# *GoEco!* - A Set of Smartphone Apps Supporting the Transition Towards Sustainable Mobility Patterns

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**Abstract.** How can we encourage people to engage in more sustainable mobility lifestyles, reducing car use? Taking advantage of the wide availability of smartphones, we overcome the traditional awareness-raising approach and exploit eco-feedback, social norms and peer pressure elements in an ICT-based motivation system. We developed two smartphone Apps, which are currently being tested in a real-life, large-scale living lab experiment. The *GoEco! Tracker* App monitors the mobility patterns of the participants, identifying the routes they travel and the means of transport they use, and it is primarily meant to collect baseline data. Exploiting individual achievement and competition game mechanics, the full *GoEco!* App additionally nudges users towards personal goals for change and engages them in individual and collective challenges, strengthening competition with a "hall of fame" section. In this paper we introduce the *GoEco!* Apps and their theoretical eco-feedback and gamification framework, describe their key functionalities and comment on the main strengths and limitations after one month of large-scale testing of the *GoEco!* Tracker App.

**Keywords:** Mobility tracking; App; Gamification; Sustainability;

## 1 Introduction

The present urban transportation system, mostly tailored for cars, has long shown its limitations [7]. In many urban areas, alternative and effective transport

modes are already available and they could be used in intermodal combinations to satisfy many travel needs [6]: public transportation, slow mobility networks, vehicle-sharing systems. However, these transport modes still tend to be neglected due to a deep-rooted car dependency [4].

How can we encourage people to engage in more sustainable mobility lifestyles, reducing use of the car? We propose to overcome the traditional awareness-raising approach and, building on recent research in social psychology and behavior studies, to take advantage of the wide availability of smartphone devices (cf. [11]).

Can ICT-based eco-feedback, social norms and peer pressure be effective in fostering changes in personal mobility behavior? To answer this question, we designed *GoEco!*, a set of two smartphone applications, and are now testing them in a "living lab" field study [2] involving around 600 volunteer real-life users in Southern Switzerland and in the City of Zurich.

## 2 The *GoEco!* Apps

We built two Apps: the first one, named *GoEco! Tracker*, monitors the mobility patterns of its users, identifying the routes they travel and the means of transport they use. Post-processing the data gathered by the tracker app allows us to identify the present mobility patterns of the users (baseline data) and their potentials for change. For this purpose, we determine their regular trips and assess the feasibility of replacing their usual transport mode with a more energy-efficient means. At this stage, feedback on people's mobility choices is as limited as possible. In order to collect non-biased baseline data, in fact, it would be even better not to provide users with any feedback on their mobility choices. However, considering present limitations in automatic mobility tracking [3], this cannot be avoided completely because a validation for both the path they travel and the means of transport they use is required.

The second App, named *GoEco!*, performs the same mobility tracking; in addition, adopting a gamification approach based on individual achievement and competitive game mechanics [10], it also nudges the users to define personal goals and targets for change with respect to their baseline mobility patterns. On a daily basis, the App provides feedback to the users regarding their mobility choices (distance travelled, means of transport used, travelling time) and related impacts (energy consumption and $CO_2$ emissions) (see Figure 1). On a weekly basis, the App also indicates the progress towards their goals for change, comparing it with achievements by other participants, invites them to take part in mobility challenges, suggests meaningful low-impact, alternative modal options and rewards good performances and achievements with virtual prizes (badges). It is important to note that change is always measured individually, i.e., in comparison to the goals and baseline data of an individual participant. This implies that every person defines her own rules.

Both Apps exploit the APIs of the commercial, free fitness tracker App Moves® (https://dev.moves-app.com). Moves records a user's position at various points and is able to determine whether the user was walking, running, cycling,

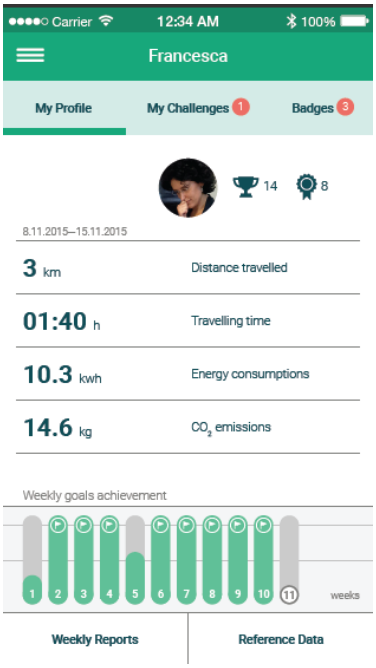


**Fig. 1.** The start screen of the full *GoEco!* app. It shows an overview of the current mobility behavior, as well as the achievements reached so far, and quick links to other important parts of the app, such as *Challenges*, *Badges*, *Reports*, and *Reference Data*.

or taking another form of transport between track points. Because we need a more fine-grained distinction between different modes of transport, we built a post-processing algorithm, which utilizes a naive Bayes classifier [9] to distinguish between modes such as bus, train, tram or car. Our classifier takes into account several route characteristics, such as travel speed, acceleration or overlay between visited points and the network of the public Swiss transportation system (stops and lines) [3]. Every day users are asked to check and validate the means of transport for every route tracked. The Bayes classifier uses validations to constantly improve its future predictions, reducing the interactions with users as time goes by.

