STREETLIFE Berlin field trial – gamification and Crowd Sourcing for cycling safety

[Research paper]

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ABSTRACT

The integration of new services for ITS (Intelligent Transport Systems) into existing transportation systems, and the reliable change of users mobility routines as a consequence of new service interventions, is a very critical challenge for city administrations, mobility planners, and service providers. It means not less than breaking and adjusting existing users' mobility habits; such as individual routines and applied services. In the project STREETLIFE a gamification approach was used to introduce new mobility services in three individual pilot sites and to convince users to leave their "mobility comfort zone". The article will pay special attention to the pilot performed in Berlin. Here, an inter-modal route planning App for daily mobility combined a first "safe" cycling router for Berlin with a gamification approach and crowd sourcing routines for assessing, evaluating, and finally improving cycling safety. From March to May 2016, with the Berlin STREETLIFE game "Berlin BikeRider" user collected virtual points for participating in a game and competed for both virtual and real incentives. For all cycling trips, crowd sourced information on perceived cycling safety was collected by an on-trip survey. Users were able to assess safety matters of this individual trip and to add dangerous spots in a Berlin city map.

In consequence, not only the applied gamification approach and its impacts on main impact categories, i.e. the traffic system performance and carbon emissions, were evaluated. Special attention was laid on an analysis of crowd sourced data on cycling safety and on its comparison against existing public data sets on cyclists' accidents, provided by the Berlin Senate Department of Urban Development in cooperation with the Policy of Berlin. The joint analysis of both datasets allowed an evaluation and a completion of public statistics on cycling safety for Berlin – and in final consequence an improvement of data on cycling safety. It also assessed the concept of "Fahrradstrassen", dedicated cycling streets.

This paper describes the project, the Berlin pilot and the main results of data analysis while putting main emphasize on gamification's impact on mobility behavior and on cycling safety assessment. In addition, it also provides brief results on impacts on mileages and emissions (here CO_2).

Keywords: cycling safety, crowd sourcing, safe bike routing, gamification

1 INTRODUCTION

This paper is based on findings achieved during the FP7 project STREETLIFE (http://www.streetlife-project.eu), which run from October 2013 to September 2016, especially on results concluded for the Berlin pilot. This pilot's final iteration (spring/summer 2016) and its large scale field test was dedicated to the improvement of cycling safety. This dedication was clearly requested by local stakeholders when analysing and assessing first iteration's (summer/fall 2015) findings. With an App for inter-modal route-planning the Berlin game “Bike-Rider” was applied, implementing innovative crowd-sourcing data collections for the assessment of cycling safety in Berlin.

This paper briefly describes the project and its three individual pilots, for which a common evaluation methodology has been applied. It gives an overview about methods and data relevant for the derivation of targeted impacts and research questions. As a subset of findings achieved in the project STREETLIFE, main focus of this paper is laid on the impact of a gamification approach on mobility habits as well as on the analysis of field test data for assessing cycling safety in the city of Berlin.

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.

2.1 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 - incorporated in a gamification approach.

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”. 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.

2.2 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.

2.3 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.

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.

This paper is dedicated to the impacts achieved with the Berlin pilot. The focus is put to gamification’s impact on commuters’ mobility behaviour as well as on the assessment of cycling safety against existing public statistics.

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 [2]. 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 (e.g. altered mode choice probabilities) for the TAPAS simulation for the entire Berlin population.

