Rewarding Sustainable Transportation Choices
Impacts of App-Based Outreach and Incentive Distribution

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Abstract
What is the most effective way to influence travellers’ behaviour using positive incentives and rewards? The European Project EMPOWER implements a diverse strategy to significantly reduce the use of conventionally fuelled vehicles (CFV) in urban areas, through influencing the behaviour of car drivers. The aim is to incentivise users of CFVs to change their behaviour with positive incentives, thus rewarding them, rather than penalizing them, for making sustainable transportation choices. This paper targets the setup and effects of the experiments performed in Sweden, including an expansion of the service from the main Living Lab in Gothenburg to other cities in Sweden, where users are incentivized through a smartphone app called SMARTiSverige. In the two-step experiment presented in this paper, we used the app to collect data to develop challenges, communicate personalized challenges to users, and communicate the points achieved if the challenges are completed successfully. Digital and physical rewards were then distributed to the users as a part of the complete scheme system. In addition to an account of the experiment and achieved results, this paper also discusses the implication of this research on the existing body of knowledge regarding incentives, and elaborates on how the lessons learned from this Living Lab could be used to scale up services in future sites for rewarding sustainable transport choices and impacting the use of CFVs.

KEYWORDS: Sustainable Transportation, Rewarding Change, Nudging

Introduction
Urban areas account for nearly 40% of Europe’s total road infrastructure and approximately 25% of all its transport CO2 emissions. Conventionally fuelled vehicles (CFVs) make a significant contribution to these emissions. Petri et al. (2016) identify that there are two main policy approaches to manage transport demands: accessibility restrictions vs. rewarding demand management policies, or in more colloquial terms, the stick and carrot approaches. Classical accessibility restrictions aim to lower the use of the road infrastructure by imposing a defined pricing scheme that penalize utilization of the infrastructure; this is the pain-inducing policy, or the stick. The penalty pricing scheme could be point based, cordon based, distance/time based or area licence based (Petri et al., 2016). Conversely, the carrot approach of rewarding demand management policies has emerged to stimulate specifically users of CFVs into transforming their traffic behaviour. The idea behind a reward-based scheme is to award the non-utilization of the CFVs and thus, shift the user to more sustainable transportation choices in order to achieve a reduction in congestion and emissions of CO2 in urban areas.

Anchored in the emergence of the smartphone, the rapid growth of smartphone-based applications and advances in mobile information technologies has led to the investigation and development of several reward-based schemes for transport demand management in the present decade. One such scheme is the reward-based mobile service Tripzoom. Based on real time travel data collected from citizens’ mobile devices to define positive incentives, Tripzoom distributes challenges to the users and provides real-time information on traffic patterns to government authorities, so that mobility can be managed based rewards (Bie et al., 2012; Poslad et al., 2015). Another system recently introduced, called SaveMyBike, uses RFID technology to merge the bicycle-sharing domain with the private utilization of bicycles. The system aims to incentivise and reward the utilization of bicycles in urban areas (Petri et al., 2016; Pratelli et al., 2017). Kazhamiakin et al. (2015) propose a gamification framework to support the operationalization of a reward-based scheme; by organizing the scheme as a game, you increase the attractiveness of the service and increase participation and willingness. Facilitated by mobile information technology tools (e.g. a smartphone app), an application of a reward demand management scheme may also
be used as an intermediary between the city administration and its citizenry (Gagliardi et al., 2017), enabling provision of additional value-added services beyond the simple distribution of rewards. Such tools may be viewed as platforms for providing additional value-added public services (e.g. traffic advice, city information), and may also encourage citizens to express their concern and appreciation of local services and road infrastructure to the city administration. By the remunerating nature of rewarding transport demand management, such policies have consequently the potential to stimulate a reciprocal engagement of stakeholders (e.g. citizens, communities and city authorities) in development of sustainable transport choices.