## 3 Mobility Patterns and Potentials for Change

The *GoEco! Tracker* App needs to be used for at least four weeks to collect baseline data. After such period, participants get a report showing the routes they traveled (Figure 2), summarizing their current mobility patterns and indicating potentials for change.

Mobility patterns are expressed on a weekly basis and they refer to the average kilometers traveled, the average traveling time and the average percentage of use

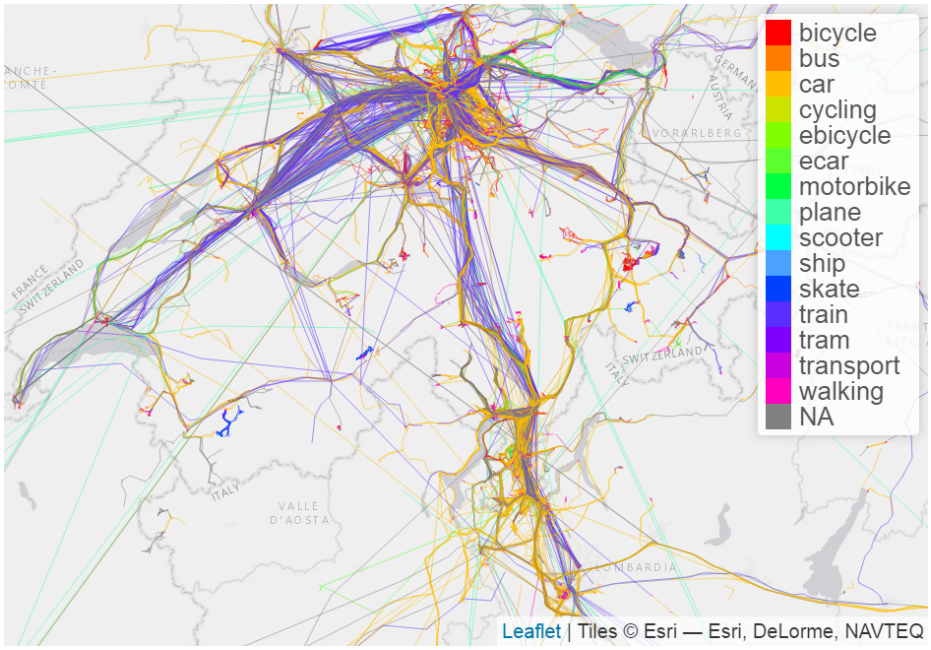


**Fig. 2.** The activities *GoEco!* tracked from the 359 members of the *GoEco!* community during the first study period, from March 7, 2016 to April 4, 2016.

of each means of transport (aggregated into the following categories; car, public transport, bicycle, walking, other). Details regarding total kilometers traveled, traveling times, energy consumption and $CO_2$ per means of transport are also provided.

Potential for change represents instead the possible mobility patterns a user could have if she would always replace her trips with the most energy-efficient mobility option. To identify them, an analysis with respect to several criteria is necessary: we first distinguish systematic from non-systematic trips. For every systematic trip, such as the daily commute to work, we identify a specific, path-dependent alternative, while for non-systematic trips we simply consider general, path-independent alternatives, only based on the length of the trip and the means of transport used. Since users will seldom repeat non-systematic trips, regarding them the report simply suggests aggregated potentials, obtained by general rules such as: for trips shorter than 1 kilometer, you could walk; for trips shorter than 3 kilometers, you could use the bicycle, and so on.

We developed various tools to perform these analyses. For the distinction of systematic and non-systematic routes, we employ a clustering algorithm that detects important places for every user (cf. [8]), followed by an assessment of which routes were taken how frequently. To determine the availability of energy-efficient alternatives for systematic trips, we combine an expert system with a custom route planner: while the route planner tries to find routes using various

means of transport, the expert system determines when a journey should actually be considered as a viable alternative.

## 4 Behavior Change Motivation Mechanics

The key elements represented in the report are also summarized in the full *GoEco!* app, so that users can always recall their baseline and potential values. Next to such static feedback, the full *GoEco!* app uses a variety of interactive gamification mechanics to nudge people towards more sustainable mobility patterns.

