

Changing Mobility Behaviors: A State of Art Analysis

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Abstract. Sustainable Urban Mobility Plans are today implemented in all most important European Urban Areas. The change in mobility habits towards sustainable transport modes is one their main objective. Methodology to achieve this goal are differents and go from restriction and payments for access to urban area (the stick) to rewarding systems (the carrot). The analysis carried out on the use cases shows how in recent years the 'carrot action type' has seen a great development even if, to date, there are few truly applicative and correctly applied solutions. The article highlights different use cases describing their pros and cons with a special attention to rewarding framework and technologies.

Keywords: Sustainable mobility · Transport access restriction · Mobility reward · Smartphone APP

1 Introduction

In this first part we want to introduce those elements of the mobility state of the art at European level useful in the subsequent considerations relating to the modifying mobility behavior systems. The data that are proposed, to clarify the situation of the transport sector in Europe with a greater focus on road transport, were collected from the publications that Eurostat, the statistical office of the European Union, made available in 2020 [1, 2].

In 2017, passenger cars accounted for 82.9% of passenger land transport in the EU, with coaches, buses and trolley buses and trains both accounting for less than a tenth of all traffic measured in passengers/sqkm and 9.4% and 7.8% respectively (see Fig. 1).

As for passenger cars, 11 of the 23 EU Member States for which 2018 data are available, more than 50% of the cars were petrol (see Fig. 2). Cyprus reported the highest percentage (81.7%), followed by Finland (73.7%) and Denmark (68.3%). Diesel cars exceeded the 50% mark in Lithuania (67.7%), France (65.8%), Latvia (59.1%), Luxembourg (58.9%), Spain and Portugal (both 56, 1%), Austria (55.8%), Ireland (55.5%), Belgium (54.7%) and Croatia (50.7%). Alternative fuels made a significant contribution in Poland (15.9%), Italy (8.6%), Lithuania (8.2%) and Latvia (7.3%).

Moreover, in 2018, it was estimated [2] that more than half (51.6%) of all passenger cars in the EU-27 were at least 10 years old, compared to a scant 11.8% of those less than two years old.

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Given also the high motorization rate of the European population, rather than acting on incentives to change its type (electric, hybrid, others), there is the need to decrease the vehicle density and encourage the use of alternative transport modes to the car.

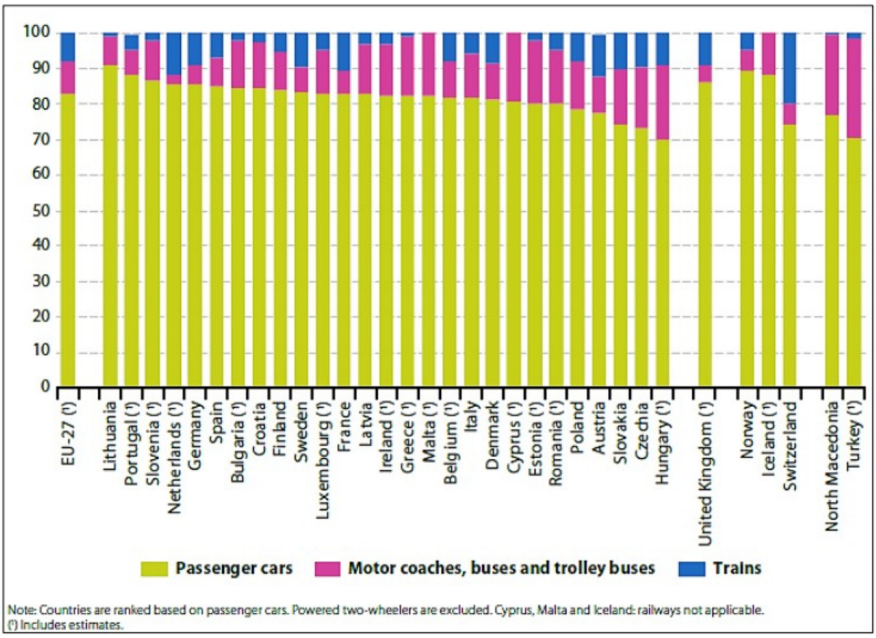

Fig. 1. Modal split of inland passenger transport in 2017 (source: Eurostat).

