SaveMyBike – A Complete Platform to Promote Sustainable Mobility

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Abstract. Bicycle theft is a prevalent problem in every country around the world and its part of everyday life, especially in urban areas. At the same time, the return of stolen bicycles to their owners is generally very low. This phenomenon decreases bike use in our cities, and population feels it in depth. In Europe, only 14% of SUMP has done the biennial monitoring plan due to the difficulty to recover data: another need of our urban areas is the continuous monitoring of mobility behaviour useful to verify mobility measures impacts. So, the SaveMyBike platform joins a private bike antitheft and identification service with a mobility rewarding system (including all sustainable transport modes) called "Good-Go" to collect great amounts of anonymised data to analyse mobility patterns and to make mobility measures evaluation and to incentive sustainable mobility.

Keywords: Bicycle · Sustainable mobility · Rewarding · Incentive · Big data · Monitoring

1 The Actual State of Art

In this first part, the state of the art of each feature linked to the SaveMyBike platform is described underlining its actual development level and the main problems. In the following second part, the platform is described in detail, while the third section presents the experimental results obtained from the prototypical application to the city of Livorno. The paper ends with some conclusions outlining and addressing to possible future developments.

1.1 Urban Transport Planning Needs

The recent report on the "User' need analysis on SUMP take-up" [1] submitted to European Commission from Civitas SUMPS-UP project analyzes the current status of SUMP take-up in 328 European Cities indicating drivers, barriers and support needs. One of the main extracted feature is the need of tools to facilitate the biennial SUMP monitoring measure (as recommended from the European SUMP guidelines [2] and from the Italian Transport and Infrastructure Ministerial Decree [3]); this because only 14% of the surveyed cities have a monitoring plan implemented (in Italy no sump has implemented it). Moreover, medium-small cities often do not have adequate resources to implement a suitable ITS system to monitor systematically mobility behavior.

© Springer Nature Switzerland AG 2019
S. Misra et al. (Eds.): ICCSA 2019, LNCS 11620, pp. 177–190, 2019.
https://doi.org/10.1007/978-3-030-24296-1_16

So they do not have enough data to implement all the indices that many European Projects describe in detail to evaluate the impact of their mobility measures [4, 5]. For this reason, SaveMyBike arises, monitoring at low cost a significant population sample in its daily trips as a possible supplier of decision support elements and urban mobility monitoring. Therefore, SaveMyBike is a basic element for many urban areas in order to encourage cycling and plan the whole sphere of mobility.

Traffic emissions in our cities do not decrease as required by European strategic policies [6–8], that is why it is important to highlight sustainable mobility. While the autonomous vehicles market is going to be implemented, thanks to the interests of the car companies, the transition to the 'cycle towns' seems a step back. Recent 'defeats' of the most innovative cycling systems (see the free-floating bike sharing, abandoned due to vandalism and low profitability in some important European companies), show how the possible improvements in the cycle area are still wide. SaveMyBike introduces a new incentive system for private bicycles, able to open new roads for cycle mobility, such as bike-sharing peer-to-peer (a field not yet experienced in reality). In addition, it combines the GOOD_GO system, an innovative rewarding system capable of encouraging sustainable mobility in general.

1.2 Mobility Rewarding System

A detailed description of the state of art regarding the mobility rewarding platforms and systems has been already analyzed in a previous paper [9] but here we want to underline the main problems of these incentive systems. They are mainly experiments often temporally limited to the period of application of European projects. These last coped with individual subsystems of SaveMyBike, in cities such as Berlin ("Green Jobs" with bike discovery), Massarosa and Bari (monetary incentive to use bike), Bologna (with the App "Bella Mossa", today no longer active), Trento/Rovereto (with the "Play&Go" system, the only one with a minimum level of longevity), Singapore (awards) and a few others (see the Deliverable D1.1.2 of the SaveMyBike project at www.savemybike.eu). The main problem is to create a system for a continuous time plan, due to the following:

- problems in the incentives financing;
- problems in the citizen involvement and loyalty

The first problems arise where monetary rewards have adopted, in a wrong way following the rewarding psychology:

In fact, the image of an individual that has communicated to others is an element of important incentive, as it leads the citizen to appear as a person of high social standing.

Often the use of monetary prizes goes against this principle because the citizen loses the social purpose to the more venal economic one. In addition, the virtuous behavior of acquaintances and colleagues can influence individuals and therefore, once again, the use of social networks to spread virtuous behavior acquires a high importance.

Furthermore, Ampt [10] highlights how the communication of one's own virtuous behavior to others involves a mental process of strengthening one's commitment to sustainability.

Prizes that coincide with a person's wishes and stimuli can help to break the habit and create new patterns of behavior. Every time we receive a prize, the new model has reinforced. When we celebrate a behavioral change with prizes, we are recognizing successes, motivating ourselves to continue and increasing self-esteem.

