GOOD_GO: An Open-Source Platform to Incentive Urban Sustainable Mobility

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Abstract. Good_Go is the first complete platform to incentive urban sustainable mobility. It contains different modules to incentive use of sustainable mobility like foot, bike, bus or innovative sharing solutions (car-pooling, car-sharing, bike-sharing and others). A first module of the platform is linked to a bike-theft disincentive system with the innovative Bluetooth OBU (On-Board-Unit) called BlueBI able to send an acoustic alarm in case of theft and allowing a participative finding of stolen bikes. A second module is linked to a rewarding platform while a third module allow to organize Mobility Managent measures or sustainable mobility competition at different scale level (whole city, institutional system like hospital, university or single company/school).

Keywords: Sustainable Mobility, Bluetooth Sensors, Mobility Management, Rewards, Incentives

1 Introduction

Private car mobility registers a high accident rate: in 2014 it was responsible for over 25,000 fatalities in the EU-28. In addition, in 2014 in the EU-28, around 70% of the overall CO2 emissions from transport were generated by road mode% [1]. Moreover, in urban areas they occur 38% of the overall fatalities from road transport, and 23% of the overall CO2 emissions [2]. As a result, a modal shift of at least a part of passenger transport in urban areas, from private car to sustainable transport systems is desirable. Several policies have been adopted in the EU in this direction [3]. Moreover, bike-sharing solutions has a high maintenance costs and, especially in medium size cities, this limits its application.

The Good_Go Platform is the development of the initially called SaveMyBike project, the project that has been developed in order to improve, at first, the private bike mobility [4, 5]. In fact, now, the whole project regards the development of a '*space of services*' for sustainable mobility users linked to a second stage of ITS sensors and an ICT social platform called GOOD_GO capable of:

- monitoring systematically bicycle trips and all the other transport modes by

using an APP for smartphone (inherited from SaveMybike project);
- creating secure areas for private bike parking (developed effectively in Good_Go platform);
- finding stolen bicycles (developed in the final version in Good_Go platform);
- rewarding people who perform sustainable trips in the city (developed in the final version in Good_Go platform);
- organizing sustainable mobility competition at different scale level (whole city, institutional system like hospital, university or single company/school) (developed exclusively in Good_Go platform).

In the following paragraph, leaving an in-depth analysis and description of reward strategies and their state of the art at [6], we present the general Good_Go platform framework and its last developments. Finally, some future developments are described.

2 The general Good_Go framework

The general idea is to join service for private bikes (and in the future other modes) with a social rewarding platform, called GOOD_GO, to increase sustainable mobility in the city. Then, it integrates hardware and software development with innovative measures regarding transport demand management and, mainly, with rewarding measures.

Firstly, the platform takes data mainly from an app for smartphone that integrates a service for private bikes, based on two types of low-cost equipment, installed on private bikes or on sharing-mobility solutions:

- A first solutions based on RFid/NFC passive tag installed both inside the bike than outside of it. It allows the identification of the bike legitimate owner and its registration in the national bike registry. This system tries to avoid the cycle of used bikes thefts and resale, allowing police-men to check the rightful owner of the bike, during the resale phase.
- A second solutions regards the introduction of a Bluetooth sensor containing an accelerometer allowing bikes theft discouraging and the development of "secure areas" where bicycles could be parked safely: if a bike is stolen, an alarm signal, directed to the bike owner, to all other platform clients and to the police, is activated with a local acoustic alarm; moreover, in case of theft, it is possible the 'participative' bicycle recovery.

Moreover, in order to increase the sustainable mobility 'incentive power', the platform develops a social space where people can: denounce the theft of their bike, post any information about events or any other news related to sustainable mobility and participate to a competition based on points collected from their daily trips monitoring.

In the following sections, after analysis of necessary requirements for a rewarding platform, the two new main parts of the system are described that's to say the new Bluetooth sensors and the rewarding and mobility management platform.

