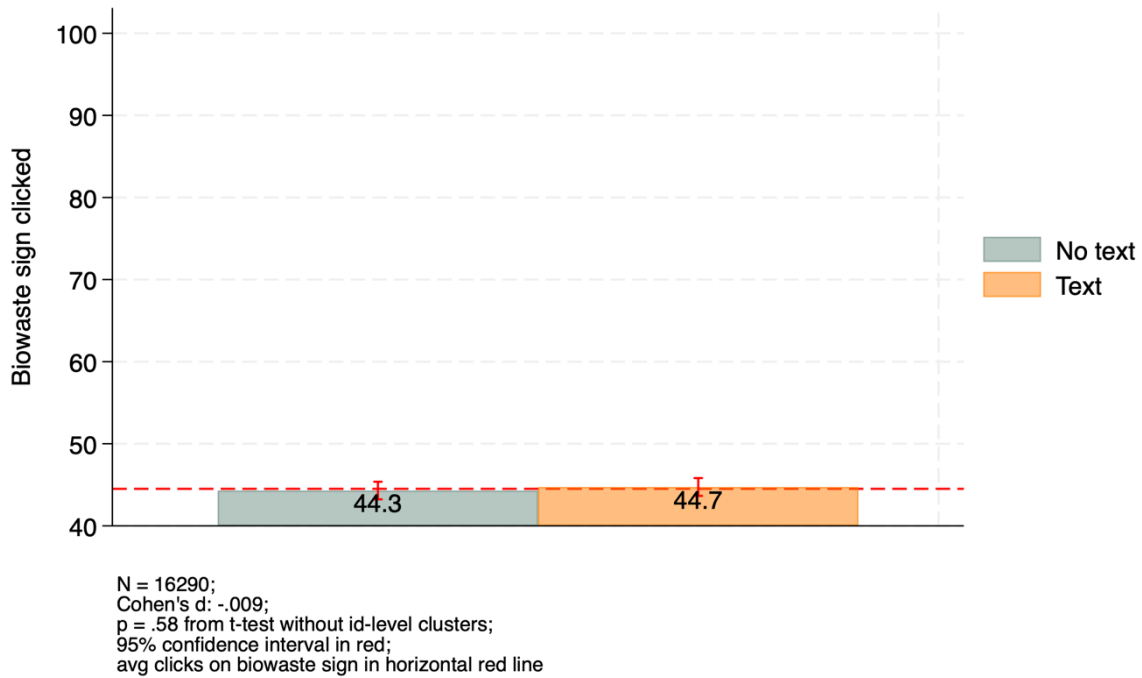
Source: Authors' elaboration

Figure 123. Effect of text on paper sign clicks



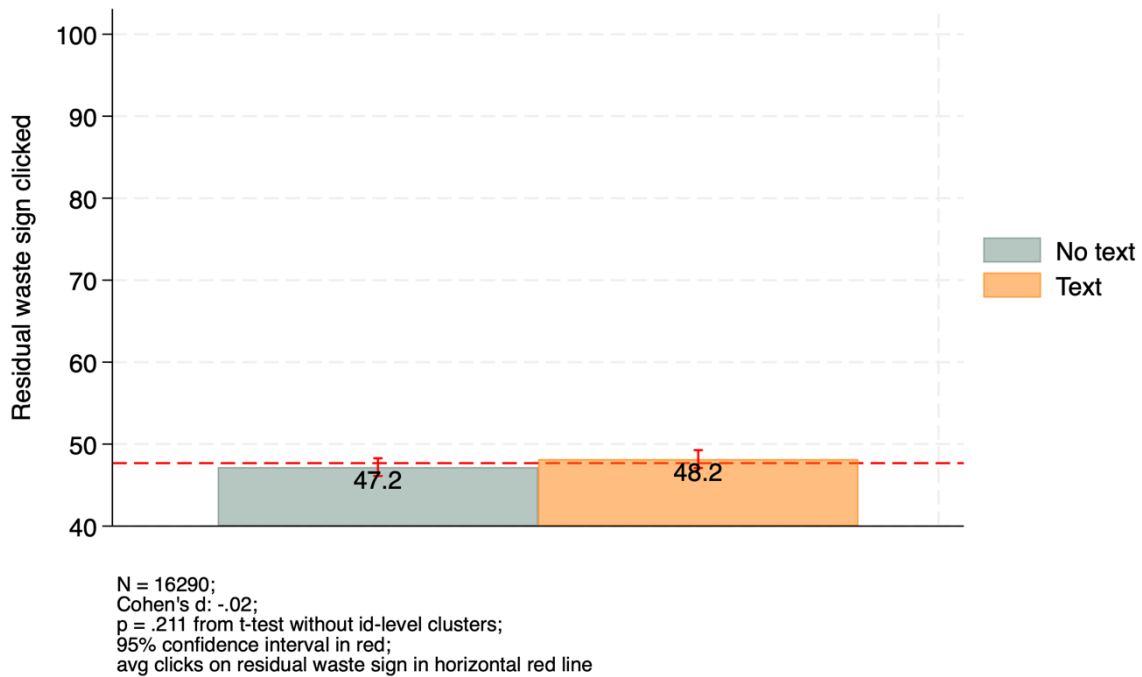
Source: Authors' elaboration

Figure 124: Effect of text on biowaste sign clicks



Source: Authors' elaboration

Figure 125: Effect of text on residual waste sign clicks

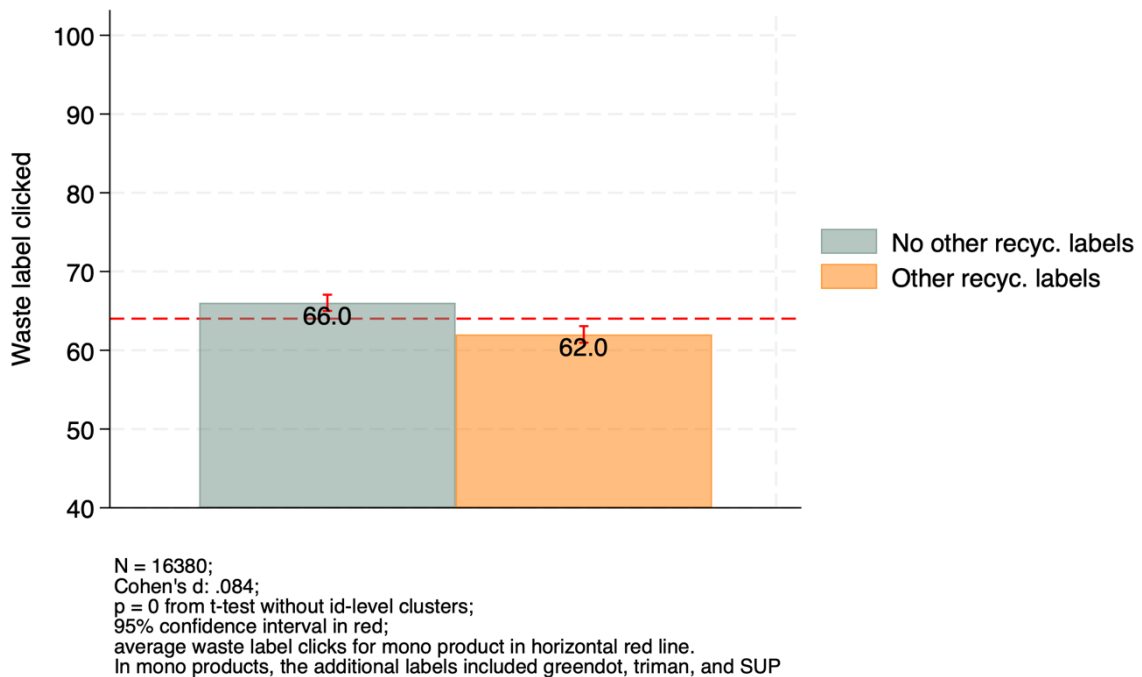


Source: Authors' elaboration

6.4.4.7. Effect of other labels on waste label clicks, disaggregated

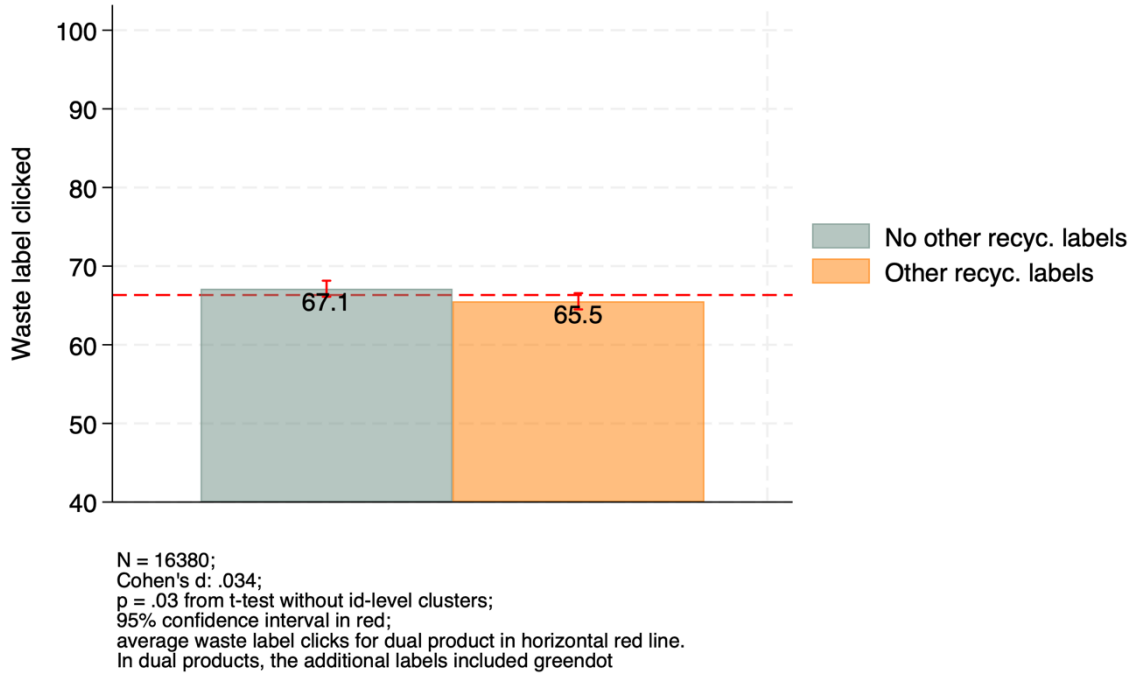
The following figures illustrate the disaggregated results of the effect of other labels on waste label clicks. The analysis examines how the presence of other labels influences click behaviour across mono, dual, and triple material product variations, providing a detailed breakdown for each condition.

Figure 126: Effect of other labels on waste label clicks - mono



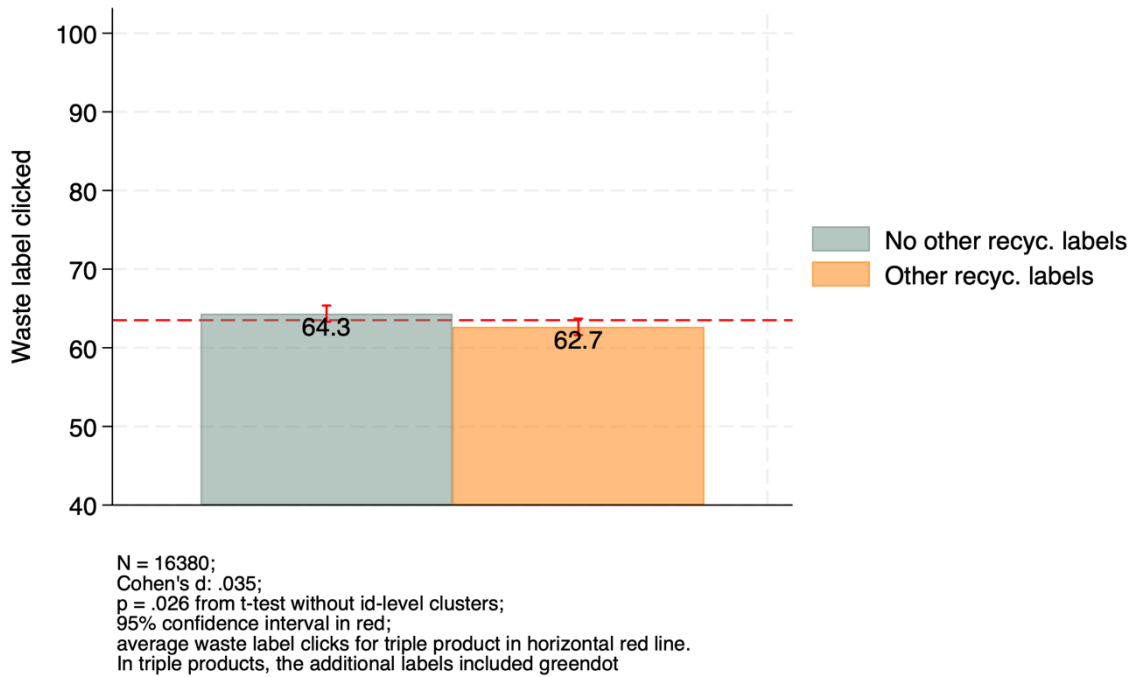
Source: Authors' elaboration

Figure 127: Effect of other labels on waste label clicks - dual



Source: Authors' elaboration

Figure 128: Effect of other labels on waste label clicks - triple



6.4.4.8. Effect of matching label and receptacle colours on waste receptacle sign clicks, disaggregated

The following figures present the disaggregated results of the effect of matching labels and receptacle colours on clicks for different waste receptacle signs. The analysis explores whether colour alignment between labels and receptacles influences participant interactions across specific waste categories.