This last part is the fulcrum to keep the changes in time, as self-esteem gives us the courage to keep going and trying. As can be seen, the psychological analysis of the prizes goes well beyond their monetary value. Compared to the monetary prizes, with the presents the participants are more satisfied and motivated, although, when asked, most people say they prefer to receive money.

1.3 Bike Antitheft and Recovery System

Bike-sharing in general is profitable only in metropolitan areas and not in medium-small cities where the use of private bicycles prevails. The use of private bikes could increase if one finds the way to reduce the number of the thefts linked to them.

The phenomenon of theft has become a worldwide phenomenon that has not yet found effective solutions. The European Cyclist Federation said that every year there are 20,000 bikes stolen in London's streets. In Berlin there are 85 bikes stolen per day, which accumulates into a total value of 160 million Euros in stolen bikes across the whole Germany. The Netherlands' Central Bureau of Statistics estimates that 630,000 thefts reported to the police in only 30% while a survey of cyclists in Montreal showed a percentage of returned 2.4%. There are also anti-theft systems certified but, to date they only delay the theft but do not prevent it. SaveMyBike tries to develop low-cost systems that can really be used by everyone, studying advanced and differentiated sensors depending on the cost of the bike, including futuristic solutions that allow efficient and low-cost communications (e.g. Lora sensors). At the Italian National level, the ANCMA-National Association of Cycles, Motorcycles and Accessories (branch of ConfIndustria) are developing the BiciAcademy project with the development of a web platform for the registration of the different bike identification systems that will go into operation after summer 2019. SaveMyBike could be among the first identification systems to connect with this national platform and have an official recognition within the National Bicycle Register. There are identification systems such as "SecurMark" that fulfill this need by writing a code on the bicycle frame and protecting it with a label. This system is only limited to this function, moreover it is easily manipulated and requires the close reading of the single bar code.

2 The SaveMyBike Platform

The strength of SaveMyBike consists in joining a set of services for the cycling world with a rewarding multimodal system in a single platform, succeeding in creating a system that adapts to every type of city and that brings benefits to more types of customers. SaveMyBike platform is a new system to accommodate every type of technological development, the interest of citizens, administrations, large companies (which have a Mobility Manager who must monitor home-work travels), schools (monitoring and user rewards) with the "bicibus" and the "pedibus" and for the

home-study trips. SaveMyBike also accomplishes the interest of the environmental and cycling associations or other association types and the interest of the activities located in the urban area. The platform is customizable and connectable to other existing platforms in a streamlined way (see Fig. 1).

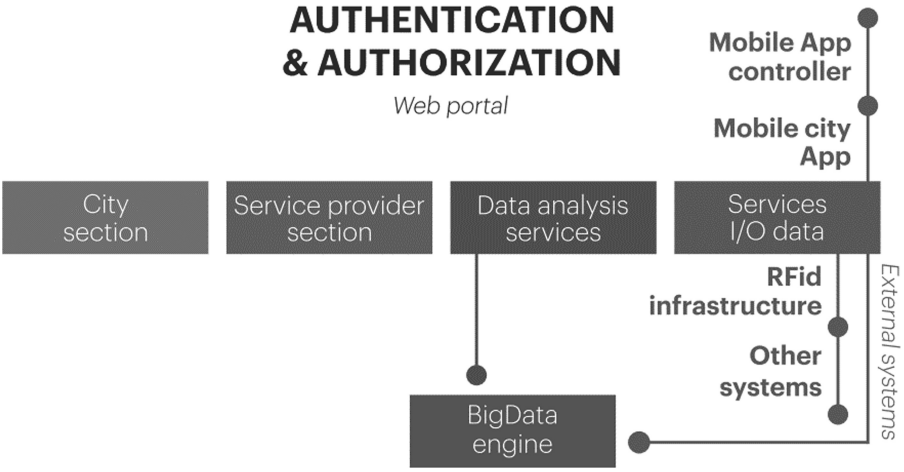


Fig. 1. Scheme of the GOOD_GO platform

In addition, the combination of multiple services, such as the burglar alarm, the description and complaint of the bike, the discovery of the bikes, the reward and the *gamification* [11] of each of its elements, make SaveMyBike an attractive element for most citizens. All this above allows, for the first time, the direct collection of trips data for a statistically significant population sample, proposing itself as a system for collecting user data of particular interest to the Administrations.

In the following paragraphs, the two main parts ("bike" and "rewarding" sections) has described.

