STREETLIFE FIELD TRIALS – APPLIED GAMIFICATION APPROACHES AS A KEY TO MORE SUSTAINABLE MOBILITY BEHAVIOUR

René Kelpin
German Aerospace Center, Institute for Transport Research, Germany
Dr. Flemming Giesel
German Aerospace Center, Institute for Transport Research, Germany
Dr. Matthias Heinrichs
German Aerospace Center, Institute for Transport Research, Germany

1. INTRODUCTION

To integrate new ITS (Intelligent Transport Systems) services into existing transportation systems, and especially, to engage users reliably to change respective mobility routines as a consequence of these new service interventions, is a very critical challenge for service providers as well as for piloting projects. It means not less than breaking existing mobility habits; such as individual routines, applied services and Apps, and replacing them with new routines. Existing services are well established and applied by a majority of users who are hardly willing to get acquainted to new services, routines and applications – even if new services offer more and partly better information. In the project STREETLIFE a gamification approach has been used to introduce new mobility services in three individual pilot sites and to convince users to leave their “mobility comfort zone”. In consequence, it was not only to evaluate how this gamification approach has supported the service take-up by the users, but also to validate those behavioural changes’ impacts on main impact categories, i.e. the traffic system performance and carbon emissions. This paper pays particular attention to the latter aspect. Do have competitive gamification approaches combined with affordable incentives a significant impact on transport system performance criteria?

This article introduces the three individual pilots, the commonly applied gamification approach and the individual games. Main achievements will be mainly based on data collected at the Berlin pilot.

2. THE STREETLIFE PROJECT AND ITS PILOTS

The FP7 project STREETLIFE (Oct 2013 – Sept 2016) set a clear focus on supporting “greener” mode choices by means of Information and Communication Technologies (ICT). ICT are applied to establish Intelligent Transportation Systems (ITS), namely for provision of pre-trip and on-trip information about available trip and mode options and about impacts respective decisions may have on the overall traffic system performance and the environment. The project STREETLIFE in general is

- to understand why and under which conditions travellers opt for a specific mode of transportation,
- to use this knowledge to provide and highlight “green” alternatives when needed and appropriate, and
- to finally convince users to opt for more eco-friendly modes of transportation.

This general set of targets has been commonly applied to three individual city pilots.

Berlin (Germany)

The focus has been laid on an App based information provision for inter-modal routes including all modes of transport and – as the unique selling point of the App – paying particular attention to safer bicycle routes and a corresponding safety assessment.

With large scale field test (March – May 2016) of the Berlin pilot special attention has been laid on city specific issues clearly addressed by local stakeholder and transport operating authorities, namely i.) the usability of a newly integrated “safe” bicycle router, ii.) a verification and enrichment of public statistics on cycling safety and, finally, iii.) the assessment of the role gamification approaches may play in urban transportation contexts to break existing and partly old-fashioned mobility routines. Those issues have been clearly addressed with the technical and logical integration of components into the Berlin STREETLIFE App and the game “BikeRider”. It has been clearly oriented to the incentivised modal shift from car to bicycle. Each kilometre ridden by bicycle has been rewarded with game credits which could be used to take part in a field test competition. Credits – green leaves – could be collected and turned into virtual trees – and into real incentives such as cycling helmets, bags and, as the “jackpot” into real Berlin city trees sponsored by the Berlin city department of urban development and the project partner Siemens. The field trial period has been segregated into three phases of the Berlin STREETLFIE game “BikeRider”. For each game period two city trees and several prizes have been offered. In consequence, “greener” mobility decisions, namely the usage of bicycles for daily mobility purposes, have been rewarded in a virtual competition. In this three months’ competition more than 150,000 leaves have been collected, which stands for more than 15,000 kilometres travelled by bicycle.

Tampere (Finland)

Implementations have sought to improve the reliability and, thus, the usage of public transport under different circumstances (weather, time of the year, trip purpose, etc.) by means of advanced information provision and innovative augmented reality (AR) integration.

