Driver Diaries: A Multimodal Mobility Behaviour Logging Methodology

Martin Kracheel
University of Luxembourg/SNT
4 rue Alphonse Weicker
L-2721 Luxembourg
(+352) 46 66 44 5235
Martin.kracheel@uni.lu

Roderick McCall
University of Luxembourg/SNT
4 rue Alphonse Weicker
L-2721 Luxembourg
(+352) 46 66 44 5511
Roderick.mccall@uni.lu

Vincent Koenig
University of Luxembourg/SNT & EMACS
Route de Diekirch
L-7220 Walferdange
(+352) 46 66 44 9528
Vincent.koenig@uni.lu

ABSTRACT

The Driver Diaries are a mobility behaviour logging methodology, consisting of an online survey, a mobile application and focus group interviews. They are used to collect data about mobility behaviour, routines and motivations of commuters in Luxembourg. The paper focuses on design and development of the Driver Diaries and it explores the use of the application as a requirements capture and an integral element of an infotainment application that can change the standard routine driving behaviour of mobility participants in order to reduce traffic congestion.

Categories and Subject Descriptors
J.m [Computer Applications]: Miscellaneous – behavioural engineering, road traffic

General Terms
Theory, Measurement, Design, Human Factors

Keywords
Mobility behaviour, requirements capture, mobile application design, field study.

1 INTRODUCTION

Road traffic congestion remains a serious problem in many countries and methods to assess mobility patterns may offer new solutions in order to reduce peak traffic. In this paper we outline the development of a mobility logging system (known as Driver Diaries) that is used for examining the daily activity patterns of commuters. It uses a combination of a mobile application, an online questionnaire and focus group interviews with the users in order to find out detailed information about the mobility behaviour of commuters in Luxembourg. The primary purpose of the Driver Diaries is to act as the requirements capture approach for developing a gamified mobility optimisation system.

The work presented here is part of the I-GEAR (Incentives and Gaming Environments for automobile routing) project, which explores how to gamify certain aspects of mobility [1]. One key part of this work is not only identifying where people travel but also their underlying motivations and constraints for their commutes. It was the later two aspects, which shaped the development of Driver Diaries.

In the following paper we present the background to our work, the underlying conceptual design decisions taken within Driver Diaries and present an overview of the completed system.

2 BACKGROUND

It is against the backdrop of improved communication platforms (in particular vehicle-to-vehicle communication) and traffic congestion that the I-GEAR project was conceived. I-GEAR explores using gamification to reduce traffic congestion [1]. The basic idea of the project is to provide commuters with a mobile game that they can take part in and that will provide suggestions for actions they can undertake e.g. taking an alternative route, taking the bus once per week or stopping for another activity on route. Gamification broadly speaking provides game-like elements within non-game situations in order to encourage behaviour change [2]. It can be used implicitly within many platforms such as “Facebook likes” where people try (perhaps not even deliberately) to gain as many likes as possible or explicitly, with applications such as FourSquare where people compete against one another for points and badges by visiting specific locations [3]. Other examples of gamification can be found for example in health applications [4] and at the workplace [5]. Of particular interest is how we can gain a better understanding of commuter motivations in order to identify a range of game-like extrinsic and intrinsic motivations that could be applied.

I-GEAR views mobility as a holistic activity consisting of traffic participants (drivers, passengers, public and “soft” transport users), mixed modes of transport (e.g. bus, car or train) and related activities (taking someone to the school on the way to work, doing shopping on the way home). The goal is the development of a game for all traffic participants.

I-GEAR consists of two key elements: the development of game-like environments to reduce traffic congestion and a testing platform that allows for the assessment of the proposed application under simulator and in-car conditions [6]. The Driver Diaries are deployed as a method of requirements capture that will be used to inform the design of the game-like environment.
The results of the Driver Diaries intend to support the design of a game-like mobile application and to act as a basis upon which aspects of the game logic are developed.

3 STUDYING MOBILITY

In the relatively new field of ICT based mobility behaviour research two approaches to data collection can be differentiated, a more “passive” approach that strives for automatised collection and analysis of mobility data [e.g. 7], and an “active” approach, which uses mobile applications and web based services to involve users in the collection and validation of mobility behavioural data. The I-GEAR project takes the second approach. In I-GEAR collaborative mobile gaming together with the idea of social, psychological or economic incentives will be used as a way of persuading traffic participants to undertake new behaviours. In order to know which alternative behaviours to propose, we study the existing mobility behaviour of commuters with a mixed method approach, consisting of an online questionnaire, the Driver Diaries mobility application and later on focus group interviews.

Mobility behaviour, as it is captured by our application, comprises of all journeys undertaken over a fixed period (currently two weeks) including every day and rather unvarying trips such as the trip to educational courses or to the workplace; to get or bring somebody; recurrent excursions to friends or families, shopping, leisure activities such as going for a walk or for sports, etc.; personal business, as well as spontaneous trips to get a coffee, meet a friend who is close by or similar.