Figure 129: Impact of matching label and receptacle colours on plastic/metal sign clicks

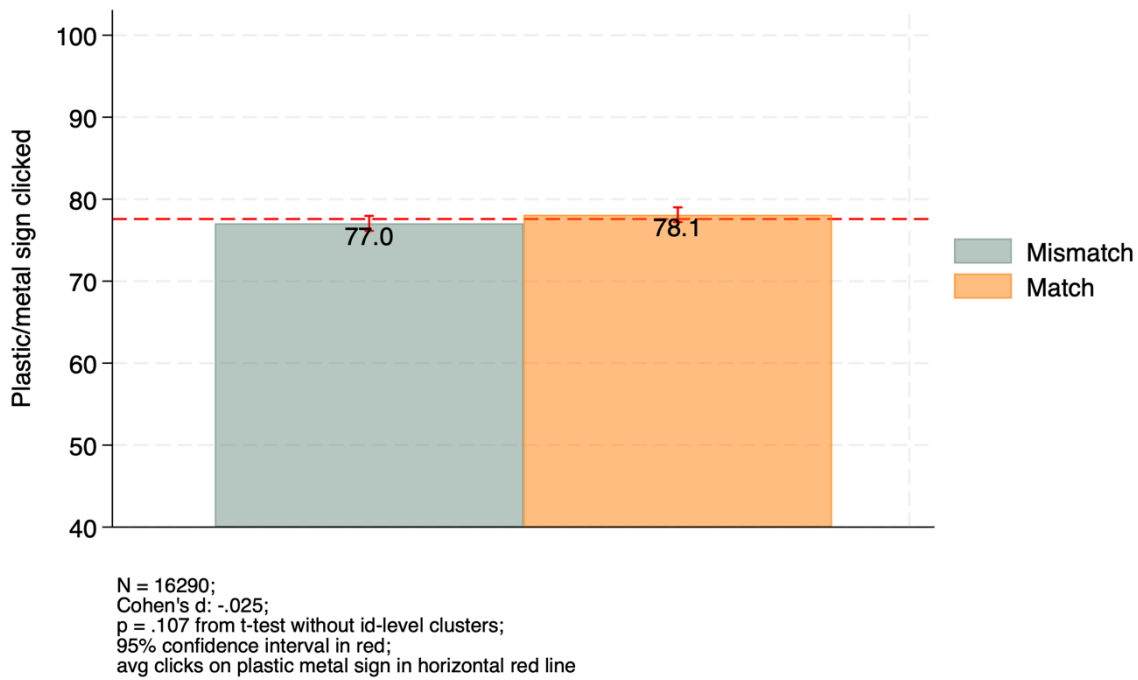
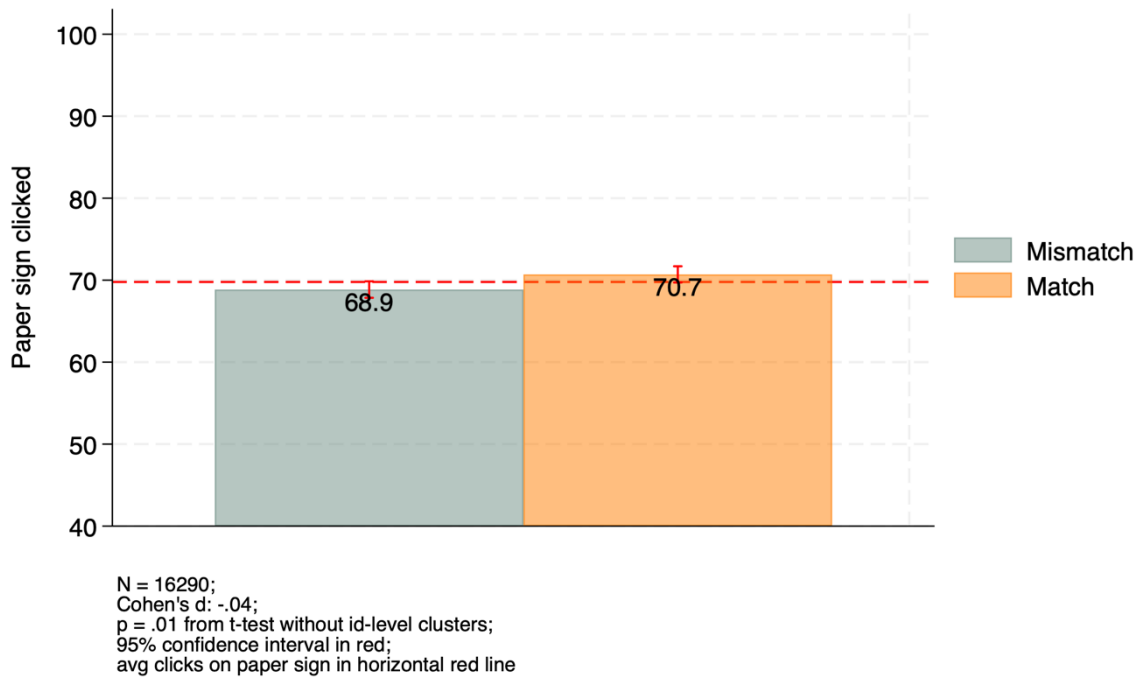
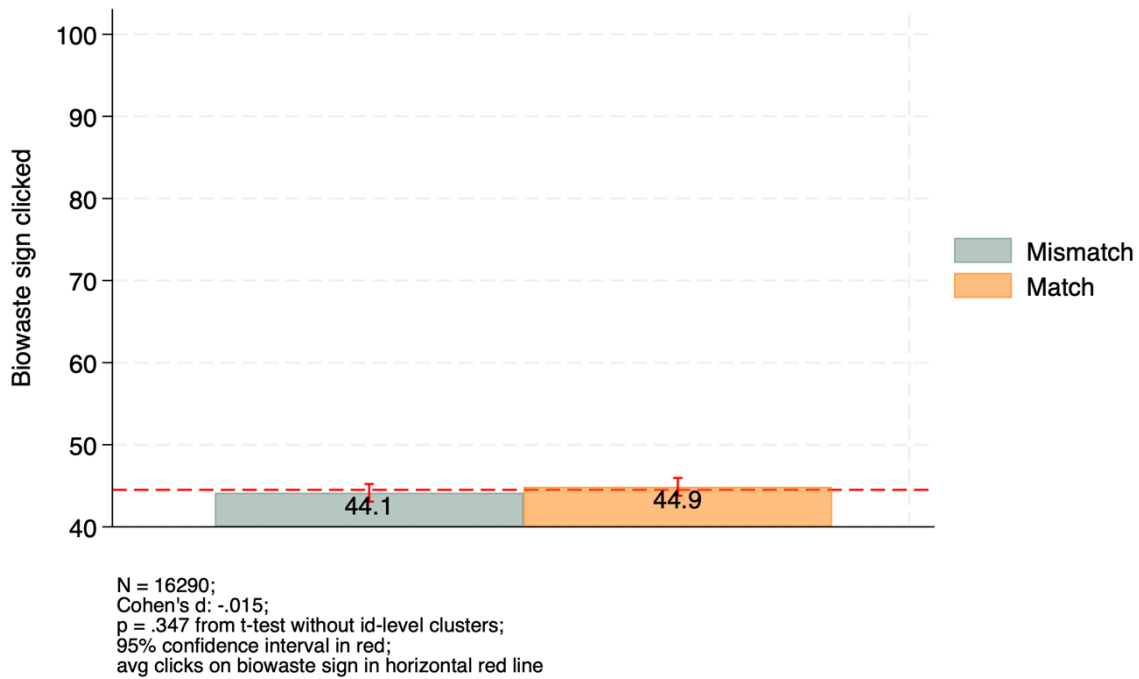


Figure 130: Impact of matching label and receptacle colours on paper sign clicks



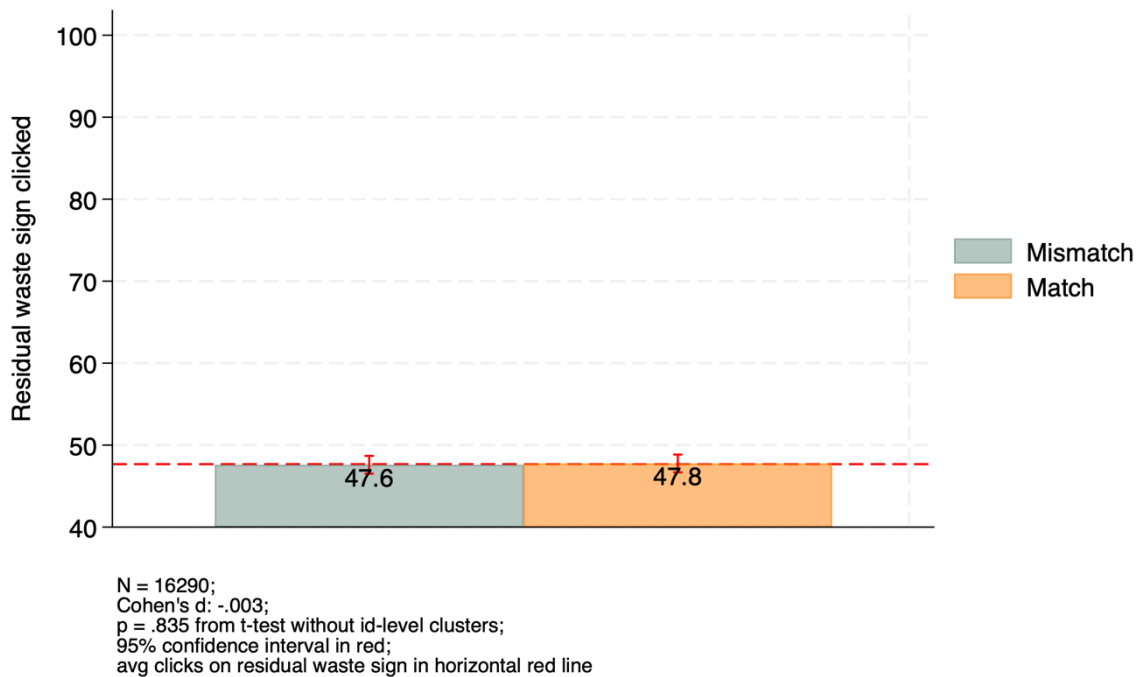
Source: Authors' elaboration

Figure 131: Impact of matching label and receptacle colours on biowaste sign clicks



Source: Authors' elaboration

Figure 132: Impact of matching label and receptacle colours on residual waste sign clicks



Source: Authors' elaboration

Understanding task

This section provides a detailed overview of the understanding task. The analysis focuses on participants' ability to correctly sort materials based on packaging and waste receptacle labels across experimental conditions. We begin by presenting the sample sizes across experimental variations, followed by a breakdown of correct sorting outcomes and the effects of label elements, including text, colour, pictograms, and matching. Subsequent subsections use OLS and Probit regression models to examine these effects, with results disaggregated where relevant to highlight differences across product types and label components. Reaction time analysis is also included to explore the time participants took to make sorting decisions.