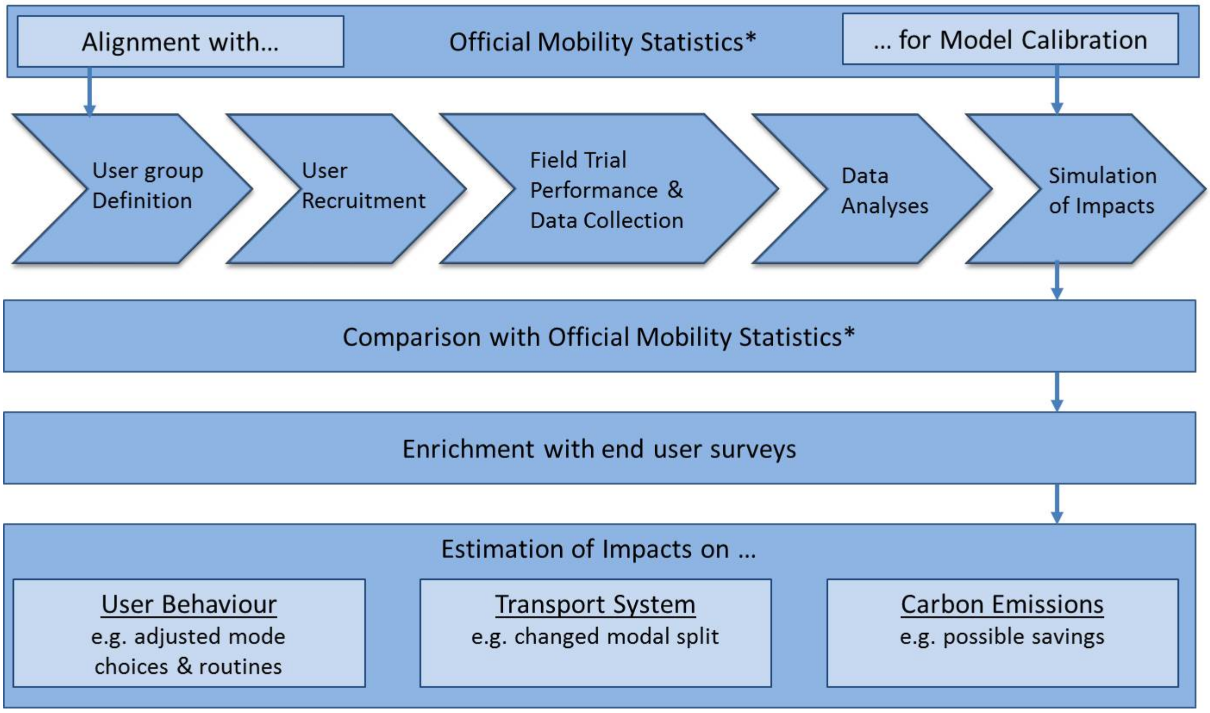

Figure 1: STREETLIFE Berlin methodological approach, * Survey Mobility in Germany 2008 [1]

For project evaluation purposes, TAPAS simulation output (traffic demand data for the entire Berlin population) has been compared with official statistics*. Based on this comparison impacts on the three main impact categories have been estimated and quantified [3]. In this paper, STREETLIFE TAPAS output is shown in chapter 4.4 – namely the impact on mileage and carbon emissions.

3.1 User data and gamification

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.

This final survey also paid particular attention to the investigation of the impact of gamification on the change of mobility habits. Survey data was compared with data collected while recruiting field test users before the field test. In consequence, reported user assessments could be compared against real field test data.

3.2 User data and cycling safety assessment

Field test users have been asked for a safety assessment of cycling trips or cycling stretches in inter-modal trips. When assessing safety as neutral or even negative users have been asked to add “dangerous points of interest” for cycling. During the Berlin field test 2.819 cycling safety assessments have been collected; 635 times the cycling safety assessment has been enriched with map entries of new dangerous points. This data set has been analysed carefully after the three months field test and finally compared against available statistics on cycling safety. Here, a data set from the Berlin Senate Department of Urban Development has been used for comparison which was collected and analysed together with the Berlin Policy in 2013.

4 RESULTS

4.1 Description of the sample

Briefly, the sociodemographic structure of the sample is explained in more detail. In Figure 2 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.

