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How to Foster Sustainable Behaviors through Multi-Campaigns Rewarding Mechanisms: The AIR-BREAK Experience

Antonio Bucchiarone [1,*], Simone Bassanelli [1,2] and Annapaola Marconi [1]

[1] Motivational Digital Systems (MoDiS) Research Unit, Fondazione Bruno Kessler (FBK), Via Sommarive, 18, 38123 Trento, Italy
[2] Department of Psychology and Cognitive Science (DiPSCo), University of Trento, Corso Bettini, 84, 38068 Rovereto, Italy
* Correspondence: bucchiarone@fbk.eu

Abstract: The primary objective of the AIR-BREAK mobility campaigns is to disseminate information to the general public and increase their awareness of the sustainable mobility services available. This is intended to promote the adoption of alternative, more environmentally friendly, mobility practices. Due to human heterogeneity, different individuals are motivated by different factors and for this reason the effect of intrinsic and extrinsic rewards vary from subject to subject. Depending on the citizen's personality and preferences, specific rewarding mechanisms can have different impacts in terms of behavior change. The goal of this article is to report the rewarding mechanisms developed in the context of the project to raise citizens' awareness, encourage participation, break bad habits and promote behaviour change towards more sustainable lifestyles. It also presents an analysis assessing the impact of the implemented rewarding systems to evaluate their real influence on eco-sustainable behaviors. The results indicate that every campaign successfully achieved its objective of modifying user behavior. Furthermore, the implementation of incentivizing mechanisms proved to be a pivotal factor in attaining this goal, exerting an impact on both the experienced fun and the behavioral outcome.

Keywords: gamification; sustainable mobility; rewarding mechanisms; behavioral changes

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1. Introduction

According to a report by the European Environmental Agency (EEA), the transportation sector accounts for approximately 25% of all greenhouse-gas emissions in the European Union (https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-transport (accessed on 19 December 2022)). In order to formulate upcoming urban development plans, it is imperative to prioritize the implementation and advancement of sustainable mobility strategies [1]. These policies should emphasize the affordability, accessibility, and sustainability of mobility options, including improvements to walking, cycling, and public transportation services. Additionally, it is essential to reduce the negative influence of automotive transportation on both a regional and national scale. Encouraging the shift towards sustainable mobility strategies based on public transport and active/shared mobility is one of the main challenges of European cities (European Commission, 2019), since they are increasingly facing problems of traffic congestion, road safety, energy dependency and air pollution.

In this context, Sustainable Urban Mobility Plans (SUMP (https://www.eltis.org/mobility-plans/sump-concept, (accessed on 19 December 2022)) and Sustainable Urban Mobility Indicators (https://transport.ec.europa.eu/transport-themes/clean-transport-urban-transport/sumi_en, (accessed on 19 December 2022)) (SUMI) provide a framework and tools for cities to define and assign value to ambitions for the delivery of sustainable mobility. The European common goal is to reduce CO_2 emissions from the transport sector by 90% by 2050, and the overall strategy is based on three pillars: sustainable, intelligent

and resilient mobility. Encouraging users to become more involved in sustainable mobility actions and changes is essential for the successful implementation of various Green-Deal initiatives. This is because mobility behavior has a significant impact on the environment.

The idea of using game design elements in non-game contexts [2] to motivate and increase user activity and retention [3] has rapidly gained the attention of research communities. This approach, also known as *gamification* or *gameful design*, utilizes game-like features and elements in non-game contexts to enhance motivation. The intrinsic motivation [4] and intention [5] guide the promotion of positive behaviors (e.g., quitting smoking, ecological behaviors, food choices, civic engagement, mental healthcare, and sustainability, etc.) [6] through a behavior-change process, leading to a positive influence [7]. Designers have the ability to leverage the symbolic attributes of games to direct players towards behavioral modifications within the context of their gameplay experience [8]. Essentially, games can serve as a form of persuasive technology, as they have the ability to act as cognitive frameworks that shape the understanding and interpretation of the symbols and cues contained within them.

Studies suggest that to promote behavioral change, user-centered approaches are preferred in the design of a gamification application [9]. Due to human heterogeneity, different individuals are motivated by different factors [10]. Therefore, a gamified system should not only focus on the ulterior motive that is to be fostered, but should also be tailored towards the target audience.

Within the AIR-BREAK project (https://airbreakferrara.net/, (accessed on 19 December 2022)), we designed and implemented four sustainable mobility campaigns (as summarized in Table 1) targeting different mobility contexts (home-to-work mobility, home-to-school mobility, and leisure-and-free-time mobility) and various target groups of end-users (general public, students, employees). *Ferrara Play&Go* (https://airbreakferrara.net/ferrara-playngo/, (accessed on 19 December 2022)) is a long-running gamified urban mobility campaign which utilizes gamification to encourage voluntary changes in travel behavior. *Ferrara Bike2Work* is a sustainable mobility initiative which targets public- or private-sector employees commuting from home to work in Ferrara. It is part of the sustainable mobility initiatives put in place by the Emilia-Romagna Region to meet the new challenges of the COVID-19 emergency and aims to promote the use of bicycles for home–work trips by providing economic incentives to employees.

Running concurrently with the Play&Go program, the *Play&Go – High School Mobility Challenge* engages high-school students in a competitive class-level challenge. Meanwhile, the *Kids Go Green* (www.kidsgogreen.eu, (accessed on 19 December 2022)) program utilizes gameful education to involve the entire school community (i.e., children, teachers, and families) in promoting sustainable and active home-to-school mobility for primary- and middle-school-aged children.

The primary goal of the AIR-BREAK mobility campaigns is to promote the adoption of environmentally conscious modes of transportation and create public consciousness of the diverse sustainable mobility services available. This is achieved through information dissemination and education to encourage changes in existing mobility practices (https://ec.europa.eu/futurium/en/system/files/ged/promoting_behaviour_change.pdf, (accessed on 19 December 2022)) [11]. However, designing a gamified environment is full of challenges [12]: due to human heterogeneity, different individuals are motivated by different factors and, for this reason, the effect of intrinsic and extrinsic rewards varies from subject to subject [13]. Depending on the citizen's personality and preferences, specific rewarding mechanisms can have different impacts in terms of behavior change. To assess the goodness of the implemented rewarding mechanisms and the utility of the gamified environment, researchers agree that we might pay particular attention to the behavioral outcome, as the final aim of the gamification use, which can be evaluated with users' reports with an experience questionnaire [14] and in-game mapping and tracking affordances [15], and the fun level, which promotes and supports this behavioral outcome [16]. Fun is a specific and complex construct which contains both effective and motivational properties

which may elicit a flow state, which is a mental state of absorption and engagement in an activity or a game [17], and it is considered a more suitable element for predicting gamification effectiveness in both educational and behavior-change fields [16,18,19].