Going into the Italian situation, the annual study carried out by the ISFORT institute [4] provides a more detailed picture and indicates that occasional journeys are almost 40% of the total and the urban modal split sees private mobility (by car or motorcycles) down from 59 (in 2008) to 55%s (in 2019) while extra-urban mobility has an unsustainable share of travel equal to over 88% and constant over the last 10 years. It is, therefore, clear that it is particularly necessary to intervene in the traffic flows entering in the cities from external areas. Given the almost impossibility of acting on existing infrastructures (for limits in road network or in disposable resources), the rewarding policies in this context acquire a significant weight and are opposed to, or better integrate with, the tolling and charging policies related to urban accessibility.

The next paragraph presents the methodologies used to manage urban accessibility and mobility behaviors, with particular attention to the interventions following the important features now underlined.

2 Mobility Management Policies

The European Commission, in the Communication no. 433 “Greening Transports” at the European Parliament in July 2008, underlines the importance to identify methodologies for calculating user mobility costs. Commission highlighted the necessity to

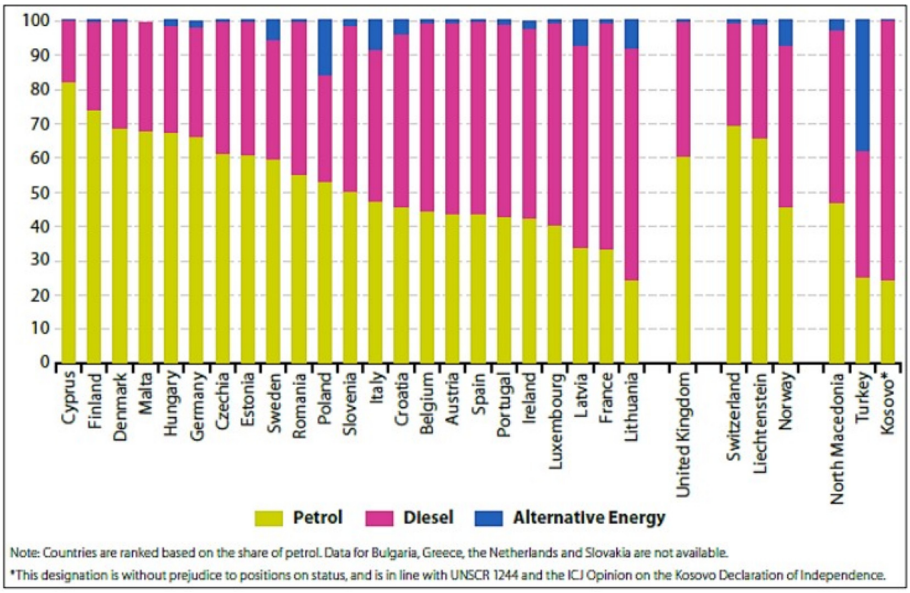

Fig. 2. Passenger cars by fuel type (%) in 2018 (source: Eurostat).

evaluate indirect prices that society must support and the need for incentives to engage behaviors that can generate lower costs for society. This is a first input to introduce mobility management measures such as charging company employees for parking vehicular access, rewarding commuters using park & ride or other. Moreover, in many European cities there is practically the impossibility of acting on existing infrastructures, so soft mobility management policies in this context acquire a significant weight and rewarding ones are opposed, or rather (and better) integrated, with tolling and charging policies. It is important to calibrate mobility management policies because we need to guarantee accessibility to residents even in restricted traffic areas and avoid, with excessively restrictive policies, the citizens urban centers abandonment. Unfortunately, these are dynamic already existing in some inhabited centers such as Cagliari, for example, where the excessive restriction on residents accessibility (only in some daily time periods) led to the transfer of larger family groups, where the presence of children required greater flexibility in daily travel.

Moreover, recent statistics [4] shows relevant suggestions to design and implement correctly mobility management policies. For example, from 2008 to 2019 in Italy trips within urban areas saw a decrease in the share in private cars from 58.8% to 54.9% with an increase in sharing mobility of almost 2% as well as for public transport. In the same period, extra-urban journeys ending in urban areas remained practically unchanged, with a share of private cars near 85%. It is therefore important to manage more efficiently the trips accessing urban areas, often commuting ones.

Policies to manage mobility go from **accessibility restriction** to **reward systems.** In the next two paragraphs we describe both.

2.1 Accessibility Restriction Mobility Management Policies

These former policies have already seen many application areas and can be applied on a point-base framework, such as for the Bridge Tolls in Motala and Sundsvall in Sweden [5] where a tax was introduced in February 2015, and it is still in operation, which all vehicles have to pay for every time they use the two bridges. The toll is active 24 h a day and a fixed fee is charged for crossing through the automatic checkpoints.

