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Behavioral change and social innovation through reward: an integrated engagement system for personal mobility, urban logistics and housing efficiency

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Abstract

A significant role among soft mobility measures to influence people's mobility choices and to raise awareness is played by the provision of targeted information. The integration of user-centered design, social innovation, portable devices, and sensors may have a role in influencing people's choices and consumption patterns. The paper presents two ongoing works that investigate, design and develop tools for valuing people's positive behaviors and rewarding choices in the domain of mobility and energy. The objective of such tools is both to raise people's awareness and to engage it into a collaborative environment, in order to meet a common set of targets. The strategy adopted in both the cases is based on linking "bottom-up" with "top-down" approach, i.e. by making people to behave and to make choices coordinately with decision maker's (i.e. the Public Administration or the Administrator of the system) objectives. The first regards Opti-LOG, a project co-funded by Regione Lombardia under the Smart Cities and Communities program, which concerns last-mile delivery with low emission and zero emission vehicles. The second case regards Sharing Cities, a H2020 project that includes a pilot project in the Municipality of Milano, where the focus is on citizen engagement and behaviors in the domains of personal mobility and energy. The system, by enabling mechanisms of collaboration, sharing and human capital generation, tackles the objectives of lowering energy consumption and promoting sustainable mobility and contributes to the weaving of a more cohesive social tissue.

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1. Introduction

The Conclusions of the European Council of 8–9 March 2007 emphasized the need for the European Union (EU) to achieve the objective of saving 20% of primary energy consumption by 2020, compared to projections. As a consequence of this, the European Commission defined the Energy 2020 strategy, setting the targets and the priority of actions to be performed to be met them. Such actions tackle the goal from different perspectives: technological, infrastructural, legal and political. As regards the latter, though, just a hint concerning behavioral patterns in the reference document by the EC on 2020 Energy strategy is provided: education and training are spheres that policy making should mainstream since they do deal with lowering energy intensity. The Energy Efficiency Directive (Directive 2012/27/EU) underlines the need for an integrated approach and emphasizes that cost-effectiveness is critical given the 'urgent need to restore sustainability to public finances': changing people's attitude towards energy use is seen as consequence of the application of a full implementation of the Directive and will result in persistent and long-term energy-savings benefits. The interface between a set of policy measures and people reaction towards them, though, is something relevant to address in policy-making as it is broadly considered as a key-element for a successful implementation (Barbu et al., 2013): measures and people feedback are iterating elements within the policy-making process. As a proof of this, while impacts of technical energy efficiency improvements are rather easy to estimate, it is harder to address in a quantitative way possible reductions deriving from changes in behavioral and consumption patterns. A simple reason is that people are often supposed to act rationally whilst in the most cases they do not (Van Bavel et al., 2013).

How, therefore, to consider people's choices and consumption patterns in policy-making? And what kind of tools are nowadays relevant to value behavioral dimension in pursuing common goals, like reducing carbon emissions and achieving an higher level of energy efficiency?

The present paper investigates the behavioral dimension in the field of transport, relating a set of applications and studies under the common goal of reducing carbon emissions and increasing energy efficiency.

2. The behavioral dimension: individuals against communities, rewards against penalties

Gardner and Stern (1996) and Jackson (2004, 2005) list four main tools to influence and possibly change people's environmental attitude: (1) laws, regulations and incentives, (2) education and awareness raising, (3) community management of environmental resources and (4) reference to moral, religious or ethical principles. It is interesting to notice that (3) and (4) can arguably refer to groups of people rather than individuals and since such groups do share a common set of values (e.g. environmental care) and a vision (e.g. a zero-emission lifestyle), we will refer to them as communities (Parkhill et al., 2015).

The potential of communities in tackling environmental challenges has been understated for years where targets of energy-related behavioral policies were mostly individuals as consumers of energy (Raven et al., 2008). The relation between targeting individuals rather than communities will be further explored in this paper.