Table 1. AIR-BREAK mobility campaigns and rewarding mechanisms.

Campaign	Target Users	Reward Type	Reward Description
Ferrara Bike2Work	Employees from private and public companies	Monetary individual	Employees of participating companies are rewarded for their home-to-work trips by bike with **economic incentives** in their paychecks: 0.20€ per Km, max 20 km per day, max 50€ per month. The funds for the monetary reward are provided by the Emilia-Romagna region, promoter and financier of the region-level initiative.
Ferrara Play&Go	All citizens (14+)	Game-based individual incentives and individual prizes	Ferrara Play&Go combines **game-based individual virtual incentives**—points, levels, badges, leaderboards—with **individual prizes**—gifts and discounts. Weekly prizes are assigned to the player in the first position of the weekly leaderboard and to two other players drawn from the top 50 in the weekly leaderboard. Final prizes are awarded to top players in the global leaderboard at the end of the campaign. Weekly and final prizes are offered by local associations and sponsors.
High-School Challenge	High-school students	Game-based collective incentives and team-level prizes	The High School Mobility Challenge combines team-level game-based virtual incentives—points, team leaderboards—and team-level prizes. At the end of the competition, the team that qualifies to the top of the leaderboard will be awarded with a **collective prize** (participation of the team to a social event/experience).
Kids Go Green	Primary and middle-school students	Game-based collective incentives and educational material and activities	Kids Go Green combines **game-based collective virtual incentives**— virtual kilometers and team advancement in the virtual journey—with **real incentives** in the form of educational material and activities which are unlocked when the whole team reaches a stop in the virtual journey.

The research objectives of this study are to investigate the relationships between perceived fun level and behavioral outcome, reward perception and behavioral outcome, and perceived fun level and reward perception. In addition, the study aims to determine the best predictor for behavior-change evaluation according to the user experience and identify the type of reward that is best-suited for these campaigns. To achieve these objectives, the study will employ a mixed-methods approach, combining qualitative interviews and quantitative surveys to gather data from participants. The study will also analyze existing literature and previous studies to provide a comprehensive understanding of the relationship between perceived fun, rewards, and behavior change. The results of this research will contribute to the development of effective strategies for behavior-change campaigns which can motivate individuals to adopt healthier habits and make positive changes in their lives. For this reason, in the AIR-BREAK project, particular attention is paid to the study and validation of rewarding mechanisms shaped to the target population to exploit contextual motivators and inhibitors, as well as to game-based motivational and persuasive techniques aimed at dynamically tailoring the user experience to maximize the fun level reported by the users and, thus, the impact in terms of the retainment of individual/collective behavior change. The goal of this article is to present and evaluate the rewarding mechanisms developed in the context of the project. Their common objective is the realization of an interactive technology able to raise citizens' awareness, encourage participation, and promote behav-

ioral change towards more sustainable (i.e., fewer CO_2 emissions) and healthful (i.e., active) mobility lifestyles, which is perceived as fun by the users.

In order to evaluate the goodness of each campaign, we first stated some research questions:

RQ1. What is the relationship between perceived fun level and behavioral outcome?

RQ2. What is the relationship between reward perception and behavioral outcome?

RQ3. What is the relationship between perceived fun level and reward perception?

RQ4. What is the best predictor for behavior-change evaluation according to the user experience?

RQ5. What kind of reward is best-suited for these campaigns?

The article presents an introduction to the existing rewarding systems and continues with the illustration of the AIR-BREAK mobility campaigns targeting different mobility contexts (home-to-work mobility, home-to-school mobility, leisure-and-free-time mobility) and various target groups of end users. Then, the article presents the analysis to assess the impact of the implemented rewarding systems in order to evaluate the real influence of the selected rewarding system on the eco-sustainable behaviors, the fun level expressed in the user-experience questionnaire, and the interaction between rewards perception and experienced fun in fostering the overall behavioral outcome.

2. Background and Motivations

Rewards can be of a different nature (e.g., monetary return, object, or event that a citizen or an employee receives) and are received in exchange for having done something well (e.g., rewarding creative and inventive efforts, best practice, good work) [20]. Rewards can be real and extrinsic, but sometimes can also be virtual (e.g., social recognition, game-based virtual rewards), and provide positive feedback when the recommended behavior is adopted (e.g., less environmental impact generated). To increase the probability that a certain behavior occurs, rewards are offered after the desired behavior occurs [21]. Although rewards usually refer to the allocation of pay, the literature on rewarding systems recently underlined the importance of non-financial rewards as instruments suitable to direct and shape desired behaviors [22,23]. Each rewarding system is based on two main pillars that must be properly defined: (1) the rules and indicators suitable for monitoring the achievement of desired results and the impact of the action (e.g., the number of registered users); and (2) the incentives to increase people's awareness of sustainable behaviors. The first analysis on rewarding systems was presented more than 50 years ago [24,25]. The focus was on the investigation of interlinkages between rewards and improved performance or creativity. Klotz et al. [26] defined an attractive, cost-effective, fair, and variable rewarding system as a mix of components which includes fixed, variable, and indirect rewards. This was compliant with the rewards taxonomy given by Chiang and Birtch [22], where rewards were classified into types such as financial or not, individual or team performance, and fixed or contingent on a certain criterion depending on the norms and principles on which rewards are allocated. In this context, the literature on rewarding systems recently underlined the importance of non-financial rewards as instruments suitable to direct and shape desired behaviors [22,23].