Sample sizes by condition

Table 54 summarizes the allocation of participants across the different experimental variations. We do not break this table down by each possible combination as in the salience task Table 42 and Table 43 because across all product variations in the understanding task, there are 320 possible combinations. Table 54 confirms even distribution across conditions (numbers refer to the decisions made and not to the subjects).

Table 55: Experimental treatments sample size

Element	Product type	N
---------	--------------	---

Colour	Black & white	90,072 ⁵⁴
	Colour	73,647
Text	No text	81,786
	Text	81,933
Other label (Greendot)	No Greendot	81,639
	Greendot	82,080
Component pictogram	No component pictogram	49,154
	Component pictogram	49,088
Matching	Mismatching	73,881
	Matching	73,565

Source: Authors' elaboration

Regressions for understanding task

This subsection presents the methodological approach and findings for the understanding task, focusing on participants' sorting decisions and reaction times across various experimental conditions. We begin by analysing the aggregated results for correct sorting, followed by a disaggregated analysis for specific product types (mono, dual, triple, and residual). The following elements are assessed for their impact using OLS and Probit regression models: text, colour, pictograms, and label matching. Additionally, we examine the influence of participant characteristics and sociodemographic factors on sorting performance. Finally, reaction times for correct and incorrect responses are analysed to evaluate engagement and task completion patterns. Specifically:

- **Aggregate analysis:** Overview of the effects of label elements and participant characteristics on correct sorting decisions.
- **Disaggregated analysis:** Results broken down by product type, highlighting variations across mono, dual, triple, and residual conditions.
- **Decision to separate:** Impact of label elements on participants' likelihood to separate items correctly.
- **Reaction times:** Analysis of the time, in seconds, taken to submit correct, incorrect, and overall responses.

Correct sorting - Impact of label elements

This subsection examines the effect of label elements on participants' ability to correctly sort items. We present the aggregated results, assessing the overall impact of colour, text, other labels, and pictograms,

⁵⁴ Note there are significantly more observations in B&W than in colour because we do not vary the residual waste image on colour. For 81 observations, the condition assignment (colour, text, Greendot, and product type) was not recorded due to a programming glitch. Consequently, these participants were excluded from the analyses of the understanding task.

and matching labels on sorting accuracy.⁵⁵ Additionally, we disaggregate the results by product type (mono, dual, triple, and residual), providing insights into how these label elements influence sorting outcomes across different material combinations. The regression models include the following control variables: age, education, income quartile, house type (Private house, Condo/apartment, Shared housing, other), area lived (Urban, Suburban, Rural), country, colour blindness, visual impairments, cognitive difficulties, mobile device usage for answering the survey, and colour association variables related to participants' familiarity with associating colours with materials⁵⁶.

Table 56: OLS - impact of label elements on correct sorting - aggregated

	(1)
DV: correct sorting	Aggregated
Colour	0.006** (0.002)
Text	0.006** (0.002)
Other label	-0.000 (0.002)
Pictogram = 1, Pictogram	0.007** (0.002)
Pictogram = 2, Pictogram not applicable	0.665*** (0.003)
Matching labels = 1, Match	-0.056*** (0.005)
Matching labels = 2, Matching not applicable	-0.126*** (0.004)

⁵⁵ Pictogram refers to a picture image that depicts the material of each component of the product packaging. The reference category is “no pictogram”. Matching labels refers to whether the colours match between the labels and receptacles. The reference category is “not matching”.

⁵⁶ The colour association variable is coded as a binary indicator. It takes the value of one if the material-colour association presented in the experiment matches the respondent’s self-reported material-colour association, and zero otherwise. This allows us to assess whether pre-existing associations between materials and colours influence sorting accuracy under different label designs.

Age	-0.016***
	(0.001)
Education	0.011***
	(0.002)
Income (quartile)	-0.003
	(0.002)
House = 2, Condo/Apartment	0.000
	(0.004)
House = 3, Shared housing	-0.054***
	(0.007)
House = 4, I prefer not to answer	0.012
	(0.017)
House = 5, Other	0.041***
	(0.012)
Area = 2, Suburban	-0.010*
	(0.004)
Area = 3, Rural	0.044***
	(0.005)
Mobile	-0.098***
	(0.008)
Plastic/Metal colour association	-0.033***
	(0.005)
Paper/cardboard colour association	0.064***
	(0.005)
Glass colour association	0.035***
	(0.005)

Biowaste colour association	0.028***
	(0.005)
Colour blindness	-0.059*
	(0.024)
Visual impairments	-0.130***
	(0.020)
Cognitive difficulties	-0.048*
	(0.019)
Constant	0.233***
	(0.010)
Observations	156,223
R-squared	0.447

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Table 57: OLS - impact of label elements on correct sorting, disaggregated

	(1)	(2)	(3)	(4)
DV: correct sorting	Mono	Dual	Triple	Residual
Colour	0.019***	-0.002	0.001	
	(0.003)	(0.003)	(0.004)	
Text	0.008*	0.004	0.002	0.011
	(0.003)	(0.003)	(0.004)	(0.007)
Other label	-0.000	0.001	-0.002	-0.006
	(0.003)	(0.003)	(0.004)	(0.007)

Pictogram		0.008**	0.005	
		(0.003)	(0.004)	
Matching labels	-0.087***	-0.034***	-0.054***	
	(0.007)	(0.005)	(0.007)	
Age	-0.011***	-0.016***	-0.020***	-0.026***
	(0.001)	(0.001)	(0.001)	(0.002)
Education	0.000	0.017***	0.022***	-0.003
	(0.002)	(0.002)	(0.002)	(0.003)
Income (quartile)	0.000	-0.003	-0.007**	-0.005
	(0.002)	(0.002)	(0.003)	(0.003)
House = 2, Condo/apartment	-0.002	0.000	-0.004	0.018*
	(0.004)	(0.005)	(0.006)	(0.007)
House = 3, Shared housing	-0.136***	-0.008	-0.008	-0.089***
	(0.009)	(0.008)	(0.010)	(0.012)
House = 4, I prefer not to answer	0.046*	-0.019	-0.005	0.069*
	(0.018)	(0.020)	(0.029)	(0.031)
House = 5, Other	-0.030*	0.081***	0.100***	-0.029
	(0.014)	(0.015)	(0.019)	(0.026)
Area = 2, Suburban	-0.014**	-0.006	-0.006	-0.021*
	(0.005)	(0.005)	(0.006)	(0.008)
Area = 3, Rural	-0.007	0.070***	0.095***	-0.006
	(0.005)	(0.006)	(0.008)	(0.009)
Mobile	-0.176***	-0.049***	-0.057***	-0.144***
	(0.010)	(0.009)	(0.011)	(0.017)
Plastic/Metal colour association	-0.037***	-0.032***	-0.038***	-0.016
	(0.006)	(0.005)	(0.007)	(0.010)

Paper/cardboard colour association	0.068*** (0.006)	0.056*** (0.006)	0.080*** (0.007)	0.056*** (0.009)
Glass colour association	0.070*** (0.007)	0.014* (0.005)	0.021** (0.007)	0.038*** (0.009)
Biowaste colour association	0.054*** (0.006)	0.013* (0.005)	0.019** (0.007)	0.026** (0.009)
Colour blindness	-0.104** (0.038)	-0.036 (0.020)	-0.023 (0.030)	-0.083 (0.051)
Visual impairments	-0.169*** (0.036)	-0.090*** (0.017)	-0.119*** (0.022)	-0.199*** (0.051)
Cognitive difficulties	-0.099*** (0.026)	-0.009 (0.019)	0.004 (0.025)	-0.150*** (0.039)
Constant	0.944*** (0.012)	0.160*** (0.012)	0.223*** (0.016)	0.949*** (0.020)
Observations	46,873	62,497	31,247	15,606
R-squared	0.074	0.042	0.056	0.126

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Decision to separate - Impact of label elements

This subsection evaluates how label elements influence participants' decisions to separate waste. Table 57 presents Probit regression results, showing the marginal effects of colour, text, other labels, and pictograms on waste separation decisions. The analysis includes the variables age, education level, income quartile, house type, area of residence (urban, suburban, rural), mobile device usage, colour blindness, visual impairments, cognitive difficulties, colour association familiarity, and product type (dual and triple material).

Table 58: Probit marginal effects - impact of label elements on decision to separate, dual and triple material products

(1)

Colour	0.001 (0.003)
Text	0.002 (0.003)
Other label	-0.003 (0.003)
Pictogram	0.012*** (0.003)
Matching labels	-0.047*** (0.008)
type = 3, Triple	0.056*** (0.001)
Age	-0.023*** (0.001)
Education	0.024*** (0.003)
Income (quartile)	-0.007* (0.003)
House = 2, Condo/Apartment	-0.006 (0.006)
House = 3, Shared housing	-0.018 (0.010)
House = 4, I prefer not to answer	-0.023 (0.028)

House = 5, Other	0.123***
	(0.022)
Area = 2, Suburban	-0.011
	(0.007)
Area = 3, Rural	0.097***
	(0.008)
Mobile	-0.046***
	(0.011)
Plastic/Metal colour association	-0.049***
	(0.008)
Paper/cardboard colour association	0.075***
	(0.008)
Glass colour association	0.020*
	(0.008)
Biowaste colour association	0.012
	(0.008)
Colour blindness	-0.056
	(0.043)
Visual impairments	-0.200***
	(0.048)
Cognitive difficulties	-0.013
	(0.031)
Observations	93,744

SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Reaction times - Impact of label elements

This subsection examines the influence of label elements on participants' reaction times, measured as the time taken, in seconds, to submit correct, incorrect, and overall responses. Table 58 presents the OLS regression results, analysing the effects of colour, text, other labels, and matching labels. The analysis includes control variables such as age, education, income quartile, house type (private house, condo/apartment, shared housing, other), area of residence (urban, suburban, rural), country, mobile device usage, colour association variables, and individual characteristics like colour blindness, visual impairments, and cognitive difficulties.

Table 59: OLS - impact of label elements on reaction times for correct, incorrect, and overall responses

	(1)	(2)	(3)
Reaction time (seconds)	Correct	Incorrect	Overall
Colour	-1.041 (0.635)	-0.828 (0.489)	-0.582 (0.398)
Text	0.864 (0.668)	0.644 (0.538)	0.913* (0.449)
Other label	-0.747 (0.692)	1.157* (0.486)	0.469 (0.434)
Matching labels	0.466 (0.453)	-0.866 (0.526)	-0.347 (0.375)
Age	0.530** (0.176)	0.987*** (0.148)	0.895*** (0.130)
Education	0.578 (0.385)	0.385 (0.246)	0.493 (0.260)
Income (quartile)	-0.097 (0.342)	-0.424 (0.256)	-0.102 (0.212)
House = 2, Condo/Apartment	1.128 (0.612)	2.097*** (0.630)	1.576** (0.482)
House = 3, Shared housing	3.844**	1.472	3.502***

	(1.175)	(1.469)	(0.910)
House = 4, I prefer not to answer	5.572**	2.231	3.421*
	(2.090)	(2.487)	(1.706)
House = 5, Other	4.176*	3.618***	4.099***
	(1.840)	(0.974)	(0.943)
Area = 2, Suburban	-1.445*	-0.923	-0.957
	(0.682)	(0.789)	(0.568)
Area = 3, Rural	-0.073	3.120**	2.293*
	(1.461)	(1.064)	(1.156)
Mobile	-1.815*	-4.054***	-2.719***
	(0.738)	(0.969)	(0.656)
Plastic/Metal colour association	0.379	-0.058	-0.039
	(0.770)	(0.964)	(0.697)
Paper/cardboard colour association	-2.871	-1.691*	-2.626**
	(1.843)	(0.775)	(0.947)
Glass colour association	-0.619	0.370	-0.130
	(1.423)	(0.825)	(0.819)
Biowaste colour association	1.704	1.286	1.937*
	(0.873)	(1.014)	(0.921)
Colour blindness	-3.043*	-2.164	-0.563
	(1.410)	(1.461)	(1.587)
Visual impairments	2.516	-1.651	-0.972
	(2.872)	(1.461)	(1.429)
Cognitive difficulties	0.107	2.509	1.744
	(1.529)	(1.971)	(1.528)
Constant	12.739***	11.190***	10.285***