A last noticeable factor is more technical. It is understandable that people need appropriate frames of reference in order to value their behavior: it is quantitative or qualitative, does not excessively matter but terms of reference are needed for both comparing with personal or others' trends and to create synergies among people in achieving a common goal.

An important point, as well pointed out by Ben-Elia and Ettema (2009), is that psychological research on Operant Conditioning Theory shows that in general rewards produce overall better outcomes than punishments. Rewards promote learning and internalization (i.e. sustainable changes) whereas punishment succeeds in compliance and halting of unwanted behavior but creates a problematic effect associated with unpleasant memories and avoidance (Rescorla, 1987). Penalties such as road pricing have been recommended by transport economists as the first best

solution to efficiently alleviate congestion externalities. In theory, by internalizing the external cost, and assuming that toll revenues are returned in some way to the users, the total user welfare would increase resulting in a better off situation compared to the non-tolled one (Rouwendal & Verhoef, 2006). In practice, imposing an efficient tolling scheme is controversial and involves social equity and political acceptability in addition to economic efficiency (Banister, 1994). Furthermore, subjective conceptions of fairness and freedom play an important role in social acceptability of pricing schemes (Eriksson et al., 2006).

The feasibility problems of first based solutions lead to alternative suggestions i.e. second best schemes, see the review by Small and Verhoef (2007). Providing users a reward can achieve a similar behavioral change to that of pricing (Ettema & Verhoef, 2006).

Morant (2012) references a recent report by the *Behavioural Insights team* at the Cabinet Office of the United Kingdom, which suggests that people do not behave rationally with respect to energy usage in the workplace. It is worth noting that most employees would not benefit directly from initiatives to reduce energy consumption in a commercial setting, unless incentivized through competitions and provided with regular feedback on progress. Mobility and transport of both people and goods are a domain within many rewarding schemes have been proposed. A short review of some applications is reported in the next paragraph, together with the a more detailed presentation of two new applications around the concept of rewarding.

3. Applications in the mobility and transport domain: Opti-LOG and Sharing Cities projects

There are many examples of studies on the impact of rewarding schemes in the field of mobility (SUNSET, DEMOCRITOS, MIMOSA) and also some applications especially in the field of personal mobility: for instance, “Nuride” (http://www.nuride.com/) that is a US-based solution which rewards green trips (carpool, bike, walking, etc.) with discount, coupons; “Eco Rewards” for green travel choices by residents & employees in Surrey & the rest of the UK (http://www.ecorewards.org.uk/). Some programs are also directed towards the freight transportation sector: e.g “SmartWay” (epa.gov/smartway/) an US EPA program that helps improve supply chain efficiency, by measuring, benchmarking and streamlining freight supply chain operations. “Green Freight Europe” (http://www.greenfreighteurope.eu/) is another similar example in the European context. These industry-driven approaches establish a certification system to reward shippers and carriers who fully participate in the program, promoting collaboration between carriers and shippers in driving improvement actions and monitoring progress. Finally the program “Lean and Green” (lean-green.nl) proposes to businesses and authorities to demonstrate through a plan of action a 20% CO_2 emissions by in five years’ time. This makes them eligible for the Lean and Green Award. With the Lean and Green Award, organizations can show that they are actively engaged in making their logistics and mobility process more sustainable. An important aspect of Lean and Green is that this program insists on collaboration between municipalities and companies thereby making it possible for companies to obtain privileges in return for their (green) business operation.

On the basis of these first results two applications have been designed: the first within Opti-LOG, a project about last-mile logistics and the second within the Sharing Cities project, regarding urban mobility and energy for smart cities. These works have the aim of investigating, designing and developing tools for valuing people’s positive behaviors and rewarding choices in the domain of for freight and people transport. The objective of such tools is both to raise people’s awareness and to engage it into a collaborative environment, in order to meet a common set of targets.