2.1 The reasons for a choice

Summarizing the results of the state of art analysis of the aforementioned existing projects [6], one can infer that:

- the mobile app is a fundamental tool for any sort of initiative in this field, whereas the web app should consist in the portal mainly aimed to manage the content provided by the service provider to the engaged community;
- the ICT system has to be able to ingest and process a relatively limited sort of data, related mainly to GPS tracks, but predisposed to provide a very wide range of feedbacks, based on relatively simple processing;
- the most appreciated products include decision support systems, at least for provisional services in deferred time.

Those previous experiences also taught that to attract more users and to be effective in changing mobility behavior with citizen categories different by age, interests and social classes, at least 3 elements are fundamental:

- to promote a multi-modal approach for daily mobility,
- to engage different type of "contributors", i.e. enterprises and service providers able to manage different sort of economic advantages, including discounts on goods, services and even local taxes,
- to propose the services using a gamification approach, and dominant link to social networking, environmental awareness, safety, health and wellbeing in general.

It is worthwhile to remind that, for an effective involvement of a contributor, either public or private entity, it is important first to analyze the real scope to satisfy by the ICT solution, in a win-win perspective for both the citizens user and the provider, as the platform success depends at the first by the resources the latter spent in its initial stages.

Good_Go mobility platform takes into account all previous features integrating both external systems by means of an API libraries, ensuring also a Single Sign-On (SSO) access control property. A diagrammatic representation of main components constituting the Good_Go platform is represented in Fig. 1.

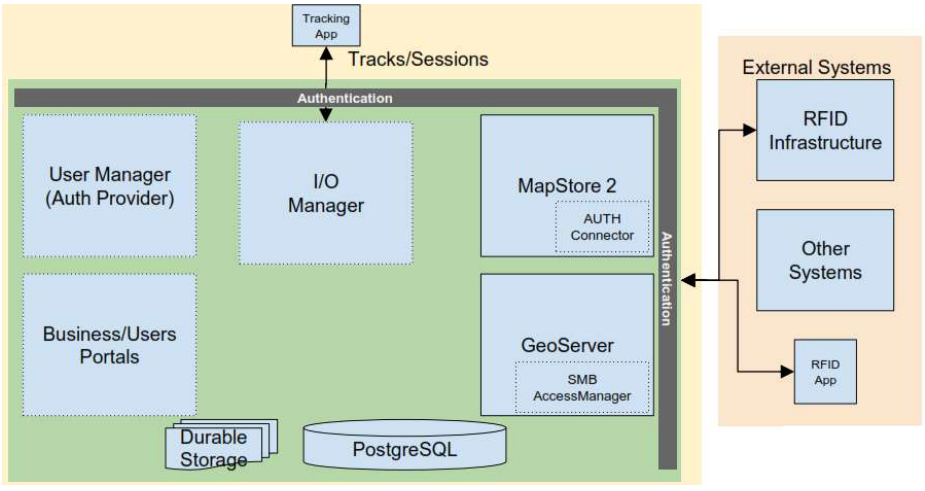

Fig. 1. Good_Go Platform General Framework

The main differences among Good_Go and the other Smart Mobility platforms, are:

- the platform is entirely developed and based on Open Source software;
- it will offer community based functions to help individuals to find back their bicycle in case of theft and, optionally, to register and integrate the RFID based anti-theft system specifically developed within the project;
- it allows to organize multiple competitions (see forward in the paper).

Citizen, after the registration to the web portal, will have access to the mobile app for the track record and monitoring. He will also be chance to save a personal profile including description and pictures of his own bicycles. On the base of mobility behavior, the user will gain badges allowing discount for public transport tickets or commercial goods. Once the user will reach an adequate badge amount will have chance to request an offered discount, or to accumulate more badges to access at a superior discount level.

2.2 RFID final solution

In case of bike theft, the user can immediately send a geocoded notice with all description and pictures of his bike he previously registered. The members of Good_Go community will have the possibility to reply it in case of retrieval, giving the position and a short note. In case the user is using also the RFID anti-theft system, the RFID code is marked in a "blacklist" and notified also to local authorities which are provided with a RFID reader able to detect and recognize the stolen bike during their routine activities. Also in this case, the bicycle owner will be automatically notified in case of retrieval. According to the level of publication chosen by the user, his history can be shared with friends and public, for a community contest regarding km run wealthy and contribution to air pollution reduction.