Access restrictions can be cordons-based, with the restriction applied for crossing a dividing line between two city areas. Examples of representative applications are the Stockholm and Gothenburg congestion charge.

The Stockholm congestion charge is a charging system (still working) applied to vehicles passing through checkpoints, both inbound and outbound, placed on a cordon. The congestion charge was applied on a permanent basis on 1 August 2007, after a seven-month testing period between 3 January 2006 and 31 July of the same year.

The main purpose was to reduce traffic congestion and improve the environmental condition in central Stockholm, as well as to allocate the collected revenues to new infrastructure supply. The charge zone initially included the whole Stockholm city center, but from 1 January 2016 it was also extended to the access and exit ramps of the two Essingeleden motorway junctions to reduce traffic jams during peak periods and, consequently, in a reduced way, even on the surrounding roads. Operation is simple: there are unattended electronic control points at all bead inputs. Vehicles passing through them are identified by automatic license plate recognition thanks to cameras, laser detectors, antennas and information signals mounted on a series of portals at each control point. There are no payment booths and this is done through a monthly report relating to the identifications. The idea is that with a traditional toll booth, a substantial percentage of the toll, instead of being used for infrastructure investments, would be destined for staff, which is avoided here. The system is not exclusively aimed at traveling by car to the city center; the congestion charge is applied both at the entrance and at the exit of the interested area. The tax amount depends on the control point (if it is on the motorway or if it concerns the cordon of the center of Stockholm) and on the time of day when a citizen enters or leaves the congestion zone. There is no charge on Saturdays, public holidays and days before holidays or between 18:30 and 06:29. Some vehicle classes are exempt from congestion charge such as: emergency service vehicles, certain types of buses, motorcycles, military vehicles, etc.

Stockholm has seen a drop in traffic volumes across the cordon of around 25%. Of these, about 10 percentage points represented business trips and a further 6% were due to changes in personal trip (change of destination, reduction of frequencies and planning of multiple activities in a single trip). Commercial vehicle drivers have also changed their routes so to decrease the number of cordon crossings. It should be noted that a good part of the traffic throw the checkpoints was occasional, therefore, not all transits took place for work reasons and then it was possible to adapt mobility behaviors to these limitations.

Gothenburg's congestion charge, which is still working, was introduced on 1 January 2013, covering the entire center of Gothenburg and the main E6 road through the city. The operation is very similar to the congestion charge applied in Stockholm. Here, too, different rates are applied depending on the time slot, it is charged in both directions

(both inbound and outbound) when the cordon is crossed and it is applied to all vehicles, even the least polluting ones. In addition, a new rule has been introduced that attributes the maximum amount to those who pass through two checkpoints in one hour. There is no charge on Saturdays, days before holidays and holidays or between 18:30 and 05:59. About 8 months after its introduction, a reduction in traffic volumes in transit at the cordon was observed, stabilizing at 12%.

The last type of restriction is area-based where the restriction is applied for entry by car within an area during a certain period of time and with a specific vehicle. These restrictions are simple to understand and easy to implement. The London Congestion Charge is the best known example of this vehicle access restriction regime, together with the Milan Area C and the Singapore ERP.

The London congestion charge was introduced in 2003, within the London Inner Ring Road, an area enclosed by a series of main roads surrounding central London and which forms the boundary of the restricted traffic zone. The goal was to make vehicular traffic more fluid, obtain funds to invest for public transport network greater efficiency, improve the quality of life and above all reduce congestion and pollution in the delimited area or in the city center. The London Congestion Charge is a daily rate of £ 11.50, between 7 am and 6 pm, Monday to Friday which drivers of certain motor vehicles must pay in order to access the parts of London designated as congestion charge zones and located in the city center. Some vehicles, such as taxis, buses, commercial vehicles do not have to pay the toll, while residents receive a 90% discount.

The tax is still present and has led to a reduction of about 20% of vehicles subject to full toll even if it has been accompanied by an increase in entrances not subject to any tolls (taxis and private rental vehicles). A significant modal change was also obtained also because the revenues were used to support sustainable mobility. In particular, vehicle entrances for transit only increased from 29% of the total in 2002 to 37% in 2015 (mostly buses) while car transits decreased, from 46% to 36% in the same period. The share of bicycle admissions doubled from 1% to 2%.

London has shown that it is possible to achieve significant changes in travel patterns in a relatively short time frame.

The Milan Area C is a large area (the ZTL includes about 8.2 square kilometers and 77,000 residents) of the Milan historic center with access restrictions for some types of vehicles. It coincides with the limited traffic zone (ZTL) “Cerchia dei Bastioni” and is bordered by 43 gates with cameras, of which 7 are for the exclusive use of public transport.

