STUDYING COMMUTER BEHAVIOUR FOR GAMIFYING MOBILITY

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1. INTRODUCTION

The idea behind our project is to introduce traffic participation into a game-like environment. Our approach is to develop and assess new methodologies that bring together gamification and collaboration through a mobile application as a way of encouraging commuters to undertake new behaviours that help to reduce traffic congestion.

The project aims to produce a pervasive, gamified system that tries to incentivize mobility behaviour change by offering alternative activities in contrast to usual journeys in such way that it will reduce traffic, emissions and, in the end, save money. The alternatives, for example, such as taking different modes of transport, are incentivised through gamification. In order to develop this pervasive system, we analysed existing mobility patterns of commuters in Luxembourg. The methodology that we developed consists of a questionnaire, a smartphone application and focus group interviews. This paper presents the findings of the questionnaire and how they influence the design of the gamified pervasive application.

Luxembourg is a very heterogeneous country and a particular case for mobility studies as many people enter and leave the country on a daily basis to work there. On average 157.6k cross boarder commuters come every day to Luxembourg, most of them employees from France (77.8k), Belgium (39.5k) and Germany (39.6k). Therefore, the participant recruiting as well as the actual studies are done in multiple languages as explained below. Approximately half of the commuters converge in Luxembourg City – the biggest city and capital with 103.6k inhabitants. This creates significant challenges for the road infrastructure and the traffic management. Furthermore, around 442k motor vehicles are registered in Luxembourg compared to an overall population of 537k. This very high rate of vehicle ownership was confirmed in our own findings (see section 5.3). [1]

We approached the study of this heterogeneous population by firstly designing and developing a proof of concept game in order to explore if the gamification elements that we want to implement work well. Then we planned a mobility behaviour study that consisted of three elements: a) an online questionnaire, recording planned and reoccurring behaviours; b) the Driver Diaries mobile application recording spontaneous behaviour and GPS data

[1] 2013 report *Luxembourg in Zahlen* by STATEC, the national institute for statistics and economical studies.

and c) a series of focus group interviews in which we validated the recorded data and developed and tested game concepts. This paper will focus on part a). The paper continues with an overview of related work and then introduces our methodology. Section 4 illustrates findings from the questionnaire and section 5 presents the conclusions we draw for our application design.

2. RELATED WORK

This interdisciplinary project incorporates mobile traffic research, behavioural research and mobile gaming.

2.1 Gamification

Playing games is part of the human nature and our social life. The theoretical foundations of gamification go back to Maslow's Hierarchy of needs (Maslow, 1943), where he mentions belonging and esteem as fundamental needs of humans. These needs are well addressed by digital and especially social games. Furthermore digital games have specific and challenging goals, which according to goal setting theory (Locke & Latham, 1990) is crucial to task performance. Games motivate players to perform game related actions, such as tasks, quests etc. Games and Gamification use incentives or rewards in order to encourage the accomplishment of certain tasks. In serious games, for example sport applications[2], the goal is the modification of certain behaviours that are linked to the lifestyle of the player. This idea goes back to applied behaviour analysis, where systematic rewards gained for intended behaviour can be exchanged for desired activities or material returns (token systems). In this sense, gamification is not very different from token systems that were originally used in mental hospitals, homes for antisocial adolescents or prisons (Fliegel, 1998). To summarize, games can motivate players to perform actions. They can do so because of the specific character of the task to be performed and because of the immediate feedback, or reward.

Gamification was defined as an informal umbrella term for the use of video game elements in non-gaming systems to improve user experience (UX) and user engagement (Deterding et al, 2011). Gamification in this project is the use of certain (video-) game elements in an application for mobile devices with the purpose of influencing user behaviour in non-gaming mobility related contexts. In the gamified mobility application we develop, we add the social dimension that allows for collaborative and competitive gamification elements and therefore strengthens the motivation.