2.1 The Bike-Side Platform

SaveMyBike offers an antitheft-identification-recovery system for private bikes providing several sensors offers that vary with the value of the bicycle to be 'protected'. The 'basic version' provides a retrieval/tracing system through additional low-cost tags (about 10 € 0.20/each) RFID UHF external "hidden" legible at the same time simply walking a meter away from the bikes, then with an high efficiency level. To this it add an identification system consisting of a low-cost tag (about 4.0 Euros) RFID HF to be installed inside the bike frame, unmovable and readable by telescopic antennas equally low-cost but invisible, non-intrusive on the structure of the bicycle. Finally, it can be added (this is an ongoing research) a bluetooth device coupled with an accelerometer capable of communicating with the safe area bluetooth reader and able of emitting an acoustic signal during the theft/movement of the bike. It then joins an internal digital

identification/digital plate to an external tracing system that also becomes, in its extended version, a system of disincentive to theft.

The system is based on a client-side platform called GOOD_GO with the homonymous App (see Fig. 2) allowing the users' registration, the uploading of their bike characteristics and images, the complaints of theft and the record of notification in case of bike recovery.

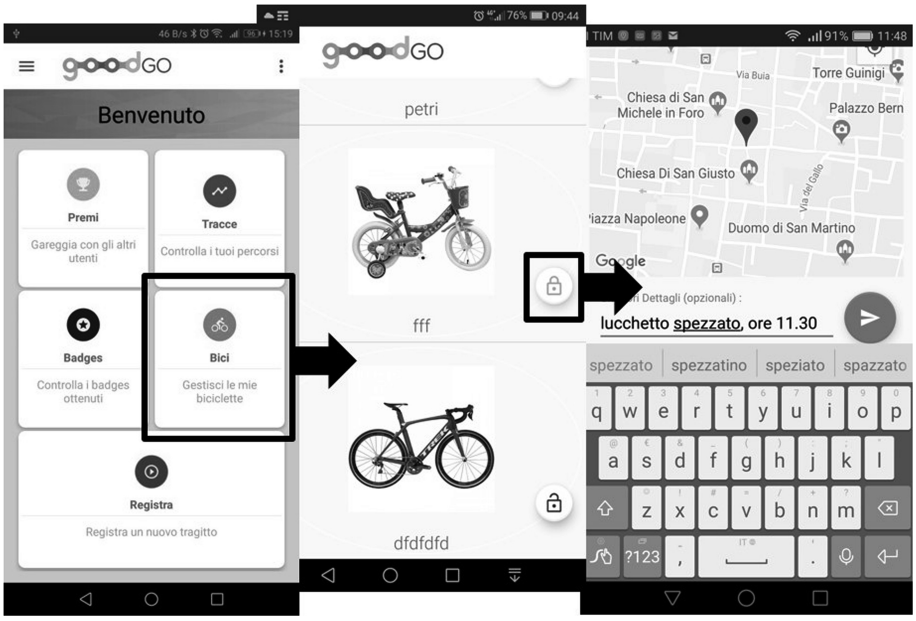


Fig. 2. Some screenshots of the GOOD_DO App relative to the bike module

For example, the complaints of theft allows you to build maps of areas at risk of theft to be communicated to citizens or to be 'in safety' through the ex-post installation of video cameras or other technologies. This service is not today present in Europe, but is in the USA with the BIKE INDEX system where you record the bike, alert in case of theft and the community helps to find the bike. As you can see, SaveMyBike becomes, therefore, a system to find the bike also 'participated', where users access the list of stolen bikes and can report the probable finding, also indicating the location and a photo. This is, moreover, an incentive to citizens to customize the bike as much as possible so that others can find it more easily.

In addition to the client side platform, there is a platform to manage sensor installations, allowing the joining of each sensor ID to the its bike and to the owner, the management of installation booking (cancelations, changes, corrections, etc.) and the annual sensor revision service (see Fig. 3). There is the ADMIN section that manages of user types, roles and permissions, the SMD section that allows portable RFid reader loading and assignment to operators (auxiliary, police, sensor installators, etc.), the