3.1. Opti-LOG

Opti-LOG (www.optilog.it/en/) means to design, develop and test a software platform for an integrated management of last-mile logistics, enabling the following functionalities:

- a service allowing logistic operator to reserve load/unload areas (temporary parking slots at the edge of the roadway devoted to logistic activities) (see Figure 1); the areas will be equipped with sensors to determine in real-time the presence of a vehicle;

- a system to optimize load factors and routes of last-mile operators, by an optimal assignment of goods to vehicles based on weight, volume, delivery constraints (e.g. planned delivery) and destination. See Bruglieri et al. (2015) for a description of the used algorithms;
- a system for real-time track and trace of last-mile vehicles and of vehicles carrying dangerous goodsr;
- a social networking platform supporting the aggregation of the demand of shipments and interaction among users willing to send or receive a parcel.

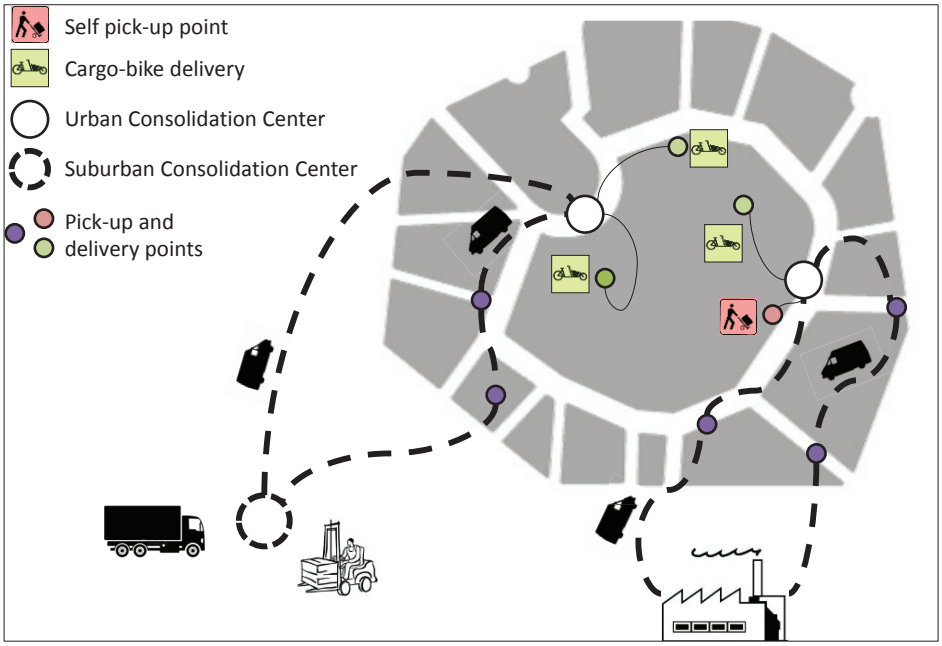

Fig. 1. The Opti-LOG double tier model for urban logistics, which includes a set of dedicated urban satellite platforms to enable delivery with bikes.

The project focuses on measuring the effectiveness, in terms of reducing environmental and social externalities, of the identified logistics solutions for the last-mile, with regards to Business As Usual (BAU) scenarios. In this regard, evaluation scenarios are defined, based on the four pilot-cities and for each of them the effects of different policies and configurations of the logistics of last mile are simulated. The simulations at a local and micro scale use both mathematical models of diffusion and dispersion of pollutants and models to estimate emissions.

Upon completion of the described functionalities, Opti-LOG has been studying models and behavior-based policies for management and control, in order to encourage good behaviors and virtuous choices by operators. Basically the idea is to develop a specific rewarding mechanisms in the domain of last mile logistic with the aim to aggregate demand and facilitate the optimization (e.g. groups of delivery). The mechanism is borrowed by the existing rewarding schemes in logistics, but it tries to maximize collaboration between the stakeholders in order to highlight all the possible privileges for the different actors in return for their (green) behaviors. The system is based on an analysis of the different stakeholders in the field of last mile logistics (municipalities, logistics companies, associations, sender, recipients, infrastructure operator) and the possible set of incentives that they can offer and receive to improve the environmental performances (see Figure 2 for an example).