Introduced in 2012 and active, the rate is applied to all vehicles entering the city center on weekdays (excluding Saturdays) from 7:30 to 19:30. Each vehicle that enters the paid area must pay 5 € to be able to enter and exit for the whole day. Electric vehicles, mopeds and motor vehicles (motorcycles, tricycles and quadricycles), hybrids with certain specifications, public utility vehicles, police and emergency vehicles, buses and taxis are exempt. Residents inside the restricted area also have to pay to reach their home but have 40 free admissions per year and a discounted rate of € 2 from the 41st access onwards. As a result, there was a decrease in traffic of 35.9% and it was observed that occasional entrances are absolutely prevalent, with 45.65% of vehicles entering only one day and 86.99% of vehicles entering for less than 10% (<13 days)

of the 125 days considered. Systematic movements are extremely limited, i.e. 2.58% of vehicles entered the ZTL. It is interesting to note that, for the category of residents, 85.8% did not exceed the 40 free admissions provided for by the provision, while 7.5% made systematic admissions ($\geq$63 days of admissions).

Electronic Road Pricing (ERP) was implemented by the Singapore Land Transportation Authority in September 1998 to replace the previous "Area Licensing Scheme" and was the world's first electronic toll collection system.

The charge takes place thanks to an IU (In-vehicle Unit - On-board unit) device, connected to a CashCard, which is placed in the lower right part of the windshield. When a vehicle crosses the portal, the installed sensors communicate with the UI via a short-range communication system and the driver receives the message of the deducted amount on the LCD screen of his UI.

The results were a reduction in road traffic of nearly 25,000 vehicles (13% of total traffic) during rush hour, with an increase in average road speed of around 20%.

An interesting example of restriction policies is the Greater Manchester congestion charge. The Greater Manchester Congestion Charge is reported because the congestion charge was not introduced due to strong resistance from a large part of the population, who saw the intervention as one of the many impositions to make citizens pay.

In 2008, two curbs were proposed: one outside that surrounded the main urban core and the other that covered the center of Manchester (for a total of 210 kmq). The Greater Manchester Transport Innovation Fund was rejected in a referendum at the end of the same year (December 2008). It was proposed that vehicles entering the area bounded by the M60 motorway would be charged £ 2.00 during the morning rush hour, plus £ 1.00 also when crossing the internal cordon. If the exit from each cordon had taken place in the evening, an additional £ 1 was charged (these rates were those proposed in 2007).

Inbound rates would be applied between 7:00 and 9:30, and outbound rates between 16:00 and 18:30. There would be no charge during the central hours of the day, after 6:30 pm, on weekends and for travel during non-congestion hours: leaving the city in the morning or entering it in the evening.

The charge payment had to be carried out through a prepaid "tag and beacon" system (tag that sends signals within its range and communicates with the receiver made up of antennas, devices, etc.), connected directly to the driver's account, to the overcoming of the seams. Casual visitors to Manchester without a tag could have paid via the call center or the internet for a surcharge. Exempt from the fee were motorcycles, black taxis and private rental cars. Presumably in the spring of 2022, a Clean Air Zone will be introduced by order of the government. This will be different from a Traffic Restriction Zone where all or most of the vehicles will be subject to payment for transit, but will hit with a daily rate, only vans, buses, coaches, taxis, private hire vehicles, minibuses and heavy commercial vehicles that do not they will meet emission standards. Private cars, motorcycles and mopeds will not be included.

So, this last example show the needs to integrate restriction policies also with other types like rewarding ones, described in the following paragraph.

2.2 Rewarding Mobility Management Policies

Reality shows that people are more motivated when they are rewarded rather than when they are punished, as in this way positive thinking is associated with the behavior itself [6]. As reported in their article Dogterom, Ettema and Dijst [7], road pricing methods and other toll measures are attractive from a theoretical point of view but are often perceived as controversial due to their lack of social acceptability. Therefore, the introduction of tools able of allowing the management of transport demand in a politically and socially acceptable way is a factor of primary importance.

One of the few comparisons between pricing and reward systems at a scientific level [8] shows how the theoretical pricing solution must make each user pay what it costs the company. To pursue this hypothesis, taxes of different levels should be applied for each user and for each road line, an element that is difficult to apply and has led pricing policies to simplified solutions that are less socially acceptable.