Hjalmarsson (2015) compares six reward-based services that provide positive incentives to participants in the scheme to stimulate them to change their travel behaviour. The comparison is done from a business-model viewpoint, yielding four challenges and ten key factors in designing reward-based schemes with a sustainable business model. A major hurdle is to achieve the critical mass of a large user base for reward-based services, and thus be able to create and sustain an active user base so that significant impact in reducing utilization of CFVs is made possible (Amelsfort et al, 2016). Amelsfort et al. (2014) conclude that one major risk with a reward-based service is that the level of complexity in the scheme may cause people to drop off in participation. A fine balance must be struck between the challenge, the reward, the user’s needs for transportation, and the user’s individual interest in the “game” or tool. Hof (2015) concludes that rewarding schemes may have a higher effect or change potential when directed at new drivers. Older drivers of CFVs have well-established habits which are not easy to alter with a purely retroactive reward-based system. Consequently, despite the potential in rewarding transport demand management policies, significant challenges exist in defining and implementing such schemes.

Through funding from Horizon 2020, the European Project EMPOWER1 employed a diverse strategy to significantly reduce the use of conventionally fuelled vehicles (CFVs) in urban areas by influencing the behaviour of car drivers. The aim is to incentivise users of CFVs to change their behaviour with positive incentives, thus rewarding them for making sustainable transportation choices. As a part of the project, incentive schemes will be tested in four lead cities and seven take-up user cities in Europe between 2015-2018. This paper explores the setup and effects of the test in the Gothenburg Living Lab, with an expansion of the test to include Stockholm as complementary Living Lab area.

In the Living lab campaign “Res SMART Tillsammans” (i.e. Travel SMART Together) users have been incentivized through a smartphone app, SMARTiSverige, (i.e. SMART-in-Sweden)2 which is the end-user component of the SMART system applied in the lab. The SMART system has the capability to automatically track the travel behaviour of users, including automatic detection of mode, trip purpose, route and travel time. The automatic trip detection process consists of two stages, similar to the process described in Greus et al. (2015). The first stage takes place on the smartphone of an end-user, via the installation of SMART-in-Sweden app. The app allows users to see a visual overview of their travel behaviour, as well provides information about challenges, received rewards etc. The measurement capabilities are created by a sensing module integrated in the app that uses a selection of available sensors in the Smartphone (GPS, WiFi, Accelerometer and cell-ID information). This module also manages authentication and communication with the back-end part of the SMART system, to perform measured data analysis in the second stage of the process.

In the Living Lab campaign, the SMART system was used to collect data as base to develop challenges for users, communicate personalized challenges to users, and communicate the points earned if challenges were completed. The incentives were selected for their attractiveness and potential to “nudge” people towards more sustainable transportation modes. Using the campaign as a data collection opportunity, a two step-experiment was performed. The research question addressed was: what impacts are achieved on travellers’ behaviour through app-based outreach and positive incentive distribution? The paper is organized as follows: It begins with a literature overview of state-of-art research regarding digital distributed incentives. Thereafter, an account of the case is presented. Adjacent to the case description, the experimental design describes how users were stimulated to alter behaviour based on defined, monetary-based incentive schemes. The paper continues with a comprehensive report of the results from the experiments and a

1 www.empowerproject.eu
2 www.smartisverige.se
discussion about the impacts that digitally distributed incentives have on the user communities travel behaviour. The paper ends with conclusions and an outlook of future research directions.

**Rewarding sustainable transport choices: literature overview of state-of-art research**

What we frequently refer to as "sustainable transport choices", are more clearly defined as *any* mode selection by travellers that excludes the use of CFVs. This explicitly means the use of public transit, walking or bicycling. While other forms of sustainable transport exist (such as carpooling, electric vehicles or ridesharing), we limited ourselves to these three forms of mobility. Bie et al. (2012) propose that a smartphone-based service has the potential to reach travellers and challenge them to make sustainable transport choices; moreover, smartphones can accurately record the travellers’ behaviour to validate the impact of the incentives used to enable the shift. Amelsfort et al. (2014) shows, based on a large-scale test of the app Tripzoom, that positive reward-based incentives have the potential to shift people’s behaviour in terms of travel time and travel mode, if they are challenged via an app-based service.

