SUPERHUB: Integrating behaviour change theories into a sustainable urban-mobility platform

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The SUPERHUB project (SUstainable and PERsuasive Human Users moBility in future cities) promotes the creation of a new urban mobility services ecosystem to facilitate the take-up of environmentally sustainable behaviours. It will design and test an open platform able to combine in real time all mobility offers from the relevant stakeholders together with a set of enabling mobility services able to address users' mobility needs and to foster behavioural change. This paper explores how SUPERHUB plans to integrate behaviour change theories.

Behaviour Change, Greenhouse Gas Reduction, Sustainable Travel, Persuasion, Transport, Urban Mobility.

1. INTRODUCTION

The world's population is increasingly city based with 51% or 3.5 billion people currently living in urban areas. Existing mobility systems are under enormous strain and are using an increasing amount of the planet's resources. The transport sector currently represents 30% of the final energy consumption of the EU and is a major source of greenhouse gas emissions and pollutants. If we are to ensure sustainable development for Europe as well as meet EU targets for greenhouse gas emissions and energy efficiency, it is vital that we have an efficient and usable mobility system that has as little impact on the environment as possible.

SUPERHUB aims to provide an integrated, multimodal system that supports transport needs and encourages environmentally sustainable choices to help limit the environmental impact of transport. It is a collaboration of 20 European partners, including academic institutions, transport companies, environmental agencies and city councils. (See superhub-project.eu for a full list and more detail). Another aim is to investigate what are the most effective methods to persuade people to adopt environmentally sustainable behaviour.

To achieve behaviour change, one option is to lower the barrier for uptake of a behaviour, so a system that makes it easier for people to find mobility information, book public transport and share lifts may encourage sustainable behaviour. Therefore, SUPERHUB aims to empower people with information, providing accurate, real time data on travel options and any disruptions to services, and providing support for car pooling and taxi sharing. Crowd sourcing will be used to provide up-to-date information (e.g., on transport delays and the crowdedness of busses), whilst care will be taken to ensure the reliability of information.

Additionally, behaviour change can be achieved by employing more direct behaviour change techniques. SUPERHUB will therefore support the setting of individual mobility related goals (e.g. use public transport at least once a week, provide a lift at least once a week), and provide feedback on mobility behaviour and encouragement to do better. SUPERHUB will also exploit the potential of serious games and social networks to sensitize people and make them reflect about behavioural change. This paper is mainly concerned with the second way of achieving behaviour change, and explores how SUPERHUB can use behaviour change theories.

2. DESIGN AND EVALUATION OF SUPERHUB

To ensure that SUPERHUB provides an effective tool, it will be developed in a User-Centric way, putting the user at the heart of the design process. Requirements gathering research has already taken place in SUPERHUB's three trial cities: Barcelona, Helsinki and Milan. Quantitative data was obtained by questionnaire (about 200 responses per city) and qualitative data by running Focus Groups (about 10 focus groups in each city, using different kinds of transport users). Scenarios

have been developed to showcase the core SUPERHUB functionalities. The initial research provided a large amount of data on demographics, current transport usage, problems experienced, mobility preferences, feedback and inspiration for scenarios, and a wide range of attitudinal data ensuring that we are as well informed of the needs of the target users as possible. We are currently running a series of Participatory Design workshops with a variety of end-users who will play a key role in the development of the system. In each city, the SUPERHUB functionalities will be tested in a realistic environment with large numbers of users, investigating the impact of SUPERHUB solutions in different contextual backgrounds. We are also developing Key Performance Indicators to measure how successful aspects of the system are.

3. HOW CAN WE PERSUADE PEOPLE TO MAKE SUSTAINABLE CHOICES?

There is a section of society that is committed to the environment and will do what they can to reduce their carbon footprint. Others may take more persuading to make more sustainable travel choices. Anable (2005) states that travel research methodology and policy interventions often overlook how the combination of instrumental, situational and psychological factors affect travel choice and differ for distinct groups of people. Understanding what will motivate people to change their behaviour will be a key element of successful persuasion. For example, visualising the amount of CO2 people will produce over a year may work for some whereas for others finding out the amount of money they could save by taking the bus rather than driving may be more motivating (as found in our focus groups). Different people will respond more or less to different cues and we aim to investigate what the most effective methods for persuasion are and how they can be implemented. We want to provide a system that can be optimised for each individual to maximise the persuasion for individuals to become more environmentally aware when making transport choices.