2.1. Monetary and Financial Incentives

Various studies have focused on the effects of pay incentives on performance improvements for teams and individuals [27–29]. Some studies have looked at the effects of a combination of reward systems in different types of teams [30]. In general, the studies highlighted the positive influence of the use of the combination of individual and team-based pay incentives on performance. The studies also highlighted the indirect relationships between pay incentives and performance—emphasizing the role of motivations and goals. Research in rewarding systems has also examined the effects of motivation and worker performance, where extrinsic motivations are captured by monetary compensation in addition

to any intrinsic motivation workers may have for solving the tasks. Recent works have shown that monetary reward may undermine the effects of intrinsic motivation [31] and that increasing the amount of financial compensation may yield more results, though not necessarily results of higher quality [32]. In a survey which analysed more than 30 research results on the relationship between financial incentives and performance, Jenkins et al. [28] found that, although financial incentives were somewhat associated with increased individual performance quantity, this relationship did not exist with performance quality. Research has also shown that to employees, in addition to their monetary value, incentives are also perceived as a source of recognition and status [28]. However, other researchers have highlighted the negative effects of financial incentives, where the incentives appear to reduce intrinsic motivation (https://hbr.org/1993/09/why-incentive-plans-cannot-work, (accessed on 19 December 2022)) [33], the self-determination of employees [34] and desirable risk-taking behaviors of the employees [28]. The voluntary adoption of "good" behaviours is increasingly linked to rewarding systems aimed at motivating people's attitudes and perceptions towards sustainability. Many benefits can be gained from implementing a reward programme, including enhancing environmental awareness, pollution reduction and cost reduction. Special motivational and reward programs have been reported as one of the most effective means for sustainable mobility [35]. Lack of regulatory control and enforcement, lack of motivation and lack of experience lead to the necessity of rewarding systems and incentive schemes to improve the environmental performance of a community or production and consumption processes (supply chains). The success of reward practices is also country-dependent, depending on individual needs, values and expectations strictly related to different cultures [22]. The close interdependence between the reward system, motivation and the culture in which it is embedded was deeply investigated by Schuler and Rogovsky [36], Kerr and Slocum [37] and Chiang et al. [22]. Reward practices considered successful in North America, for instance, may not be readily transplanted to Europe or Asia.

2.2. Virtual Game-Based Incentives

The idea of using game design elements in non-game contexts [2] to motivate and increase user activity and retention [3] has rapidly gained the attention of research communities. The application of gamification or gameful design involves incorporating game-like features into non-game systems to stimulate motivation [3]. Through this approach, an individual's inner motivation [38] and intention [39] drive the process of behavioral change, leading to a favorable outcome [3,7]. Game designers can utilize the symbolic nature of games to direct players' behavior and promote behavioral change [6,40,41]. Essentially, games can serve as a form of persuasive technology by acting as cognitive frameworks that guide the interpretation of embedded signs. In other words, games can be used as a persuasive technology since they can function as cognitive frames to guide the interpretation of the signs embedded in them [41]. Gameful systems are capable of cultivating collective intentions, which can facilitate the occurrence of genuine cooperation, resulting in increased engagement and commitment to the activities that foster this sense of collectivity [42]. Gamification has already been experimented with as a tool to promote green mobility habits. In the city of London, the utilization of the gameful system known as Chromaroma (https://www.theguardian.com/media/pda/2010/nov/30/chromaroma-oyster-transport-gaming, (accessed on 19 December 2022)) incentivizes individuals to explore novel locations in exchange for accruing virtual points and succeeding in challenges. Similarly, in Bogota, Colombia, gamification has been leveraged to modify human behavior patterns by motivating citizens to opt for ecologically sound means of transportation [43]. UbiFit (https://www.consolvo.org/ubifit, (accessed on 19 December 2022)) is a mobile app that gives users feedback on the level of "greenness" of their transportation behaviours by sensing their actions through both smartphones and wearable devices, and self-declarations. Wells et al. [44] propose a gamified system to promote sustainable multi-modal urban travel among EU citizens. In GoEco! [45,46], the authors show that a game-based application

significantly impacted CO_2 emissions for car-dependent urban areas. Studies suggest that to promote behavioural change, user-centered approaches are preferred in the design of a gamification application [9]. Due to human heterogeneity, different individuals are motivated by different factors [10]. Therefore, a gamified system should not only focus on the ulterior motive that it is fostering but also be tailored towards the target audience.

3. The AIR-BREAK Method

3.1. Sustainable Mobility Campaigns

The main aim of the AIR-BREAK sustainable mobility campaigns is to disseminate knowledge to the public and increase awareness of the benefits and opportunities provided by sustainable modes of transportation, with the aim of inspiring the embrace of alternative, eco-friendly, transportation practices. For this reason, one of the main project activities has been the design and development of different initiatives targeting different mobility contexts (home-to-work mobility, home-to-school mobility, leisure-and-free-time mobility) and various target groups of end users (general public, students, employees). In the following, we briefly describe each of these mobility campaigns.

The overall objective of *Bike2Work* is to promote a more sustainable home–work mobility, contributing to a reduction in CO_2 emissions. Considering the emergency related to COVID-19, this aspect becomes even more important as new habits will have to be re-invented to adapt to the new constraints and limitations imposed by the government for the safety of citizens to improve, at the same time, the quality of life of employees. The adoption of technological solutions alone cannot make transport more sustainable; to do this, it is necessary to involve people and guide them towards behavioural change. To achieve these goals, *Bike2Work* intends to engage companies with its employees to build new innovative, sustainable, and targeted solutions that can improve quality of life more effectively. The specific objectives of this mobility campaign, identified together with the Municipality of Ferrara in the context of the AIR-BREAK project, are:

- To support workers in switching to sustainable mobility habits.
- To support private companies in the adoption of policies, initiatives, and the development of urban mobility plans.
- To increase the perception of corporate (ecological) social responsibility and improve total quality management (TQM) within companies.
- To increase cooperation between different modes of transport and promote interconnection and interoperability between existing transport networks.
- To increase the attractiveness of sustainable transport modes through the implementation of different measures such as proposing new private mobility policies, promoting public transport, and pooling and sharing services.

To achieve the identified objectives, *Bike2Work* provides:

- A web console for company mobility managers (as depicted in Figures 1 and 2) to manage the necessary information (entity data, participating employees) and to visualize the information (trips/valid kilometers) of their employees.
- A web app for employees (as depicted in Figure 3) which allows them to track their home–work trips and visualize the results achieved.

Ferrara Play&Go is a long-running gamified urban mobility campaign which enables players to track their sustainable journeys via a mobile app. These journeys are automatically validated and players are awarded virtual points which allow them to progress through the competition. Play&Go merges conventional game elements, such as points, badges, leaderboards, and real prizes, with customized game content which caters to the player's preferences. This content includes single- and multi-player modes, and weekly challenges which are competitive or collaborative in nature and geared towards motivating and rewarding positive changes in player behavior.

The *Play&Go—High School Mobility Challenge* will run in parallel to the *Play&Go* main action and will involve high-school students in a class-level competition. Each student of a

participating class will register to the *Play&Go* game and, with her/his performances in the main game (green leaf points earned with sustainable home-to-school and free-time trips), will contribute to the results of the class in the high-school competition. The class that, thanks to its team members, at the end of the competition has the best results will be rewarded with a class-level prize.