2.2 Mobility behaviour studies

The use of travel diaries has a relatively long tradition in mobility research. Schlich and Axhausen (2003) found in a longitudinal study of routine mobility behaviour that actual travel behaviour is neither only repetitive, nor completely variable. However, on working days, mobility routines are consistent. They concluded that new travel opportunities have to be created in order to optimize mobility, for example from the environmental point of view. In our

[2] "Zombies, Run" is good example for a serious game. It is a gamified running application that immerses the player in a post-apocalyptic scenario where zombies follow the runner. The community around this game exceeds 1 million players.

approach we do not want to create new travel opportunities, such as new roads, bus lines etc., but rather try to make users aware of existing possible alternatives.

Milmeister and Roob (2010) looked at the attitude of especially younger people in Luxemburg towards public transports from a sociological perspective using grounded theory and interview techniques. They found that for commuters, the time spent in the commute is not only objectively quantifiable, but that it has an important dimension of subjectivity on how the time was spent, which carries an important layer of meaning. This aspect is valuable for us, as when we try to change the behaviour of commuters, we also first and foremost have to change the meaning of certain routines. In this perspective, the former perception of, for example, “time lost having a coffee before going home” could be changed to: ”time spent in a meaningful/pleasant way, instead of in the traffic congestion”. A slogan that we therefore used during the recruitment was “we want to give you back your time”.

Based on the idea of pervasive games which are defined as playable on mobile equipment and in different contexts and related to the real life world (Montola, 2005), Brunnenberg (2008) brought gaming and traffic together by describing the highway as a space for social interaction and developing gaming prototypes. Though, her work focused mostly on passengers as players and not on the involvement of the driver. We aim to involve the driver, not with distracting real time gaming, but with short prompts and decisions that might be based on audio queues, as suggested by Nees and Walker (2011). Therefore, our project also explores novel interface design in the car context (Louveton et al, 2013).

This paper contributes to mobility research for the Luxembourgish context with presenting questionnaire data about static and reoccurring mobility behaviours of commuters. Furthermore we will outline how these results can shape the design of a gamified mobile application.

3. GAMIFYING MOBILITY BEHAVIOUR

The main aim of this project is to change the mobility behaviour of commuters in Luxembourg and to reduce road congestion without changing existing infrastructures.

Therefore, we needed to study the existing mobility behaviours / patterns of commuters in Luxembourg and to find out which one of these are stable and which ones are open for change. Finally, we need to explore how we can motivate the commuters to change certain patterns through the design of our gamified system.

Our target audiences are commuters and inhabitants of Luxembourg that at least occasionally use the car to go to work and therefore might add additional load on the road infrastructure, which, in turn, increases congestion level. The objective is to reduce road traffic or/and to reduce congestion. In order to achieve it we want to encourage modal split, smart planning, shared rides and

off peak commutes as encouraged behavioural changes.