The game “Zone Hunter” has been a city exploring game where users have acquired points and virtual trophies by visiting different locations and locales of the city. The game concept has been targeted for both public transport heavy users and people interested starting to use public transport. The game engine has been integrated into new real-time journey planner App and it, thus, helped to bring the new App into mass usage.

Rovereto (Italy)

The pilot has focussed on park-and-ride, company car sharing and pooling services for commuters as well as visitors, guests and tourists.

The Rovereto game “Play&Go” has allowed users to collect Green Leaves points according to the kilometres travelled with sustainable transportation means and extra bonuses associated to zero-impact trips (no CO2 emissions). The game has also rewarded exploring sustainable mobility alternatives (e.g. Park&Ride, Bike Sharing, etc.); new game mechanics, such as thematic weeks and personalized challenges, have been implemented with the goal of maintaining existing users and engaging new ones through a dynamic game. Every week was characterised by a different theme (e.g. bike week, bus week), and personalised challenges have been proposed to players on the basis of the theme.

These STREETLIFE pilot sites represent three different types of urban agglomerations. Local problems were to be resolved and evaluated by similar approaches and methods. Local achievements have been analysed, compared and finally provided as best practices for rolling-out individual services by further pilot cities and regions.

In the following, the paper will be dedicated to the impacts achieved with the **Berlin pilot**. Its simulation based methodology will be described and impacts based on the Berlin game “BikeRider” will be derived from qualitative field test observations.

3. METHODS

The general methodological approach is depicted in Figure 1. Based on the research questions for the evaluation of the Berlin STREETLIFE pilot a targeted user group has been defined and recruited. The composition of this specific user group has been synchronised with official German mobility statistics, using the study Mobility in Germany 2008 [1]. The data of the study has been applied not only for this purpose, but also to calibrate the TAPAS model. The field test has been executed in Berlin from March to May 2016. In this period the Berlin App has been used to plan, execute und track more than 4.000 trips – mainly by game participants. With a large user survey in conjunction with a final user group workshop – besides a variety of mobility, usability and user acceptance aspects – specific game related mobility impacts have been investigated. These investigation's data have been analysed, and translated into input variables for the TAPAS simulation for the entire Berlin population.