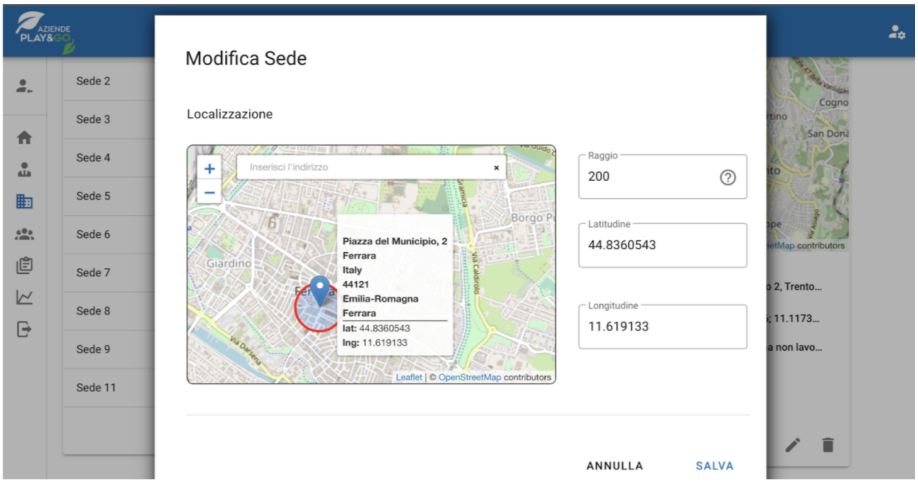

Figure 1. Company information in the Bike2Work web console.

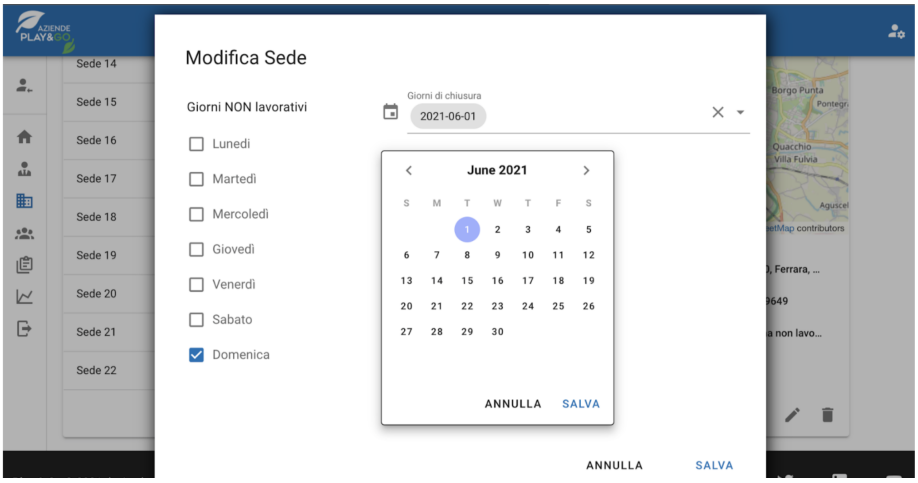

Figure 2. Non-working days declaration in the Bike2Work web console.

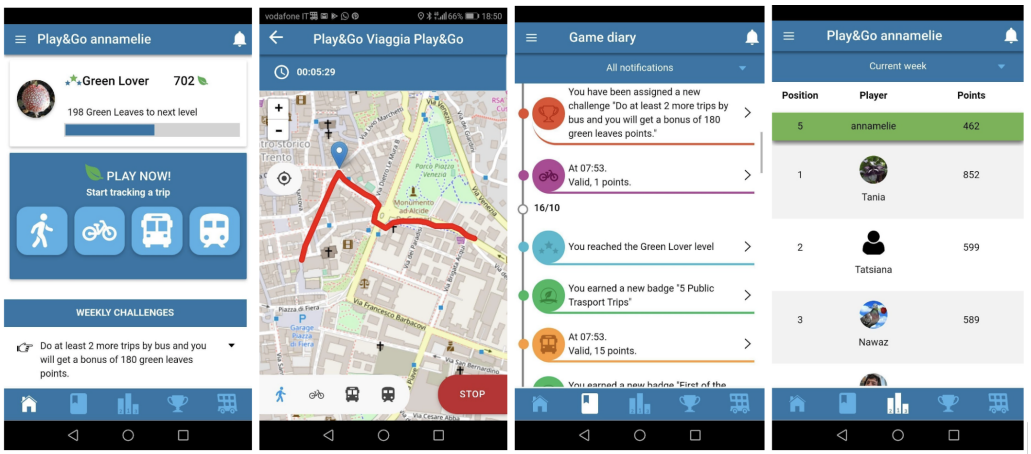

Figure 3. Home page and main functionalities of the Ferrara Play&Go App.

Kids Go Green enlists the full school community, comprising of students, teachers, and families, in an interactive educational undertaking aimed at fostering sustainable and physically active commuting to and from school. The initiative caters to children in primary and secondary education levels. In *Kids Go Green*, the collective progress of a group of children on a customized virtual educational journey (as depicted in Figure 4), based on their interests and abilities, is boosted by the sustainable distance covered by each child during their commute from home to school. This can be achieved through various means, such as walking, cycling, or utilizing school transportation services.

Figure 4. Kids Go Green solution: an overview.

Table 2 summarizes, for each of the previously introduced campaigns, the indicators measured to analyze the impact and the periods in which they have been run or will be run. The term *sustainable* indicates that the trips and kms are accumulated only when the journeys are made with the use of sustainable transportation means (walking, biking, public transport, car sharing).

Table 2. Indicators and periods of the AIR-BREAK mobility campaigns.

Campaign	Indicators	Periods
Ferrara Bike2Work	Sustainable trips, sustainable mms, CO_2 emissions saved.	From May 2021 to October 2023 with a unique campaign.
Ferrara Play&Go	Sustainable trips, sustainable kms, CO_2 emissions saved, calories burned.	December 2021–June 2022 and Autumn 2022–Spring 2023.
High-School Challenge	Sustainable trips, sustainable kms, CO_2 emissions saved, calories burned.	February 2023–May 2023 (not yet started).
Kids Go Green	Sustainable trips, sustainable kms, CO_2 emissions saved, calories burned.	Two consecutive school years (2021–2022, 2022–2023) in primary and secondary schools in Ferrara.