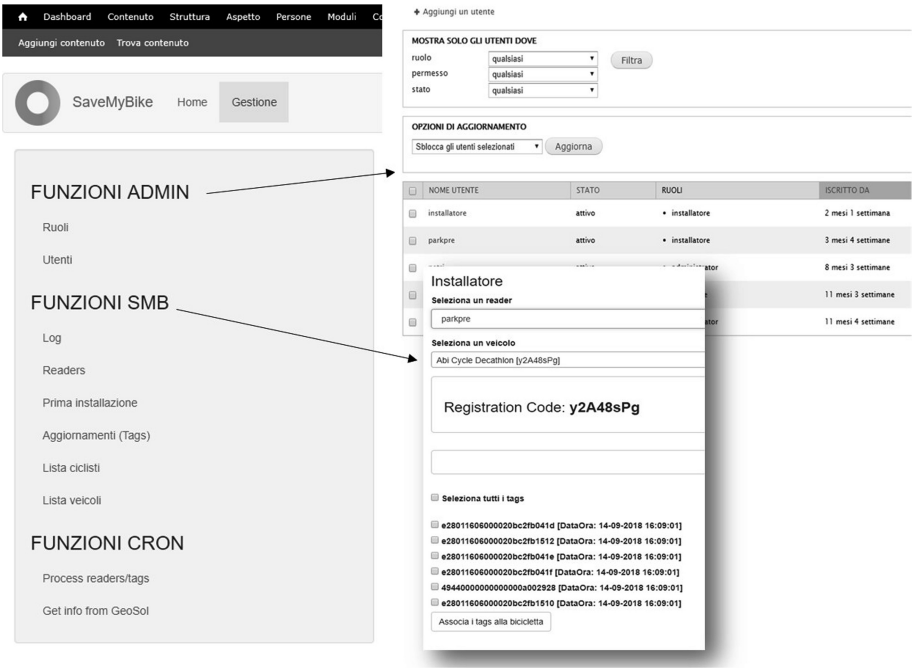


Fig. 3. Some images of the bike sensors management platform

installation of additional tags to already "*sensorized*" bike and manage the user list and "*sensorized*" bike list.

2.2 The Rewarding-Side Platform GOOD_GO

The reward system is integrated in the same GOOD_GO App; it tracks daily trips monitoring the mean speed, the total distance and time, the start and end time of each track, calculating a general individual score about sustainable mobility and the following three indices groups (see Figs. 4 and 5):

- Environmental indices: atmospheric emissions produced and avoided about CO_2, SO_2, NO_x, CO and PM10
- Transport cost indices: transport costs per single mode aggregated or divided by km
- Health indices
  - Calories consumed in the trips
  - Benefit index (reduction of the probability of cardiovascular disease from the HEAT model [12])

The reward platform developed and already working in the prototype, implements welfare policies towards the elderly, or divides the premiums by age group. To date, in Europe there are rewarding systems, such as "Positive Drive", or "Bella Mossa", but they all put the whole population in competition, slowly losing the participation of an

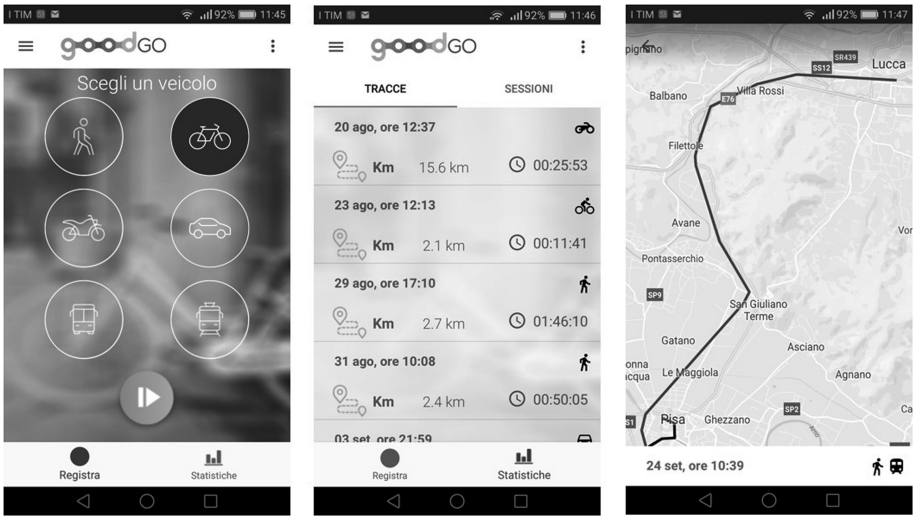


Fig. 4. Some screenshots about the tracking system

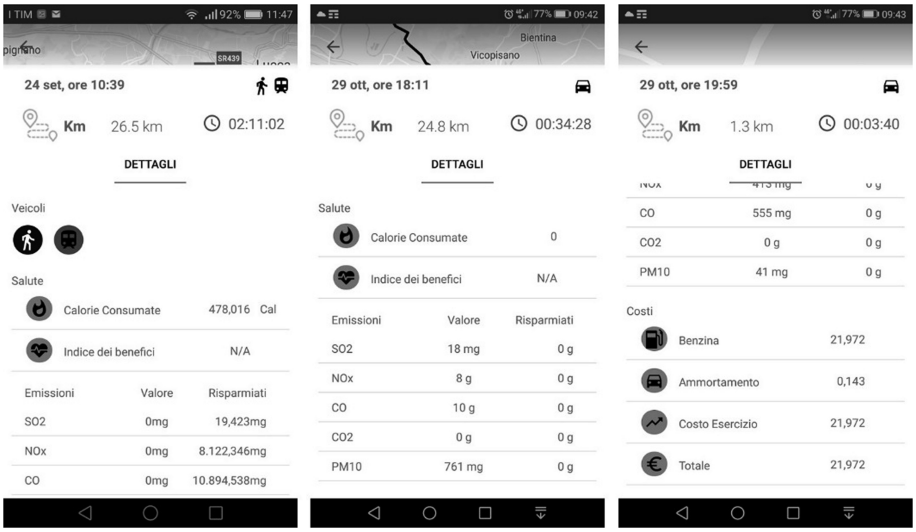


Fig. 5. Some screenshots about the calculated indices

important band of citizens, the elderly. SaveMyBike divide population in three age groups giving a weekly prize to the first classified of each one.