	(2.036)	(1.591)	(1.721)
Observations	61,623	83,922	156,223
R-squared	0.002	0.003	0.002

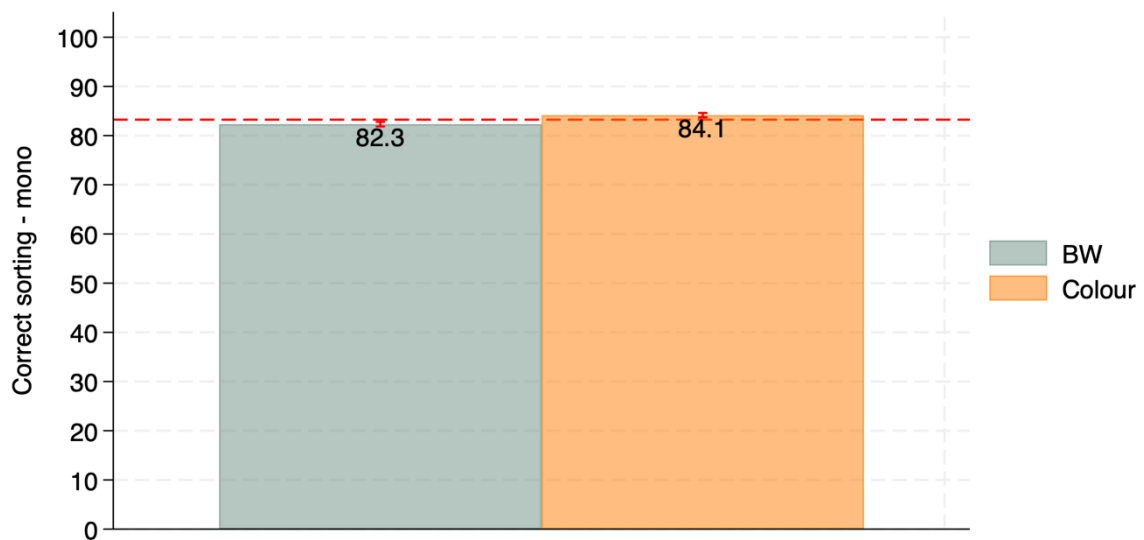
SE clustered by id; Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Effect of colour on correct sorting, disaggregated

Because the regression analysis identified a significant effect of colour on correct sorting, we present the disaggregated results by product type. This allows for a closer examination of how colour influences sorting accuracy across mono, dual, and triple material combinations.

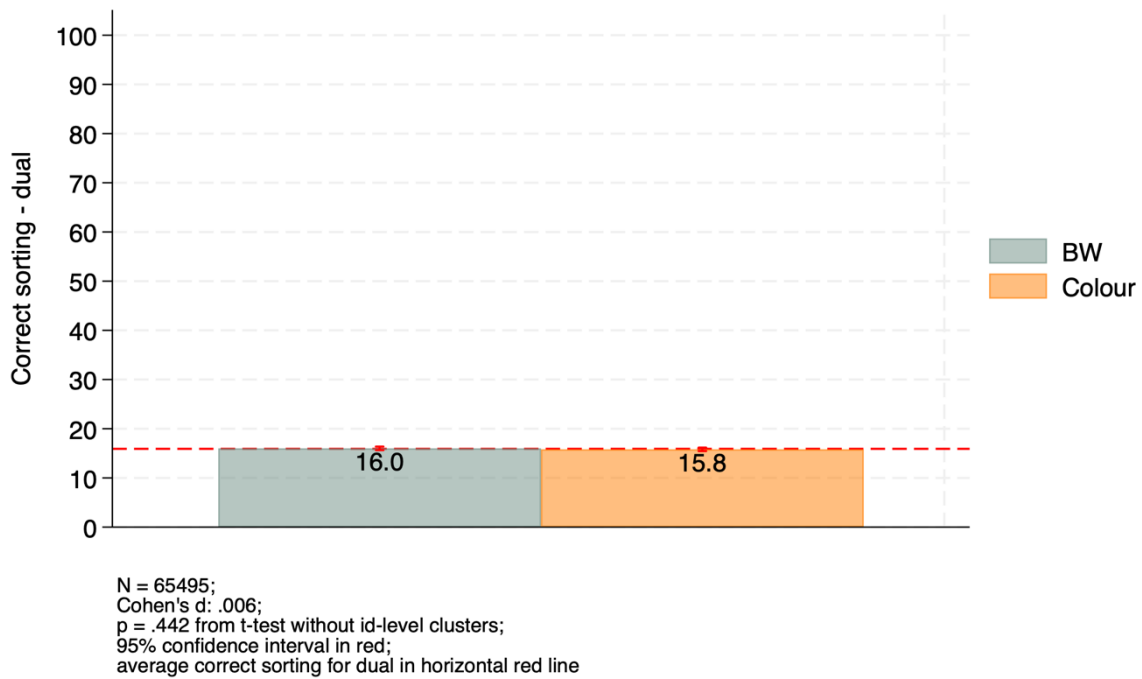
Figure 133 impact of colour on correct sorting - mono



N = 49123;
Cohen's d: -.049;
p = 0 from t-test without id-level clusters;
95% confidence interval in red;
average correct sorting for mono in horizontal red line

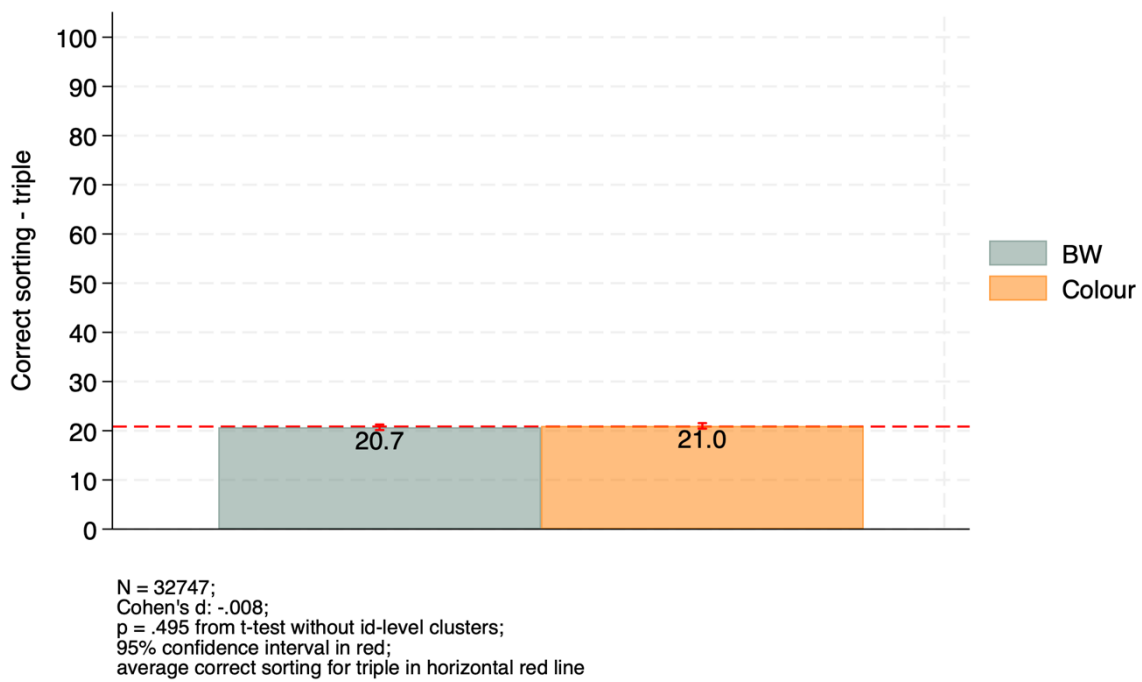
Source: Authors' elaboration

Figure 134 Impact of colour on correct sorting - dual



Source: Authors' elaboration

Figure 135: impact of colour on correct sorting - triple

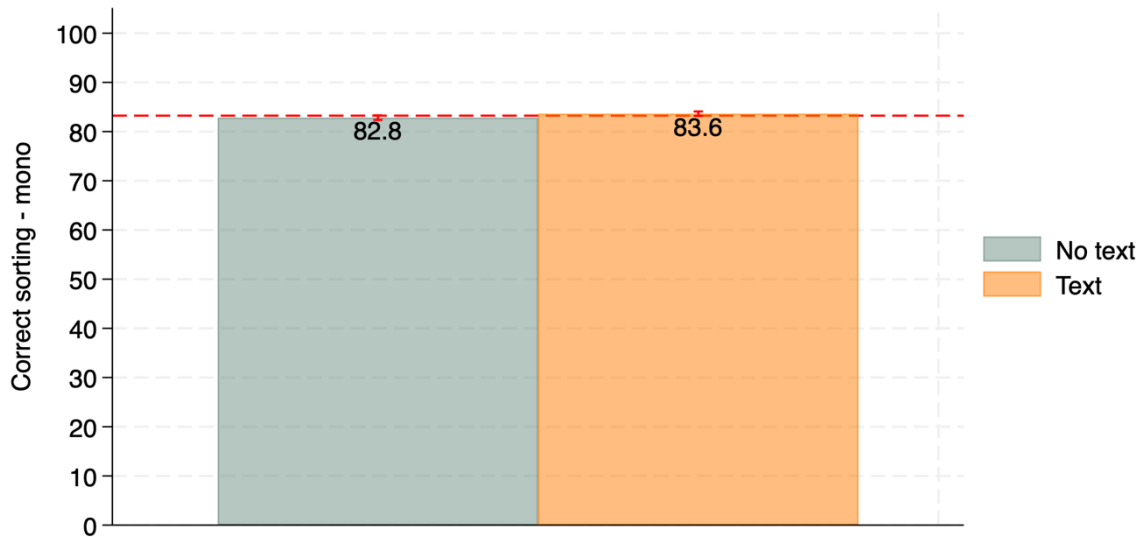


Source: Authors' elaboration

Effect of text on correct sorting, disaggregated

Because the regression analysis identified a significant effect of text on correct sorting, we present the disaggregated results. This breakdown highlights how the presence of text influences sorting accuracy across different product types.

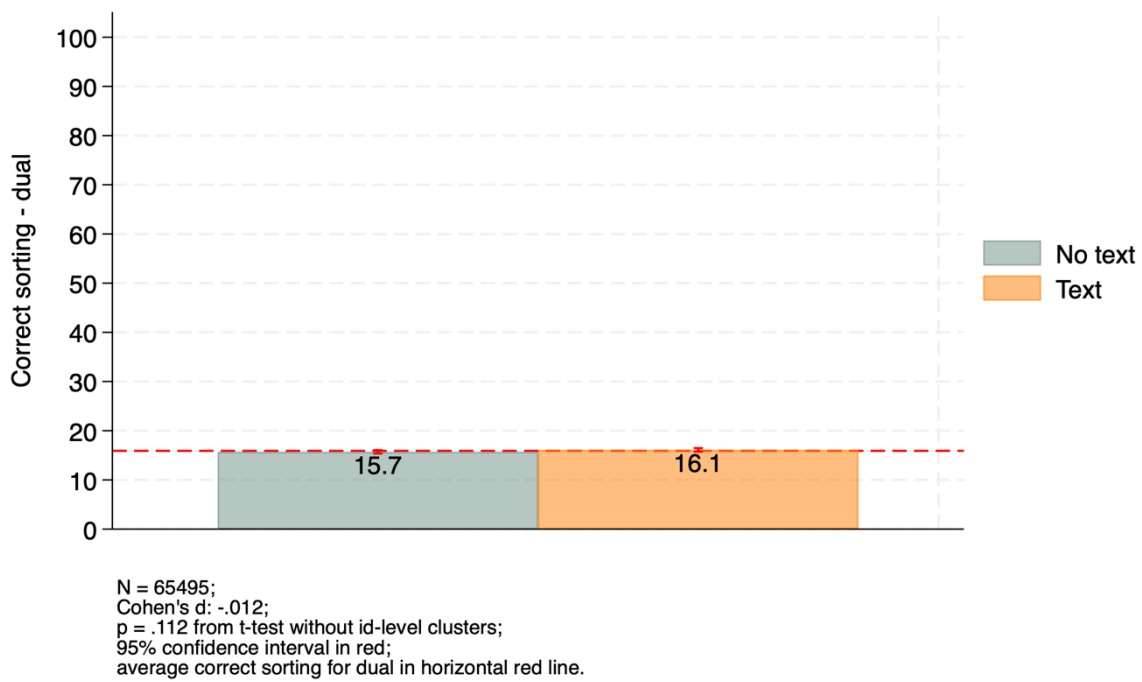
Figure 136 Impact of text on correct sorting - mono



N = 49123;
Cohen's d: -.021;
p = .018 from t-test without id-level clusters;
95% confidence interval in red;
average correct sorting for mono in horizontal red line.