We conclude this section by describing the rewarding mechanisms—or combination of rewarding mechanisms—that have been defined and implemented within each AIR-BREAK sustainable mobility campaign (see Table 1). The evaluation that we performed after the first iteration of the AIR-BREAK sustainable mobility campaigns includes the validation of these applied rewarding mechanisms. The evaluation results (see Section 4) and the final discussions (see Section 5) will be exploited to inform the definition of the rewarding mechanism to be implemented in the second iteration of the sustainable mobility campaigns.

3.2. Questionnaire Design

To assess the player experience, we developed an ad-hoc user-experience questionnaire for each campaign. All questionnaires were completed during the campaigns. The use of ad-hoc questionnaires allowed us to customize the questions and format to fit the specific goals and needs of our project. In this way, we made sure to gather useful and necessary information so that we could improve the campaign features before the next applications, and at the same time gather information about the user experience, the application procedure, comments about each campaign's strengths and weaknesses, and suggestions regarding improvements. Each questionnaire measured several features with a 5- or 6-point Likert-scale response that provided us with indications of how much users agreed either with the phrases formulated or how positive or negative they found them, among which were sentences about the user experience related to the rewarding system (in-game and external), fun, and behavior change towards sustainable behaviors, which was the ultimate goal of the different campaigns, and open-ended questions to collect opinions, critiques, and suggestions on the various features and affordances of the campaigns and software used for joining initiatives and tracking movements.

3.2.1. Ferrara Bike2Work

For *Ferarra Bike2Work*, we developed an ad-hoc questionnaire (https://osf.io/8t4bm, (accessed on 19 December 2022)) which presented a central part composed of several items with a 6-points Likert-type scale [47] (from 1 = very negative, to 6 = very positive) aimed at analyzing the user experience. We created an opening part aimed at collecting information on the users' overall experience, environmentally sustainable travel habits before and during the campaign, satisfaction related to Bike2Work features (i.e., tracking, economic incentives, accession procedure, and data visualization), and willingness to participate in any future campaigns. This section enables the measurement of Bike2Work's influence on the choice of transportation mode. In addition, the survey included open-ended questions to assess the strengths and weaknesses of Bike2Work and gather valuable feedback and suggestions for enhancing future Bike2Work initiatives.

3.2.2. Ferrara Play&Go

For *Ferrara Play&Go*, we developed an ad-hoc user-experience questionnaire (https://osf.io/zm3c4, (accessed on 19 December 2022)) which included a central part with several six-points Likert-type items (from 1 = in no way, to 6 = very very much) with the aim of analyzing the user experience. The questionnaire collected information about the overall experience, behavior change and reward perception. Then, the questionnaire provided ad-hoc items related to possible enhancements for this campaign. In this campaign, the rewarding system consisted of both in-game and economic rewards.

3.2.3. Kids Go Green

For *Kids Go Green*, we developed an ad-hoc user-experience questionnaire (https://osf.io/3wdyc, (accessed on 19 December 2022)) which presented a fundamental section, consisting of numerous elements utilizing a Likert-type scale with five gradations (ranging from 1 indicating not at all, to 5 indicating an extremely high degree). Its purpose was to evaluate the level of satisfaction experienced by the user. The questionnaire collected

information about the overall experience, focusing on campaign appreciation, reward-system evaluation, and the perception of behavioral outcomes. Then, the questionnaire presented a series of questions about the best and worst components of the campaign. In this campaign, the rewarding system consisted of in-game rewards, such as advancing in the game path and unlocking game-content features.

4. Results

Currently, only three of the previously mentioned campaigns have been analyzed, since the HIGH-SCHOOL CHALLENGE will start in 2023. Hence, in the section, we present the results related to *Ferarra Bike2Work*, *Ferrara Play&Go*, and *Kids Go Green*.

To answer the research questions presented in Section 1, we first identified the items for each analysis category on the basis of semantic meaning, then we run several linear regression analyses to understand the interaction between the reward-system-experience values, the perceived behavioral outcome, and the fun level expressed by the questionnaire for each campaign.

To answer the first three research questions, we run a linear regression in order to evaluate whether the perceived fun level or the rewards perception could predict the behavioral outcome and whether the reward perception could predict the perceived fun level.

To assess which is the best predictor for the behavioral outcome (RQ4), and which kind of reward is best-suited for the campaign (RQ5), we used the Akaike information criterion (AIC) [48,49], which is an estimator of prediction error and, thereby, the relative quality of statistical models for a given set of data: AIC rewards goodness of fit and includes a penalty which is an increasing function of the number of parameters estimated [50]. The results were calculated using the statistical software RStudio (v.2022.07.2).

4.1. Ferrara Bike2Work

Bike2Work was launched on 15 May 2021 and it is still running. At the end of June 2022, 72 companies, in the territory of the municipality of Ferrara, were registered to the campaign, with 668 active employees. In this first period, 56,859 sustainable trips were tracked and considered valid. These trips contributed to achieving 202,501 sustainable kms and 25 tons of CO_2 saved. During the Bike2Work campaign, 83% of participants indicated a positive overall experience with the initiative, as evidenced by a mean score of 4.7 ± 1.44. Additionally, a significant proportion of users (89%) expressed an intention to maintain the transportation practices adopted during the initiative, as reflected in a mean score of 5.21 ± 1.2. Finally, an overwhelming majority (95%) of participants expressed a desire to partake in future Bike2Work initiatives, with a mean score of 5.6 ± 0.98.

In this campaign, the rewarding system consisted of economic incentives (external rewards) which were provided upon the achievement of objectives. To analyze the interaction between fun, rewards, and behavioral outcome, we clustered several questionnaire items into different factors (see Table 3).

Table 3. Questionnaire results according to the selected features for the *Bike2Work* campaign.

Dimension	Item	Mean	SD
Perceived fun level	*How would you rate your experience with Ferrara Bike2Work?*	4.79	1.34
	Would you participate in a new edition of Ferrara Bike2Work?	5.62	0.90
Reward perception	*Did you appreciate the economic incentives associated with the initiative?*	4.30	1.70
Behavior change	*If you have improved your mobility habits, do you think you will keep them even at the end of the initiative?*	5.20	1.20

To analyze the users' report on the use of bicycles before and after the campaign, we performed a Mann–Whitney–U test [51], finding a statistically meaningful disparity in the utilization of bicycles before and during the campaign ($W = 16{,}245$, $p < 0.001$, $\delta = -0.24$),

implying a substantial upsurge in the population of individuals utilizing bicycles as a means of transportation from their residence to the workplace following the implementation of the initiative. Hence, the study examined the impact of transportation modalities on the user's overall experience. Notably, the statistical analyses failed to reveal any significant distinctions in both the overall user experience (W = 2661, $p > 0.05$) and the inclination to partake in future initiatives (W = 3231, $p > 0.05$) based on the means of transportation employed prior to the BIKE2WORK campaign. This implies that the program was perceived as equally favorable by two distinct groups: (1) individuals who frequently utilized bicycles as a mode of transportation prior to the intervention, and (2) individuals who altered their transportation habits during the campaign.