The RFid solution analyzed initially consists of the employment of UHF-RFID technology to realize an identification system in cycling applications with the aim to contemporary manage multiple bicycles within the parking area. To discourage the bike theft two shrewdness are adopted:

- The bicycle is equipped with passive RFID tags allowing the bike identification after a theft from an operator equipped with a portable RFID reader.
- The user has an RFID smart card in such a way that the reader has to contemporary recognize the bike tags and the user tag during the input and output operations within the parking area. Any unauthorized removal may be notified to the bike owner GOOD_GO App or with an acoustic alarm.

To ensure tags detection for several bicycles within the parking area and independently on the tag position on the bike, the UHF-RFID reader is connected to panel antennas at the side of the rack, and to ground antennas (also named mat antennas), namely a thin antenna placed on the ground underneath the rack with a sturdy random (Fig. 2). A mat antenna can be also installed on the parking area input to record bicycle transit.

A preliminary experimental setup has been realized at the Department of Information Engineering of the University of Pisa where a five-seater bike parking area is available. Five bicycles have been tagged with multiple on-metal tags. In details, five Intermec IT65 tags have been employed. For the measurement campaign, the CAEN ION 4300P reader operating in UHF RFID (865 - 868 MHz) band has been employed [7] together

with the CAEN WANTENNAX019 circularly polarized antenna. Such an antenna has been placed downward and 3.6 m apart from the ground (Fig. 3).

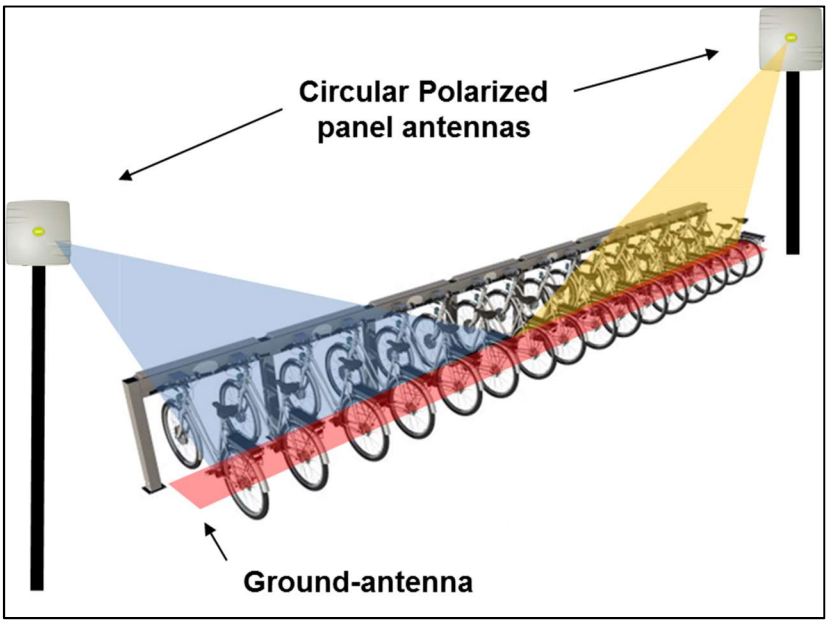

Fig. 2. UHF-RFID system with multiple panel antennas at the side of the rack and ground antenna underneath the rack

An input power of 28 dBm has been used. The bicycles have been placed 30 cm apart each other by occupying an area of about 4 m. The closer bike to the reader antenna is at a distance of about 4 m, while the farer bicycle is at about 6 m. The reader has been able to detect tags fixed on the first three bikes namely up to a distance less than 5 m. It has been noticed that the central section of the bicycle frame is a good installation position to ensure tag detection. Additional measurements have been carried out by using the CAEN R1240IE portable reader connected to a smartphone via Bluetooth, with the aim to verify the possibility of an operator to detect bikes during its daily working activity. The portable reader has been able to detect the bicycle tag at a distance of around 1 m by

Fig. 3. Measurement setup illustration

employing an input power of 27 dBm. It is worth noting that the material of bicycle frames influenced measurements scenario (multipath phenomena).