However, Amelsfort et al. (2014) also conclude that extremely complex challenges cause people to drop off in participation. A delicate balance must be found between the challenge, the reward, and the user’s individual interest and needs. Amelsfort et al. (2016) also identify what kinds of barriers a commercially-driven, app-based service designed for rewarding sustainable transport is likely to encounter, as well as the kinds of features or design traits that would increase such a commercially-driven approach’s chances for success. One such positive feature is that the incentive scheme that is offered must be developed around on the currently-held values and needs of the targeted CFV user group, accounting for cultural and social mores, as well as matching the needs of the commercial entity that is serving in the role of incentive provider. A win-win situation must be established for the scheme to be successfully operated (Amelsfort et al. 2016). In Hof (2015) the effectiveness of different incentive scheme techniques is compared and analysed. Behaviour change techniques are grouped into five categories:

- free travel cards
- objects providing information, feedback and/or instructions
- discounts and rewards
- interpersonal communication and informational maps
- comparative information on consequences

Positive incentive schemes based on *free travel cards*, have shown to be effective on travellers that have not yet developed strong routine transportation patterns (Taniguchi et al., 2014). Groups with more- established routines, or that perceive a shift to using public transport limits their mobility, appear to be harder to motivate with a free travel card as incentive (Baker and White 2010).

Incentive schemes based on *objects providing information, feedback and/or instructions*, e.g. provide information on travel consequences and provide rewards, show even greater potential than the free travel cards (Hof 2015). Abrahamse and Keall (2012) examined the effectiveness of “Let’s Carpool”, an initiative aimed at increasing vehicle occupancy in the Wellington region of New Zealand. Let’s Carpool used ride-matching software to facilitate finding a carpool match for the commute to and from work. Their evaluation study among nearly 1300 registrants of Let’s Carpool showed that the percentage of commuters enrolled in the scheme who carpooled as their main mode of transport for getting to work increased significantly, from 12% to 27%, while the percentage of commuters indicating they drove alone decreased significantly.

Clowes (2013) researched the impact of *discounts and rewards* as incentive scheme and documents the impact of the 100% discounts to the charge that are available for various categories of vehicles and road users. Private car drivers that drive a low emission vehicle got a 100% discount on London’s congestion charge. Clowes (2013) concluded that the number of low emission vehicles was higher than it would have been without the discount in place. A similar approach was used by Knockaert et al. (2012); just like Clowes (2013), Knockaert et al. (2012) also only provided a reward (not combined with anything else) for good behaviour. They conducted an extensive reward experiment in real-world conditions on a congested highway corridor in the Netherlands. Participants were given a “Yeti” model of smartphone for the experiment, and then could choose one of two types of reward: 1) five euros for each morning rush-hour that the participant avoided or 2) credits that, when a sufficient number were earned, allowed keeping the “Yeti” model of smartphone at the end of the trial. The results showed a clear indication that rewards could be used as an effective instrument to create impact on travel behaviour. Findings from Knockaert et al.
(2012) also indicated that shifting departure time is more likely than a modal shift or working at home using digitally means of co-operation.

In a study performed by Taniguchi et al. (2012), these researchers investigated how informational maps and interpersonal communication can motivate travellers to make sustainable transportation choices. They study how several different brochures and leaflets impact students’ residential choices. Taniguchi et al. (2012) found that, five months after receiving the information, students that had received pro-bus stop leaflets which described the environmental and personal health benefits of public transit, were twice as likely (32.4%) as the control group (13.5%) to choose to live within a 3-min walk to a bus stop. Students that had received a motivational leaflet with similar information were three times more likely (45%) than the control group (13.5%) to live within a 3-min walk to a bus stop. In a previous study, identified by Hof (2015), Rodriguez (2010) concludes that students who were exposed to the housing and accessibility information in the “Smart Moves” apartment finder map, travelled fewer miles per day via single occupancy vehicle when accessing the university campus versus those who were not exposed to the information. Interestingly, even students who were CFV owners demonstrated a change in housing preferences, as they were more likely to select a residence closer to the campus with more transit stops nearby.

In a study performed in California (Mortazavi, et al., 2011), an adaptable message signs portal along the highway corridor showed participants travel time information for cars and trains along a common stretch of road and railway. This example represents how comparative information on consequences may impact the choice of sustainable transportation modes. A small percentage of the respondents said they had shifted to transit due to the portal presenting travel time information for car and train. A larger percentage indicated they would consider switching modes in the future.