The results suggest that in this campaign, the fun level predicts the maintaining of behavioral outcome ($F_{1,151} = 22.83$, $p < 0.0001$, $R^2 = 0.1256$. See Figure 5), the economic rewards perception affects both the users' behavior-change maintainance ($F_{1,151} = 5.307$, $p < 0.01$, $R^2 = 0.02755$) and the perceived fun level ($F_{1,151} = 38.5$, $p < 0.0001$, $R^2 = 0.1979$). The AIC criterion suggests that the fun level, which received the lowest AICc score (AICc = 474.88) and 73% of the total weight of the models considered, best predicts the overall behavioral outcome expressed in the user-experience questionnaire.

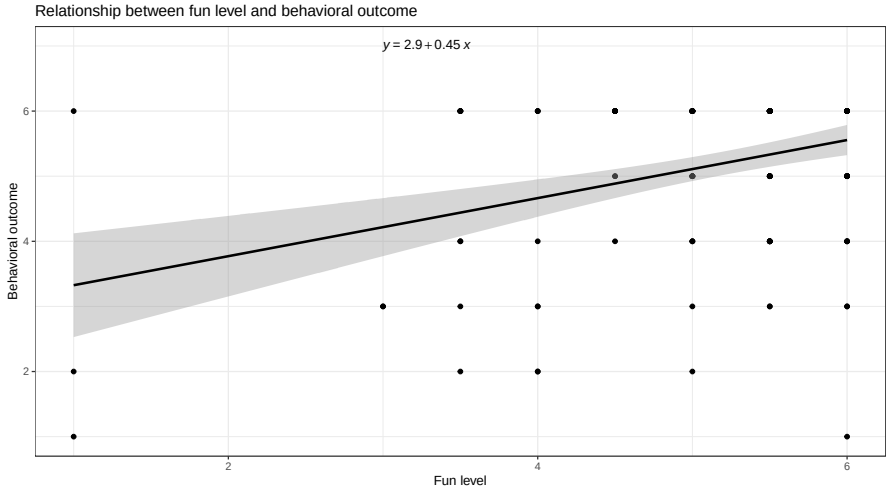

Figure 5. Relation between the perceived fun level and the behavioral outcome expressed in the user-experience questionnaire during the BIKE 2 WORK campaign.

4.2. Ferrara Play&Go

Field trials have achieved significant results. During the 2020–2021 edition of the game, a total of 1039 players actively engaged in the initiative, recording 19,747 sustainable trips and covering more than 77,000 kilometers through sustainable means of transport over a six-month period. Impressively, 66% of players indicated that their mobility habits had become more sustainable as a direct result of the game, while 45% had discovered a new eco-friendly mode of transportation, with 366 individuals citing the game as their inspiration for doing so. These outcomes demonstrate both the capacity of the approach to encourage continued citizen involvement in long-term gaming, as well as its effectiveness in transforming players' behavior towards sustainable mobility habits by breaking old patterns. Within the first round of AIR-BREAK sustainable mobility campaign, *Play&Go* has been experimented by citizens of Ferrara for 6 months (December 2021–June 2022). A second iteration of *Play&Go* is planned to be operated within the project timeline (Autumn 2022–Spring 2023).

A total of 76 participants voluntarily completed the questionnaire. Of these participants, 82.6% reported a positive overall experience with the Play&Go intervention, as evidenced by a mean score of 5.25 ± 0.95. A large proportion of participants (84%) expressed an intention to maintain the transportation practices adopted during the initiative, as indicated by a mean score of 5.25 ± 0.9. Additionally, 96% of participants expressed an interest in

participating in future iterations of the Play&Go initiative, as indicated by a mean score of 5.76 ± 0.76.

To analyze the interaction between fun, rewards, and behavioral outcome, we clustered several questionnaire items into the same factors. The results for the three factors and for the subsequent division within the reward system can be seen in Table 4.

Table 4. Questionnaire results according to the selected features for the PLAY&GO campaign.

Dimension	Item	Mean	SD
Perceived fun level	*How would you rate your gaming experience with Ferrara Play&Go?*	5.25	0.95
	Would you participate in a new edition of Ferrara Play&Go?	5.76	0.76
Reward perception	*Did the prizes up for grabs seem interesting to you?*	3.81	1.34
	The Green Leaves points attributed to journeys with the various means of transport are well balanced with respect to the sustainability of the means	4.15	1.21
Behavior change	*Will you continue to move as suggested by the app even after the Ferrara Play&Go initiative is over*	5.25	0.92
	To what extent has the initiative led you to change your mobility habits?	4.42	0.64

The analysis suggests that in this campaign the overall rewards perception affects both the users' behavior change perception ($F_{1,74}$ = 16.19, $p < 0.0001$, R^2 = 0.1685), and the fun level ($F_{1,74}$ = 22.68, $p < 0.0001$, R^2 = 0.2242), and the perceived fun level predicts the behavioral outcome expressed in the user experience questionnaire ($F_{1,74}$ = 17.68, $p < 0.0001$, R^2 = 0.1819. See Figure 6B). However, analyzing more specifically the two different rewarding systems, the data suggest that: (1) in-game rewards significantly predict users' behavior-change levels ($F_{1,74}$ = 8.81, $p < 0.0001$, R^2 = 0.1919. See Figure 6A) and fun levels ($F_{1,74}$ = 16.55, $p < 0.001$, R^2 = 0.1717), and (2) external rewards show prediction of both users' behavior ($F_{1,74}$ = 6.731, $p < 0.01$, R^2 = 0.07098), and the users' fun ($F_{1,74}$ = 14.82, $p > 0.0001$, R^2 = 0.01556).

The AIC criterion suggests that the fun level, receiving the lowest AICc score (AICc = 120.30) and 65% of the total weight of the models considered, best predicts the overall behavioral outcome expressed in the user-experience questionnaire. However, analyzing more specifically the two different rewarding systems, the AIC criterion suggests that the interaction between in-game reward and fun level best predicts the behavioral outcome (AICc = 114.14) with the 85% of the total weight of the models considered.