Commuters generally repeat their activity patterns due to various aspects such as spatial and temporal factors as well as extrinsic constraints [10]. For example the daily commute for many people is a relatively fixed due to the wish or need to arrive at a specific time at work, the child’s school or other locations. Despite the relatively static nature of daily mobility patterns, there is space for modest changes as the number of static journeys declines [8]. Proposing behaviour alternatives that fit the activity profile of a user may induce those changes. One possible solution is to suggest seemingly more complex trips, for example by moving from single purpose trips (e.g. go home after work) to multi-purpose trips that include other destinations (e.g. the café). This approach helps to optimise traffic flow while still allowing commuters to perceive themselves as receiving a benefit for changing their behaviour.

3.1 Prior Work

In order to test if mobility related behavioural patterns can be changed through the use of material and nonmaterial incentives, we designed an indoor real world game that was tested in different versions (one day gameplay vs. two days gameplay) in different environments (in a university building and at the Mobile HCI 2012 conference). The so-called coffee games [11] showed that participants do engage in serious games and change their behaviour in order to comply with game (and reality) related goals.

4 DRIVER DIARIES

As noted in 3.1 simple incentives can provide a way for people to change their behaviour. We take the view that changing commuter behaviour requires an in-depth analysis of the daily situation, motivations and constraints that effect their travel decisions.

We will explain in the following sections how to collect data about the mobility behaviour of our target group – the working population of Luxembourg.

4.1 Overview

The Driver Diaries consists of three parts. Part one is the one time fill out of the online questionnaire. Part two – the use of the mobile application for a period of two weeks. We decided for the relatively short duration of two weeks because we collect a high density of data and the participant engagement might decrease after this time span (cf. [8]). Part three consists of semi-structured focus groups interviews, in which we want to a) validate selected data examples, b) look for aspects regarding the mobility behaviour that we might have missed, c) explore which incentives are suitable for our target group and d) explore which features of gamification (such as leagues, leaderboards, badges, quests etc.) are relevant for the design of the mobility game.

Part one and two are already deployed for testing and the data collection officially started on June 14th 2013. The focus group interviews are planned for August 2013. The survey and the application will be further explained below.

4.2 Sampling

In the officially trilingual country of Luxembourg (Luxembourghish, French and German) English is the 4th most used language (21%) followed by Portuguese (20%). In order to allow for representative sampling in the very heterogeneous work population of Luxembourg, which consists as well of many cross border commuters as well as expats and international labour force [9], the application provides an English, French and German interface.

In order to attract a diverse range of participants we engaged in a significant media campaign that comprised of issuing a press release, interviews on various radio stations, newspaper coverage and extensive use of social networks. We asked that the participants occasionally use a car to get to work, that they work in Luxembourg and that they use an Android GPS enabled device. At the time of writing 40 participants had signed up.

4.3 Online Questionnaire

The online questionnaire allows the participants to self-register for the project. It mainly asks for socio-demographic and geographical information such as access to different means of transport and working / leisure habits, allowing participants also to provide special remarks and checking their attitude towards individual motorised transportation, and public transport. The questionnaire aims to collect data about the routine behaviour of commuters. Most drivers and commuters tend to repeat their activity patterns if they meet their objectives and constraints. After having completed the survey, participants can download the application and use the same credentials to login.

4.4 Driver Diaries Application

With the Driver Diaries application, participants report about their daily mobility related activities in detail and in situ.

4.4.1 Mobile Tracking Applications

Mobile applications, such as FourSquare, WAZE, Greenway, Drivescribe, MapMyWalk and others directly or indirectly monitor the mobility behaviour and related activities of their users. Nevertheless, none of these applications was designed to collect data from which comprehensive activity related mobility
patterns of commuters could be extracted. Therefore, we designed a mobile application that collects behavioural data, such as activities undertaken, modes of transport used, companions on each trip/activity and tracks at the same time trajectories using GPS.

4.4.2 Design decisions
A critical part of the application is how to display the trip and related activities. This has an impact on the unit of analysis (e.g. what is considered as a trip?) used in the study and also the precision of the data collected. The unit of analysis e.g. one trip with multiple destinations or one trip one destination, has an impact on the design of the user interface.

4.4.3 Representation of Mobility in the Application
We realised soon in the early design stage that if the user inputs the daily activities and trips only once at the beginning of the day, a high response rate, even over a longer duration of time, can be expected. However, the application would only record a static representation of assumed mobility behaviour and activities, which would be rather hard to match with actual GPS data with the degree of precision that is required. On the other hand, if the user is required to input minor mobility activities that occur at any time of the day, high precision for a short time span could be reached but with a considerable risk of data loss due to participant drop out.

