COmmunity-Based Organized Littering

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A gamification processor that enriches the dashboard and the user profiles with gamified information

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Abstract

Minimizing littering and waste is a critical sustainability challenge requiring the cooperation of different professionals and agencies. Abandoned waste is mainly the consequence of the unethical and illegal behavior of citizens. Involving the citizens themselves in removing the waste has both short-term and long-term effects. Citizen participation is often incentivized by gamification, with interesting applications, making monotonous tasks more appealing for the users. In this deliverable, we report our preliminary proposal for the integration of gamification techniques to enable the engagement of all the stakeholders playing a role in the littering disposal process, including citizens, in the littering reporting process in the context of the COBOL project. Furthermore, we present the pilot study we are launching to demonstrate the effectiveness of the waste reporting platform and to assess the impact of the gamification processor.

Keyword list

Gamification, citizen participation,litter disposal process

Glossary, acronyms & abbreviations

Item	Description
COBOL	COmmunity-Based Organized Littering
DPPs	Digital Participatory Platforms
SDGs	Sustainable Development Goals
KPIs	Key Performance Indicators

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1 Introduction

Littering is an environmental problem that affects citizens' economy, safety, and health. Natural and rural areas are often targets of abandoned littering, while urban areas often accumulate more waste than can be disposed of in a timely manner.

Minimizing littering and waste is a critical sustainability challenge requiring the cooperation of different professionals and agencies. Abandoned waste is mainly the consequence of the unethical and illegal behavior of citizens (Amizi et al., 2018) . *Involving the citizens* themselves in removing the waste has both short-term and long-term effects. In the short term, if citizens proactively engage in waste disposal, the environment will be cleaner. In the long term, the involvement of the citizens can likely increase awareness and respect for the environment, our cities, and our countryside, prospectively reducing the amount of abandoned waste through education.

For this reason, engaging citizens in preventing, detecting, and removing waste is crucial to generating a long-lasting impact. A trend of recent years has redirected the services of local administrations to Digital Participatory Platforms (DPPs), which are collaborative data production platforms that can help local administrators make decisions. Interesting examples are CitizenLab, CollaborativeMap, and Crowdbrite (Falco et al., 2018). Citizen participation is often incentivized by gamification, with interesting applications, making monotonous tasks more appealing for the users (Morschheuser et al., 2016). Any realistic solution must be based on lightweight engagement models that exploit citizens' contributions but do not exclusively rely on their proactive inputs.

Gamification has proven to be an effective strategy to increase users' long-term engagement, motivation and participation in digital services, including environmental and civic reporting applications. For instance, platforms like FixMyStreet use achievement systems to recognize active users and stimulate participation. Moreover, literature on gamification design (e.g., Werbach & Hunter, 2012; Hamari et al., 2014) highlights the importance of aligning game mechanics with intrinsic motivators, such as competence, autonomy, and social relatedness, to avoid superficial engagement and foster meaningful behavioral change.

In this deliverable, we report our vision and preliminary proposal for the integration of gamification techniques to enable the engagement of all the stakeholders playing a role in the littering disposal process, including citizens, in the littering reporting process in the context of the COBOL project. Specifically, we integrate gamification elements in the context of our waste reporting platform, not only to encourage the reporting of abandoned waste, but also to foster a sense of community responsibility and lasting contribution.

We designed a gamification processor that integrates reward mechanisms into both the user profile and an administration dashboard. This processor dynamically computes and updates gamified information, such as reporting points, and rankings, based on user activities within the app. The goal is to make participation more rewarding and visible, thereby enhancing the overall effectiveness and user retention of the platform.

In the administration dashboard, the progress achieved in waste management is monitored and publicly reported according to a set of Key Performance Indicators (KPIs). This is extremely important to measure the impact of actions and further incentivize citizens and public authorities to participate in the waste removal process. COBOL includes dashboards to ensure the transparency of the processes. For instance, in the context of the Sustainable Development Goals (SDGs) the indicator

number 12.4.2 is about collecting information on the treatment of waste, the generation of hazardous waste, and the hazardous waste management.