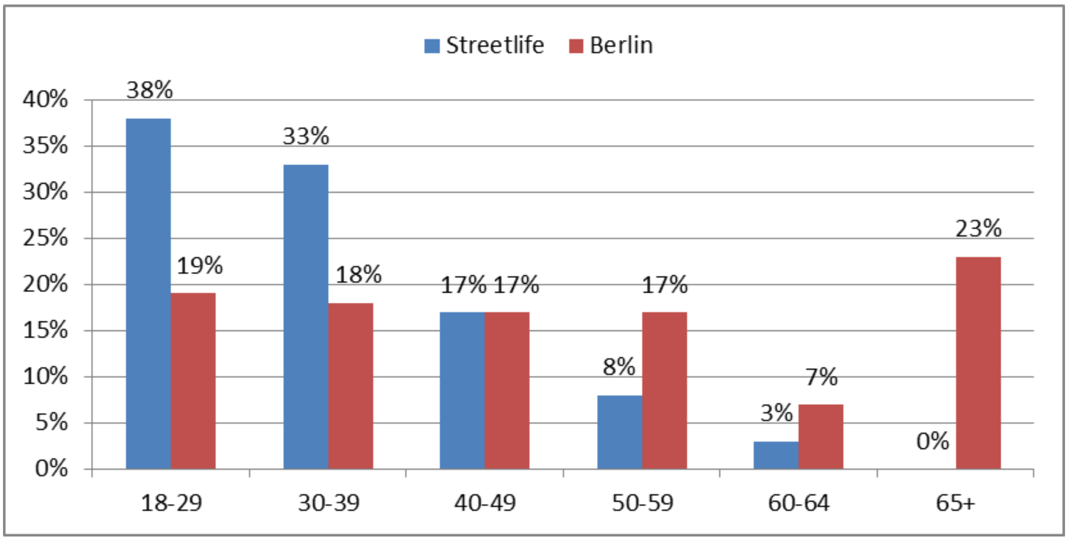

Figure 2: Age structure of the sample (n=63) and the Berlin population (Statistical Office for Berlin-Brandenburg, data status end of 2014)

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.

Table 1: Sociodemographic structure of the sample and the Berlin population aged 18+

	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 gamification impact

The STREETLIFE App integrated a set of innovative functions like the "route companion" (GPS tracking), the option "avoid accident black spots for cycling", the "Berlin BikeRider" game, and "the feedback option on the safety of cycling". In the questionnaire, all respondents have been asked for an assessment of these components' integration into the App (Figure 3). It can be seen that the integration of all functions have generally been rated positively. But the good evaluation of the "Berlin Bike-Rider" game and the "feedback option on the safety on cycling" stand out.