Another work that compares reward systems (in particular the Tradable Mobility Permits-TMP) and pricing systems is that of De Palma, Proost, Seshadri and Ben-Akiva (9). In it, the search for the social optimum was simulated, that is, the condition for which total welfare is maximized. The results show that, in real conditions, where the uncertainty, represented in the model by an increase in the random term of the logit behavioral formulation (e.g. variations in queues, travel times and more), is not zero, TMP systems maximize more global welfare and consumer surplus (positive difference between the price that an individual is willing to pay to receive a specific good or service and the market price of the same good). It is interesting to note that an equity measure was carried out (represented by the Gini coefficient) with more equitable values closer to zero and where equity is assessed with respect to the different income classes. In this case, the Gini index is always higher for payment systems, indicating how they have a lower level of equity.

The preference of road users towards reward systems was also found by Parag, Capstick and Poortinga [10] who investigated preferences on the carbon emissions reduction in a population sample, verifying how the rewarding systems have an higher conviction capacity than payment systems [11].

In fact, the reward, together with the other toll/fare interventions, is an excellent tool able of changing the behavior of citizens towards sustainable mobility. The reward, to be effective and achieve the goal, cannot ignore human behavior and must take into account the relating research conducted in the field of sociology, psychology and marketing.

As for the intervention strategies aimed at modifying the behavior itself, "The Fogg Behavior Model (FBM)" is very interesting, a behavior modification model proposed by B.J. Fogg [12] who states that behavior is composed of three different factors: **motivation, ability** and **triggers**. According to this model, to be successful in changing behavior, each person must be motivated, have the ability to execute the behavior, and have a trigger to execute it (for example, in the GOODGO reward system [13] there are prizes for three age groups, in order to motivate also the elderly who, if placed in competition with the highest level of mobility of young people, could lose motivation to participate). Fogg defines several motivators: such as pleasure or pain, hope or fear, social acceptance or rejection. Skill, on the other hand, refers to the perception of self-efficacy in performing a target behavior. The elements that characterize an high capacity

or on the contrary simplicity to perform a behavior could be time, money, physical effort, brain cycles, social deviance, non-routine, etc.

Fogg states that an activity that can be done easily requires little motivation and a trigger element is enough while, when an activity is tiring, such as changing one's behavior, the motivating element must grow (see Fig. 3). In the field of mobility, this model consolidates the position of rewarding, in fact, when the goal is to change the behavior of citizens towards sustainable solutions, a long and tiring process, the motivating element must grow and this consists precisely in introducing prizes.

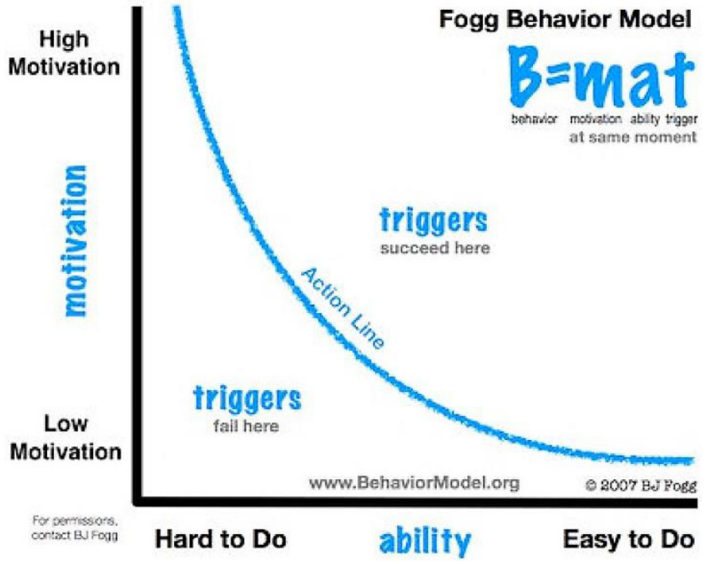

Fig. 3. General scheme of Fogg's behavioral model (source: [12])

Motivation to change

A first intervention can concern the communicative level. Already the knowledge of the change possibility and the presence of an alternative mobility network are elements of information which, in themselves, constitute a stimulus to change, even more so if connected to reward elements [14].

The identification of achievable individual goals can also be part of incentive mechanisms together with feedback on the goal achieved and their sharing; knowing that one's virtuous behavior will be made public makes it more pleasant to continue with such attitudes.

Barsky et al. [15] report that it is much more impactful on the user to receive information in a negative format than a positive one; for example, receiving the quantification of the CO2 avoided Kg leads to more incisive results than showing the emitted Kg. Tools to activate the stimulus can be: posters, radio/TV advertising, newsletters, magazines, guides, websites or informative and interactive material, videos, social networks such as Facebook groups, Twitter, LinkedIn, events, meetings, workshops, smartphone apps etc.