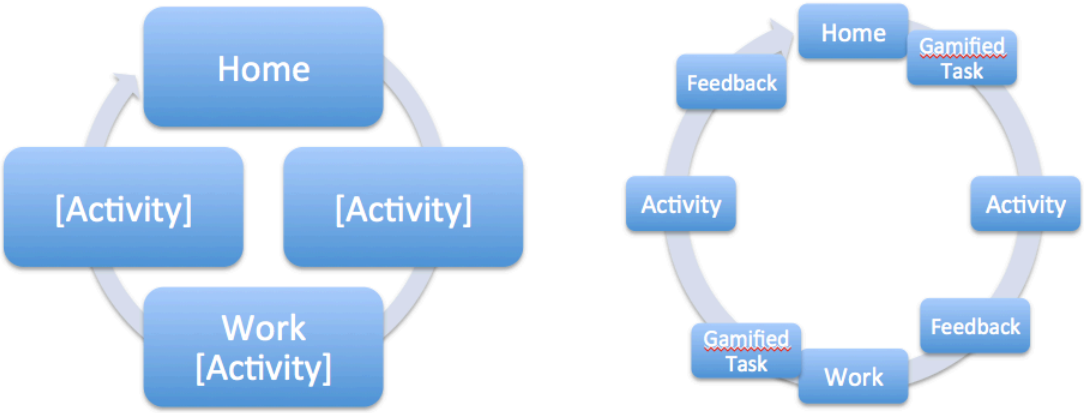

Figure 1: Model of non-gamified and gamified commute

Figure 1 shows on the left side the model of a non-gamified commute from home to work and from work to home. The commuter might undertake an activity on the way to work, in the lunch break or on the way home, according to his preferences and routines. The model on the right side on Figure 1 shows an archetypal commute with use of a gamified mobility application. Depending on the task, the user gets information on his or her device (while being at home or on the way to work) that proposes an activity on the way to work. This can be, for example, the suggestion to buy lunch. However, not every commuter can follow any suggestion. That is why the exploration of actual mobility behaviours and their constraints is essential for the design of alternative activities. If the user accepts to go shopping on the way to work, he or she will get points afterwards. The same is possible for the way from work to home where the user can accept, for example, the proposition to go to for a coffee before going home. These examples stand for route change or peak- to off peak change. The user will be prompted both situated and in advance to slightly modify the mobility behaviour. If the user accepts these offers by the system, he or she can gain points. This feedback part is central to a successful gamified system (Salen & Zimmerman 2004). Furthermore, the user will have the possibility to share the gain of points with other users what leverages the social dynamic. These points can be exchanged for real live incentives, such as a discount on a coffee, or can be accumulated in order to win a bigger prize.

In order to provide attractive activities, we need to find local business and service providers that can offer reductions for participants as partners. They can get, for example, a coffee for the half price on their way to work.

The gamified application provides information to the user, also during the commute. Therefore, we explore in the I-GEAR project also novel ways of interaction with mobile devices in the context of driving, in order to design the interfaces in ways that minimize distraction and, therefore, risk for the user.

In order to evaluate the gamified system, we measure the level of participation and engagement, not on the level of traffic output. We want to explore if and

how specific gamification elements work in the serious or non-gaming context of traffic and we are interested in the percentage of behaviour change within the same chosen population. The types of incentives we use are defined according to the target audience, the actions we want to encourage, and the gamification components we implement. The participation of “natural” mobility agents in Luxembourg being a key aspect of our project, we take into consideration the promotion of the system as a central budget component.

4. FROM GAMIFICATION TO A MOBILITY APPLICATION

Since we want to change mobility routines in a gamified way, we have to know if gamification as a concept in general, and which particular elements in special can work. Starting from this second point, we developed the Coffee Game studies.

4.1 Coffee Games

We started in 2012 by developing and successfully testing an indoor mobility game series called the Coffee Games (McCall et al, 2012). The coffee games were an experiment, based on the assumption that certain road mobility characteristics can be observed in an indoor mobility environment, such as an office building or a conference venue. Building on the metaphors of peak times (in the morning, lunch time and evening), bottlenecks (coffee machine, microwave, toilet) we created a mobility game that offered participants the possibility to slightly or strongly change their behaviour, e.g. get their coffee at a different place or different time or to not have coffee at all, and to gain points for that. These points could be either directly traded for a small reward (chocolate bar) or accumulated in order to compete for a main prize. This test of different rewarding systems (immediate vs. delayed reward) showed that different player types go for different rewards. The occasional players with little and opportunistic participation tend to prefer the immediate reward while the more engaged competitive long-term players strive bigger rewards. Furthermore, these games, which were implemented in office grounds in Luxembourg and in the Mobile HCI 2012 conference premises, showed that local mobility behaviours could be altered using gamification.

4.2 Driver Diaries

The Driver Diaries consist of three parts. First, a trilingual (French, English and German) online questionnaire gathered static data and the users perception about their mobility behaviour. Then a smartphone application (Driver Diaries) was used for the extraction of mobility behaviours and routines based on GPS data and user input. The objective of the Driver Diaries was to collect data about the participants’ types of journeys (e.g. single destination vs. multiple destinations), modes of transport (Car, Bus, Train, Bike, Walk, mixed) and companions (alone, colleague, family).

4.3 The questionnaire

The recruitment was done over media publicity (Anglophone newspaper, radio channel, lusophone radio channel, University newsletter) and through flyers and mini-games on events we visited (ICT spring, OGBL meetings etc). Participants had to fill in the questionnaire once and put their mobility related

actions (modes of transport, purpose of travel, companions, estimated arrival time, eventual delay etc.) just before they were starting using the Driver Diaries application for two weeks in succession. The participation was incentivised by an Amazon voucher. The answers of 187 users were included in the analysis of the questionnaire data as they filled in most of it (completion rate over 50%).