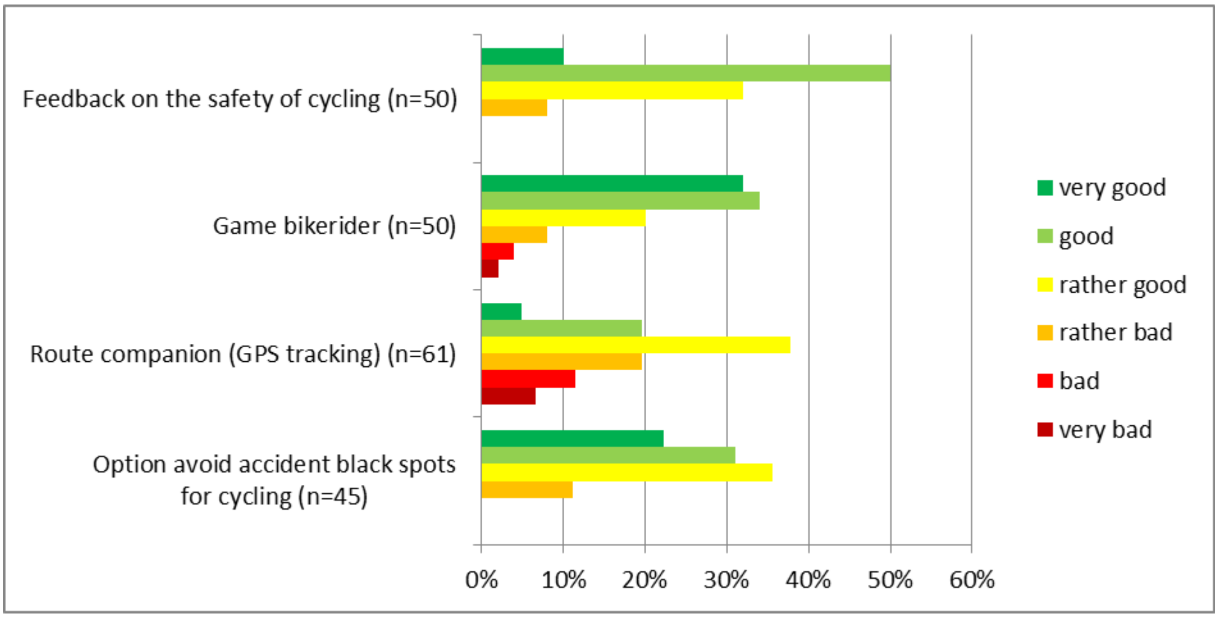

Figure 3: Assessment of the integration of different functions in the App

The change of travel behaviour as a result of STREETLIFE pilot interventions and its reported reasons are shown in the following figures. Figure 4 is based on 38% respondents who have stated a change of their mobility behaviour in the survey. As expected for the Berlin game setup, bicycle is much more often used. Astonishing 96 percent reported that they used the bicycle frequently or more frequently than before the installation of the App. In contrast, 46 percent have reduced their car use during the field test. The usage of the App only had a minor influence on the frequency of the use of public transport. 63 percent stated that they used public transport just as often as before.

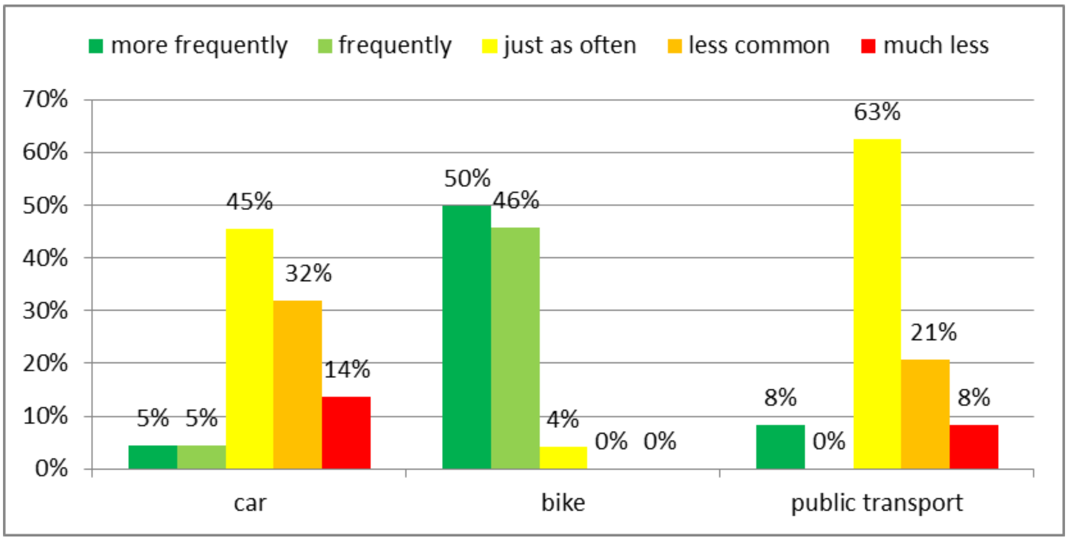

Figure 4: General change of travel behaviour due to the App (n=24)

Stated reasons for a change of mode choices are shown in Figure 5. The main reason for the change is the game (75 percent). In addition, more than every second person has stated environmental protection as a reason for the behaviour change. Around one third has saved travel time due to the App and 25 percent reported that the possibility of choosing safe cycling routes as an important reason for changing the use of transport modes.