For instance, government-sponsored accreditation programs can give awards for companies performing green operations like: use of green modes (especially cargo-bikes and EV), monitoring fuel efficiency, loading factors, bundling for transports for different companies, tire pressure controls, cleaner fuels, coordination of delivery times, use of advanced software module for optimal transport planning, etc.. On the other hand the infrastructure operator

(or the Public Administration) can offer privileged access to areas or in restricted time-windows or dedicated (un-)load locations for greener vehicles. Other uncommon privileges can be exchanged among sender and receiver: i.e. retailers can display goods that have certified green freight labels. This scheme is being discussed in the different Municipalities involved in order to analyse the feasibility of the different alternatives.

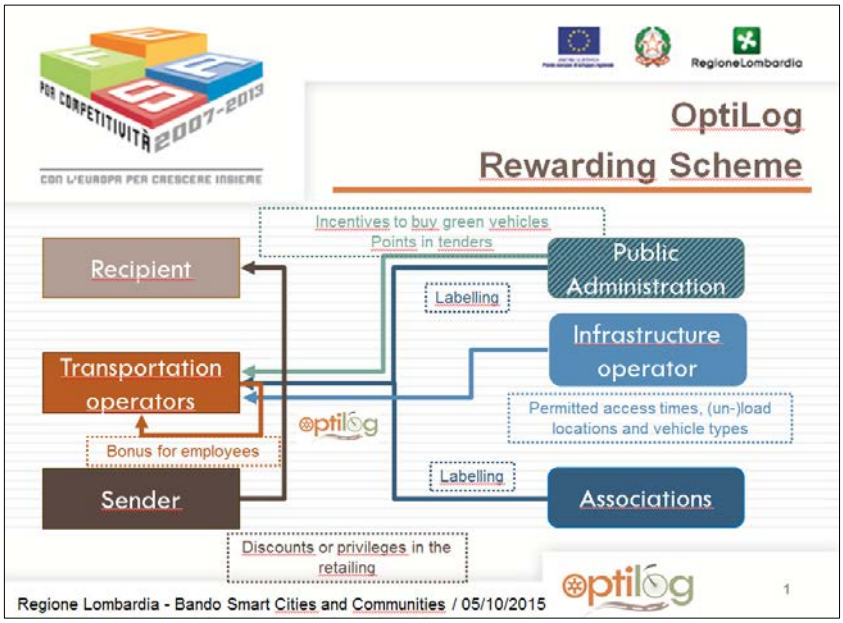

Fig. 2. OptiLog general rewarding scheme model.

This platform is particularly interesting because, in respect to other existing collaborative platforms that offer a greater choice of delivery options for customers and higher incomes for small transportation operators, Opti-LOG aims to adopt a collaborative approach among all the stakeholders, with the main objective of a more sustainable system. The weakness are related to the stakeholders involvement strategies, especially of small movers, that constitute the main part of transport vehicles in urban areas but are the least optimized and generally the most pollutant.

3.2. The Behavior Based Social Market in the Sharing Cities proposal

The second ongoing work is related with the “Sharing Cities” project just co-financed under the call H2020-SCC--2015 – under the topic “Smart Cities and Communities solutions integrating energy, transport, ICT sectors through lighthouse (large scale demonstration – first of the kind)”. The project has the objective of proving that properly designed smart city solutions, based around common needs, can be integrated in complex urban environments. This allows for the creation of a new set of next stage digital services which will help citizens make better and beneficial choices around energy efficiency and mobility: once scaled up, they will enhance the city’s ability to hit key targets for mobility, housing, energy efficiency and resilience, and economic development. Citizen engagement activities have been also designed as crosscutting tools to support and speed up the uptake of the foreseen actions. The citizen engagement instruments include participatory actions such as co-designing of mobility services, awareness raising campaigns, testimonial communities for the transfer of knowledge and training and a game called the Behavior Based Social Market (BBSM) whose aim is valuing positive behaviours and choices in the domains of housing and mobility. See Figure 3 for the general scheme of the BBSM model.