The requirements for the participants were that they had to be aged between 25-64 years, working in Luxembourg, using a mobile device with Android or iOS and GPS and using (at least occasionally) a car for the commute to work.

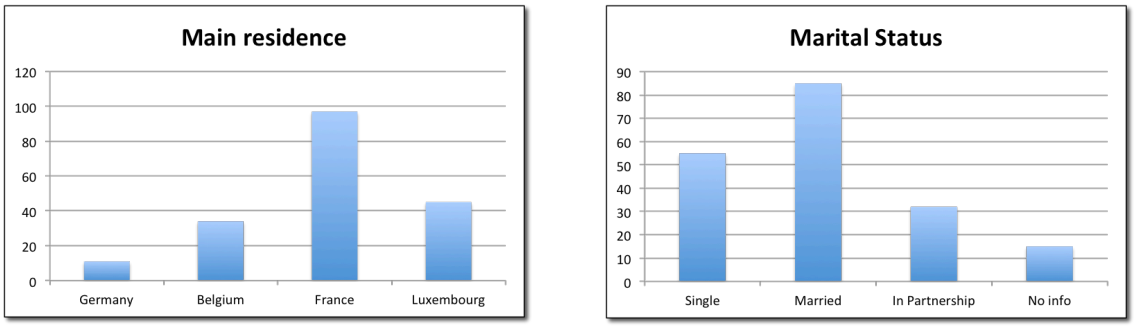

Figure 2: Residency and marital status of the participants

The participants had their main residence primarily in France, were married and lived in multi-party households.

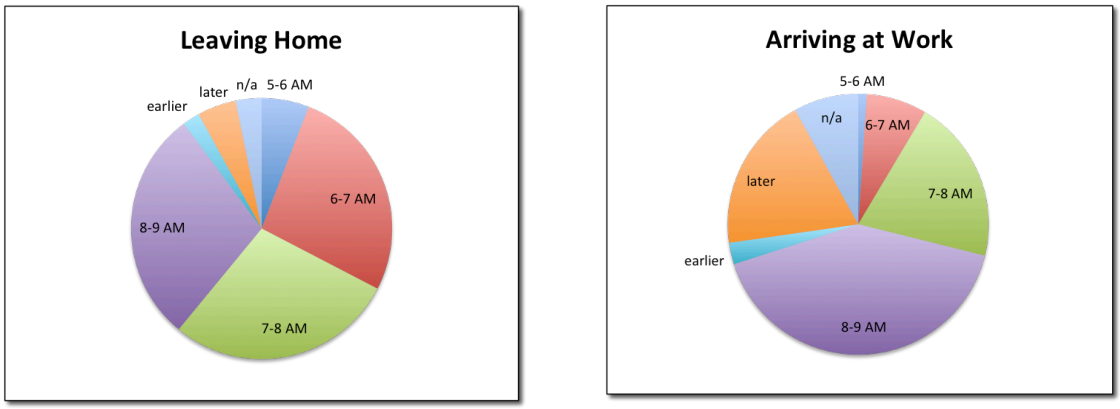

Figure 3: Home - Work Commute

Around 25 % of the participants leave between 6 and 7 AM while 45 % arrive between 8-9 PM. This indicates a relatively long journey time, which is typical for commuters, especially from France (see Figure 3).

This is confirmed by the commute back home, where most of the participants leave work between 5-6 PM and arrive between 6-7 PM (see Figure 4 below).