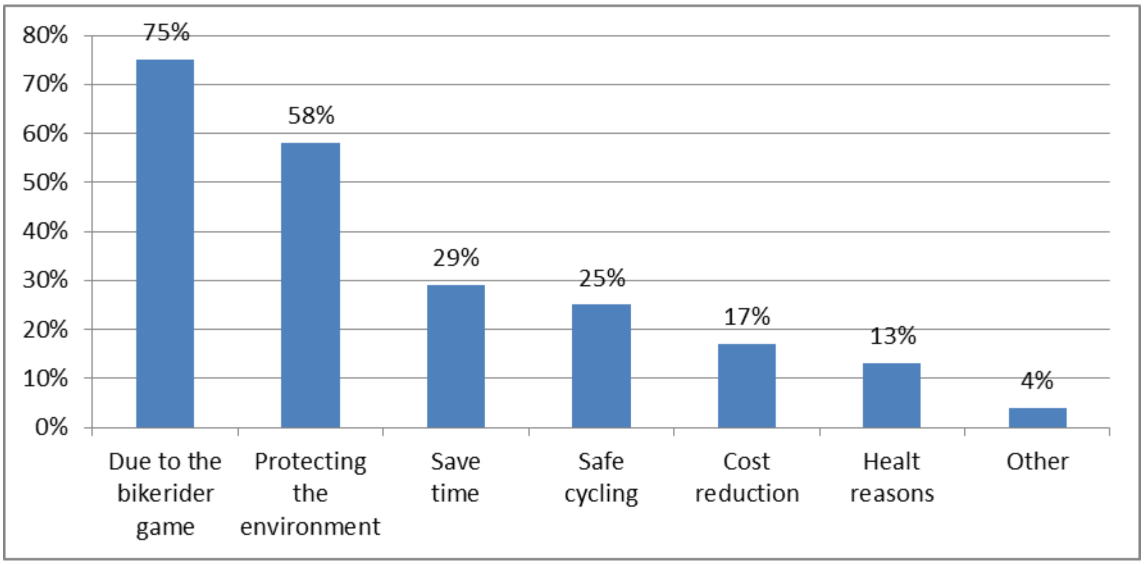

Figure 5: Reasons for the change of travel behaviour due to App (n=24) (multiple answers possible)

In consequence, it can be concluded that the integration of a gamification approach into Berlin pilot interventions, but also environment protection and a contribution to cycling safety improvement had a significant impact on test users' behaviour.

4.3 Data analysis for cycling safety assessment

During the Berlin pilot field test, for 4.873 trips users have specified their compliance with route proposals (Figure 4).