For these last reasons, we decided to use only short range HF RFid solutions installed inside the bike and readable by policemen with an 'ad-hoc developed' telescopic antenna. This system tries to avoid the cycle of used bikes thefts and resale, allowing policemen to check the rightful owner of the bike, during the resale phase.

2.3 Bluetooth solution

The prototypical application done in 2018 in Leghorn shows the difficulty to involve stakeholders in the recovery of stolen bikes using a RFid reader that is expensive and require too much attention to people (difficult to remember to bring it and to recharge practically every day).

Then, next solutions developed is a Bluetooth active sensor merged with an accelerometer and with an acoustic, bright alarm and talking with a smartphone becoming a real OBU-On Board Unit for bikes (see figure 4). Using the Good_Go app people can leave its bike in a parking phase during which, if someone moves it from the starting position, it emits a luminous and acoustic alarm. Moreover, the Bluetooth send a message of alarm readable from all other users with the Good_Go App installed. In this way, every user is a 'city floating reader' and allows to a participatory bike recovery.

One time a user read a stolen bike message, it sends the correct position by means of the Smartphone GPS to the system and, subsequently, to the original bike owner.

Fig. 4. The Bluetooth sensor and an example of its installation on a bike

The sensors has been tested in different positions so to verify the possibility to mount it in different place on the bike and to understand how far from the smartphone it is readable. Figure 5 shows that the signal measured with the RSSI - Received Signal Strength Indicator (dBm) value is good up to 80 meters (minimum sensibility is 100 DBm). Moreover, the sensors has been tested with different Smartphone types (Android, IoS) and the value in the graph are the mean relieved for each distance. Results shows that with at least some thousands of users it is possible to cover all urban areas. Figure 6 show the area covered from the 300 Good_Go users Bluetooth in the city of Leghorn during the testing application.