The rest of the deliverable is organized as follows:

- Section 2 presents the pilot study we plan with the students of a middle school;
- Section 3 describes the Gamification Processor we integrate into the reporting platform;
- Section 4 concludes the document with some remarks and future directions.

2 COBOL Challenge

To demonstrate the effectiveness of the waste reporting platform and to assess the impact of the gamification processor, we are launching a pilot study involving middle school students from a municipality in the Abruzzo region: Magliano de' Marsi.

The pilot will involve two classes of students, each participating in a gamified tournament designed to test both the usability of the application and the motivational effect of the rewarding mechanisms. The tournament will run in two parallel modes: an individual competition and a team-based competition. In the team-based mode, students will be grouped into teams of three to four members, collaborating in the identification and reporting of abandoned waste in their municipalities.

Throughout the pilot, participants will use the mobile application to submit geolocated reports of waste, complete with descriptive information and photographic evidence. Each report triggers the gamification processor, which dynamically evaluates the submission and assigns a score based on predefined reward rules. The status of each submission initially appears as *Started* and, after manual verification, is updated to either *Received* or *Confirmed*. Points are awarded only for *Confirmed* reports to ensure accuracy and discourage false reporting. The reward mechanism has been carefully designed to reflect both the impact and the quality of the report. The rewarding points are calculated according to the *type of waste*, assigning higher points to more environmental relevant waste (e.g.1 point for paper, 5 points for asbestos) multiplied by the *estimated size of the waste site* (i.e., if the waste site is small 1 point, if it is medium 2 points, otherwise if it is large 3 points). If several pictures from different angles are attached to the report, *extra points* are awarded for the quality of the pictures. This approach aims to promote not only the quantity but also the quality and relevance of the reports submitted.

For the team competition, group scores are computed by averaging the individual scores of team members, encouraging collaboration while still valuing individual contributions. This aggregation method also mitigates unbalanced group participation and supports peer-driven motivation.

At the conclusion of the pilot, two leaderboards will be presented: one showcasing the top-performing individuals, and another highlighting the best-performing teams. These rankings will be integrated directly into the dashboard of the application and visible within each participant's user profile, reinforcing the sense of progression and achievement.

By embedding gamification deeply into both the frontend and backend logic of the platform, this pilot aims to validate the hypothesis that rewarding mechanisms can meaningfully boost participation, data quality, and environmental awareness among younger users.

3 The Gamification Processor

The gamification processor is a core component of the platform, designed to automatically evaluate user activity and translate it into gamified elements visible in the user profiles and in the administrative dashboard. Its main goal is to increase engagement, stimulate healthy competition, and promote high-quality contributions from users.

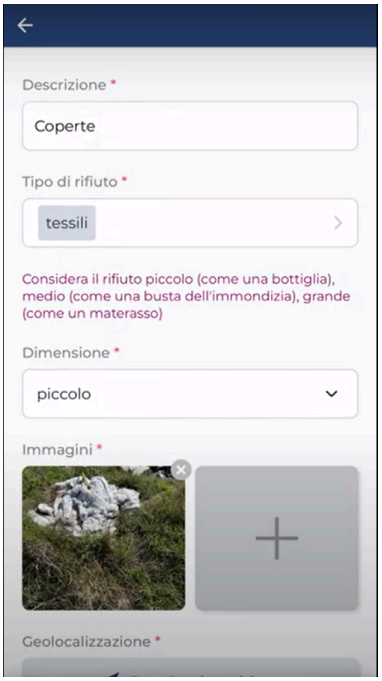
In the case of the pilot study, the rewarding process starts when a report is *Received* and the operator checks it. If the report is *confirmed*, then the gamification processor calculates the rewarding points based on the following formula:

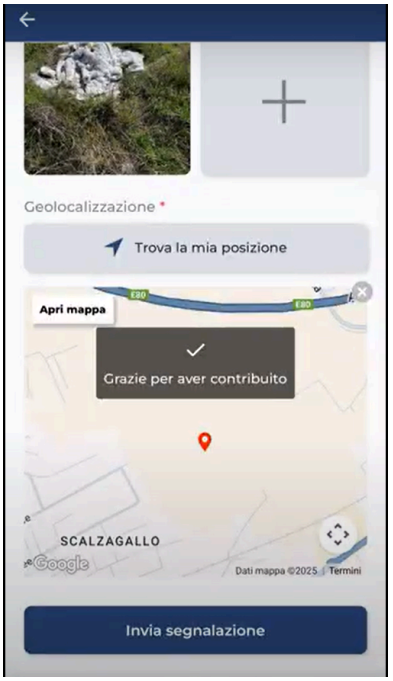
```
Reward = (waste_type x waste_size) + extra_points
```

Where the waste_type gives a reward based on the type of identified waste, e.g., plastic is quite common to find and gives 1 point, whereas asbestos may contribute 5 points. The waste size is declared on a scale of small, medium and large, each contributing with 1, 2, and 3 scale factors. The extra points are used by the manual operator and especially in the challenge, to give some extra points to users contributing with well-defined pictures or with more pictures on the same reporting site. This parameter can also be used for negative rewards to discourage unfair behaviours or workarounds.

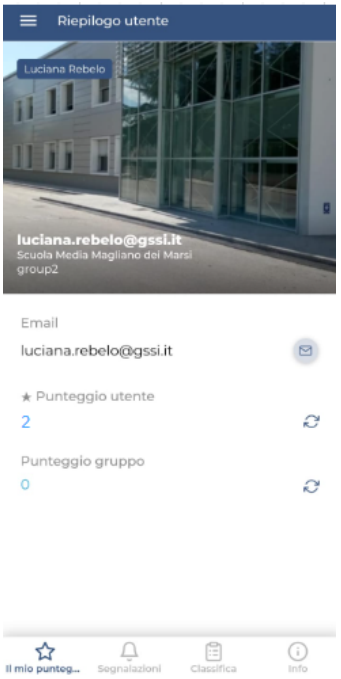
The rewarding rules are encoded in the backend logic and can be configured dynamically through an admin panel, allowing for future extension or tuning based on pilot results.

This process is repeated for every report submitted by the users. On the platform, they can monitor their rewarding score together with the one accumulated by their group on a *Summary Page* like the one in the figure on the left.





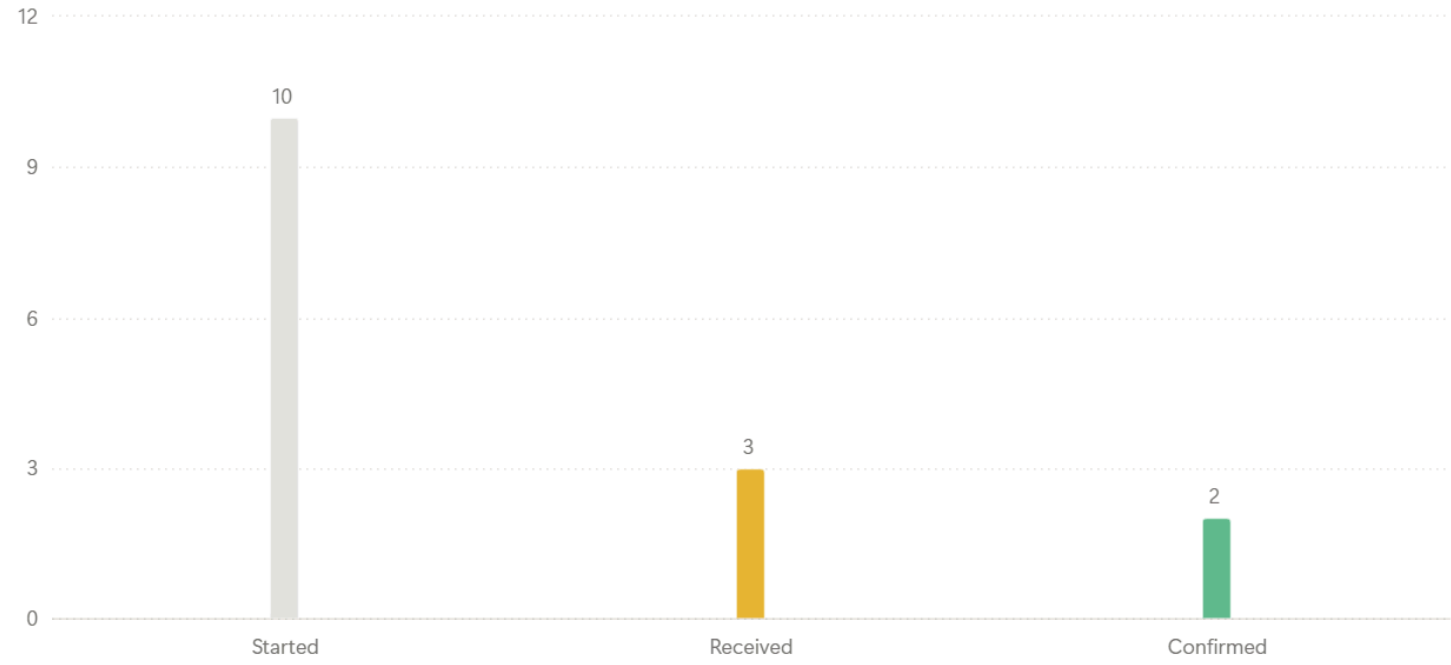
In the figures above, the report submission process is reported. Specifically, in the first one the creation of a report is started by clicking on the "+" button in the *Reports* page. Once specifying a textual description, the type and size of wast,e and uploading the photos (second figure), the platform may geolocalise the report before submitting it (third figure).