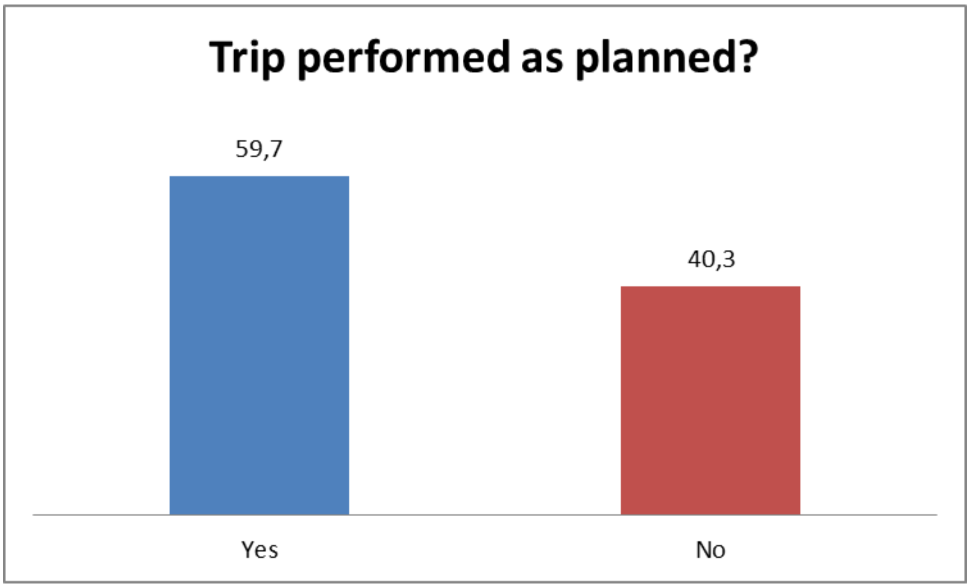

Figure 6: Self-assessment of compliance with trip proposals (N=4.873)

Reasons for not following the trip proposals are available for 415 trips. The following explanations have been given by users most often:

- “I know a better route.”
- “Route proposal too complex!”
- “Could not follow without turn-by-turn navigation.”

Figure 5 shows the distribution of safety assessments for mono-modal bicycle trips or inter-modal trips with mode bike integrated. More than 60 percent of the cycling trips have been specified as safe or very safe.

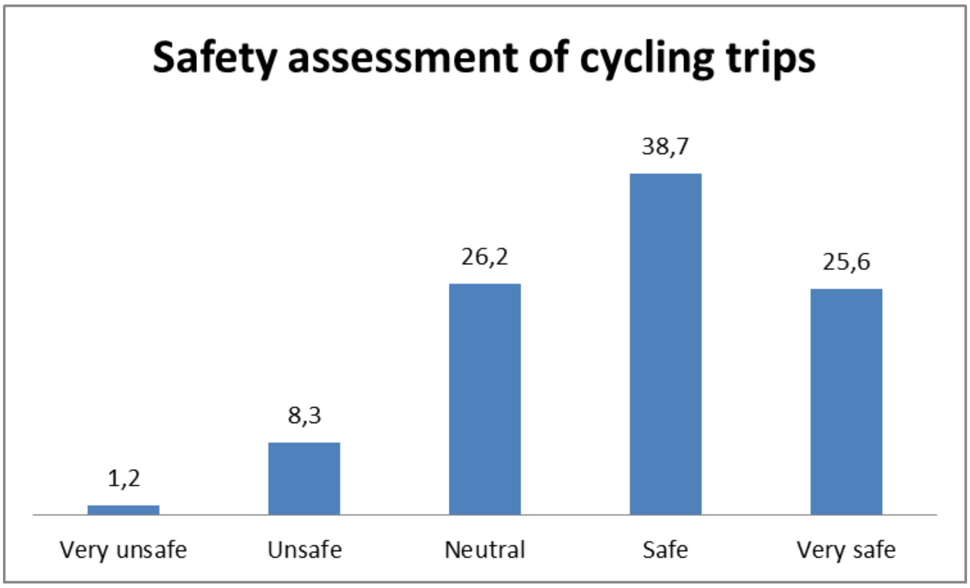

Figure 7: Safety assessment of trips with cycling included (N=2.819)

When assessing cycling safety as neutral or negative, users have been asked for adding new POI for cycling safety to a map in the App. 555 new POI have been added by the field test users. A Berlin map with all added POI is shown in Figure 6. Accumulations can be located at the city centre and at city West with some connecting corridors visible.