Trigger to change

This point concerns the need to give people access to the resources necessary to change behavior. This can be done by providing economic sums or by providing alternative systems (for example innovative accessibility systems) to existing ones that do not increase individual spending levels. The physical or social context of people must be restructured in order to activate or facilitate the desired behavior.

Ability to change

They must be provided goals quickly achievable. Furthermore, people are likely to adopt a new behavior if they see that other individuals have managed to achieve the same goal. Along the same lines is the theory belonging to Skinner [16] which states that complex behavior is learned gradually through the modification of simpler behaviors and that imitation and reinforcement play important roles as individuals learn by duplicating the behaviors observed in others and rewards are essential to ensure desirable behavior repetition.

The self-image communicated to others is an important incentive element, as it leads the citizen to be seen as a high social stature person. Often the use of monetary rewards goes against this principle as the citizen loses the social goal towards the more venal economic one. Furthermore, the virtuous behaviors of friends, acquaintances and colleagues can influence individuals and, so, the use of social networks, to spread sustainable behaviors, acquires a high importance. Ampt (2003) also highlighted how communicating one's own virtuous behavior to others involves a mental process of strengthening commitment to sustainability.

In conclusion, giving up daily "bad" habits can be painful and for this there is a need to be rewarded for every small step, especially at the beginning of this long process.

Another key element is to promote behavior change; personalized communications and tailored messages are effective and are a good way to incentivize behavioral change and improve its impact. This approach can be used to generate an emotional response such as fear, hope or anxiety and to promote the comparison between real and ideal behaviors.

Equally significant is to understand how to maintain a certain stable behavior over time, and therefore the results obtained, after the first active phase of intervention and change without continuous support. In fact, experience shows that in most cases, the effects on behaviors inherent to lifestyles are often more pronounced in the initial phase of the intervention. Without further support, the positive effects tend to diminish or fade over time also due to some factors such as climate or seasonal and/or personal changes. Hence, maintaining behavior change requires an understanding of the surrounding context that can facilitate or prevent this process.

In order to change a given behavior in the future, it is necessary to know the behavior of users and past alternatives, in fact, to achieve the desired change, the user must be aware of his present attitude and possible future alternatives. People are rarely aware of their routine behavior, since most of the actions that compose it are performed unconsciously and therefore the difficulty arises in considering other possibilities.

In this respect, technology offers countless advantages. One way to effectively influence user behavior is to communicate sustainable alternatives including the ability to

monitor oneself, set goals, be able to compare and be rewarded for achieving target behaviors.

The stage of change reached by users is important, as it affects the success of the new behavior promoted. The stages of change, therefore, highlight how ready and willing people are to behavior change. The phase-of-change model proposed by Prochaska [17] (see Fig. 4) describes the five stages people go through on their path to change. The process starts with an individual who has no interest in changing his behavior (no = pre-contemplation), begins to contemplate change (perhaps = contemplation), prepares to change it (prepare/plan = preparation), begins a new behavior (doing = action) and maintaining it (continuing = maintaining).

The "action" and "maintenance" phases are of particular importance in changing mobility behavior, because the initiation process versus the maintenance process is very different (making the initial decision versus continuing effort). Initial attraction or a willingness to try a new behavior may be enough to encourage the transition to the "action" phase, but it is important to assume that someone will continue a behavior just because they have started doing it. In fact, creating new habits and breaking old ones is incredibly difficult and there is a high relapse chance.

For a less complex service such as a single journey on public transport or even a monthly pass (low complexity due to less time spent on commitment) the mobility buyer's decision process occurs more quickly. This makes public transport users more susceptible to new solutions for their mobility needs than car owners who have a high financial loss to amortize.

It is therefore essential to consider that the success of the behavior change results from an understanding of the target group and its objectives and needs in terms of mobility; for example, by introducing car-pooling as an element of reward, allowing the use, even if minor, of one's car and, therefore, not contrasting with previous purchasing choices.