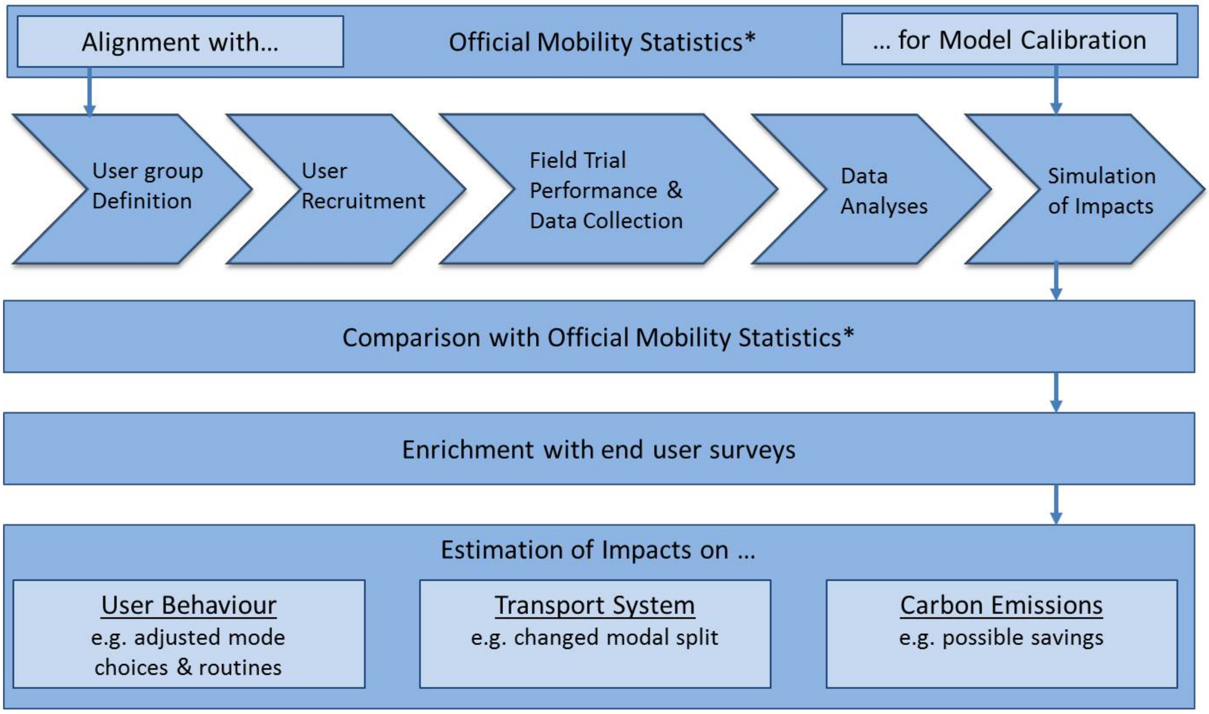

Figure 1: STREETLIFE Berlin methodological approach, * Survey Mobility in Germany 2008 [1]

TAPAS simulation output (traffic demand data for the entire Berlin population) has been compared with official statistics. Based on these main data sources impacts on the three main impact categories have been estimated and evaluated.

With the following paragraphs the three main steps, namely i.) user group analysis, ii.) field test data analysis for model calibration, and iii.) simulation of impacts, will be described in more detail. This methodology will be concluded by a results summary in chapter 4.

3.1 User group analysis

At the end of the Berlin field test (end of May 2016) all registered users were asked to take part in an online survey. These are all users who have registered with their email address in the Berlin STREETLIFE App. In total, 118 persons could be contacted per mail. Altogether, 54 percent have completed the survey (n=64). This response rate is very high compared to similar surveys in social sciences. Using this questionnaire, the user group of the Berlin STREETLIFE App can be described in more detail by various sociodemographic variables. In comparison with the official Berlin statistics it will be clear if only a specific demographic group has used the App.

3.2 Field test data analysis for model calibration

After the identification of the user group of the Berlin STREETLIFE App it has been analysed (based on the above mentioned online survey) how many users have changed their travel behaviour due to the usage of the App and the integrated gamification approach during the Berlin field test. In a next step, it has been investigated in which way the daily mobility (especially the use of car, bicycle and public transport) has changed. The trip purpose where the App was normally used has been of general interest. These results have been used for the calibration of the TAPAS model to quantify the impact of the Berlin STREETLIFE App on the travel behaviour.

3.3 Simulation of impacts

The results of the Berlin STREETLIFE field trial can be extrapolated using simulations for determining effects on traffic and environment at a bigger scale. As the Berlin STREETLIFE system instantiation targets at changing the users' mode choice, a microscopic demand model that determines the activity locations and the traffic mode to access them for a modelled synthetic population has been used. Being microscopic, the used model "TAPAS" ("Travel-Activity PAttern Simulation", [2][3]) uses a model of Berlin's population which consists of single individuals grouped into households, travel time and distance matrices, and activity locations. Berlin's baseline simulation regards more than 3.4 million individual persons which are grouped into 1.8 million households.

In TAPAS, every person is described by a set of attributes, including age, sex and employment status. Furthermore, every person has a set of mobility attributes containing driving license, public transport ticket and a personal bicycle. These individuals are grouped into households with shared attributes, like income, cars, children and a monthly mobility budget. Many different data sources are used for describing the population, including the Mobility in Germany 2008 (MiD2008) survey as well as municipal data, business registers and commercial registers for describing the activity offers in the modelled region, such as places to work, shops, schools, doctors, playgrounds, cinemas and many other types of locations. TAPAS simulates each individual by choosing an activity pattern that statistically belongs to the individual's socio-demographic group [4]. Locations of the activities are computed including the mode of transport used to reach them. The mode is determined using a MNL model fitted to the 290,000 reported trips for the city of Berlin in the SrV2008 [5][6]. Afterwards, the activity plan is rated based on estimated travel-time and budget because the activity locations and the mode of transport chosen by the individual may yield in too long travel times and higher transportation costs. In such cases, a different plan is computed. The finally generated feasible activity plan consists of trips between different activity locations including information relevant for STREETLIFE impact considerations, such as

- used mode,
- travel time,
- distance,
- purpose of the trip and
- destination.