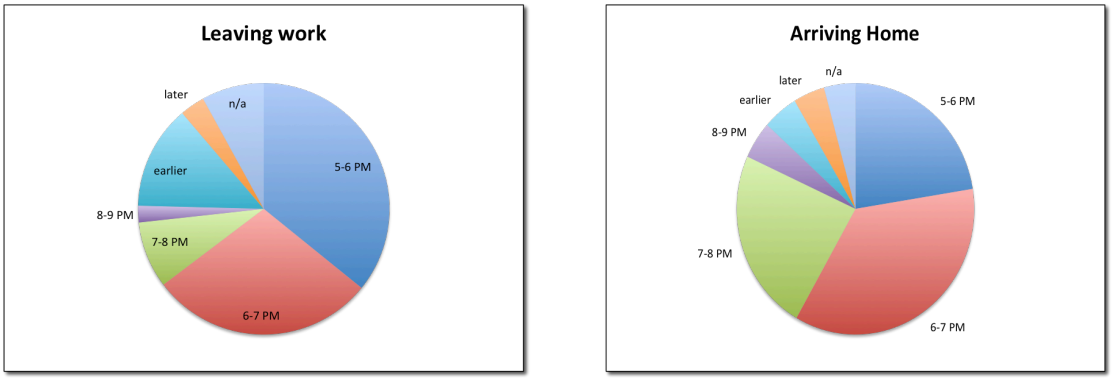

Figure 4: Work - Home Commute

An important point regarding the later game design was the mobile data connection availability of our target population. As this population mostly consists of commuters, we had to find out if they had mobile data connection in Luxembourg or only elsewhere.

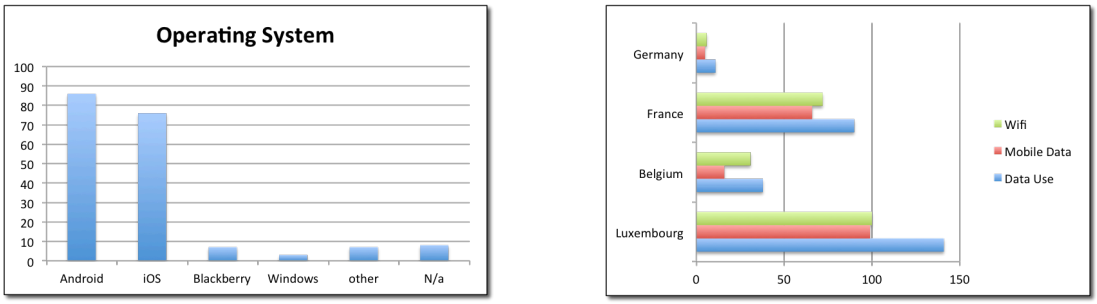

Figure 5: Mobile OS and Data Usage

Most participants use Android or iOS and also most commuters use data in Luxembourg, both mobile and over Wifi. Because of potential roaming costs, this was unexpected. As stated above, the activities that the commuters undertake are central for this part of the study. We need to know when participants do which kind of activities with what mode of transport.

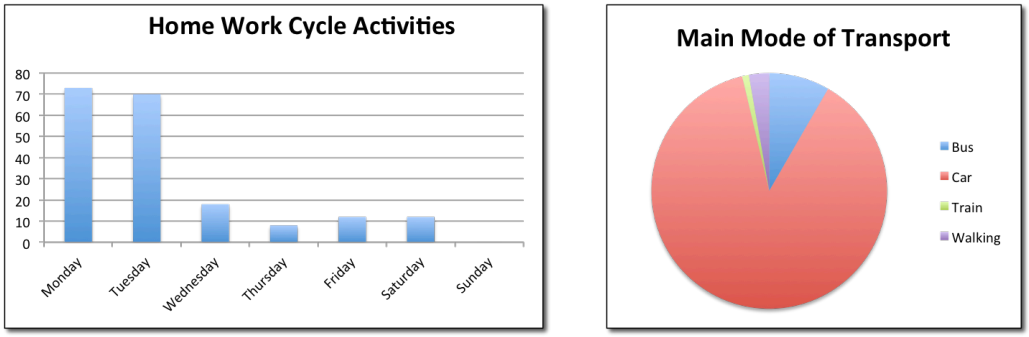

Figure 6: Activities and Mode of Transport

Most activities in context of the commute occur on Monday and Tuesday and the participants relied mostly on the car as a preferred mode of transport (see Figure 6).