It is important to keep in mind that the target user group of the mobile application consists of a considerable amount of cross border commuters. Consequently, most of the road congestion occurs during peak times, in the morning between seven and nine and in the evening between five and seven o’clock. We decided to include the lunch break in our study because [10] showed that most mobility related activities of cross-border commuters such as going for shopping, to sports, and other errands occur during these times. Also by including lunchtime in the data collection phase it becomes possible to explore how easy (or not) it may be to encourage people to move activities from peak commuter times to their lunch breaks or vice versa. Therefore we decided on a trade-off where we focus on the crucial mobility periods of the day and the mobility related activities that occur within these times. The application collects consequently mobility activities 1) in relation to the way from home to work, 2) during the lunch break 3) during the way from work to home.

During the three periods of the day already identified, the user is asked to put every trip into the application. A trip always has only one destination, but can imply several activities. We decided for this split between trip and activity because it allows for a precise recording of the activities without losing the ability to gain a better overview of all the interconnections.

4.4.4 Recording change
As urban mobility behaviour sometimes may be influenced by extrinsic (e.g. weather) or intrinsic (lust for a drink) factors, this may result in participants deviating from the plan they initially input. That is why we implemented a feedback screen that summarises at the approximate arrival time for the user where he or she was going along, with which mode of transport and with which companion. The user can modify this data and input various spontaneous changes, such as a delay because of traffic or to pick up somebody on the way. Both, the initial choice and the modified choice gets logged which allows us to come back to such spontaneous decisions in the focus groups and interviews.

One of the main goals of the Driver Diaries application is to find out about the goals of the commuters trips. We need to know the exact activities and where they take place, which we cannot always interpolate from GPS data only, as the high density of locations in urban context creates potential overlaps. Therefore the user inputs the purpose of the trip manually. Similar constraints exist when automatically detecting the mode of transport. This led us to the decision to also ask the user to input the mode of transport and the possible companions for each mode used.

<table>
<thead>
<tr>
<th>Goal/Constraint</th>
<th>Design options (implementation choice in italic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short time live interaction</td>
<td>One tap touch interaction Confirmation required (2 tap)</td>
</tr>
<tr>
<td>Precise recording of activities</td>
<td>Predefined list of activities Open activity input</td>
</tr>
<tr>
<td>Persons involved in these activities</td>
<td>Predefined list of companions Open companion input</td>
</tr>
<tr>
<td>Trajectories to and from activities</td>
<td>Separate recording of each activity One input for whole day activities</td>
</tr>
<tr>
<td>Modes of transport in context</td>
<td>Predefined list of modes of transport Open input of modes of transport</td>
</tr>
<tr>
<td>Heterogeneous users</td>
<td>Multilingual application, user tests English only interface</td>
</tr>
<tr>
<td>Spontaneous changes/ events during the trip</td>
<td>Feedback screen when arrived Mining through GPS data</td>
</tr>
</tbody>
</table>

Furthermore, the Driver Diaries application can be used in-car, which made us design the system in a way that one tap is enough for every step of the selection process in order to minimise the amount of time the user must spend interacting with it.

4.4.5 Usability test
We ran a small series of usability studies in the usability laboratory of the University of Luxembourg in order to test design decisions. The usability laboratory offers a controlled environment for systematically observing the interaction of the user with the application. Usability testing consisted of five users
that had to individually perform three predefined tasks on the application, which covered all interfaces / screens.

After having completed the tasks, the users took part in a semi-structured interview with a mix of predefined questions and a focus on issues that were identified during the first testing phase. The interactions with the application and the interviews were audio- and video recorded and observed through a one-way mirror using a standardized observation sheet. These user tests helped mainly to identify usability issues, problems in the underlying logic of the application and general attitudes towards it. Furthermore, there was a two weeks beta testing phase in the wild phase where seven users tested the application in real life conditions. Their feedback was used to enhance the application, to fix bugs and to assist in the creation of user documentation.

5 CONCLUSION AND OUTLOOK

In this paper we have presented an overview of the Driver Diaries mobility behaviour logging methodology, which is designed to capture the multi-modal mobility behaviour of commuters through the use of an online survey, mobile application and focus groups. Although situated within the context of Luxembourg the approach should be relevant for researchers working in other cities and in related domains, such as transportation research. The paper has described the rationale for the approach from the perspective of mobility activities, user interface design and with the context of the I-GEAR project which seeks to use gamification as a method of changing commuter behaviour. The Driver Diaries will form a key part of this process, as they will be able to identify the mobility patterns of commuters along with the daily motivations and constraints that inform their mobility decisions. Based on the analysis of the mobility behaviours, we will build the I-GEAR game application, which will offer its users alternatives to their routine traffic behaviour in a game-like frame and help to reduce traffic congestion.

6 ACKNOWLEDGEMENTS

We would like to thank the I-GEAR team for its support and hard work, notably Tigran Avanesov, Nicolas Louveton, our student collaborators and Thomas Engel but also external helpers like Eric “Ricky” J. Francois, Sacha Helser, Katja Weinherd and Sophie Doublot. Last but not least a big thanks to all our test participants.

7 REFERENCES