The baseline simulation of the city of Berlin resembles the mobility within the city on a usual work day (Tuesday-Thursday) in the year 2010. Figure 2 shows the most important sociodemographic population data, like age, income and household size distribution for the modelled region.

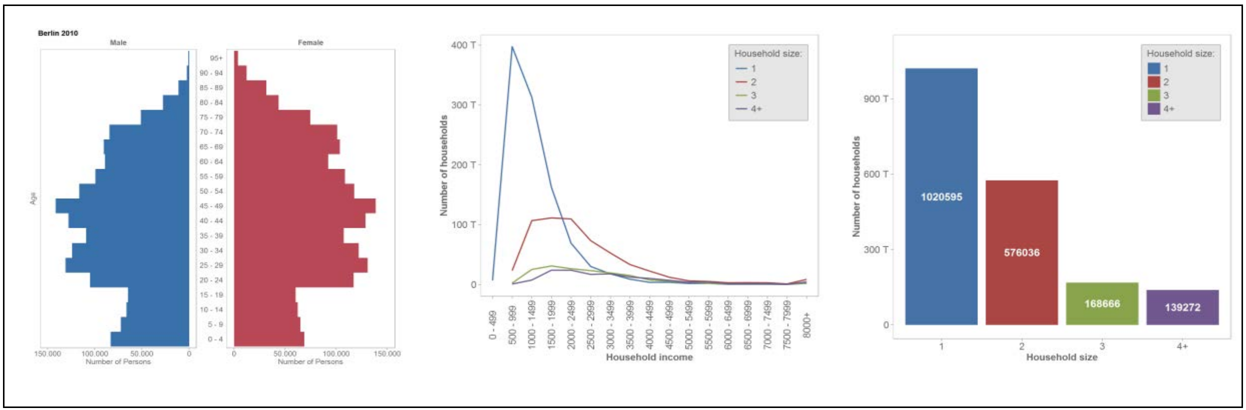

Figure 2: Sample statistics of modelled population, incl. distribution for age, income and household size

4. RESULTS

4.1 Description of the sample

In the following, the sociodemographic structure of the sample will be explained in more detail. In Figure 3 the age structure of the sample is shown compared with the Berlin population. It can be seen that younger age groups have used the STREETLIFE App. 71 percent of the sample is not older than 39 years. Accordingly, older age groups are under-represented in the sample.

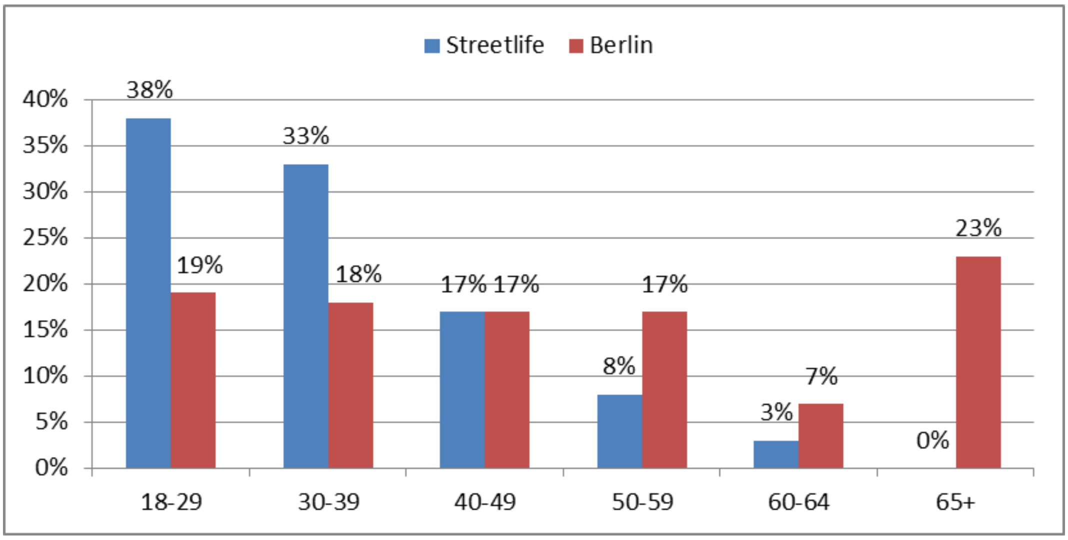

Figure 3: Age structure of the sample (n=63) and the Berlin population (Statistical Office for Berlin-Brandenburg, data status end of 2014)