The reward system gives the possibility to involve local businesses, offering them the opportunity to promote their products in this way.

There are other systems connected to the single reward function (e.g., “Positive Drive” developed by the Dutch IJsberg Consultants; “Bella Mossa” developed by the

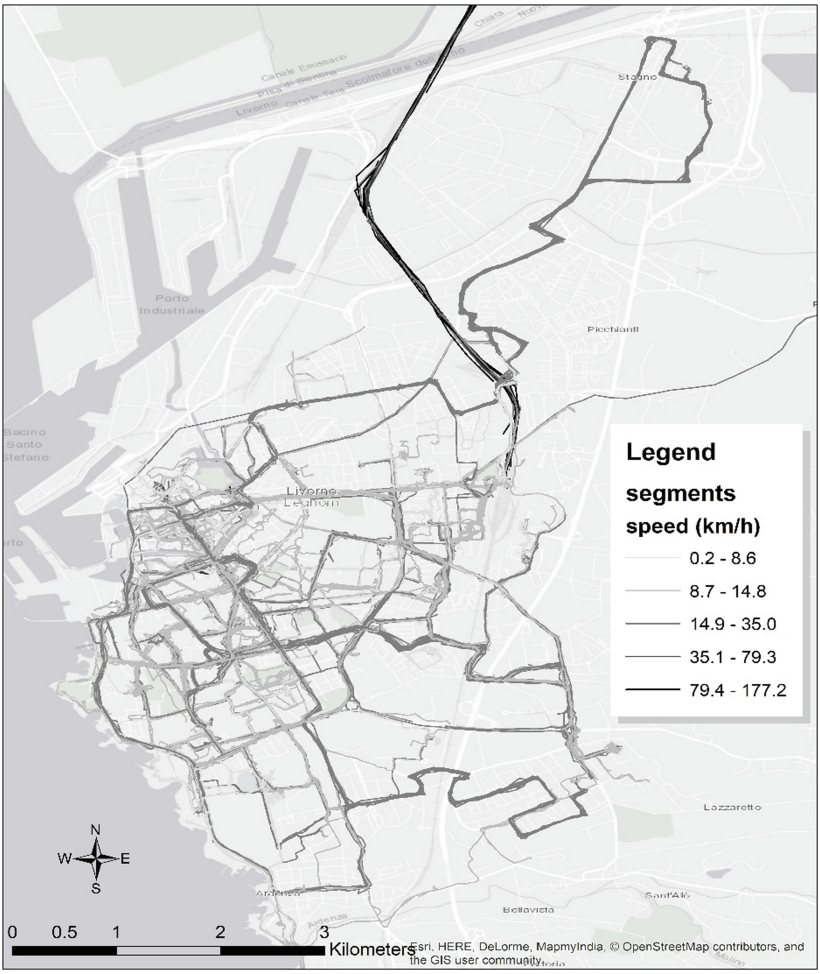


Fig. 6. The trips monitored by the tracking system

English BetterPoints Spitsmijden a Dutch incentive project; "Travel Smart Rewards" a pilot study for Singapore commuters; "TripZoom" developed by the Dutch Locatienet; "TravelWatcher" developed by the Dutch project I-Zone; "Viaggia Play & Go" developed by Smart Community Lab and applied in the Italian cities of Trento and Rovereto and others). Nevertheless, the main problem, to a certain extent, of these systems lies in their low audience of the participants. This last problem has solved by SaveMyBike, which introduces the private bicycles service, a service very felt by citizens that allows them to be loyal to them continuously.

3 The Prototypical Application Results

In the prototypal application period, which runs from September to December 2018 (the system is still active even today) more than 2.158 displacements have been traced (see Fig. 6) with a total number of over 180,000 GPS points. In total, 1,000 citizens were involved with over 300 "sensorized" bicycles.