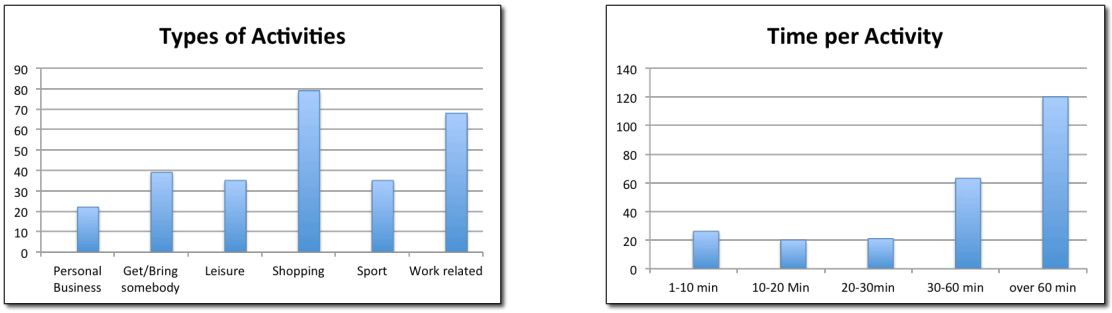

Figure 7: Activity and Time per Activity

Looking at the types of activities that occur in the context of the daily commute, we see that shopping and work related activities are most frequent, followed by pick up or dropping someone. The third most performed activities are then leisure (e.g. having a drink) and sports.

Furthermore, we found that most participants perform their activities alone. The formation of mobility groups together with colleagues or sports partners will therefore be also incentivized in the gamified application.

Our findings confirm the high car ownership that STATEC found (see section 4.1) for our population.

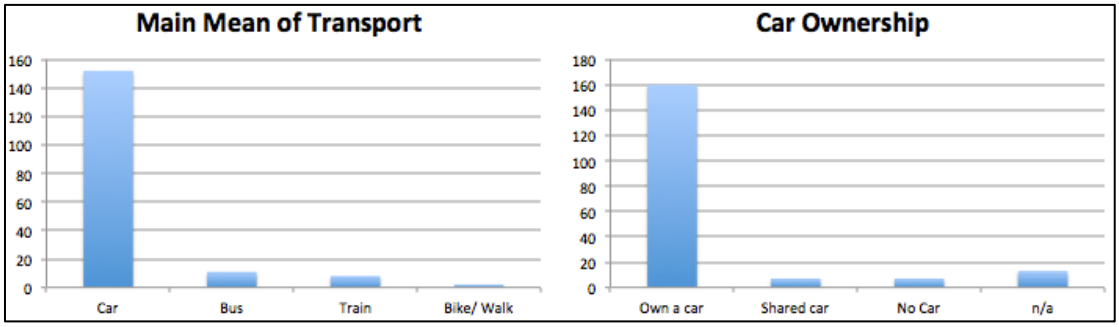

Figure 8: Mean of Transport and Car Ownership

This is a good representation of the target group of the pervasive system as we mainly aim to change the behaviour of car drivers (see Figure 8).

As shown below, both the aggregated distance of car use as well as the frequency of use is very high.

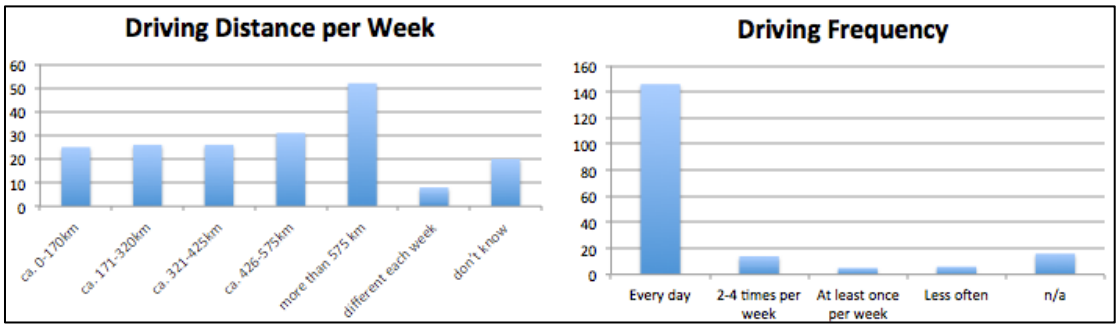

Figure 9: Distance by Car per Week and Frequency of Car Use

The perception of the traffic in Luxembourg and finally the reaction of these regular car users are key elements for our project.