Since mobility choices are individual and depend on a variety of circumstances, such as daily schedule, weather, or other persons involved, gamification elements have to be chosen carefully [10]. Points, for example, are difficult to use, as a fair distribution of points is a very delicate task in such a heterogeneous environment, if one wants to respect all individual circumstances and stay transparent. For example, users have different access to alternatives for car use, depending on the places they live and work, or might have different family requirements influencing their mobility needs. In general, there is no one-size-fits-all mobility solution to be promoted by a super-imposed scoring system. Our use of gamification thus revolves around personal goals for change with respect to the baseline mobility patterns: users are invited to choose a personal goal towards sustainable mobility patterns, selecting it from a list of possibilities (reduce car use, increase slow mobility, reduce energy consumption, etc.), and also to set the quantitative target they want to achieve. For this purpose, the App supports them, showing both their "baseline" and "potential" mobility patterns (Figure 3).

Progression towards an own goal is therefore the key motivational factor, both for the individual as well as for the social comparison to others. Users are free to progress at their own pace and in their own direction, while being slightly nudged by *GoEco!* to achieve their personal goal for change. To this purpose, we use a system of additional motivation elements (Figure 4).

The first one is "information feedback". When using feedback and gamification, optimally, the feedback is given in a well-timed manner [5]. However, because we rely on Moves for the activity tracking, this is difficult (the data Moves provides gets updated at unknown points in time). As such, we encourage users to interact with *GoEco!* once per day, at which point they receive feedback on their daily activities. Progression towards their goals, instead, is shown on a weekly basis, since daily goals would not be significant from the mobility point of view: individual mobility demand might vary a lot from one day to another and achievement of daily goals might simply be due to external factors conditioning demand, not to a real change in the users' mobility patterns.

Further motivational elements are "education", "guidance" and "rewards": besides supporting users by indicating their potential for change and providing them with personalized alternatives for systematic trips, *GoEco!* also guides users by challenging them to adopt specific, sustainable mobility patterns and nudging repetitions over time. Individual challenges compatible with the personal goal chosen, such as "I will not use the car during peak hours for five days", "I will

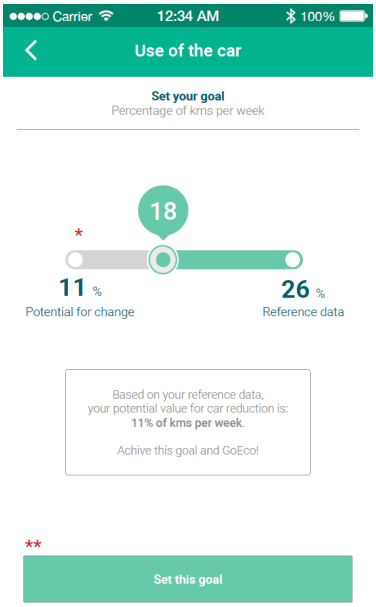


**Fig. 3.** Setting a personal goal, based on the assessment of *GoEco!*, which takes into account the baseline data and a variety of alternative travel options.

not use either cars or planes for the whole week-end" or "I will travel by slow mobility all my short routes", are offered every week to the user, who is free to choose the one(s) she prefers or to ignore them. Users who achieve challenges are rewarded with a trophy. Successfully repeating challenges over time allows leveling up and receiving higher-level trophies (bronze, silver, gold and platinum).

Users are also rewarded with surprise badges, which are automatically attributed when specific sustainable mobility choices are detected by the system, such as using the bicycle every day for at least five consecutive days or travelling long trips by train.

The possibility of comparing one's performances with the other members of the *GoEco!* community ("social comparison") is considered a powerful tool to increase motivation for change [1]. Since we opted for avoiding a point-based system, building a leaderboard is not straightforward. Coherently with the choice to put personal goals for change at the center of our motivational mechanics, comparison between members of the community is based on their level of achievement of their own personal goals, combined with the number of challenges they completed and the number of badges they obtained. The leaderboard is updated every week and the top-3 members are posted in the "Hall of fame" section (Figure 5).