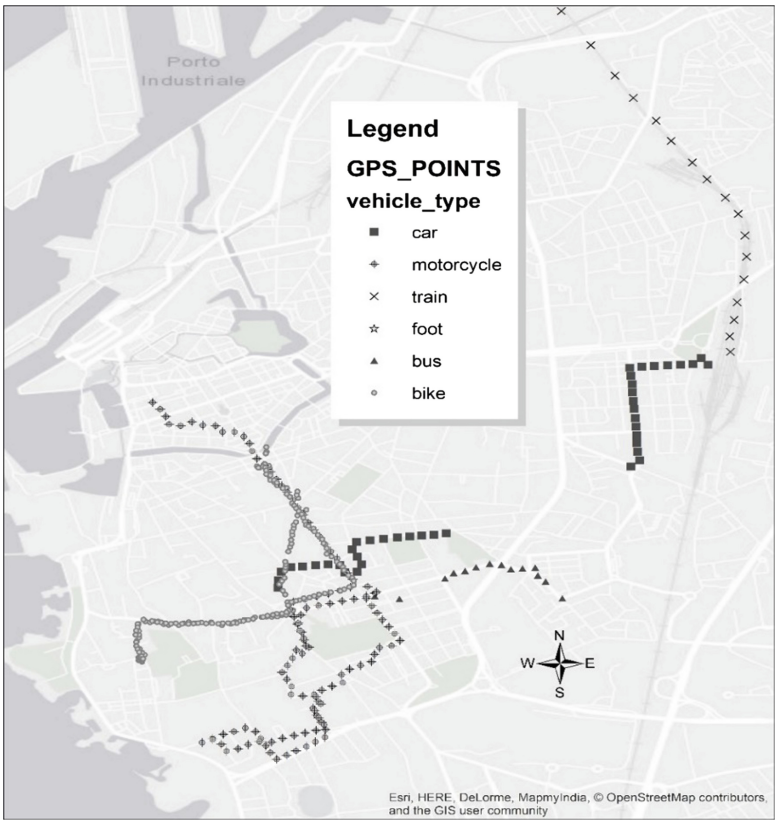


Fig. 7. Some examples of GPS points acquired

For each GPS point acquired (see Fig. 7), the Good_Go App has detected the following attributes (we find an attributes completeness very variable and represented in brackets as percentage):

- Transport mode used (100%);
- Belonging tracks (100%);
- Longitude and latitude (100%);
- Acceleration spatial components X, Y, Z (100%);
- Signal accuracy (100%);

- Timestamp (100%);
- Battery consumption per hour (69%);
- Battery level (69%);
- Device bearing (86%);
- Device roll (86%);
- Device pitch (86%);
- GPS bearing (97%);
- Elevation (100%);
- Humidity (0%);
- Lumen (100%);
- Proximity (19%);
- Speed (67%);
- Temperature (0%)

The analysis of the collected GPS points showed a clear possible detection system for the bike trips based on the only acceleration values (see Figs. 8 and 9) while for the future automatic detection of other transport modes we need to integrate other territorial data in a more complex algorithm [13] (Fig. 10).