4. PERSUASIVE TECHNOLOGY

Persuasive technology is technology specifically designed to change people's attitudes and/or behaviours (Fogg, 2003). Persuasion implies a voluntary change, without using coercion. Persuasive systems aimed at changing behaviour are often called "Digital behaviour interventions".

4.1 Theories of behaviour change

There is growing evidence that using a behaviour change theory leads to more effective interventions. For example, a systematic review of 85 studies involving 43,236 participants found that "the effectiveness of Internet-based interventions is associated with more extensive use of theory (in particular the use of the theory of planned behaviour)" (Webb, 2010). Many theories exist; see Jackson (2005) for an overview. These theories help to identify the key behavioural determinants (Michie et al, 2005). These determinants are then targeted by behaviour-change techniques.

Advantages of the theory-based approach include: (1) interventions are likely to be more effective if they target causal determinants of behaviour and behaviour change; this requires understanding these causal determinants; (2) theory-based interventions facilitate an understanding of what works and thus a basis for developing better theory across different contexts, population and behaviours; (3) vice versa, theories can be tested and improved by evaluations of interventions only if those interventions are theoretically informed.

Fogg (2003) proposed an integrated model within the field of persuasive technology. Fogg's behaviour model is deliberately simple: it states that three elements -namely motivation, ability and a trigger- must occur simultaneously for behaviour to happen. The lack of any of these elements will cause non-compliance. The Fogg model says that if you get the motivators right, and if the behaviour is made easier for people to do, and if you trigger it - then the behaviour is more likely to occur.

Considering the many theories, some attempts, based on expert consensus, have been carried out to identify a set of common behaviour determinants. Fishbein et al (2001) analysed behaviour change theories to change people from risky to healthy HIV preventive behaviours. They identified eights factors that enable the prediction and understanding of behaviour. Michie et al (2005) analysed 33 theories with 128 constructs (including the 5 theories used by Fishbein et al) from a wide variety of fields, and identified 12 factors that are most likely to influence behaviour.

4.2 Behaviour change techniques

Behaviour change techniques are strategies used to promote behaviour change (Webb, 2010). For example, an intervention designed to encourage people to walk more can ask them to monitor their daily step count to raise awareness of their current behaviour – the 'self-monitoring' technique. Each theory of behaviour change is associated with a number of techniques, each of which can be further mapped to a specific behavioural predictor defined in the theory. Many researchers have attempted to create a taxonomy of these techniques. For example, the taxonomy developed by Michie et al. (2008) has defined and mapped 137 techniques to 11 behavioural predictors with the indication of where they can be used effectively.

Behaviour change theories can be used to predict which combinations of techniques are likely to be

most effective. For instance, Control Theory suggests how feedback may interact with other techniques to change behaviour. In the domain of healthy eating and physical activity interventions, Michie et al's (2009) meta-analysis of 122 studies found that interventions that combined self-monitoring with at least one other "self-regulatory" technique were twice as effective when compared with other interventions. Based on their analysis, they suggested the inclusion of five techniques: prompting intention formation, prompting specific goal setting, providing feedback on performance, prompting self-monitoring of behaviour, and prompting review of goals.

4.3 Personalising the intervention

Theories of behaviour change agree that any voluntary change of behaviour is not an event, but a process (e.g. Prochaska & Norcross, 2001). This process can go from not wanting to change, to considering change, to making and maintaining permanent change. Such a process develops over a long time. This is particularly true when the problematic behaviour is an everyday habit (e.g. travelling by car). People neither go through the process of change in the same order nor at the same speed. Additionally, behavioural determinants, the most appropriate behaviour change techniques and optimal mode of delivery may depend on the user. Any behaviour intervention, therefore, must be tailored to the beliefs, preferences, and circumstances of each individual. Empirical evidence supports this view; a meta-analysis by Noar et al. (2007) showed that tailored messages outperformed comparison messages in affecting health behaviour change.