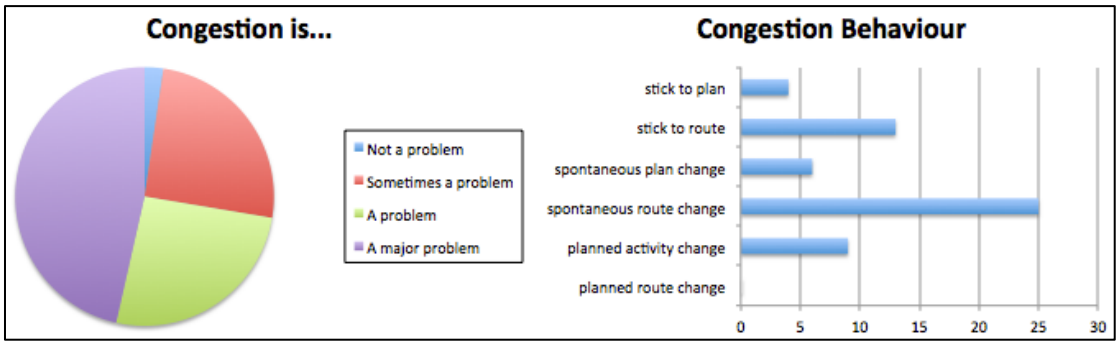

Figure 10: Congestion perception and reaction to unforeseen congestion

Twenty-five percent perceive congestion as a problem in Luxemburg and almost half of the participants see it even as a major problem.

Most of the users react to unforeseen congestion with route change. However, the second common reaction is to stick to the route (see Figure 10).

5. FIRST FINDINGS AND DESIGN IMPLICATIONS

The preliminary findings include travelling habits, activities that are undertaken in the context of the daily commute, the availability of mobile data and how these aspects can shape the design of the pervasive, gamified mobility application that is going to be developed.

5.1 Findings

The gamified pervasive system has to address cross boarder commuters coming from three different countries. Therefore, the application has to be trilingual, including French as the biggest group of commuter originates from France. Potential users leave their home between 6-9 AM and their workplace between 5-7 PM which means that these are the core times when the system has to prompt alternative activities.

Travelling habits and activities
The majority of the participants use the car daily for most of their commutes and for their commute related activities. The activities can have different purposes; most of them are however shopping or work related. Further, most of the activities occur on Monday and Tuesday and have a duration of over 30 minutes. Based on that, we decide for the gamified mobility application to focus on activity suggestions or quest related to leisure, shopping and sports. The reasons are that the task design and verification are relatively easy to implement in Luxembourg City, as we have an area where many commuters work, one big shopping center, one sports center and one leisure complex with cinema, restaurants, bars etc. The participants undertake mostly activities of longer duration (>30 min). However, we decided to design tasks that offer short activities as well. The analysis of the gamified application data will show which activity suggestions are more accepted.

However, the car is the central mean of transportation for the potential user. Most activities are car related. It will thus be difficult to induce behaviour change related to modal split or modal change.

Mobile data
A large majority of the participants uses devices with Android or iOS, which implies that we need to develop the gamified system cross-platform. The use of mobile data in Luxembourg is significantly high, both over mobile network and Wifi allows for a more dynamic game app design, including live data, push notifications etc.

Conclusively, in case of unexpected congestion, route change and activity change are the most prominent divergent behaviours. This encourages us that offering alternative activities to users that might encounter congestion might be a promising approach.

6. DISCUSSION AND FURTHER STEPS

As a next step, the findings of the questionnaire will be compared with the mobile application data set and the results of the focus groups. The gamified mobility application will then be developed based on the findings of the questionnaire and the other instruments we used, notably the application and the focus group. Once a prototype is available an in-car observation study will follow in order to get a better understanding of the decision making processes for individual commutes and at the same time to test the possibilities and limitations for gaming on the road. The final game prototype is planned to be tested in 2015. During this part of the work we will examine the effectiveness of various game concepts on commuter behaviour. Finally, we will contribute to existing mobility behavioural research, gamification research and in-car/car-use studies.

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