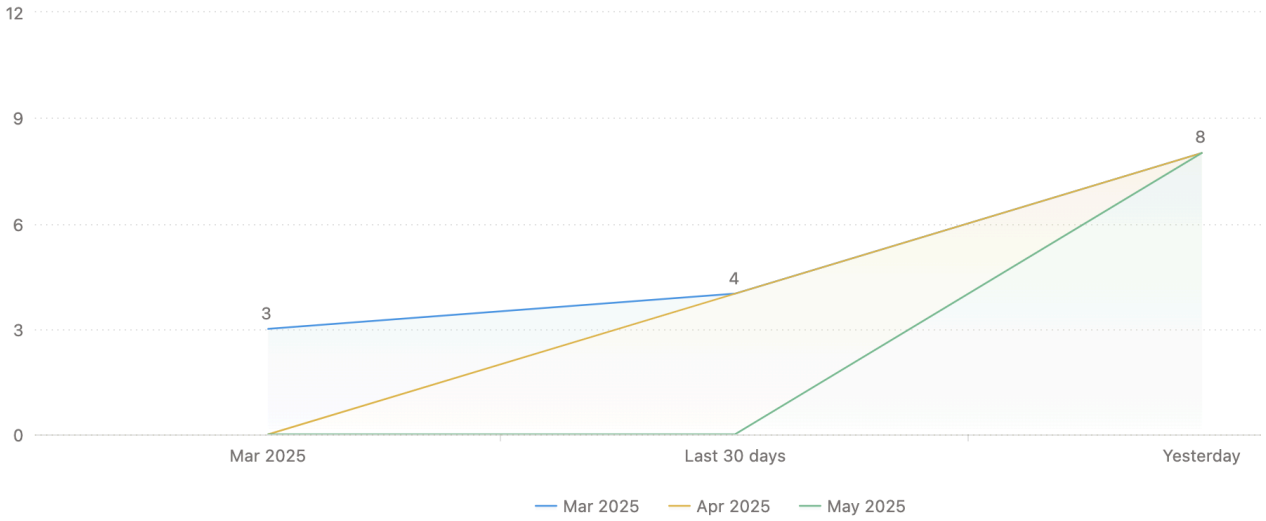


As shown in the figure on the right, after the submission of the report and its confirmation by the operator, the corresponding points are added to the user score.

A key design choice has been the integration of **Notion** as a lightweight backend for collecting and organizing the data generated during the pilot. Each report, user profile, and score is logged into shared Notion tables, which act as both a live repository and an interface for teachers and organizers. This setup offers multiple advantages, such as easy data accessibility without requiring technical knowledge. Furthermore, Notion's native support for **custom views and charts** allows the creation of tailored dashboards to monitor individual or group progress and also collaboration among project stakeholders and educators, who can annotate, tag, and review submissions directly in the workspace.