Another approach was used by Fujii (2007), who conducted a field experiment followed by a survey to investigate whether providing non-drivers with leaflet-based information about consequences of automobile use influenced their decision to go and obtain a driver’s license. The experiment involved 178 non-drivers in their first year of study at Kyoto University. The students received either no information, or information on the financial costs of owning a CFV, and/or on the potential for traffic accidents while driving, and/or the stress incurred when exposed to traffic congestion. Fujii (2007) found that 18 months after the experiment, the proportion of license holders in the control group (69.0%) was higher than in the experimental group (42.6%). The information about the risks, costs, and stress of automobile use also affected participants’ attitude toward life using an automobile. However, no differences were found between the different experimental subgroups. Interestingly, it made no difference which traffic consequences were presented in the leaflet. Based on the finding of the two studies, Hof (2015) concludes that the idea of targeting potential new drivers with information about costs, risks and stress associated with owning and using a CFV is a promising approach to pre-empt the formation of driving habits and CFV usage.

From this review of state-of-the-art studies, we can conclude that there is significant evidence that positive incentive schemes may impact traveller behaviour. It also shows that mindfully designed schemes may affect choices connected to mode selection and travel planning. However, we also conclude that there exists a knowledge gap, as current studies have mainly focused on one type of incentive scheme, and seldom address alternative schemes, such as altruism (“will the User engage in more sustainable travel to benefit a charity?”) or competition (“will the User engage in more sustainable travel for recognition on Leaderboards against other Users?”). The analysis of the state-of-the-art studies also points toward that monetary based incentives are often connected to travel cards and discounts on mobility-related services. But what will the impact be on sustainable transportation choice if the user is engaged in more sustainable travel to earn points- points that act as currency to be “spent” in a reward shop with retailers, products and services at mindfully is selected beyond transportation? Or if the User is challenged to achieve certain changes in their travel behaviour and compete using a Leaderboard to display changes and improvements and be rewarded a grand prize as a winner...how do they behave then?

**Case Description: SMART in Sweden Launch and Scale-up**

To address the knowledge gap identified in the literature overview, SMART in Sweden was adapted and launched with different features in Fall 2016 and Spring 2017, focusing on three types of incentives: Altruism, Challenge-based Rewards, and Personal Gain.

In the first phase, the service only included Altruism and used the coincidental Christmas holiday season as a motivator for encouraging downloads and creating baseline travel data for exploring the impact of shifting travel behaviour to attain benefits to a specific charity. During this
first phase, we recruited users to the scheme by encouraging them to support a local charity. We promoted the charity efforts in a digital campaign on Facebook, Instagram, and through email lists; several companies also promoted the campaign with their own staff and employees. By Winter 2016, the campaign had generated an initial user base of around 450 participants, providing baseline data as well as insights into how benefit-driven incentives may nudge people to change travel behaviour. Although the nature of the institutions behind the project was available on the website, SMARTiSverige was primarily marketed as a public-interest initiative and a game, evolving to a contest during Spring 2017.

![SMART app](image)

**Figure 1 - SMART in Sweden: iOS app and Facebook outreach**

Earning points for sustainable travel was just one function of gamification, but taking this approach meant investing significant resources into community management and engagement outside of the app, enabling users to feel connected to their city and community with their travel actions. Social media was heavily employed via Facebook, Instagram, and a website blog, where users could comment, ask questions or get help regarding the app, or just share photos via hashtags. The creation of “Mr. Smart” led to a real-life model of the SMART branding, and photos were taken on site and location to promote project partners. On the left in Figure 1, the Home screen of the SMART app, displaying total sustainable travel points earned and CO2 score. On the right, SMARTiSverige’s Facebook page. Posts regularly reached several hundred users, advertisements reached several thousands.

After three months of developing baseline data, we began to prepare a new phase of the Living Lab, which was using Challenge-based Rewards and Personal Gain as drivers. The replacement of Altruism as driver was operationalized with individual challenges to people that met certain conditions, and to provide individual gain-based rewards. Thus, in this phase, the service was expanded to another geographical area (Stockholm) which enabled us to document and research not only the impact of different types of incentives, but usage of the app in a city that had modes such as the subway as part of their public transit offering. But also, enablers and barriers to mass-scale app based rewards schemes. On the left in figure 2, a branded email announcing the shift from charitable incentives to competition-based Challenges and Rewards in 2017. On the right, “Mr. Smart” dominates most of the Instagram feed promoting the SMART campaign with
support from national partners like Lånsförsäkringar Alliances, and circular economy institutions, like the member-supported Cykelkoket.