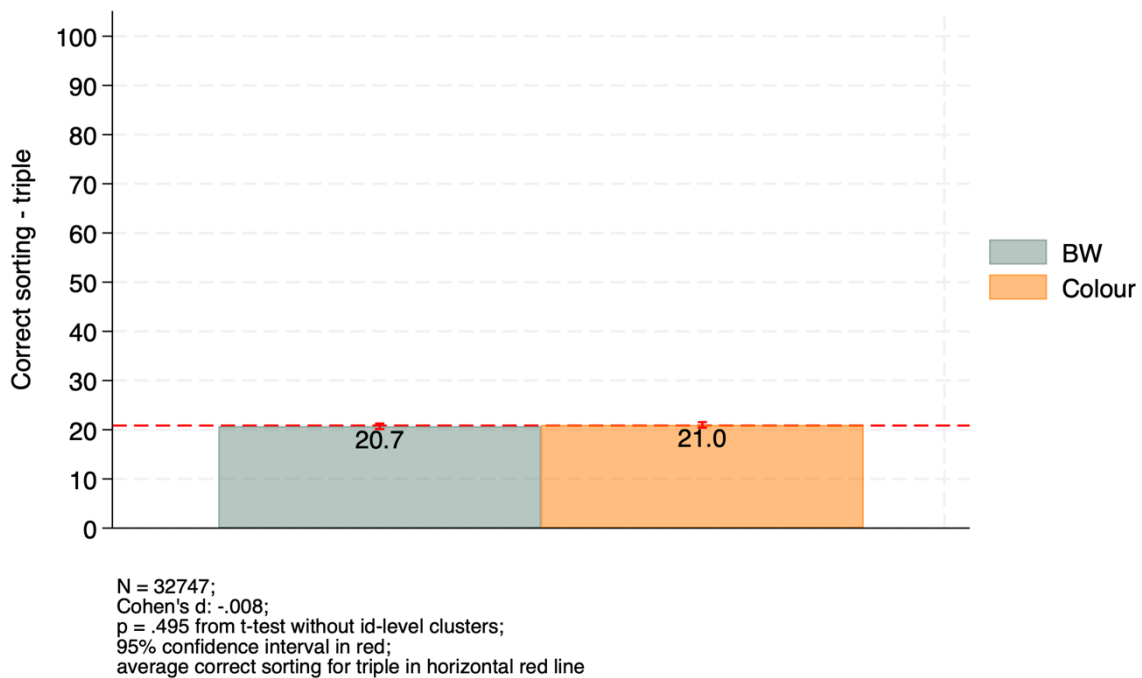
Source: Authors' elaboration

Figure 137: impact of text on correct sorting - dual



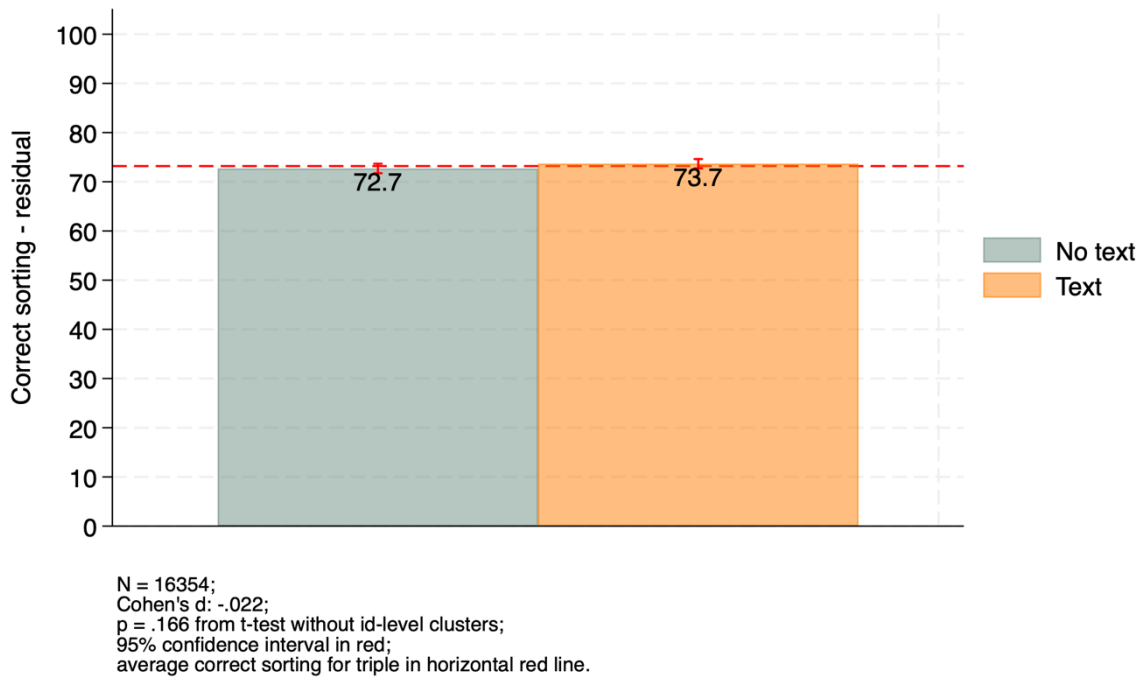
Source: Authors' elaboration

Figure 138: impact of text on correct sorting, triple



Source: Authors' elaboration

Figure 139: impact of text on correct sorting, residual

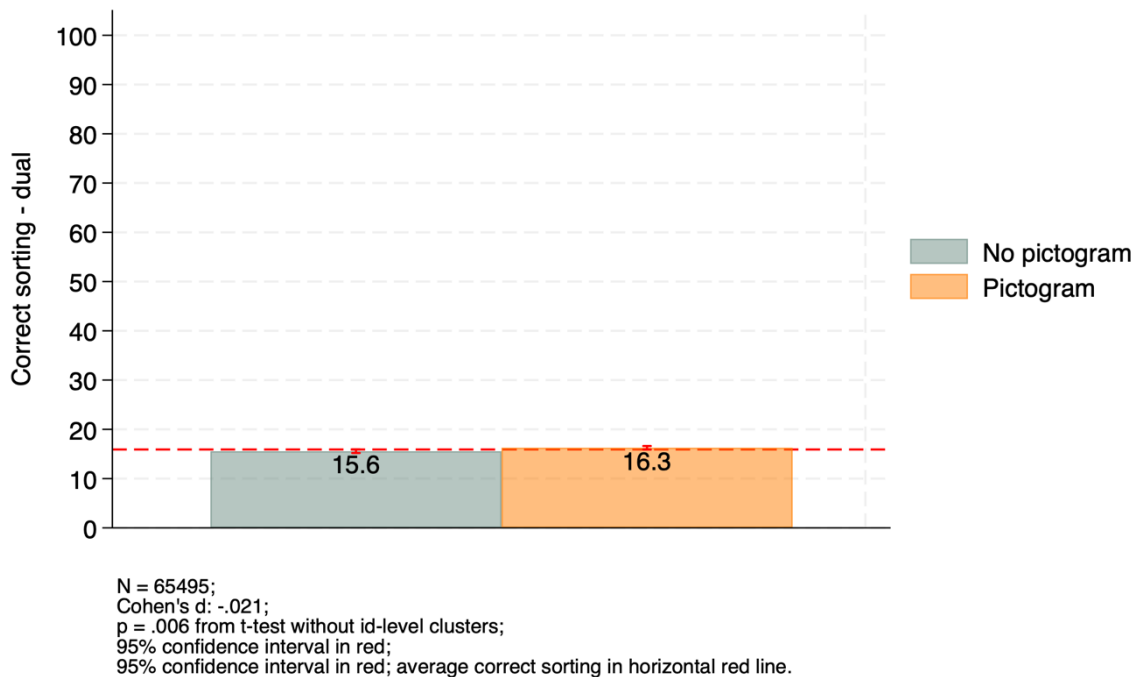


Source: Authors' elaboration

Effect of pictogram on correct sorting, disaggregated

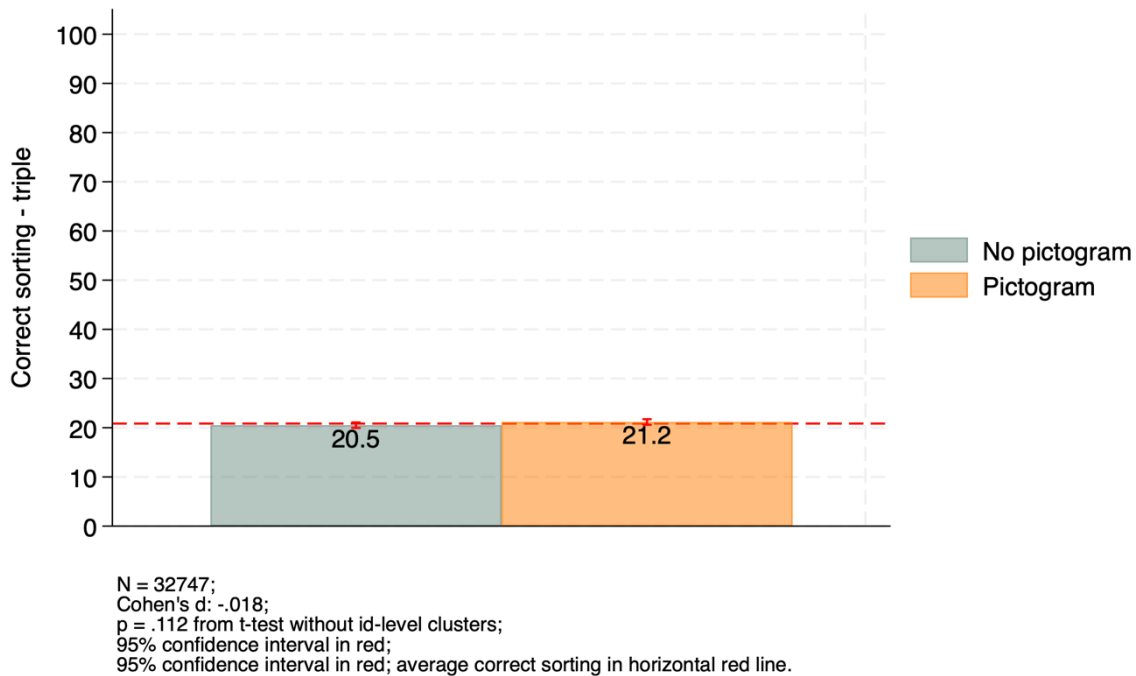
As the regression analysis revealed a significant effect of including a pictogram on correct sorting, we present the disaggregated results. Since the pictogram appeared only on dual and triple material combinations, Figure 142 and Figure 143 illustrate its impact specifically for these product types.