5. EXISTING PERSUASIVE TECHNOLOGY FOR SUSTAINABLE TRANSPORT

Although the majority of research into persuasive technology has been in the health domain, there has also been some in the transport. A particular focus has been on 'mobility management' systems that motivate people to use more sustainable forms of transport by providing detailed travel information, incentives for selecting more sustainable modes of transport, and applying marketing techniques which focus on individual travel behaviours (Jones, 2003; Taniguchi *et. al.* 2007). For EU countries, the European Platform on Mobility Management and the European Local Transport Information Service provide a large number of case studies about implementing mobility management measures..

In the transport domain, the dominant form of digital behaviour intervention is the 'travel feedback program' which gives feedback on CO_2 emissions estimates, advice on car use reduction, information on public transport, etc. Examples include Travel Blending (Rose & Ampt, 2001), TravelSmart (Ampt & Rooney, 1999), Wise Ways to Use Cars (Taniguchi et al 2003), and the UK personalized travel planning systems reported in the Smarter Choices document (Cairns et al, 2004). To give an indication of the effectiveness of these approaches, a meta-analysis in Japan by Taniguchi *et. al.* (2007) of travel feedback programs found a mean reduction in car use of 19%, while the Cairns et al. (2004) analysis in the UK reported a 7-15% reduction in car use in urban areas.

6. PERSUASIVE TECHNOLOGY IN SUPERHUB

SUPERHUB plans to go beyond the state of the art for persuasive systems within the sustainable transport domain in two main ways. Firstly, it will work with users through participatory design and user-centred development to build a system in which the functionality focuses on the real-world transport needs of the user. Secondly, it will develop a system that is able to facilitate desirable behavioural shifts by utilising much more of the potential of persuasive technologies.

SUPERHUB will facilitate behavioural shifts using a subset of the techniques identified by Michie et al (2008). The following techniques (which include the five found most effective by Michie et al., 2009) will form the core of SUPERHUB's intervention:

- **Prompting intention formation, specific goal setting and goal review.** Users set specific mobility related behavioural goals which are then reviewed on a regular basis determining to what extent the goal has been met and whether it needs to be adjusted.
- **Monitoring, feedback, and rewards.** Participants' travel behaviour is monitored, feedback provided on the monitored behaviour, and rewards provided if appropriate. The rewards to use (e.g. reduced bus fares, social recognition) will be determined in requirements gathering and participatory design.
- **(Social) Comparison.** Comparative data shows participants how their behaviour compares with their own past behaviour, and the behaviour of others in the community or their own social support group.
- **Prompts and personalisation.** Participants are prompted at appropriate times to change their behaviour, for example to provide a lift or use public transport. Prompts are personalised to user characteristics and context. For example, focus groups showed that adaptation is needed to the weather and travel company.
- **Aiding decision-making.** Users will be provided with sufficient appropriate information to enable them to make informed decisions about their travel behaviour.

SUPERHUB will use *information push* via mobile devices to prompt users about their transport

decisions and to make suggestions about alternatives. For example, when a user has indicated that they are willing, in principle, to take part in car-pooling, SMS can be used to organise an impromptu car-pool in real-time rather than relying on pre-arranged, longer-term planning. Decisions about how and when to make these kinds of interventions will be based upon data-mining of users' profiles and travel-behaviour metrics and use contextual information such as adverse weather. Furthermore, data mining enables alternative behaviours to be suggested. For example, when the system has learnt about a user's regular travel habits, suggestions can be made such as to try public transport for a given leg of their journey. In this way the persuasive elements of the systems seamlessly integrate into the travel planning functionality. Data-mining will also be used to inform the persuasive functionality in profile matching; users whose profiles suggest compatibility may be matched up for a car-pooling or taxi sharing offer if their travel plans coincide.

We aim to create a synthesis of automated digital interventions based on intelligent analysis of tracked user behaviour with explicit goal setting, adjustment, achievement-tracking, feedback and incentive mechanisms. Automated interventions will cover opportunistic contextual interventions, such as suggesting alternatives (e.g., renting a bike when a bus is late), or utilising social compatibility matching to encourage a user to join a car pool with someone with whom they share hobbies, as well as the supportive role found in conscious goal-setting based approaches to behaviour change.

7. FUTURE WORK

We are currently running participatory design workshops to inspire the user interface and persuasive component. We will perform foundational research into mobility behaviour and expectations, with special attention to sustainability and motivational aspects, and create prototypes for formative and summative evaluations. Testing will ultimately include around 1000 people per trial city.

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