By looking at some App users' sociodemographic facts more differences become obvious in comparison with the Berlin population (see Table 1). While the share of men and the share of one- and two-person households is rather the same, there are differences regarding the level of education and the occupation. Due to the low average age, more people with a high school degree belong to the Berlin field test users. Furthermore, the share of full-time employment and students is much higher. It is remarkable that 34 percent of the respondents are students.

Table 1: Sociodemographic structure of the sample and the Berlin population aged 18+ (Statistical Office for Berlin-Brandenburg, data status end of 2014)

	STREETLIFE	**Berlin**
Men	54%	49%
One- and two-person households	60%	61%
High school degree	87%	54%
Full-time employment	50%	41%
Students	34%	7%

To sum up, the analysis shows that the respondents of the online survey are characterised by a specific demographic group. Over 70 percent of the respondents are in the age of 18 to 39. Due to this fact, the share of people with a high school degree and the share of students are much higher than in the Berlin population.

4.2 Data analysis for model calibration

Within the TAPAS simulation the entire Berlin population is divided into different demographic groups. These groups are differentiated by age, occupation, and if a car is available or not. These facts are most crucial for the individual mobility and individual mode choices.

According to the above mentioned results of the survey, only the following selected population groups of the TAPAS simulation could be addressed:

- Students
- People aged 25-44, employed, car available
- People aged 25-44, employed, no car available

In a next step, the online survey has been analysed with respect to aforementioned TAPAS groups to calibrate the scenario in the simulation. The following variables were used for the calibration:

- Impact of the App on travel behaviour
- Trip purpose where the App is normally used
- General change of travel behaviour due to the App

Hereinafter, the results of this analysis are briefly described to understand the calibration of the scenario.

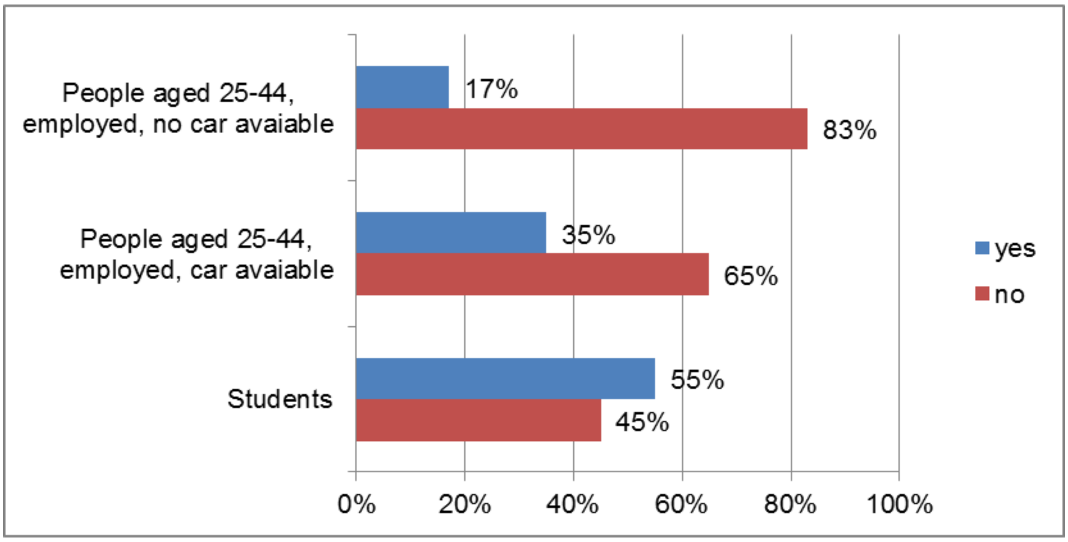

Figure 4: Impact of the App on travel behaviour of the TAPAS groups (n=54)

Figure 4 shows that the impact of the STREETLIFE Berlin App is very different depending on the respective (TAPAS) population group. 55 percent of the surveyed students stated that they changed their travel behaviour (possible only temporarily) due to the App and the integrated game. This is true for 35 percent of the employed people aged 25 to 44 with a car in their household and only for 17 percent of the comparable group with no private car in the household.