Figure 140: impact of pictogram on correct sorting, dual



Source: Authors' elaboration

Figure 141: impact of pictogram on correct sorting - triple



Source: Authors' elaboration

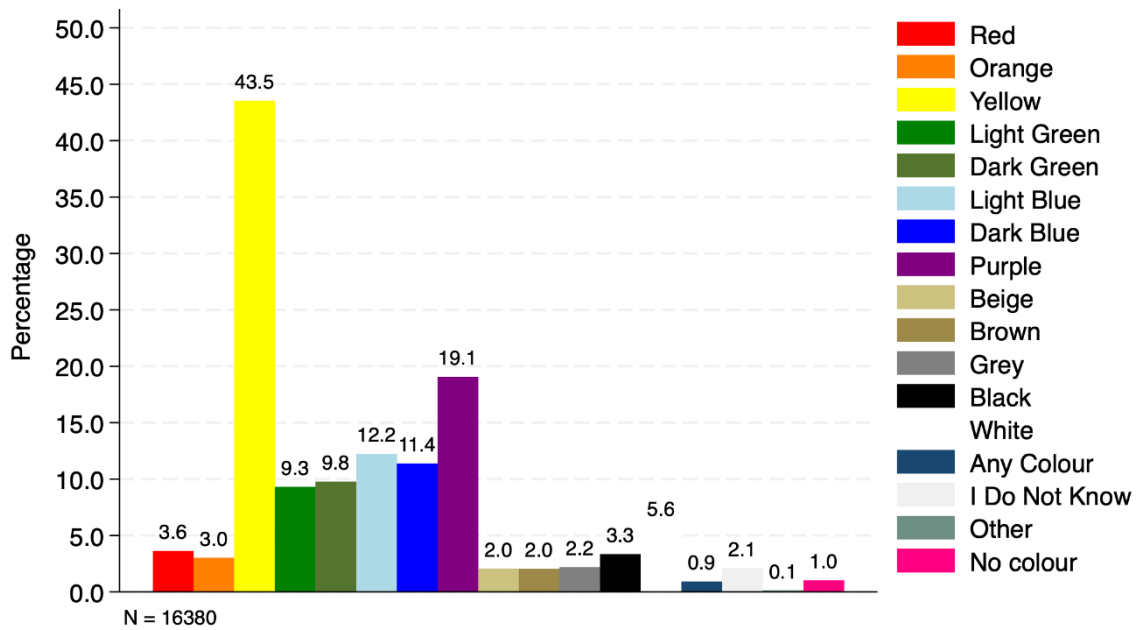
Colour familiarity task

While the earlier analysis provided a high-level overview of dominant colours and general patterns across materials, the next sections focus on the different preferences and variations within each material type. Each subsection below provides a distribution of how familiar participants were with associating certain colours with these materials, offering insights into colour-based perceptions or associations in the context of recycling and material identification. The x-axis represents the different colour options that participants were asked to associate with the material. The y-axis shows the percentage of participants who selected each colour.

Plastic

Figure 144 shows the distribution of colour selections for plastic. The main findings indicate that **yellow (43.5%) was the most frequently chosen colour**, followed by purple (19.1%) and light blue (12.2%). There is a clear preference for yellow, with the remaining colours showing significantly lower percentages.

Figure 142 Plastic colour association

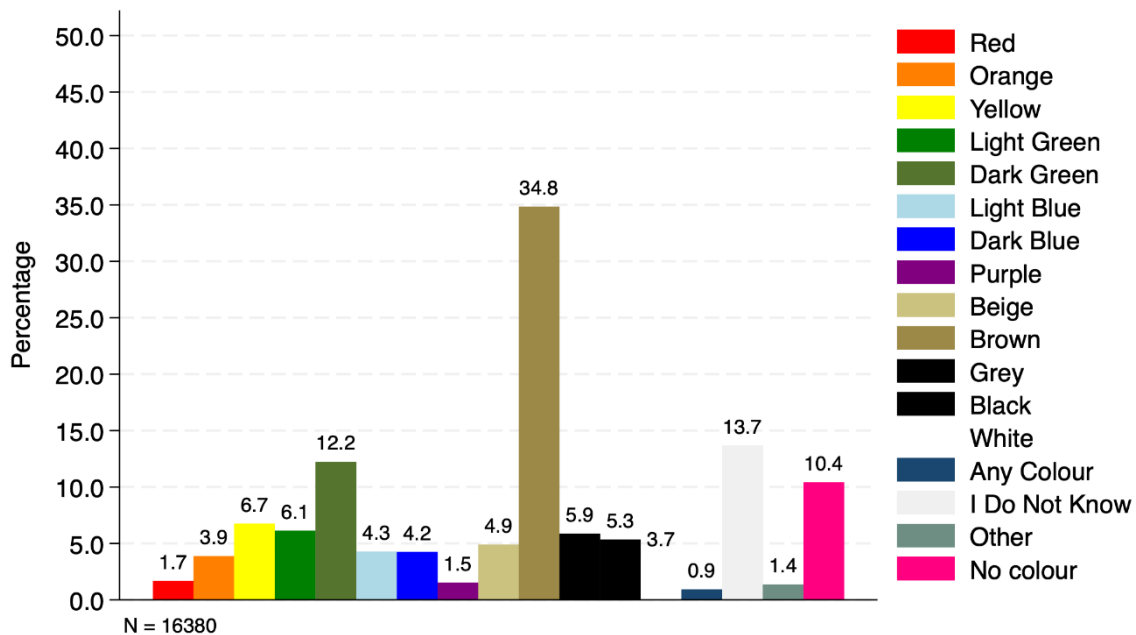


Source: Authors' elaboration

Wood

Figure 145 shows the distribution of colour selections for wood. The main findings indicate that **brown (34.8%) was the most selected colour**, followed by white (13.7%) and dark green (12.2%). Brown demonstrates a dominant preference, suggesting strong associations with wood, while other colours are less frequently selected.

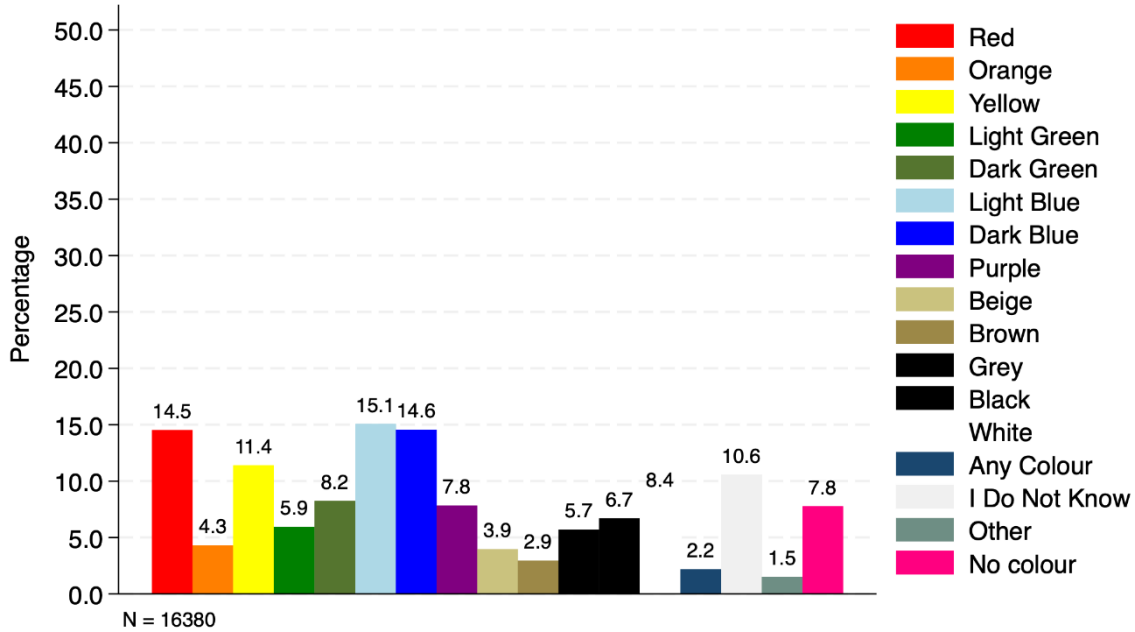
Figure 143 Wood colour association



Textiles

Figure 146 shows the distribution of colour selections for textiles. The main findings indicate that **light blue (15.1%)** and **dark blue (14.6%)** were the most chosen colours, followed closely by **red (14.5%)**. These results show no single dominant colour, but rather three colours with nearly equal preference.

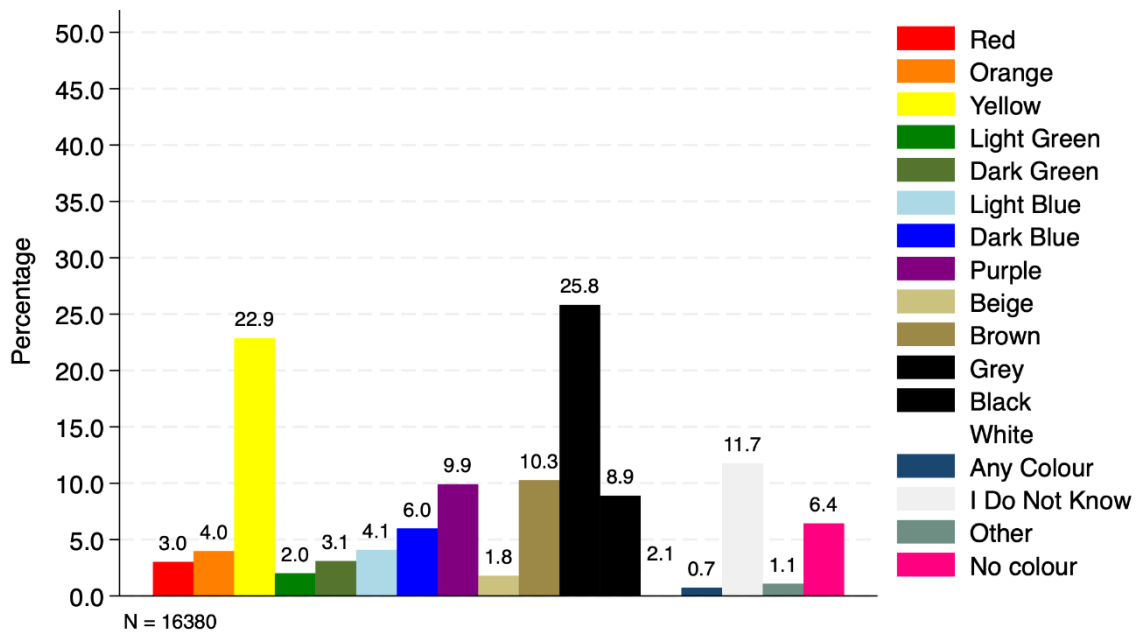
Figure 144 Textiles colour association



Steel

Figure 147 shows the distribution of colour selections for steel. The main findings indicate that **black (25.8%)** and **yellow (22.9%)** were the most commonly selected colours, with **white (11.7%)** also receiving notable selections. These results show a relatively strong preference for black and yellow compared to other colours.

Figure 145 Steel colour association

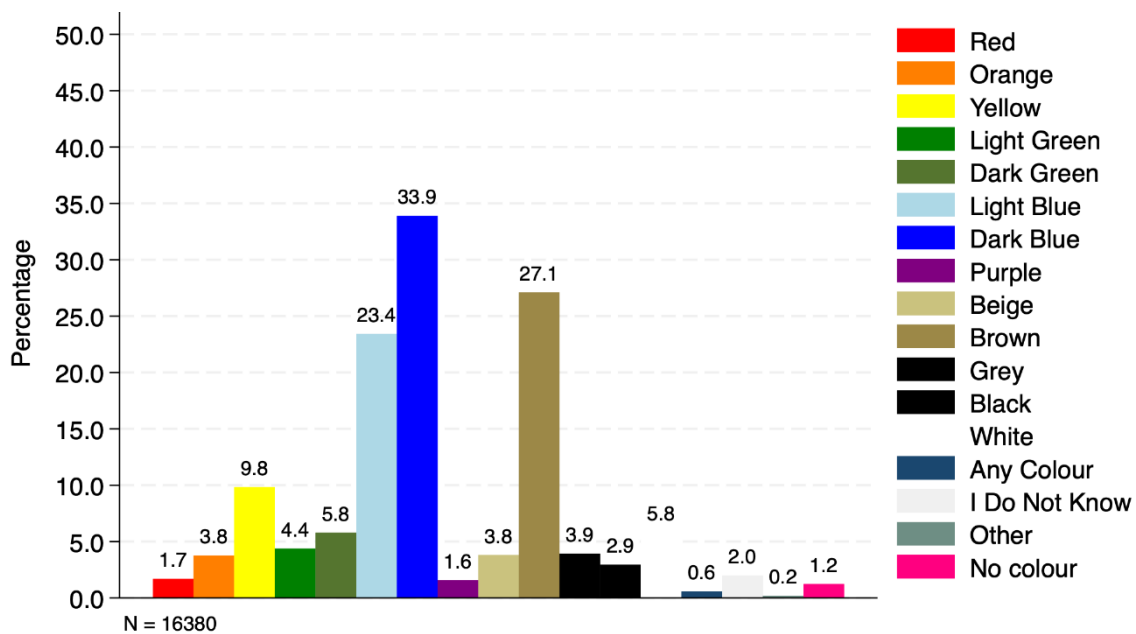


Source: Authors' elaboration

Paper

Figure 148 shows the distribution of colour selections for paper. The main findings indicate that **dark blue (33.9%)** was the most frequently chosen colour, followed by **brown (27.1%)** and **light blue (23.4%)**. There is a noticeable preference for these three colours, with dark blue being the most dominant.