Starting in January 2017, the project evolved the campaign into a form of rivalry between Gothenburg and Stockholm. Citizens in these two cities were engaged with the offer that they could compete to earn the most SMART points by using public transportation, and by walking or cycling. Their behaviour was tracked and recorded by the SMARTiSverige app and transformed into points. The leaders of the contest were published live via the contest Leaderboard\(^3\) (see Figure 3) which was developed and integrated with the SMARTiSverige via an Application Programming Interface linking the webpage with the systems back end. The scores were updated every 30 minutes. The contest was organized in three instalments (May, June and July 2017), with an overall monthly Winner, along with a monthly Public Transit Leader and a Cycling/Walker Leader. The winners were awarded GoPro cameras and FitBit watches, prizes chosen for their nature in encouraging healthy mobility and high monetary value.

Also on the Leaderboard were statistics about total number of points collected distance, mode, calories burned and CO2 produced - the scores from the two cities were also displayed (see bottom section of Figure 3). This created a composite “scoreboard” for each city that also displayed the outcome of the City vs. City competition. It also provided statistics about the most popular modes of transportation in terms of number of trips made by the participants in the contest. During the Leaderboard contest, the user base scaled to around 1050 participants. In order to further nudge participants to select sustainable transport modes, the Leaderboard contest was complemented by individual challenges, each based on the participants’ past travel behaviour. This was a part of the experimental design presented in the next section.

**Experimental design**

To answer the research question, the extended Living Lab were used as method to collect a data set to perform systematic designed field experiments. The design of the field experiment was divided into two phases. In the first phase (November to December 2016), the focus was to investigate Altruism as motivation type, and to understand to what extent Users will engage in sustainable travel to gather points for the benefit of a charity, and not themselves. Users received ten points per kilometre for cycling and walking, and three points per kilometre for using public transit. Four preselected charity partners competed for getting the most points from their connected users, and an online Leaderboard was used together with social media marketing from the partners to attract new users to the system.

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\(^3\) www.smartisverige.se/ressmart/
The main objective of this experimental step, beside investigating altruism as its own reward type, was to study how to attract user to a completely new service promoting sustainable transportation choices and to gather baseline data that we could later use to compare the efficacy of incentives. Working together with charities was also a way to attract a diverse group of users, not necessarily people that had already committed to travelling in a sustainable manner who might normally be...
attracted to the nature of this kind of product and service. Consequently, changes in travel behaviour at this point in the experiment were expected to be small.

In the second step, focus was on competition with individual prizes (April–July 2017). The completion of the challenge leads to a monetary price. An example of challenge posted was *travel less than 40 km by car this week and receive a gift card with a monetary value*. Users were invited to a challenge based on their previous travel behaviour. Ideally this process would be completely personalised, meaning that each user would have a unique challenge based on their behaviour. Technical constraints however meant that users were divided into classes. The classes depended on the objective of the challenge. Two objectives we used: 1) travel less kilometres by car in the upcoming week and 2) spend more time walking and cycling. For each of the two objectives four weeks of experimentation were done, with varying reward levels and a variation in reward type. The entire design of the experimentations is shown in Table 1.

### Table 1: Experimental design

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### Results

In phase 1 we were collecting over a 1000 trips per day from about 400 users. In order to identify potential personalised challenges, we analysed some of the trip characteristics of our users. On an aggregate level, see Figure 4, we see that about 50% of the kilometres travelled by the users is done by car, while the other major means of transport is public transit with 41%. It is important to note that the data were collected during winter months when cycling and walking may be less attractive.

![Figure 4 - Mode choice (by trip distance) of Gothenburg SMART users](image)

Looking more detailed to these data we see quite a different pattern between work and weekend days. On work days, the mode share of public transit is about 70% while this drops to 20–30% on the weekend. Preliminary analyses show that with a daily personal CO2 budget of 4 kg for travel, it is mostly the weekend travel behaviour that leads to excess of emissions. 5 shows how different
modes are attractive at different times of the day. In the morning peak public transit clearly has the highest number of trips starting, but in off peak periods the car gains importance. It may be that public transit networks are designed mostly around commute patterns and that more demand responsive service may attract more public transit user in off-peak hours in the future. There is also an interesting peak around lunch time when a lot of people go out for a walk.