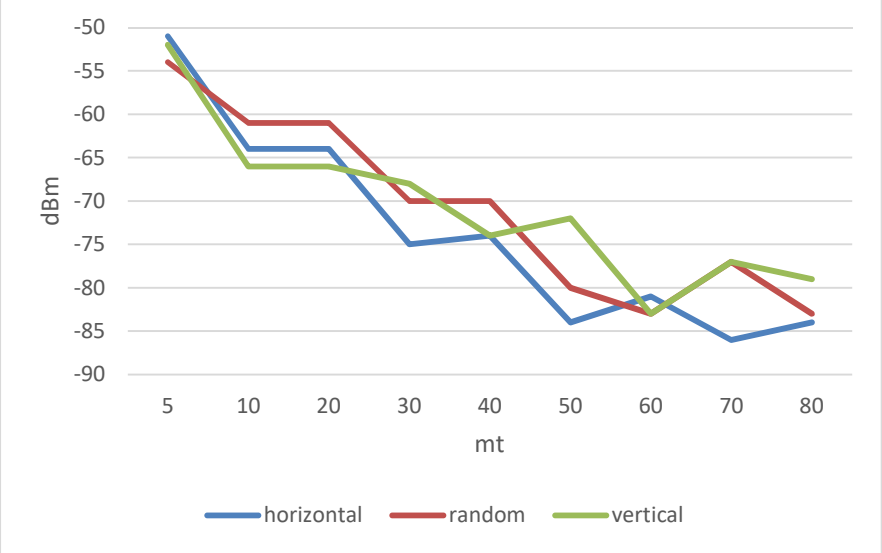

Fig. 5. The RSSI value vs Smartphone-Sensor distance

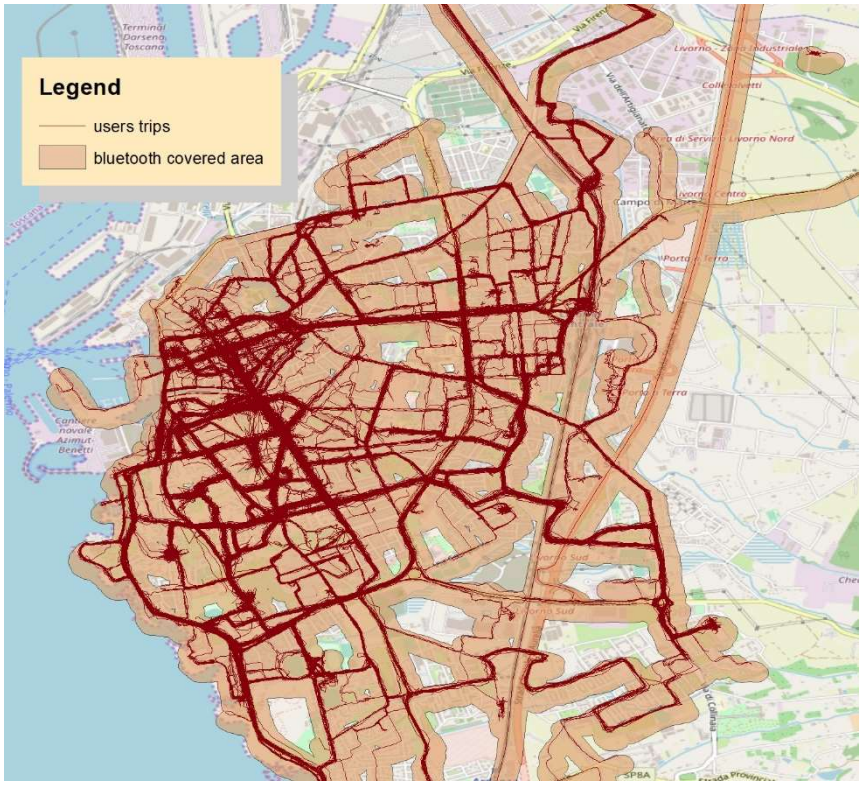

Fig. 6. The Bluetooth area covered from 300 users in Leghorn testing application

2.4 Rewarding and Mobility Management platform

At the level of rewarding policies, the goal of the platform is to develop a real multi-modal reward management system [8, 9], ables to introduce several incentive systems for sustainable mobility, based on the following:

- punctual measures (e.g. reward for crossing given road sections);
- linear measures (e.g. reward for travelling along given roads);
- areal-based measures (e.g. rewards for parking or travelling in a specific area).

All these incentive systems can differ in the level of rewards/credits provided, and can vary according to the time of day, the travel direction (in-out), the journey performed, the type of vehicle, etc.. [10].

The general idea is to develop an open system, where each public administration can set up their own rewarding strategies, with the help of stakeholders they consider important for the outcome of their measures/actions.

In addition, the choice of the prototypal application carried out in the city of Leghorn (Italy), arises from the need to simplify and study a prototype easily replicable in other urban realities, even in the search for potential users. Actually, it is not always possible: to obtain a collection of user license plates, from which a list of commuters can be extracted or to have the resources to make interviews at a population sample.

In our case, we have set up a multimodal connection, using the API library, between the platform, the local public transport system and also new sharing mobility systems (like car-pooling, car-sharing, bike-sharing and others). So, every type of sustainable mobility can be joined with the rewarding policies. Moreover, Good_Go implements a multiple-scale competition level with the possibility to organize competition at whole city level (like the one for general citizen sustainable mobility), at institutional system level like a competition for the whole hospital or university system or single competition at individual company/school level. Figure 7 shows the four actual on-going sustainable mobility competition in the Good_Go app with the following form allowing the subscription for one of them. The competitions regard:

- a multimodal node of Florence (Italy) transport network (Guidoni is a node where arrive Tram, Bus and there is a big parking area to leave cars);
- an Home-to-Work competition for the city of Pisa (Italy);
- an Home-to-School competition in Leghorn (Italy)
- a bike use only competition for Bolzano (Italy).