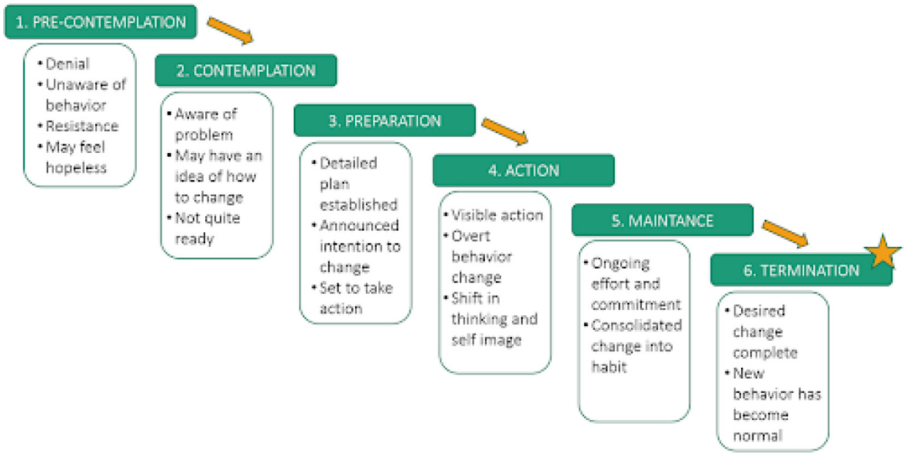

Fig. 4. Prochaska's Six Stages of Change [13]

It is very important to understand how people can be motivated to change behavior and what are the effective mechanisms that can keep users motivated once the novelty effect of such a system wears off. Planning tools, which automatically consider multiple users by offering decision support for multiple objectives, by making users aware of their past behavior and attempting to integrate personal information with spatio-temporal information, are needed to link complex objectives with simple activities. For this reason, a growing range of smart apps and price comparison tools are increasingly being made available to travelers to manage their travel in order to reduce costs and save time.

2.3 Rewarding Mobility Technologies

Many online tools, apps, ITS (Intelligent Transportation System) technologies have been created and integrated into web platforms to encourage sustainable mobility behaviors using rewarding policies. The technical term of these technologies is *Captology*, acronym for Computers As Persuasive TecnOlogy which has been becoming a new research field since the 2000s [12]. This field studies the use of different computer-based technologies as a means of persuasion to change behavior (websites, smartphones, video games, smart environments, virtual reality and more).

ICT (Information and Communications Technology) tools and especially smartphone apps are the technologies most used to monitor people's mobility behavior, collect data (for example, useful for the Administration to plan mobility), increase the motivation of users through competition and reward those who move in a sustainable way. Many examples show that smartphone is one of the most important platforms for modifying human change [17].

Analyzing all the characteristics of the individual reward projects developed would be excessive and, therefore, for brevity reasons, the analysis made (see Tab. 1) on the apps used in the most important reward projects is reported, in order to provide a general picture of the current implementation state.

The high number of reward platforms developed highlights the great interest that this system is enjoying, while the detailed analysis highlights how many of the applications have been developed internally at research projects and have been applied only at a prototype level with the decommissioning of the system. at the end of the project.

Often the applications are not designed with the target to provide a real decision support and incentive to modal change but only exercises and technological developments not adequately designed to be used in a massive and effective way.

The detailed analysis of the few platforms applied to date highlights a general superficiality in the management of the reward modules, with the following elements:

- problems from the point of view of privacy (in some Apps you can see the names and surnames of all the members in the ranking and not the nicknames);
- bugs in the registration system or in the tracking system;
- absence of verification of the declared transport modes, with consequent invalidation of the rewarding objectives

  Elements of interest are the connection with the APP personalization systems (Avatar, possibility to invite friends, to compete with friends, to publish their own photos or

Table 1. Main features of the main rewarding Apps (PT = Public Transport)

Name	Country	N° downl	Monitored modes	Note	Year	Current State	Start Stop
Muv	many	>100	multimodal	avatar, weekly competition, multipliers	2020	freezes on registrat	manual
Biklio	many	>1.000	bike	Trace proj. shops checkpoints	2018	impossible to enter	manual
Positive Drive	Holland	>1.000	multimodal	Trace Project	2018	absent in APP store	manual
BetterPoint	Italy, UK	>50.000	multimodal, car-pooling	medal, prize draw, user union	2016	no initiatives currently active	manual
GoodGo	Italy	>1.000	multimodal car-pooling	Integrated with bike antitheft system	2017	working	manual
WeCity	Italy	>10.000	multimodal unique PT	modes certification, survey on path	2015	Active with bugs in registration	mixed
Kultur-Token	Austria	>100	multimodal	owned by the Austrian government	2019	suspended for covid	auto
Pin-Bike	Italy	>1.000	bike, car-pooling	certified paths	2018	working	auto
IMove	many	unk	unk	second level maas	2019	absent in APP store	unk
Smart	many	>10.000	multimodal	personal and group competitions	2015	working	auto
Enschede Fietsstad	Holland	>10.000	bike	complete dashboard	2015	working	auto
Sharing Cities	Italy,UK Portugal	unk	bike, car-pool., PT, car-sharing	also waste recycling and energy cons.	2015	not working	unk