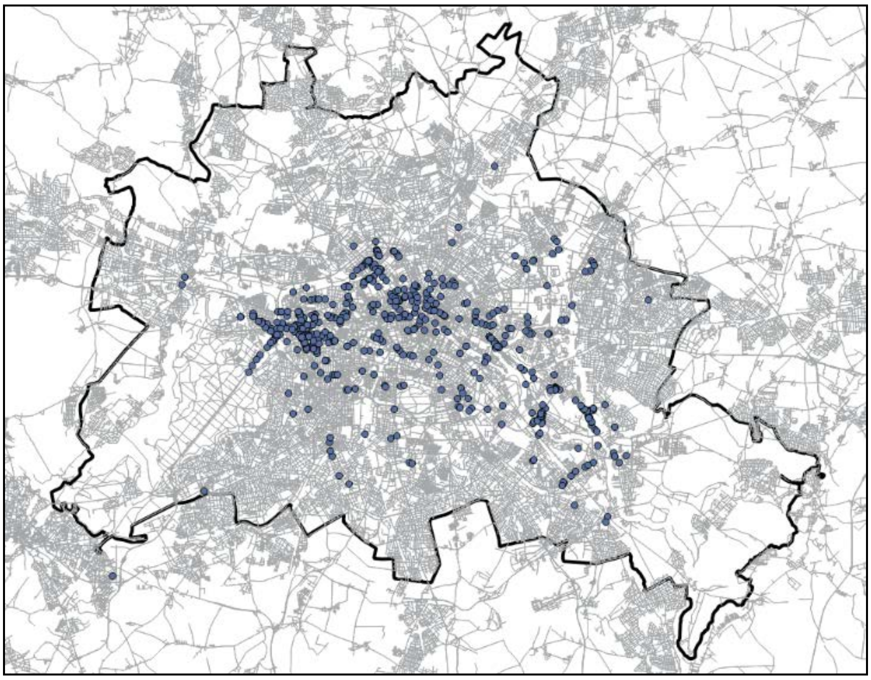

Figure 8: New POI for cycling safety from Crowd Sourcing

In the following, a representative network segment of special interest is selected and examined in more detail. The BER network segment in question is a complex setup of roads and junction around Berlin Friedrichstrasse. Figure 7 (upper left) shows the starting situation with the accident hotspots available prior the BER pilot. Yellow marks specify accident hotspots defined by the Berlin Police and the Senate Department. In the upper right figure STREETLIFE cycling trips (GPS traces) on this highly frequented road network segment can be seen with some origins (A) and destinations (B). In the lower left figure new POI added by the field test users are displayed on top of the map and STREETLIFE GPS traces. And finally, the lower right figure shows the comparison of available and new dangerous cycling hot spots.