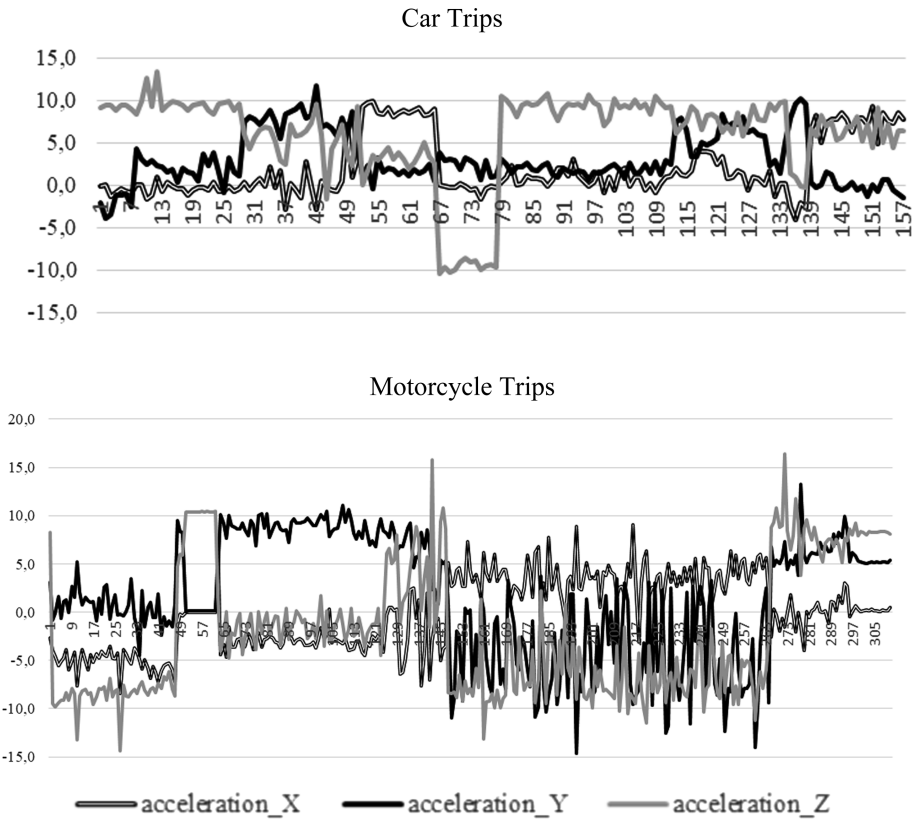


Fig. 8. Acceleration values for car and motorcycle transport modes

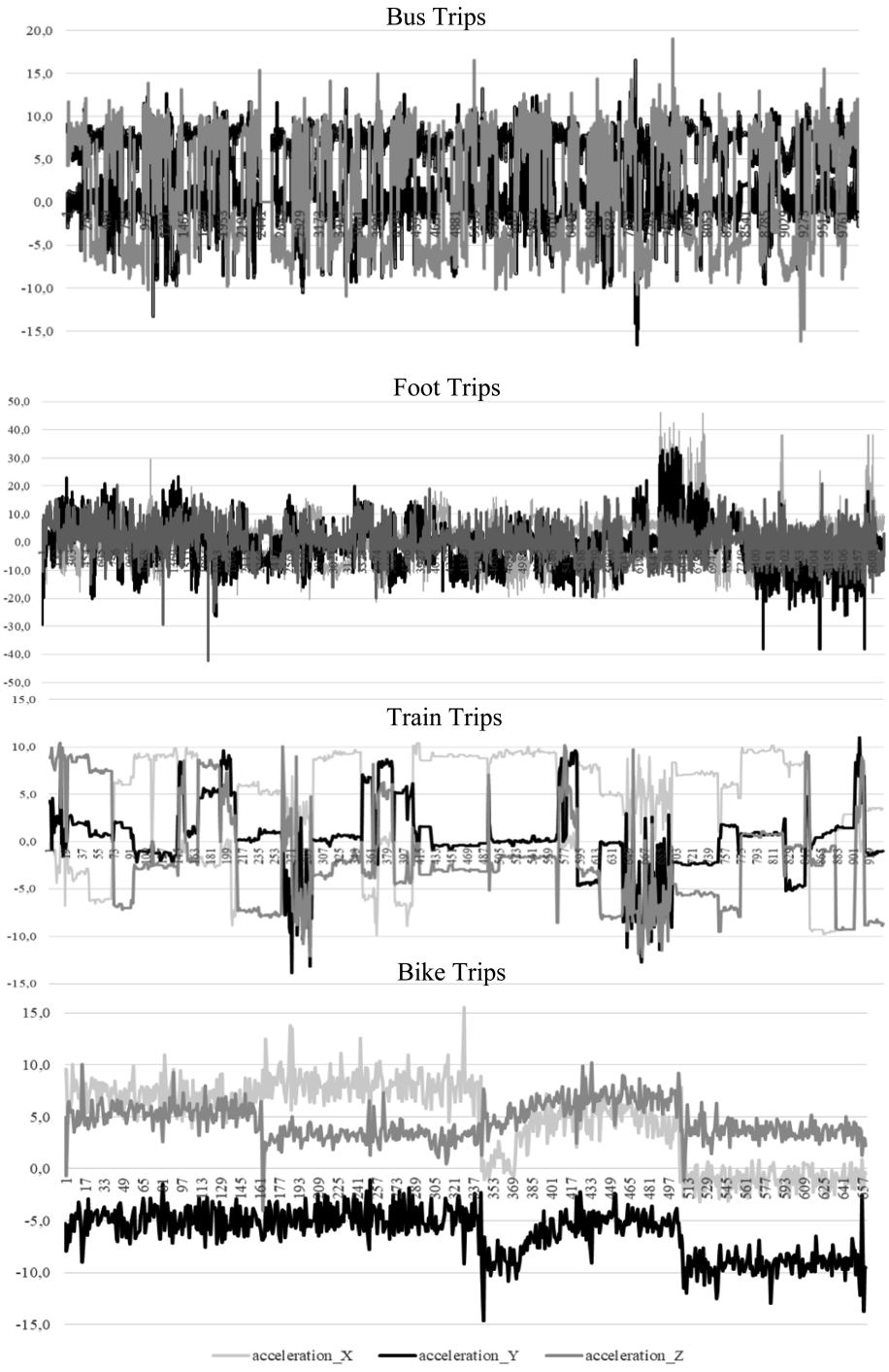


Fig. 9. Acceleration diagrams for bus, foot, train and bicycle transport modes

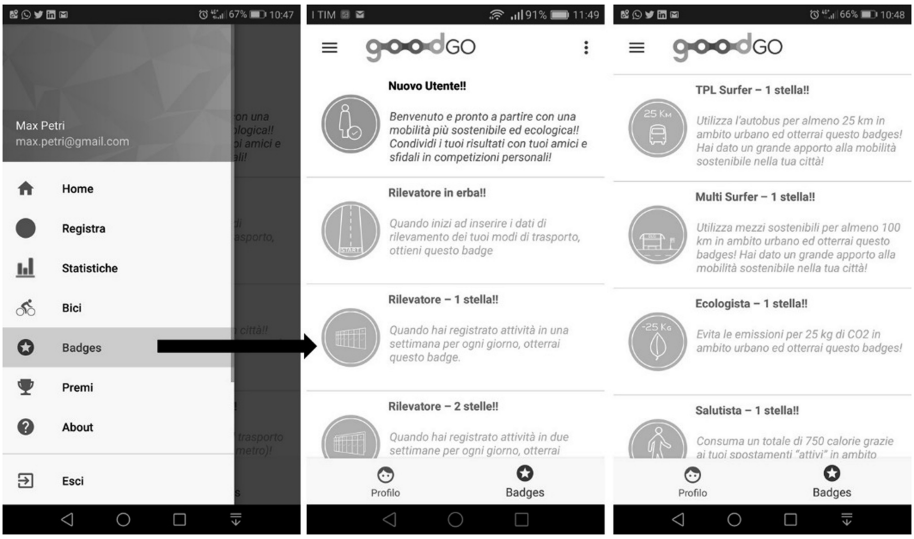


Fig. 10. The "*Gamification*" system with badges

Finally, we talk about the theft complaints acquired from the App Good_Go. In the four months of the prototypical application, among the 300 sensorized bicycles 9 were stolen (with a percentage of 3%). In Fig. 11, we represents some registered theft locations labeled with the bike id, the theft day and time.

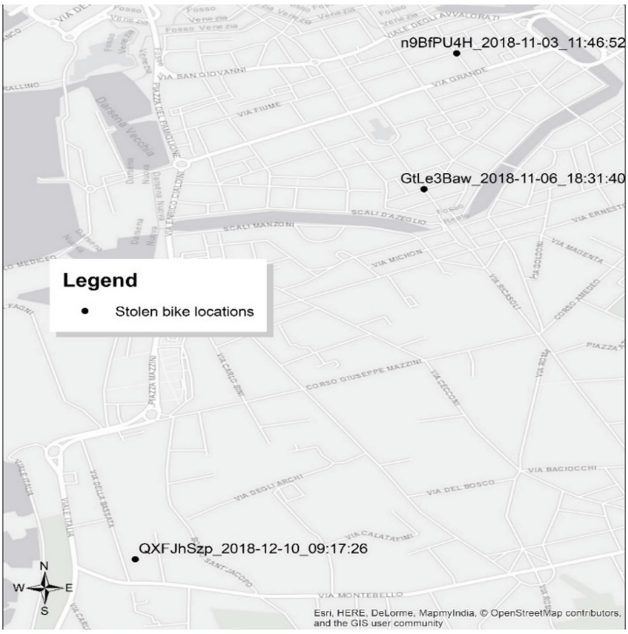


Fig. 11. Some registered bike thefts

4 Conclusions and Future Developments

The actual strength of SaveMyBike lies in its large number of potential users. They can be summarized in citizens and city users, municipal administrations, school of all levels, big companies (where a mobility manager is obligatory), insurances, associations of cyclists/environmentalists, managers of activities connected with the use of the bike (bike renters, hotels providing a bike park and others), bike manufacturers, bicycle sellers/repairers, engineering studies and commercial activities. The prototypical application has shown very good results, with the feasibility confirmation about an automatic transport recognition system, and a big interest from citizens for the whole service. Moreover, the project has seen the emergence of a cooperation system with the people who gave voluntary availability to walk around the city and detect bicycles parked along the roads.

In the future, the SaveMyBike sensors could also allow the communication between bike and autonomous vehicles by preventing accidents and giving more safety for cyclists. A first solution has proposed by the AUTOPILOT project but plans to install a real OBU-On Board Unit on the bikes, in respect to a cost that is not desirable for the final user. In the SaveMyBike project we would like to evaluate a low-cost system based on LORA technology, whose readers have rays of action of 500–800 m which can cover the entire city. This technology can allow the localization of the bicycle parking area and can facilitate data communication [14].

In this way, an autonomous vehicle can, thanks to its OBU, detect the cycle vehicles even without having direct visibility and, therefore, be able to activate actions capable of avoiding dangerous accidents (not possible with actual cameras or laser scanners).

Therefore, the results of the prototypical application and the previous analysis clearly show that now it is time to start the SaveMyBike improvement phase that will engage partners for a unique project in Europe.

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