Furthermore, the analyses show that most of the respondents (86 percent) have used the App for trips to work or to their educational institution. The differences between the selected groups are very low in this case. The impact of the App on the use of car, bicycle, and public transport is very characteristic. As expected, the car use and the use of public transport decreases while the bicycle use increases sharply across the three groups. 42 percent of all respondents (who said that the App had an influence on their travel behaviour) stated that they reduced their car use. And 33 percent have indicated a reduction of public transport use. In contrast, remarkable 90 percent have done more trips by bike. Again, the differences between the regarded groups can be neglected.

In Table 2 the single input variables are summarized which have been taking into account with the TAPAS simulation for a Berlin population share of around 368,500. That means that STREETLIFE services have had an impact on approximately a tenth of the entire Berlin population (3.4 Million).

Table 2: TAPAS input variables from field test data

User group affected in %	Students	55
	People aged 25-44, employed, car available	35
	People aged 25-44, employed, no car available	17
Trip purposes affected*	Work/education	+
	Private	o
	Leisure	o
Modal change*	Car	-
	Bicycle	+
	Public Transport	-

* **-** Moderate decrease, o stable, + moderate increase

4.3 Simulation of impact

Based on the data generated by the TAPAS simulation the following conclusions have been drawn. For the entire Berlin population of 3.4 million inhabitants for one normal working day improvements could be achieved as shown in Table 3.

Table 3: TAPAS simulation - Impact on traffic system

	Baseline		STREETLIFE game	
Mode	Trips per day	mileage in km	Trips per day	mileage in km
Walk	3,195,457	4,384,390	3,184,580	4,359,809
Bicycle	1,472,195	7,568,828	1,611,830	8,393,535
Car	2,998,665	21,292,897	2,875,940	20,113,267
Car (Passenger)	1,057,018	8,287,295	1,064,740	8,355,951
Public Transport	3,016,205	23,637,451	2,971,090	23,232,758
Total	11,739,540	65,170,862	11,708,180	64,455,319

The daily mileage could be reduced from 65.17 million to 64.46 million kilometres. Almost the same amount of kilometres is still being travelled; the modal split has changed as seen in Figure 5.