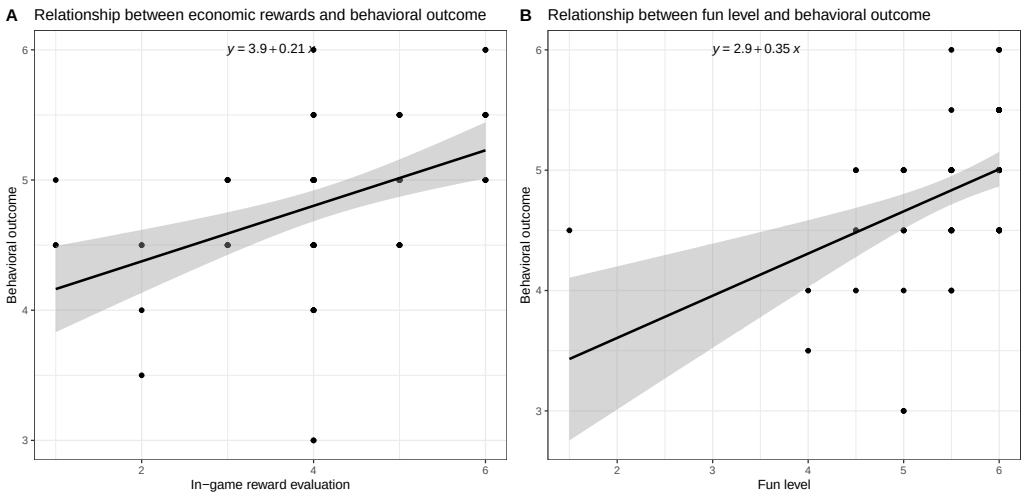

Figure 6. Relation between the perceived fun level, rewards, and the behavioral outcome in the user-experience questionnaire during the PLAY & GO campaign.

4.3. Kids Go Green

Kids Go Green has been adopted for five consecutive school years by 62 schools in Trentino, Emilia-Romagna, Lecco and Switzerland, involving almost 6000 children and their families. After five years of research and development, the impact of Kids Go Green has been evidenced in the area of sustainable mobility. Children have displayed a heightened awareness and understanding of the subject matter, while the project has had a lasting impact on their mobility behavior beyond the conclusion of the trials. The initiative also demonstrated educational value, delivering inventive, cross-disciplinary learning prospects that are interwoven into the current academic curriculum. In addition, the game has fostered a sense of community among students, motivated by a common goal, who travel together in virtual space while engaging in interactive and educational play. Within the AIR-BREAK sustainable mobility campaigns, *Kids Go Green* is experimented on two consecutive school years (2021–2022, 2022–2023) in primary and secondary schools in Ferrara.

A total of 520 users filled up completely the questionnaire. The 74.2% of users reported a good overall experience with the initiative (mean = 4.1 ± 0.86), 49.8% (mean = 3.45 ± 0.97) reported that the campaign has positively influenced their mobility habits, and 66.9% (mean = 3.91 ± 0.92) reported to have become more environmentally friendly thanks to the campaign.

As for the prior campaigns, to analyze the interaction between fun, rewards, and behavioral outcome, we clustered several questionnaire items into the same factors. The results for the three factors can be seen in Table 5.

Table 5. Questionnaire results according to the selected features for the KIDS GO GREEN campaign.

Dimension	Item	Mean	SD
Perceived fun level	*How satisfied are you with the Kids Go Green initiative?*	3.82	0.77
	Indicate how much you agree with the following sentences. [I like participating in Kids Go Green]	4.11	0.86
Reward perception	*Thinking back to when you used Kids Go Green in class, how much did you enjoy each of these activities? [Advance the Kids Go Green path]*	4.17	0.89
	Thinking back to when you used Kids Go Green in class, how much did you enjoy each of these activities? [Achieve milestones and unlock content]	4.27	0.89
Behavior change	*To what extent do you think the use of the KGG platform has influenced the following aspects: [Stimulates students' curiosity]*	3.74	0.82
	To what extent do you think the use of the KGG platform has impacted the following: [Supports the inclusion of all students]	3.51	0.85
	To what extent do you think that the use of the KGG platform has influenced the following aspects: [Positively influences my child's home-school mobility habits]	3.86	1.00
	To what extent do you think the use of the KGG platform has influenced the following aspects: [Awareness of environmental sustainability issues]	3.93	0.85
	To what extent do you think that the use of the KGG platform has influenced the following aspects: [It positively influences my child's mobility habits even in his/her free time]	3.45	0.97
	Indicate how much you agree with the following sentence: [With Kids Go Green I became more environmentally friendly]	3.91	0.93
	Indicate how much you agree with the following sentence: [With Kids Go Green I understood that it is important to use sustainable means of transport (such as going on foot, by bike, by bus)]	4.10	0.91

The analysis for the Kids Go Green campaign suggests that the perceived fun level significantly predicts the behavioral outcome expressed in the user experience questionnaire ($F_{1,518} = 489.7$, $p < 0.0001$, $R^2 = 0.485$), and the overall in-game rewards perception affects both the users' behavior change perception ($F_{1,518} = 279.4$, $p < 0.0001$, $R^2 = 0.3491$), and the

expressed fun level ($F_{1,518}$ = 347.3, $p < 0.0001$, R^2 = 0.4). Figure 7 shows the relationship between reward level and fun level and reward level and behavioral change self-evaluation expressed in the user experience questionnaire: the more rewards reach high levels, the more users change their behaviors towards sustainable behaviors and express high fun levels. Analyzing which factor best predicted the final behavioral expressed outcome, the AIC criterion suggests that the interaction between rewards and the perceived fun level, receiving the lowest AICc score (AICc = 708.48) and the 100% of the total weight of the models considered, best predicts the overall behavioral outcome expressed in the user experience questionnaire.