(*continued*)

Table 1. (*continued*)

Name	Country	N° downl	Monitored modes	Note	Year	Current State	Start Stop
Travel Smart Rewards	Singapore	unk	rail	prize draws or credits	2010	absent in APP store	unk
Alternativ	Israel	>50	multimodal	complex rules for identifying modes and stops	2016	absent in APP store	auto
Nuride	USA	> 10.000	car-pooling	money to the passage of users in front of activities	2003	absent in APP store	unk
TripZoom	Hooland UK, Sweden	>100	multimodal	social networks, friends rankings, O / D travel info	2014	impossible to enter	auto
Commuter Greener	Sweden	unk	multimodal	unk	2015	absent in APP store	unk
Love To Ride	Italy, UK	>10.000	bike	google fit, bike shops, add photos, stories	2007	working	manual
Travel Watcher	Holland	unk	multimodal	automatic travel classification system	2010	absent in APP store	auto
CO2 Fit Chargers	Germany	>10.000	multimodal	google fit, vehicle setting, invite friends, healthy nutrition	2018	working	auto
Vivibici	Italy	>50.000	bike	rewards with mobile minutes	2015	working	manual
Play&Go	Italy	>1.000	multimodal	planned trip entry	2016	working	manual

(*continued*)

Table 1. (*continued*)

Name	Country	N° downl	Monitored modes	Note	Year	Current State	Start Stop
La'Zooz	Israel	unk	multimodal	collaborative platform, zooz bitcoin coin	2017	absent in APP store	unk

travel stories or to connect to social networks) or the connection with external apps (e.g. Google Fit or Google Health).

Among the results of the various experiments it should be emphasized that, despite many apps do automatic route tracking (Table 1 last column), it emerges that users do not like continuous monitoring but rather prefer to decide for themselves when to be tracked. This approach is also beneficial in terms of sustainability, as it avoids excessive battery consumption.

Another element of interest is the use of multipliers, a typical gamification feature. They provide extra points in case of special conditions that occur. MUV, one of the platform using multipliers, has three different types of multipliers:

- Weather conditions: rewards users who move when it rains or snows;
- Rush hours: rewards users who move sustainably during peak traffic hours;
- Frequency of use: rewards users who play for multiple consecutive days.

In other ways, credits/points can also be collected by inviting friends, answering a survey, in order to encourage the dissemination of tools or the collection of important data from the point of view of mobility behavioral analyzes.

Morerover, one of the problems of rewarding systems is the involvement of occasional users, users who do not have the possibility to collect points but, in some projects such as Betterpoints, players participate in real prize draws or virtual raffles to win physical prizes.

3 Conclusions and Perspectives

In general, the lesson learned from the analysis of the rewarding best practices state of the art allows to extract some basic elements to be provided to each application:

- provide awareness of their mobility choices thanks to self-monitoring;
- provide positive and instructive feedback;
- reward users both extrinsically and intrinsically;
- create rankings to fuel healthy competition between participants and push them to do better;
- create the emulation effect and disseminate good mobility practices by publishing the achievements on social networks;
- the importance of the role of gamification;

- the importance of the prizes choice;
- the importance of tying the prizes to the territory in which the reward system is implemented.

In all the experiences viewed, good results were obtained (often in qualitative terms) but when the rewarding ceased there was a slow return to previous mobility habits. This must push to build reward systems that are not one-off applications in order to raise sustainable mobility awareness (as often happens with tenders linked to state funding or fixed-term projects) but must enter into the daily planning of mobility, for example entering between the Sustainable Urban Mobility Plan measures.

Finally we need to underline that data relating to users who move on foot, by bicycle or using other sustainable means are generally extremely difficult to collect both for public administrations and for most private data providers because these mainly depend on the willingness of individual citizens to monitor their own mobility behaviors and cannot be collected through technological devices (urban sensors, recording systems, etc.). Since decision makers, but also local communities of interest, do not have the information of those who move sustainably within the urban space, the effectiveness of the policies that should aim to motivate those same actors is reduced. Furthermore, the unavailability of these data leads to political and infrastructural planning focused on the means of transport on which the most information is available, i.e. the most polluting means.

So rewarding systems and the related data collecting are, in this sense, a double way to incentive sustainable mobility.

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