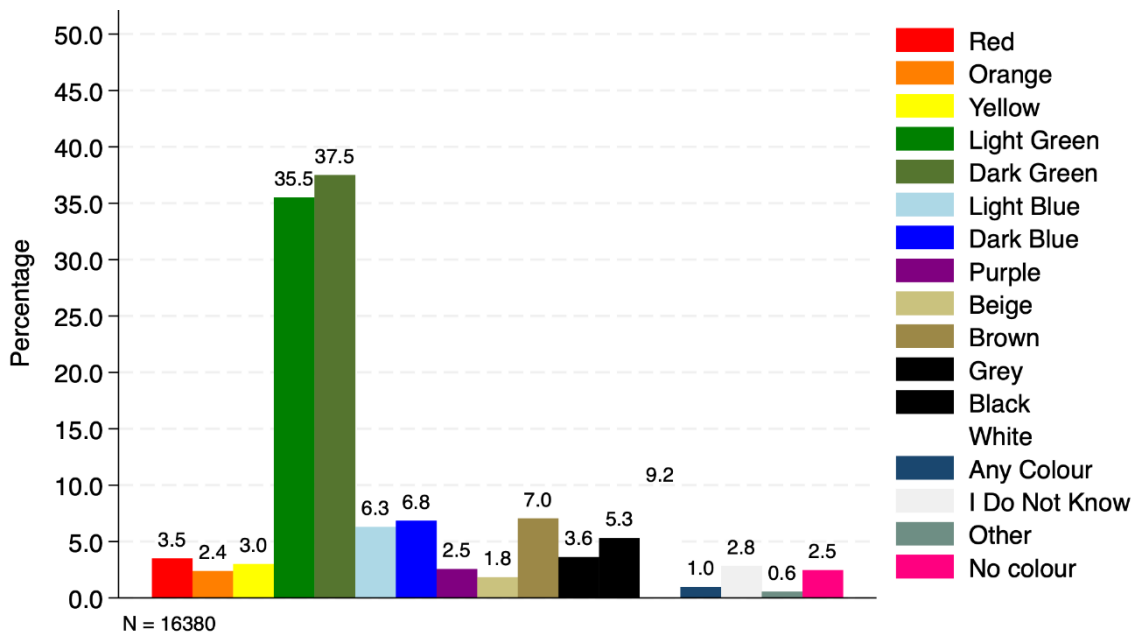
Figure 146 Paper colour association



Glass

Figure 149 shows the distribution of colour selections for glass. **The main findings indicate that dark green (37.5%) and light green (35.5%) were the most chosen colours**, with these two accounting for a strong majority. The remaining colours received significantly lower percentages, showing a clear preference for green shades.

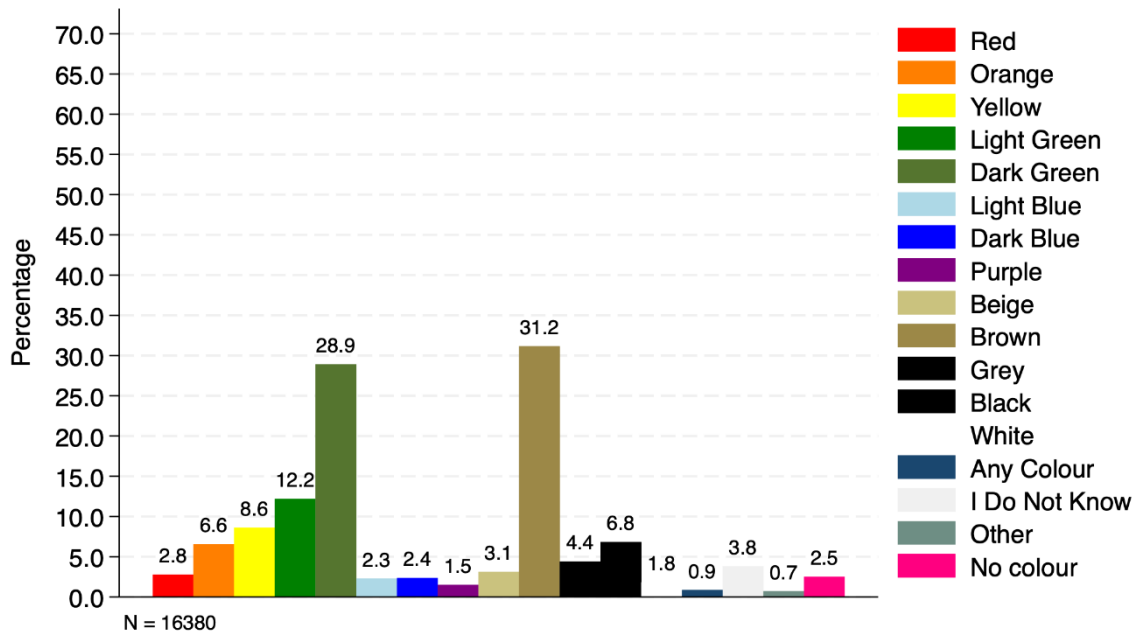
Figure 147 Glass colour association



Compostable material

Figure 150 shows the distribution of colour selections for compostable material. The main findings indicate that **brown (31.2%)** was the most frequently chosen colour, followed by **dark green (28.9%)**. These results suggest a strong association of compostable material with natural and earthy tones.

Figure 148 Compostable colour association

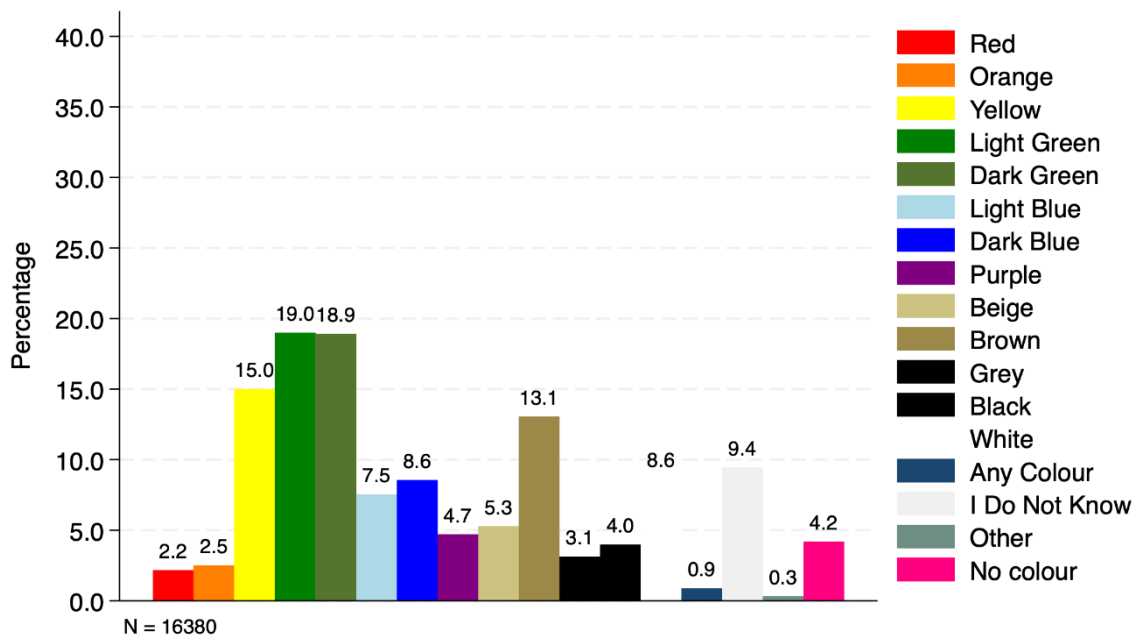


Source: Authors' elaboration

Bioplastics

Figure 151 shows the distribution of colour selections for bioplastics. The main findings indicate that **dark green (18.9%)** and **light green (19.0%)** were nearly equally dominant, with **yellow (15.0%)** also receiving a notable share. These results highlight a preference for green shades, reflecting eco-friendly associations.

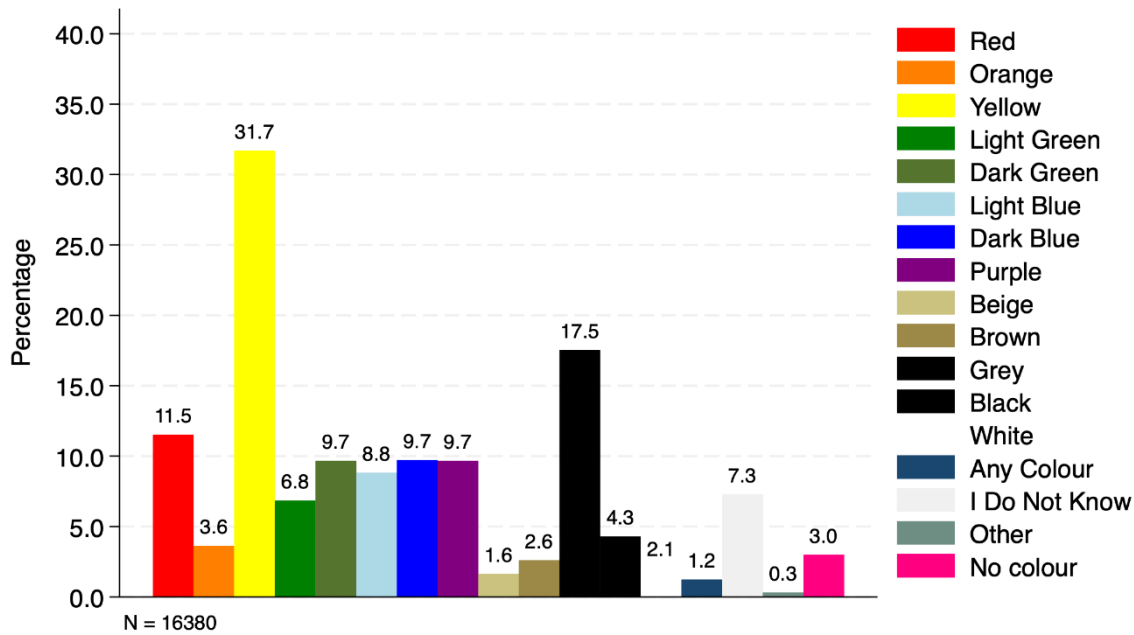
Figure 149 Bioplastics colour association



Aluminium

Figure 152 shows the distribution of colour selections for aluminium. The main findings indicate that **yellow (31.7%)** was the most frequently chosen colour, followed by **grey (17.5%)** and **red (11.5%)**. There is a clear preference for yellow, with grey showing a secondary association.

Figure 150 Aluminium colour association



Source: Authors' elaboration

Label builder task

This section presents the results of the label builder task, focusing on participants' preferences for specific label characteristics across packaging and waste receptacles. The analysis employs probit models to estimate the marginal effects of sociodemographic variables on label preferences. Specifically, we analyse the effect on the following dimensions:

- **Colour preference:** Preferences for black-and-white versus colour labels.
- **Text preference:** Preferences for including text descriptions on labels.
- **National language:** Preferences for labels presented in the national language.
- **Material identifier:** Preference for including material identifier.
- **Multicomponent label:** Preference for including multicomponent label.
- **QR code inclusion:** Preferences for including QR codes on labels.