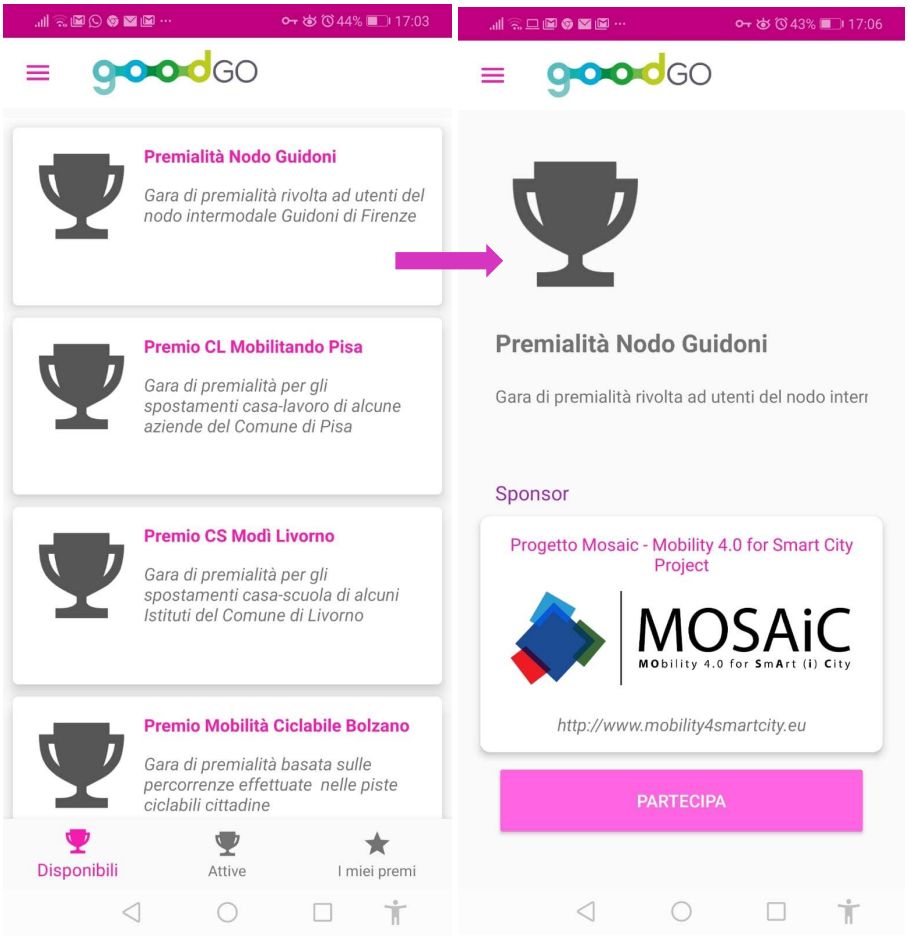

Fig. 7. The four sustainable mobility competition and the subscription form

Moreover, it has been developed a dashboard to manage the withdrawal of awards for each competition, allowing the subscription of many types of urban shops and companies. These activities can offer discount and free products taking advantage of the advertising provided by the platform itself. In this way, an interesting reward is offered to everyone, with a high level of reward personalization leaving the award system simplified as much as possible and making it easier its broadcasting to citizens and companies.

3 Future developments

The future development of the project consists of the completion of the multimodal platform with the possibility of setting up rewarding strategies by the administrations, reconstructing a real visual language / wizard to set and customize the rewarding policies. This multimodal system will be linked to a MarketPlace with an increase in the

economic viability of the project as the companies subscribed will pay an annual fee (similar to the Nuride system).

In addition, a real and proper wizard will be implemented, for the guided upload of the data about the urban reality under consideration: a very important step for the sustainability of the project. In fact, all existing and tested systems are, currently, valid only for single realities and do not contain automatic setup elements for their application to other cities. Within this development, they will be integrated a system able: to monitor transport modes chosen to perform the displacements, and to analyze their possible replacements with more sustainable transport modes, in order to activate the related rule like a Travel FeedBack Program.

The reward provider, i.e. the local transportation service enterprise, will have access to a specific section of Good_Go portal, in order to manage and publish their discount campaign. This specific content management web tool will allow to easily manage the value for money of the discount and the categories of user that will have access to each offer, according to their profile and mobility habits, other than the offer expiration. Moreover, they will chance to monitor in a dashboard basic result of track data processing and aggregation, useful to improve their service offer and timetable, as such as follow the evolution of habits changes within the community engaged in the initiative. For this last point we will integrate Machine Learning tools able to extract mobility patterns and useful to support Public Administrations decisions [11] also integrating mobility data with data becoming from local urban environment [12].

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