By bridging real and digital environments, the BBSM proposes and applies win-to-win situations where single players and group of players benefit from personal and collective choices and behaviors. Positive choices and behaviors mostly derive from (1) lowering energy and natural resources consumption and (2) collaboration, sharing and human capital generation. For how the system is conceived, the city is the scope and on particular, district-based impacts are reinforced and fostered. Besides this, each player also contributes in data provision, eventually feeding the city info-portal.

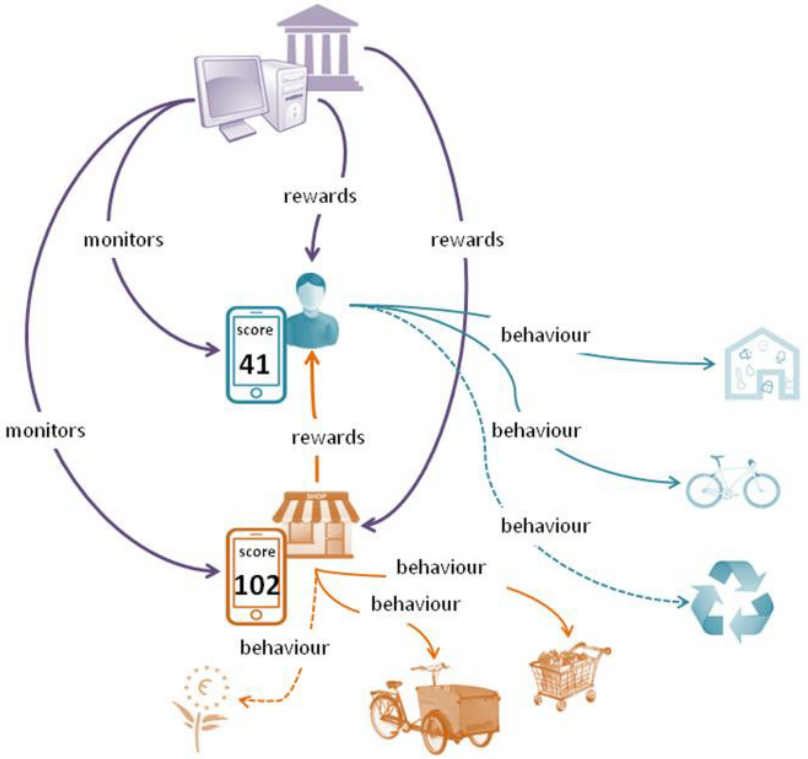

Fig. 3. the general scheme of the BBSM model: citizens' behaviours are accounted and monitored but no citizen is asked to reward; public administrations' behaviours are not accounted and they are not monitored (but they are asked to monitor); local companies' behaviours are accounted and monitored and they also have the possibility to reward citizens' by (1) accepting credits in turn of a selected set of products of services and/or (2) offering a service or a product to a selected group of citizens.

The system is built around a digital market environment, based onto trade mechanisms: each player, voluntary engaged into the marketplace, is asked to perform virtuous choices that have an impact onto collectivity and for which credits are assigned. Once achieved certain thresholds of credits, rewards are released to the players. Rewards include both monetary and non-monetary measures that, in their turn, feed the system, generating a virtuous cycle: by going by bike, public transport or using car sharing/pooling instead of taking the private car will be rewarded with a complementary amount of mobility eco savings (points). These points can be used to get environmental/energy benefits such as a free bus ticket, but also vouchers for shops. This incentive system should help to convince people to consider alternatives to the private car and start to develop their mind set towards more multimodal thinking. Rewards can be released both from the Public Administration and from companies.

The BBSM engages three main groups of players:

- citizens and their aggregations (communities of interests, families, condominiums, …);
- local business: shopkeepers, traders, …;
- public administration and its public companies/departments.

The registration to the BBSM system, therefore, is designed to suggest to the players other players to invite: groups (e.g. families, condominiums, social streets,...) and registration is rewarded in order to reinforce players' relations and real environment collaboration.

For each group of players listed above, three operations can be performed:

- behaviors: against what behaviors or choices credits are gained;
- monitoring: how behaviours and choices can be monitored and verified;
- rewarding: how credits can be expended.