Label builder task regressions

The following tables present the results of probit models analysing the marginal effects of various sociodemographic variables on preferences for waste sorting label characteristics. First, we present a

table that focuses on preferences for black-and-white versus colour labels on product packaging and waste receptacles. Next, the second table examines preferences for including text descriptions on labels for both product packaging and waste receptacles. We then present the results of multinomial model including sociodemographic controls on language preferences on product packaging and waste receptacles, followed by probit model testing the impact sociodemographic variables on preference material identifier, multicomponent label, and QR code. Each table includes the following variables: gender, age groups, country of residence, education level, housing type, area of residence, income categories, and additional characteristics such as mobile device usage, visual impairments, colour blindness, and cognitive difficulties. Results are presented separately for packaging labels (Column 1) and waste receptacle labels (Column 2). These models provide detailed insights into how sociodemographic and individual traits influence label preferences.

Table 60 Marginal effects of probit model – sociodemographic controls on colour or B&W labels

	(1)	(2)
DV: Preference for B&W labels (0-1)	Prefer B&W packaging labels	Prefer B&W receptacle labels
Age	-0.006*** (0.001)	-0.004*** (0.001)
Education	0.002* (0.001)	0.006*** (0.001)
Income (quartile)	-0.003** (0.001)	-0.010*** (0.001)
House = 2, Condo/Apartment	0.023*** (0.003)	0.021*** (0.003)
House = 3, Shared housing	-0.012** (0.004)	-0.024*** (0.004)
House = 4, I prefer not to answer	-0.075*** (0.010)	-0.115*** (0.009)
House = 5, Other	-0.059*** (0.007)	-0.081*** (0.006)
Area = 2, Suburban	0.013*** (0.003)	0.008** (0.003)
Area = 3, Rural	-0.027*** (0.003)	-0.012*** (0.003)
Mobile	0.011* (0.005)	0.027*** (0.005)
Colour blindness	0.095*** (0.013)	0.082*** (0.013)
Visual impairments	0.093*** (0.013)	0.068*** (0.013)
Cognitive difficulties	0.010	0.100***

	(0.011)	(0.011)
Observations	146,870	146,870

Robust standard errors. Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Table 61 Marginal effects of probit model – sociodemographic controls on text or no text

DV: Preference for Text labels (0-1)	(1)	(2)
	Prefer Text packaging labels	Prefer Text waste receptacles
Age	0.007*** (0.000)	0.004*** (0.000)
Education	-0.002** (0.001)	-0.006*** (0.001)
Income (quartile)	0.001 (0.001)	0.005*** (0.001)
House = 2, Condo/Apartment	0.007*** (0.002)	0.002 (0.002)
House = 3, Shared housing	-0.040*** (0.003)	-0.057*** (0.003)
House = 4, I prefer not to answer	0.062*** (0.005)	0.088*** (0.003)
House = 5, Other	0.004 (0.005)	0.020*** (0.005)
Area = 2, Suburban	0.005* (0.002)	0.001 (0.002)
Area = 3, Rural	0.005* (0.002)	-0.015*** (0.002)
Mobile	-0.009** (0.004)	-0.003 (0.003)
Colour blindness	-0.050*** (0.009)	-0.044*** (0.009)
Visual impairments	-0.041*** (0.009)	-0.044*** (0.009)
Cognitive difficulties	-0.027*** (0.007)	-0.075*** (0.007)
Observations	147,850	148,590

Robust standard errors. Country effects included in the models but not shown for ease of presentation.

* $p < .05$; ** $p < .01$; *** $p < .001$. Source: Author's elaboration.

Table 62: Marginal effects of multinomial model - sociodemographic controls on language preferences on product packaging

	Age	Education	Income	Condo	Shared housing	House - Prefer not to answer	House - Other	Suburban	Rural	Mobile phone	Colour blind	Visual impairment	Cognitive difficulty
National language	0.0235*** (0.00208)	-0.00891** (0.00375)	0.0158*** (0.00399)	-0.00365 (0.00911)	-0.0282* (0.0153)	-0.0938** (0.0371)	0.0581* (0.0305)	0.0276*** (0.0101)	0.0307*** (0.0113)	0.0911*** (0.0188)	0.154** (0.0631)	0.140*** (0.0534)	0.175*** (0.0437)
English	-0.0128*** (0.00143)	0.0131*** (0.00273)	-0.00534* (0.00280)	0.0373*** (0.00657)	0.0255** (0.0102)	-0.0500** (0.0219)	-0.0406** (0.0171)	-0.0348*** (0.00640)	-0.0254*** (0.00765)	-0.0569*** (0.0101)	0.0819** (0.0366)	0.0721** (0.0362)	0.0321 (0.0293)
Both languages	-0.0112*** (0.00222)	-0.00586 (0.00403)	-0.0106** (0.00425)	-0.0384*** (0.00970)	0.00543 (0.0162)	0.137*** (0.0427)	-0.0279 (0.0316)	0.00400 (0.0105)	-0.0135 (0.0119)	-0.0466** (0.0188)	-0.253*** (0.0726)	-0.0342 (0.0618)	-0.0823 (0.0502)
I am not sure	0.000266 (0.000345)	0.000519 (0.000593)	-0.00124** (0.000587)	0.00280** (0.00122)	0.00226 (0.00212)	-0.00279*** (0.000652)	0.00709 (0.00605)	0.000744 (0.00130)	0.00305 (0.00206)	0.0135** (0.00606)	0.00779** (0.00322)	-0.0541*** (0.00781)	0.00136 (0.00481)
I don't care	0.000229 (0.000474)	0.00119 (0.000826)	0.00144 (0.000959)	0.00193 (0.00181)	-0.00496** (0.00244)	0.00998 (0.0193)	0.00326 (0.00612)	0.00245 (0.00203)	0.00502* (0.00268)	-0.00113 (0.00262)	0.00927 (0.00932)	-0.124*** (0.0126)	-0.126*** (0.0126)
Observations	13,263	13,263	13,263	13,263	13,263	13,263	13,263	13,263	13,263	13,263	13,263	13,263	13,263

Note: Standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$. Base categories and country coefficients omitted for ease of presentation.

Source: Author's elaboration.

Table 63: Marginal effects of multinomial model -- sociodemographic controls on language preferences on waste receptacles

	Age	Education	Income	Condo	Shared housing	House - Prefer not to answer	House - Other	Suburban	Rural	Mobile phone	Colour blind	Visual impairment	Cognitive difficulty
National language	0.0240***	-0.00554	0.0207***	0.00234	-0.0619***	-0.111**	0.0741**	0.0365** *	0.0382** *	0.0645***	0.113	0.274***	0.124**
	(0.00228)	(0.00408)	(0.00418)	(0.0102)	(0.0171)	(0.0549)	(0.0308)	(0.0113)	(0.0122)	(0.0203)	(0.0804)	(0.0653)	(0.0517)
English	-0.0128***	0.00829***	-0.00923***	0.0208***	-0.00128	0.0207	-0.0530***	- 0.0336** *	- 0.0409** *	-0.0457***	0.0902**	0.0163	0.0360
	(0.00145)	(0.00275)	(0.00278)	(0.00686)	(0.0102)	(0.0447)	(0.0153)	(0.00684)	(0.00746)	(0.0122)	(0.0429)	(0.0429)	(0.0360)
Both languages	-0.0109***	-0.00378	-0.0120***	-0.0270**	0.0699***	0.0788	-0.0275	-0.00648	-0.00448	-0.0227	-0.172**	-0.113	-0.0301
	(0.00239)	(0.00438)	(0.00444)	(0.0107)	(0.0181)	(0.0656)	(0.0316)	(0.0117)	(0.0127)	(0.0208)	(0.0837)	(0.0785)	(0.0588)
I am not sure	-7.50e-05	0.000164	-0.000267	0.00152	0.000135	-0.00262***	0.00400	0.00184	0.00220	0.00426	-0.0439***	-0.0448***	0.00478
	(0.000345)	(0.000558)	(0.000502)	(0.00129)	(0.00182)	(0.000723)	(0.00474)	(0.00147)	(0.00184)	(0.00343)	(0.00869)	(0.00864)	(0.00397)
I don't care	-0.000212	0.000872	0.000778	0.00236	-0.00684***	0.0141	0.00232	0.00167	0.00498	-0.000339	0.0130	-0.133***	-0.134***
	(0.000531)	(0.000910)	(0.00100)	(0.00211)	(0.00211)	(0.0234)	(0.00646)	(0.00228)	(0.00315)	(0.00315)	(0.0101)	(0.0148)	(0.0147)
Observations	10,747	10,747	10,747	10,747	10,747	10,747	10,747	10,747	10,747	10,747	10,747	10,747	10,747

Note: Standard errors in parentheses. *** $p < .01$, ** $p < .05$, * $p < .1$. Base categories and country coefficients omitted for ease of presentation.
Source: Author's elaboration.

Table 64 Marginal effects of probit model – sociodemographic controls on preference for material identifier

DV: Preference for Material Identifier (0-1)	(1) Prefer material identifier - packaging labels	(2) Prefer material identifier - receptacle labels
Age	-0.000 (0.002)	0.002 (0.002)
Education	-0.003 (0.003)	-0.015*** (0.003)
Income (quartile)	0.000 (0.003)	-0.002 (0.003)
House = 2, Condo/apartment	-0.047*** (0.007)	-0.067*** (0.008)
House = 3, Shared housing	-0.071*** (0.013)	-0.075*** (0.013)
House = 4, I prefer not to answer	0.066* (0.029)	0.036 (0.034)
House = 5, Other	-0.142*** (0.026)	-0.201*** (0.027)
Area = 2, Suburban	-0.018* (0.008)	-0.026** (0.008)
Area = 3, Rural	-0.031*** (0.009)	-0.054*** (0.010)
Mobile	0.044*** (0.013)	0.013 (0.014)
Colour blindness	0.000 (0.043)	-0.079 (0.043)
Visual impairments	-0.079* (0.040)	-0.049 (0.042)
Cognitive difficulties	-0.032 (0.033)	-0.039 (0.035)
Observations	15,630	15,630

Robust standard errors. Country effects included in the models but not shown for ease of presentation.

*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Table 65 Marginal effects of probit model – sociodemographic controls on preference for multicomponent pictogram

(1)	
DV: Preference for multicomponent pictogram (0-1)	Prefer adding multicomponent pictogram
Age	-0.000 (0.002)
Education	0.015*** (0.003)
Income (quartile)	0.003 (0.003)
House = 2, Condo/apartment	-0.025*** (0.007)
House = 3, Shared housing	-0.028** (0.011)
House = 4, I prefer not to answer	0.021 (0.028)
House = 5, Other	-0.051* (0.022)
Area = 2, Suburban	0.028*** (0.007)
Area = 3, Rural	0.015 (0.008)
Mobile	-0.001 (0.013)
Colour blindness	0.021 (0.040)
Visual impairments	-0.087* (0.036)
Cognitive difficulties	-0.033 (0.030)
Observations	15,630

Robust standard errors. Country effects included in the models but not shown for ease of presentation.
*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

Table 66 Marginal effects of probit model – sociodemographic controls on preference for QR code

	(1)	(2)
DV: Preference for QR code (0-1)	Prefer QR code - packaging labels	Prefer QR code - receptacle labels
Age	-0.003 (0.002)	-0.001 (0.002)
Education	-0.008* (0.004)	-0.017*** (0.004)
Income (quartile)	-0.004 (0.004)	-0.010** (0.004)
House = 2, Condo/Apartment	-0.040*** (0.008)	-0.064*** (0.009)
House = 3, Shared housing	0.020 (0.013)	0.005 (0.014)
House = 4, I prefer not to answer	0.036 (0.039)	0.048 (0.039)
House = 5, Other	-0.211*** (0.028)	-0.232*** (0.028)
Area = 2, Suburban	-0.016 (0.009)	-0.024** (0.009)
Area = 3, Rural	-0.052*** (0.010)	-0.079*** (0.011)
Mobile = 1	0.006 (0.016)	-0.006 (0.017)
Colour blindness	0.066 (0.052)	0.020 (0.052)
Visual impairment	-0.091 (0.046)	-0.039 (0.049)
Cognitive difficulties	-0.035 (0.039)	-0.019 (0.041)
Observations	15,630	15,630

Robust standard errors. Country effects included in the models but not shown for ease of presentation.
*p<.05; **p<.01; ***p<.001. Source: Author's elaboration.

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