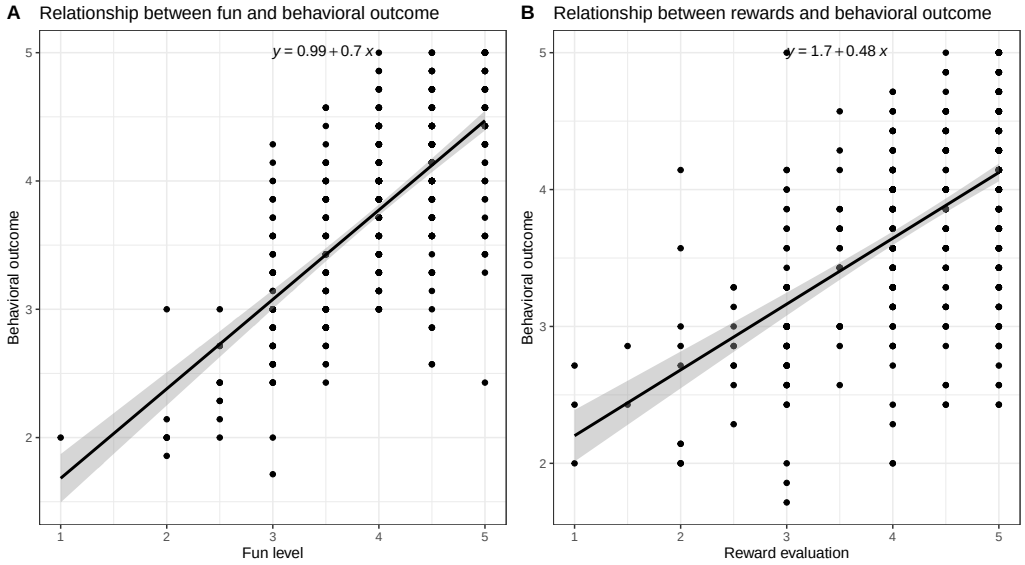

Figure 7. Relation between the perceived fun level, rewards, and the behavioral outcome at the user experience questionnaire during the KIDS GO GREEN campaign.

5. Discussion

All the presented campaigns reported very good levels in the rewards evaluation, fun level, and behavioral outcome in the user-experience questionnaire.

The questionnaires analysis suggests that the reward system was well implemented in the campaigns and positively perceived by the users, thus promoting adequate fun levels to foster sustainability behaviors over time: this data is of crucial importance since the fun level is strictly related to the success of gamified solutions [16,18,19]. Rewards played a crucial role in perceiving the campaign as fun and both rewards and fun directly affected the final behavioral outcome. Moreover, the interaction between fun and the rewarding-system perception seems to be the best predictor to sustain the final behavioral outcome.

According to the findings in the literature [52,53], in-game rewards (such as badges, leaderboard position, points, unblocking game contents, and so forth) seem to be best-suited for target users who are intrinsically motivated, while the use of external rewards or economic incentives seems to be best-suited to foster behavior change for those gamified activities that are mandatory, or designed to be long term: hence, those users motivated by the inherent enjoyment of the activity itself (intrinsic) may respond poorly to the external, tangible and economic rewards [52]. Hence, external rewards or economic incentives which are badly implemented could provide a loss of motivation.

Specifically, the economic incentives in the *Ferrara Bike2Work* showed a statistically significant relationship with both the fun level and the behavioral outcome—in this case, particularly on the will to maintain the sustainable behavior—and that the overall fun level (enhanced by an adequate rewarding-system perception) best predicted the behavior change. The rewarding system implemented in *Play&Go* showed a statistically significant relationship between both the fun level and the behavioral outcome for both in-game rewards and economic incentives. Interestingly, since in this case the *behavior-change* factor

also contains information about the users' will to maintain the behavior after the end of the campaign, the interaction between in-game rewards and fun levels, as depicted in the literature [54], best predicted the users' behavioral outcome. The rewarding systems implemented in the *Kids Go Green* campaign showed a statistically significant relationship with both the fun level and the behavioral outcome, and that, as in the other campaign analyses, the interaction between the in-game rewards and fun level best predicted the final behavioral outcome. Overall, the presented analysis suggests that both the reward systems (in-game rewards and economic incentives) were adequately implemented in the campaigns, and, specifically, were perfectly balanced in the FERRARA PLAY&GO campaign, since users reported the will to maintain the sustainable behaviors adopted during the campaign. Moreover, this analysis suggests that, in line with the literature [53], in-game rewards seem to promote behavior change over time. The AIR-BREAK initiative has yielded significant effects, including the examination of vast, open-source datasets. These data sets offer support to policymakers, decision-makers, urban planners, and designers, facilitating informed and evidence-based policy development and design choices [55].

6. Limitations

This study has several limitations. For the analysis of each campaign, three different user-experience questionnaires were used. The choice of using ad-hoc questionnaires came from the need for tailored information and suggestions in order to enhance the campaigns for the subsequent runs. Despite being useful in collecting information for design, ad-hoc questionnaires lack item reliability. Then, the selection of analyzed items was defined arbitrarily according to the meaning of items instead of using a confirmatory factor analysis (CFA) or an exploratory factor analysis (EFA): these analyses work properly when there are multiple items related to each factor. Hence, a holistic questionnaire for all four campaigns which includes user experience and usability, with specific items for rewards analysis and fun level, is under development. Moreover, the lack of a link between the results of the questionnaires and the data from the travel tracking did not allow us to establish an objective measure for assessing behavior change during campaigns. Moreover, the *Ferrara Bike2Work* campaign does not report the user perception of in-game rewards, giving only a description of the economic incentives. Hence, the above-mentioned limitations reduce the data reliability and make it difficult to generalize the results.

7. Conclusions and Future Directions

One of the main goals of the AIR-BREAK project is the implementation of sustainable mobility campaigns to educate and enlighten citizens regarding the numerous advantages and possibilities presented by sustainable mobility services. The aim is to promote the adoption of alternative, more environmentally friendly, transportation practices.

Three mobility campaigns have been launched and operated within the reporting period: Kids Go Green, targeting school students; Ferrara Play&Go, targeting all citizens; and Bike2Work targeting employees from Ferrara public or private companies.

This article described each campaign, how we implemented the rewarding systems, and then it reported an analysis of each rewarding system applied to foster behavioral changes toward more eco-sustainable behaviors, providing a high fun level to the users. The data show that each campaign achieved the aim of changing users' behavior and that the rewarding systems implemented played a crucial role in the realization of this goal, affecting both fun and behavioral outcomes.

In the future, we will also run and analyze the High-School Challenge campaign data, which is important for understanding whether the implemented rewarding system works in cooperative and competitive situations. To face limitations presented in Section 6, we are working on a user-experience questionnaire for all the campaigns of the AIR-BREAK project, which might give us a more reliable evaluation of the implemented rewards and fun analysis, and will be linked to the user ID, providing us a direct correlation between the user experience and behavioral outcomes. Then, after the analysis of the four campaigns,

our last aim is to create a rewarding-system framework in order to help designers and practitioners designing rewarding systems in the proper way.

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Informed Consent Statement: User consent was waived due we administered the questionnaires anonymously and voluntarily.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declares no conflict of interest.

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