The BBSM can be instantiated in any domain having an impact on energy consumption and associated emissions. The domains we considered in the frame of the proposal are *housing* and *mobility* whilst the associated behaviors are grouped into two main categories: consumption and collaboration. Of course monitored behaviors change among players, as displayed in Table 1.

Table 1. Players' behaviors accounted by the BBSM system.

Domain	Behavior	Type of behavior	Citizen or group of citizens	Shopkeeper or group of shopkeepers
Mobility	Use of sustainable means of transport	Consumption	✓	✓
Mobility	Select a sustainable delivery mechanism	Consumption	✓	✓
Mobility	Establishment of a Pick-up Point	Collaboration	×	✓
Mobility	Reallocate a shared bike	Collaboration	✓	×
Mobility	…	…	…	…
Housing	Energy consumption	Consumption	✓	✓
Housing	Provision of energy from renewables	Consumption	×	✓
Housing	Share of self producted energy with renewables	Collaboration	×	✓
Housing	…	…	…	…
…	…	…	…	…

As regards rewarding, both local business companies and public administrations do have a role in it although with a different approach and depending on the player they are directed to.

From public administration towards local business companies and citizens, rewards can include:

- incentives for green procurement;
- discounts on energy bill;
- free tickets/season tickets for mobility services;
- free tickets/season tickets for cultural places, e.g. free entrance to museums,...
- etc.

From local business towards citizens, rewards mainly regard the products or services they provide: it is asked to local business companies to select a subset of their products or services for which credits gained by citizens can be accepted as a mode of payment.

Additional rewarding effects are also expected, especially for local business, in terms of brand and image and customers' pool enlargement and loyalty. Also advertisement initiatives may be included to encourage local business to join the game.

Of course such a system has to be built upon proper accountability and scoring mechanisms. Running in background as a mobile application, the BBSM accounts the credits players collect. Since each behavior can be repeated with a certain frequency, e.g. a citizen can use its own bike more than once a day, there is the need to build utility functions than convert the metering of behaviors (e.g. number of kWh consumed in a day) into a certain amount of credits. The definition of such functions is up to public administration that has to decide the relative

weight of a behavior compared to another, thresholds and targets. Of course, low level accounting mechanisms such as the number of credits each behavior is rewarded with or the single behavior relative importance has to be transparent to players.

The system will be designed to allow updates of domains: besides housing and mobility other domains may in the future be available for playing.

4. Conclusions

A transition towards a low-carbon economy has to deal with the running increase of energy consumption, a trend that will persist unless a paradigmatic shift in world economic model will occur. Along with technological advancements for improving energy efficiency and with the increase in the ratio of renewable energy supply, a long--term transition cannot take apart individuals. And if technological advancements move as fast as economy growth, people change in behavioral patterns do not share the same hurry but move as slow as natural environment grows: it is a generational movement. Arguably, whether or not specific societal trends or combinations of trends are sustainable may depend in large part upon whether or not changes in individual behaviors can be brought about through policies that affect drivers and constraints upon relevant types of action.

The first results reported from reward strategies are promising (Ettema et al., 2010), but concluding from current behavioral research on the values of rewards compared to tolls is premature especially due to some key aspects which characterize commuters' travel related choices.

The two ongoing works presented suggest that there are various handles to influence effectiveness of rewarding schemes in transport. First, as already mentioned, the type of the reward should be targeted to the different stakeholders involved and they can be offered by multiple actors. Furthermore a demand-driven public-private network approach of the program can be very effective. Platform for private companies and public authorities can work together on one common goal: more sustainable and profitable transport with less CO_2 emissions.

This model of mutual benefit among the stakeholders will increase its attractiveness and enhance awareness of sustainable mobility by revamping the behavior of "coupons culture" linked to sustainable transportation, which has worked so effectively with Nuride (with public funding). Mobility providers will also be beneficiaries due to the perceived increase in the usage of their transportation services by using multimodal transportation.

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