![Distribution of number of trips starting in 15 minute intervals for different modes](image)

**Figure 5 - Distribution of number of trips starting in 15 minute intervals for different modes**

In this section, we present some of the initial results of a first run of analyses for challenge week 5 in which selected users, divided into four groups receive the challenge to reduce their car use. Users were given either a challenge to travel less than 30, 100, 200, or 300 kilometres depending on the past behaviour. Users travelling more than 500 km per week did not receive a challenge. Users were not assigned a challenge but were invited to participate on a voluntary basis. The acceptance rates were lower than desired (22% for week 5), and research is ongoing on how to achieve higher acceptance rates. One hypothesis is that more personalised reward based challenges are needed.

![Changes in weekly car kilometres from three weeks before challenges start up to the last challenge week, separate for all users and users that accepted the challenge in week 5](image)

**Figure 6 - Changes in weekly car kilometres from three weeks before challenges start up to the last challenge week, separate for all users and users that accepted the challenge in week 5**

Figure 6 shows how the average weekly car kilometres change over different weeks for two groups of users. The blue line represents the behaviour of all users and the orange line for the users that accepted the challenge for week 5. As expected the overall level for this second group is lower
since it for example excluded users with 500 km or more per week. Figure 6 also shows that average weekly distances are not constant (364 active users per week on average).

![Figure 6 - Average weekly distance by car](image)

**Figure 7 - Weekly car kilometres travelled (index: 3 weeks before start of challenges = 100)**

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a. Dependent Variable: carkm_sum

b. All requested variables entered.

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a. Predictors: (Constant), dummyinc

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a. Dependent Variable: carkm_sum

b. Predictors: (Constant), dummyinc

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a. Dependent Variable: carkm_sum

**Figure 8 - Simple regression model explaining weekly kilometres travelled by car with a dummy variable for having accepted a challenge in that week or not**

Figure 7 shows the same data as Figure but with an indexation to the first week of measurements. This figure shows that in week 5 the kilometres travelled by the users that accepted the challenge increased less than for the group as a whole. This incentivised group also seems to show at higher relative decrease before week 5 and increase after week 5. More analyses are needed to draw
conclusions on the effectiveness of the challenges, but for week 5 there may be small positive effects.

In a first attempt to look at the effectiveness of the challenges over all weeks, a very simple regression model was run trying to estimate the effect of having accepted a challenge for a specific week on the total distance travelled by car. Figure 8 show the estimation results for this very simplistic model. The overall model fit is not great as expected, but dummy variable dummyinc (0 no challenge accepted, 1 challenge accepted) is somewhat significant and shows that users that accepted a challenge drive CFVs on average 29 kilometres less for that week.

Conclusions and Future Research
This paper reports a two-step experiment performed using the Res SMART Tillsammans campaign and the app SMARTISverige as an opportunity to collect reliable data about how positive incentives and rewards may affect the choice of sustainable transport modes. The research question investigated is what impacts are achieved on travellers’ behaviour through app-based outreach and positive incentive distribution?

In the paper, we have reported a first attempt to assess the effectiveness of the challenges over every week in the campaign. Our initial analysis of the data show that positive incentive distribution has an impact on travel behaviour. However, our first analysis show that the impact was not great as expected. The examination show that rewarding sustainable transport choices have an effect on the users travel behaviour, but that this impact is only limited, according to the results from the first initial analysis. In short, users on average drive CFV less for the week that they accepted a challenge to shift to sustainable transport alternatives; but the number of kilometres they drive less are relative low despite the use of reward-based challenges and personal gain rewards with attractive prizes (GoPro cameras and FitBit watches).

The analysis of the immense empirical material collected will continue throughout fall of 2017. The material will in addition be complemented by a survey on the user population collecting their experiences from using the app and participating in the campaign. Through the continued analysis we will cross-check the findings presented in this paper and also expand the analysis initiated to further explore what enables users of CFV to shift to sustainable transport choices through challenges and reward. The results from this research will add understanding on the potential with and design of rewarding demand management policies.

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