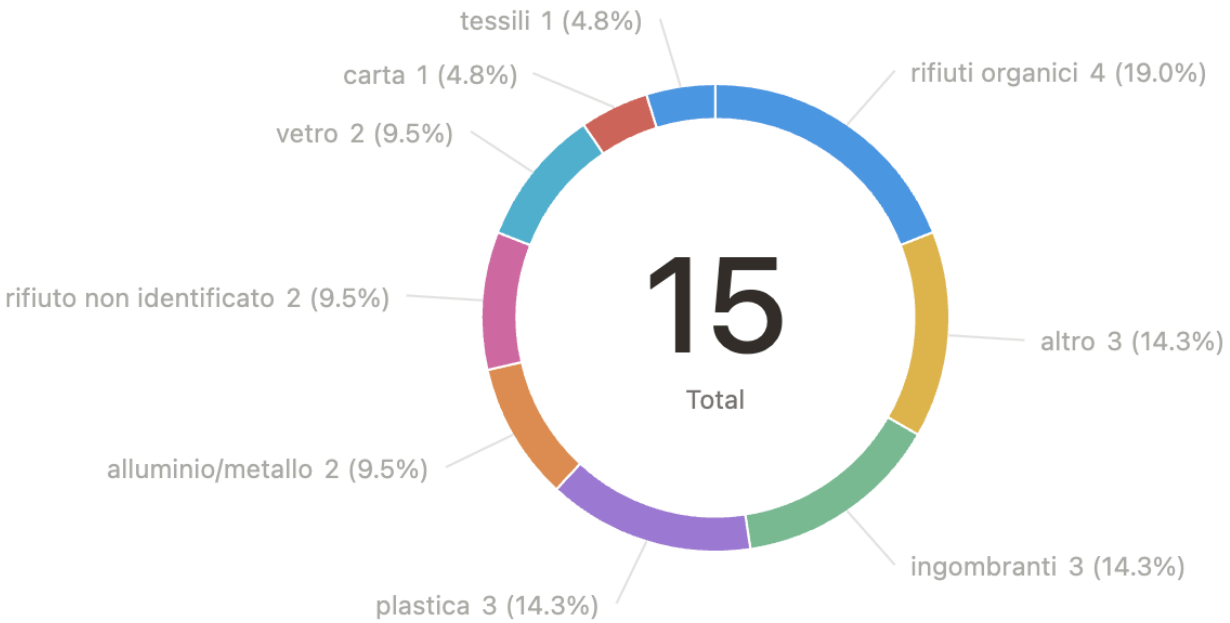
Teachers and organizers, on the other hand, can use the **admin dashboard** to monitor the pilot in real time, track submission statistics, and evaluate engagement metrics across classes and municipalities. Below are two example charts generated from the dashboard:

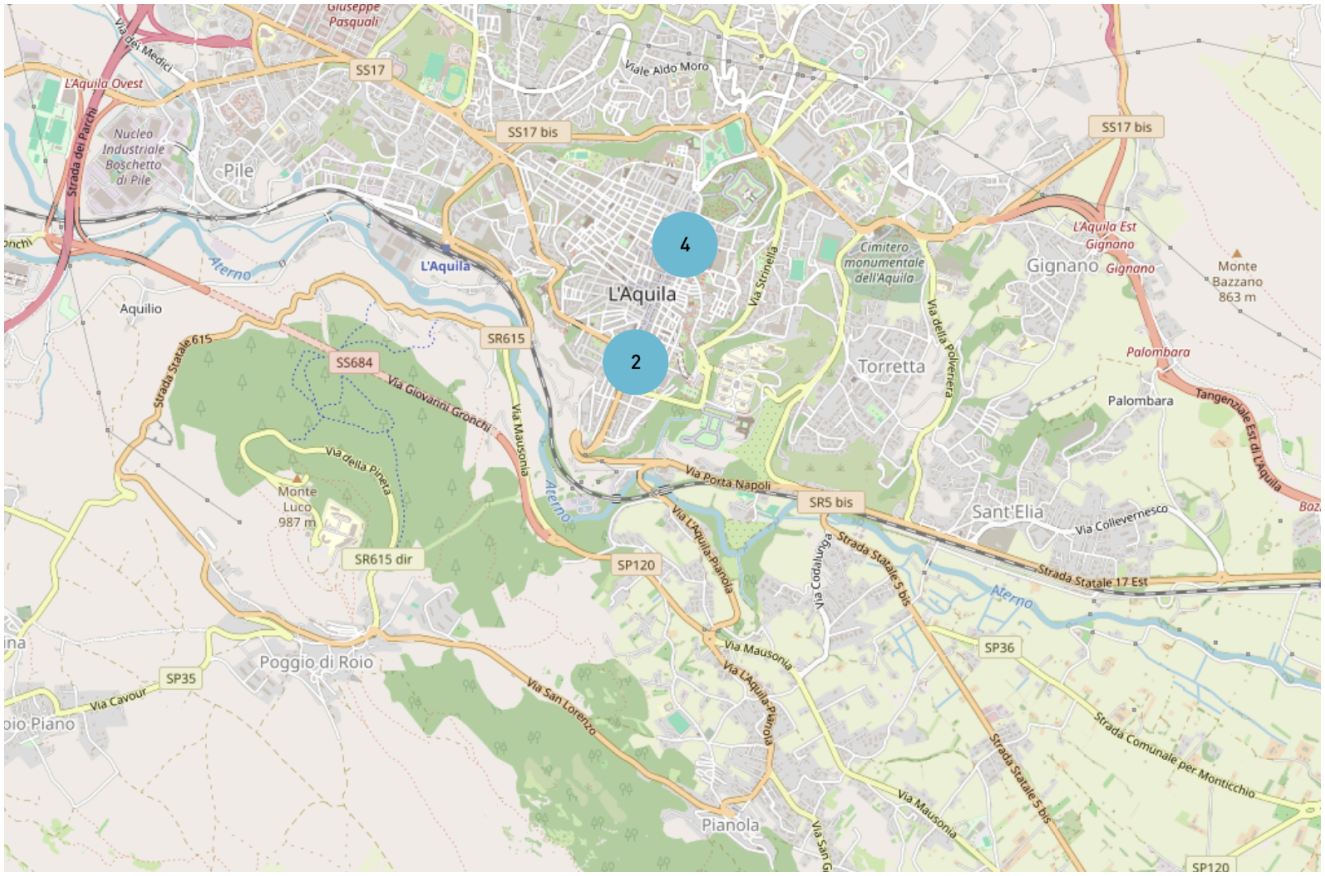




In the first chart, the distribution of the status of the submitted reports is shown. Meanwhile, in the second chart, there is the distribution of submitted reports per month.

We can also design other types of views like the ones reported below. For instance, the first one shows the distribution of waste types for the submitted reports. Instead, in the second one, the distribution of the number of reports is shown on a map per geographical area.





These types of views may support stakeholders in decision-making processes, in the identification of habitual waste sites, in the prediction of littering in a specific area, and so on.

The dashboard not only enhances transparency but also acts as a motivational driver by making achievements and competition visible to all participants. The gamification processor ensures that this feedback is timely, fair, and based on criteria that reward meaningful contributions.

In the following figure, we reported an example of ranking based on the users' rewards. Also this type of view may be produced with Notion and the data collected from the reports.