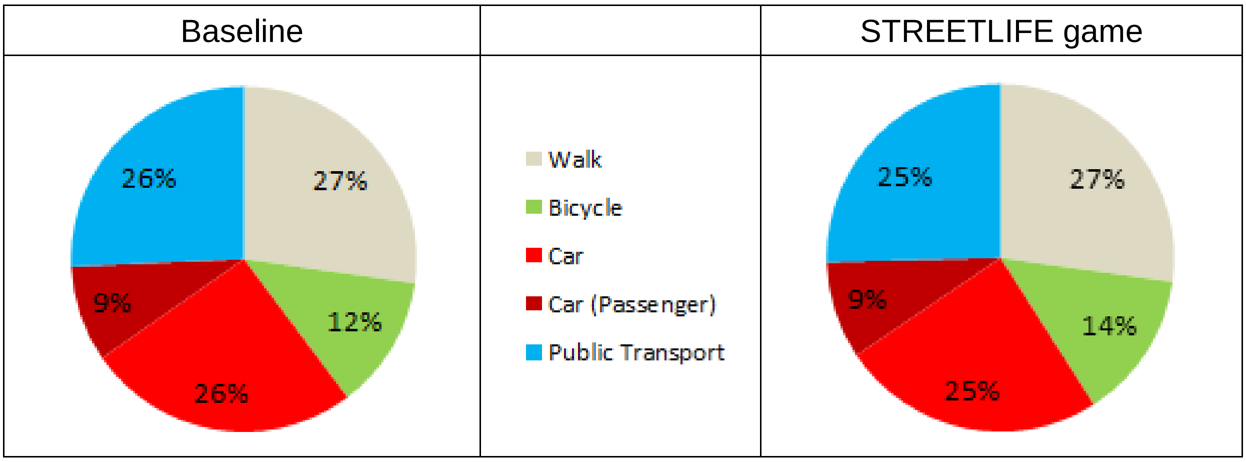

Figure 5: Berlin Modal split simulated

As expected, for the whole Berlin population the share of mode *Bicycle* only slightly increased (+2%), which was taken from mode *Car* (-1%) mainly. But, numbers of *Bicycle* trips have been significantly increased (+9%) and its mileage increased by 10% as well, while number of *Car* trips decreased (-4%) and the *Car* mileage by -5%. More bicycle trips with slightly longer average trip distances have replaced *Car* trips. As an important prove of concept: The share of modes *Walk* and *Public Transport* have not been negatively affected by the game.

Based on results shown in Table 3 Carbon emission can be easily calculated; values in Table 4 could be derived from the simulation output.

Table 4: TAPAS simulation - Carbon emission savings calculations

Baseline				
Mode	Trips per day	Mileage in km	Emission factors	Emissions in kg CO2
Walk	3,195,457	4,384,390	0	0
Bicycle	1,472,195	7,568,828	0	0
Car	2,998,665	21,292,897	176	3,747,550
Car (Passenger)	1,057,018	8,287,295	88	729,282
Public Transport	3,016,205	23,637,451	49	1,158,235
Total				**5,635,067**
STREETLIFE game				
Mode	Trips per day	Mileage in km	Emission factors	Emissions in kg CO2
Walk	3,184,580	4,359,809	0	0
Bicycle	1,611,830	8,393,535	0	0
Car	2,875,940	20,113,267	176	3,539,935
Car (Passenger)	1,064,740	8,355,951	88	735,324
Public Transport	2,971,090	23,232,758	49	1,138,405
Total				**5,413,664**

With the applied simulation based on data investigated with the Berlin pilot field test carbon emissions could be reduced from **5.64 tons to 5.41 tons** per day for the overall Berlin transportation system. That would equate for about 4% of the road based transport emission (without logistics, busses). In fact, the potential of carbon emission reduction for a large city is remarkable when realising a comprehensive cycling approach.

This calculation incorporates the following emission factors: Car = 178g/km, Car (Passenger) = 88g/km. It further assumes that the modal split for public transport modes bus, metro, train and tram is equally distributed. Corresponding mode specific emission factors (bus = 118g/km, metro, train and tram = 26g/km) are averaged to 49g/km. Emission factors have been investigated in 2014 in the FP7 research project MOLECULES [7] – not distinguishing between different car engine types. Factors of public transport modes have been provided by Berlin public transport operators.

5. CONCLUSION & OUTLOOK

The paper describes the integration of a competitive gamification approach into a mobility planning App, the corresponding evaluation and impact assessment methodology dedicated to feed a simulation based quantification of impacts on the transport system performance and its carbon emissions. In consequence, the paper clearly shows that gamification have had a strong influence on the mobility behaviour of the Berlin field test user group. The integrated game had a clear cycling orientation; and in combination with reasonable (virtual and real) incentives it fully evolved remarkable results. The share of mode bike has increased from 12 to 14% for the entire Berlin population; the number of motorised trips for daily mobility purposes has significantly decreased. Translated into emissions, those modal changes could save around 4% of daily emitted carbon emissions.

It is also to be concluded that future games in urban contexts should not exclude other sustainable modes of transportation, such as *Public Transport*, from the game and its rules definitions. So, impacts on the traffic system could be better balanced between "green" transport modes.

This paper is referencing to a simulation setup which has been directly derived from data collected during the field test. In the Berlin evaluation of the project STREETLIFE further assumption based scenarios have also been simulated and analysed – allowing specifying a range of possible impacts under assumed conditions. These results will be published with respective reports via the project website end of 2016.

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