Independent of whether the users choose simple or complex goals, they have the chance to be listed in the *GoEco!* hall of fame if they achieved them. The system doesn't judge goal complexity, which depends on the users' initial mobility

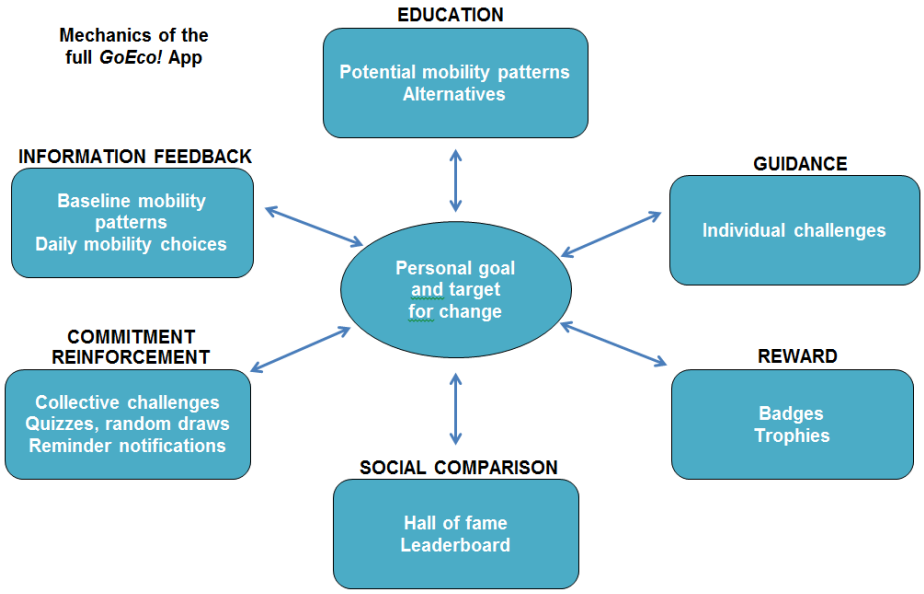


**Fig. 4.** Components of the *GoEco!* motivation mechanics.

patterns, on the intensity of their potential for changes, on external, personal constraints and on the overall level of engagement they accept.

Unexpected elements such as badges help for "commitment reinforcement". Besides this, *GoEco!* also promotes in-person meetings among members of the community, named "collective challenges". These are recreational events hinting at sustainable mobility, such as slow mobility and public transport treasure hunts across the city or lazy bicycle rides in natural areas, where participants can meet, accompanied by their families. The virtual community is therefore backed up by physical meetings held once a month, where participants can share their experience and also try sustainable approaches to leisure time mobility (a further guidance function).

Additional reinforcement is provided by a notification system, which remembers users to validate their trips daily, notifies them of new challenges or updates of the weekly statistics, and congratulates them whenever they achieve good results (goals, challenges, badges, visibility in the hall of fame).

Finally, monthly quizzes and random draws with tangible prizes addressing the active members of the community are used to further keep their commitment. They are the only tangible motivational elements in the whole *GoEco!* experience. By explicit choice, prizes have low monetary value. We want in fact to stimulate mobility behavior change as a personal, intrinsic choice of the participants, instead of buying their change for money, which would only have temporary effects.

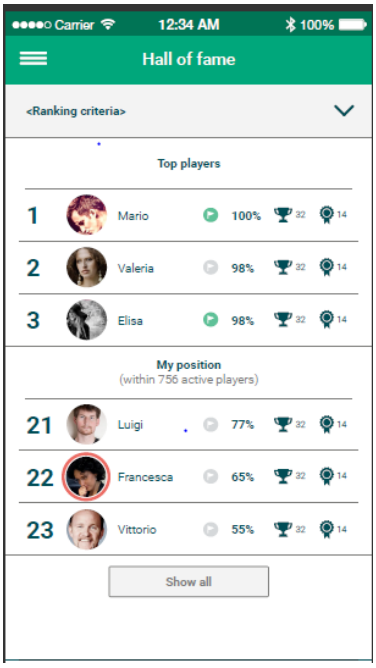


**Fig. 5.** The "Hall of fame" section in the *GoEco!* App.

## 5 Conclusion and Outlook

The *GoEco! Tracker* App has been tested in the *GoEco!* living lab in Spring 2016. An assessment of the baseline data yielded acceptable data and algorithm quality [3]. We developed and presented algorithms to automatically analyze mobility patterns and potentials of every user individually. The so generated reports are used as a first feedback for users and are currently being integrated into the full *GoEco!* App, to be deployed in Autumn 2016.

However, while the interest in *GoEco!* is generally high, about one third of the participants, who voluntarily signed up for the study, did not even start with the experiment. Also, only one third of them regularly validated the tracked trips. Such a low activity rate raises doubts on the possibilities for future up-scaling and enlargement of the *GoEco!* community at the society level. Before performing any assessment, however, we'll wait for the conclusion of the next phase of the *GoEco!* living lab, when participants will test the full *GoEco!* App. Results of this activity will show if the *GoEco!* approach is effective in improving mobility behavior and also, up to some degree, which of the employed motivational elements had greater effects on user behavior. If the overall approach will be proven effective, we will then focus on how to favor a wide penetration of the *GoEco!* community within society, directly involving participants to the living lab experiment, with the aim of collecting their perceptions and suggestions.

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