COBOL-Users

Table | Ranking | +

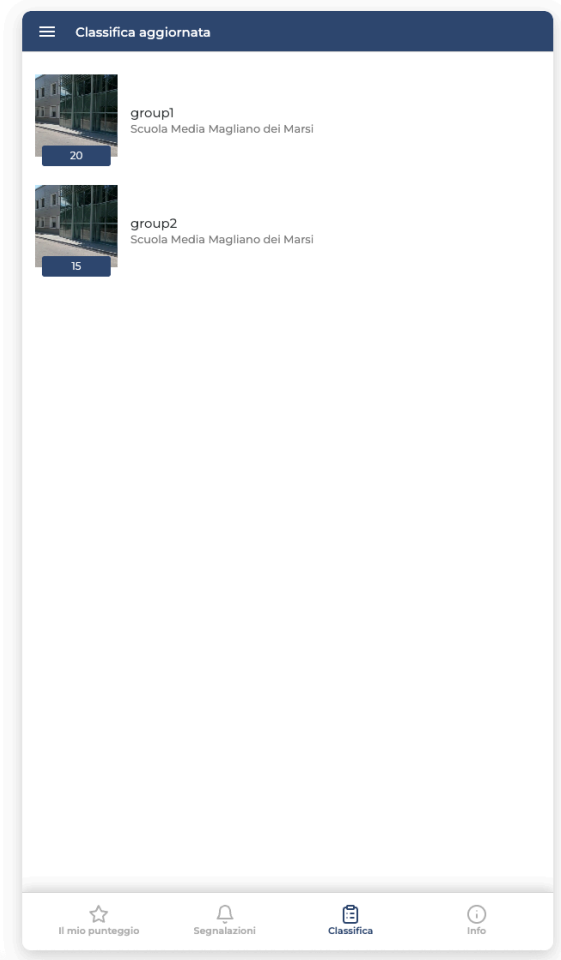
Aa Name	UserReward
Leonardo	43
Claudio	39
Ludovico	38
Daniela	3
Luciana Rebelo	1

The rankings may be computed also based on the rewards earned by each team participating in the challenge. In the figure below, the users have been grouped in two exemplar teams whose reward has been computed based on the individual rewards of their components.

Table +

Aa Name	COBOL-Users	TotReward	Organizations
group1	Ludovico Maria Teresa Claudio Daniela	20	Scuola Media Magliano dei Marsi
group2	Arianna Fedeli Luciana Rebelo Leonardo	15	Scuola Media Magliano dei Marsi

From the front-end point of view, each user may visualize the ranking of the teams participating in the challenge in a dedicated page, such as the one shown in the figure below, and the same for the ranking of users. For the pilot study, we plan to show this ranking only for the first week of the challenge. This is because we want to mitigate possible negative competitive behaviour of the students, who might be discouraged by a low position in the ranking.



4 Conclusions and remarks

The integration of a gamification processor into our waste reporting platform represents a concrete step towards improving user motivation and participation by means of the combination of automated reward logic with dynamic dashboards and data organisation accessible via Notion.

The upcoming pilot study in a middle school will allow us to evaluate the real-world effectiveness of this approach. By observing how students interact with the application and analysing their engagement in individual and team competitions, we intend to validate the design choices underlying the gamification processor, in particular the strategy for calculating points, the feedback mechanisms and the visibility of the dashboard.

One of the key strengths of our implementation lies in its flexibility: all scoring parameters can be tuned, the reward schemes extended, and the visualization of progress easily adapted to different audiences thanks to the use of Notion as a backend. This makes the system well-suited not only for educational pilot, but also for future scaling into broader civic participation contexts.

As a future direction, we intend to integrate an automated process to analyze the reports and assign the reward by taking into account privacy and ethical concerns. Furthermore, when distributing the platform to citizens we plan to incorporate additional elements such as mission-based challenges, progressive levels, and cross-municipality competitions to further increase engagement. We also envision expanding the analytical layer to assess long-term behavioral changes and community impact.

This way, all parties participating in the waste management process (not only citizens) are engaged. This project will establish gamified processes for both citizens and administrations. Citizens will be rewarded for both reporting and removing waste, with the latter activity being rewarded the most. Further, citizens will be rewarded for confirming or disproving waste removal actions taken by other actors obtaining virtual rewards that may be exchanged for tangible benefits such as free entry to public institutions, like museums.

Administrations will also compete in terms of their ability to keep areas clean, based on citizens' reports. Further, the indexes derived from the collected data could be used by administrations to demonstrate the impact of actions about littering management in terms of KPIs, also in the context of the SDGs.

This deliverable presents a well-designed gamification strategy, grounded in literature and enriched by modern, flexible tools, transforming a simple reporting task into an educational and socially meaningful experience.

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