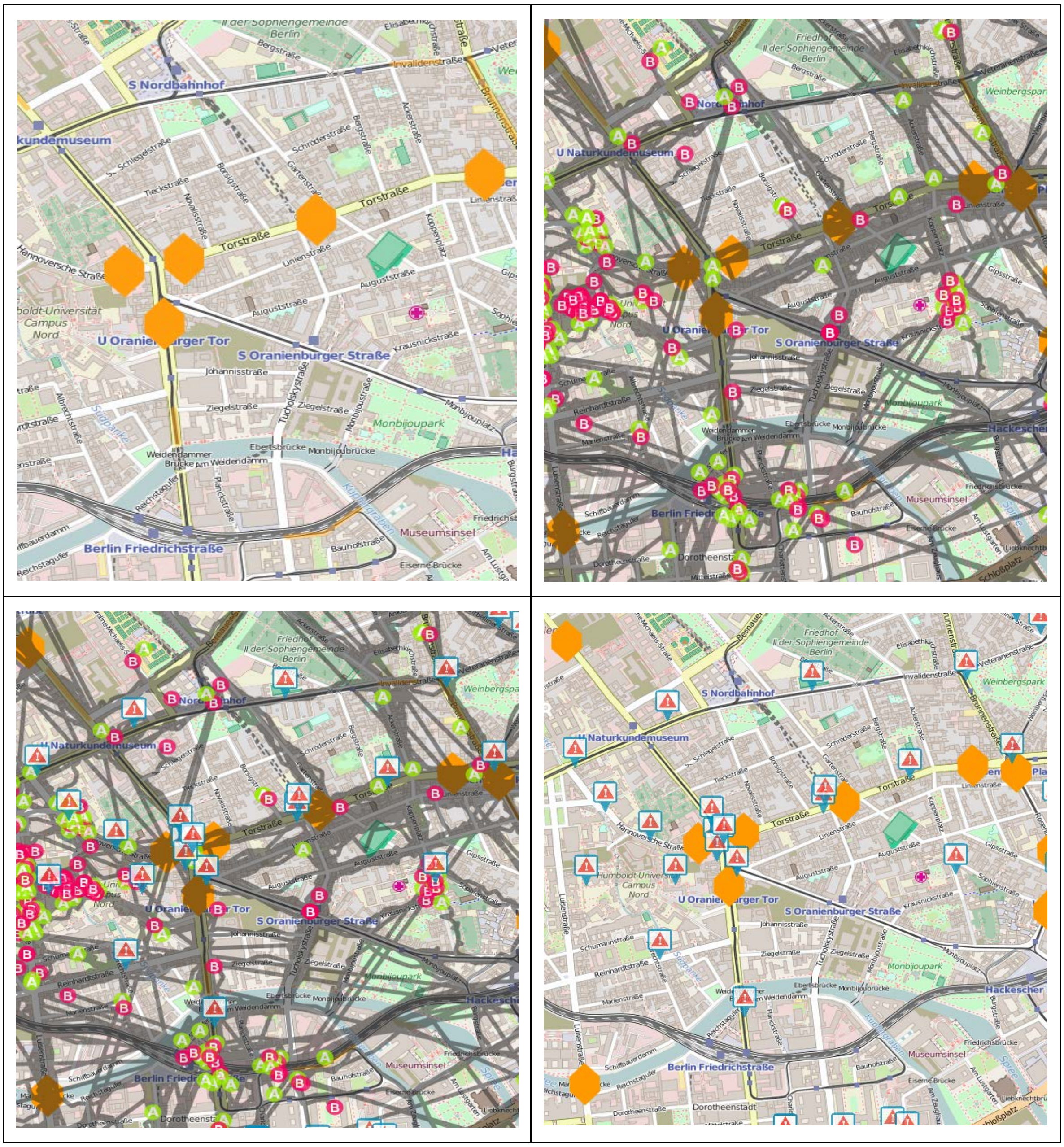

Figure 9: Crowd Sourced data analysis

This example describes how crowd sourced data of BER field test users has been used to validate and supplement the official statistics on cycling accident hotspots. At this particular road segment the “safe” bicycle router apparently tried to avoid the usage of highly frequented Torstrasse – from West to East. Cyclists have been rerouted via Linienstrasse south and Invalidenstrasse north of Torstrasse. However, the complex and dangerous crossing Torstrasse/Friedrichstrasse could not be avoided for any route. In consequence, known accident hotspots at Torstrasse and crossing Torstrasse/Friedrichstrasse have been confirmed by the field test users. But, by circumnavigating Torstrasse new POI for cycling safety have been added for instance at Invalidenstrasse.

It is also interesting to see that the concept of cycling streets (”Fahrradstrassen”) seems to work. The highly frequented Linienstrasse south parallel to Torstrasse is such a dedicated cycling street. Here, no POIs for cycling safety concerns have been added.

A more thorough analysis of this huge amount of crowd sourced data on POI for Berlin cycling safety is still being carried out and discussed with main stakeholder and cycling policy experts of the Berlin Senate department for Urban Development. Collected data and possible utilizations for supporting Berlin measures targeting at an improvement of cycling safety by means of policies and infrastructural improvements (reconstructions, policy recommendations, etc.) will also be discussed with other BER cycling bodies, such as the Berlin cycling association or the Berlin Police.

4.4 Simulation of impact

Based on the data generated by the TAPAS simulation, for the entire Berlin population of 3.4 million inhabitants improvements could be achieved as shown in Table 2 for one normal working day.

Table 2: 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 8.

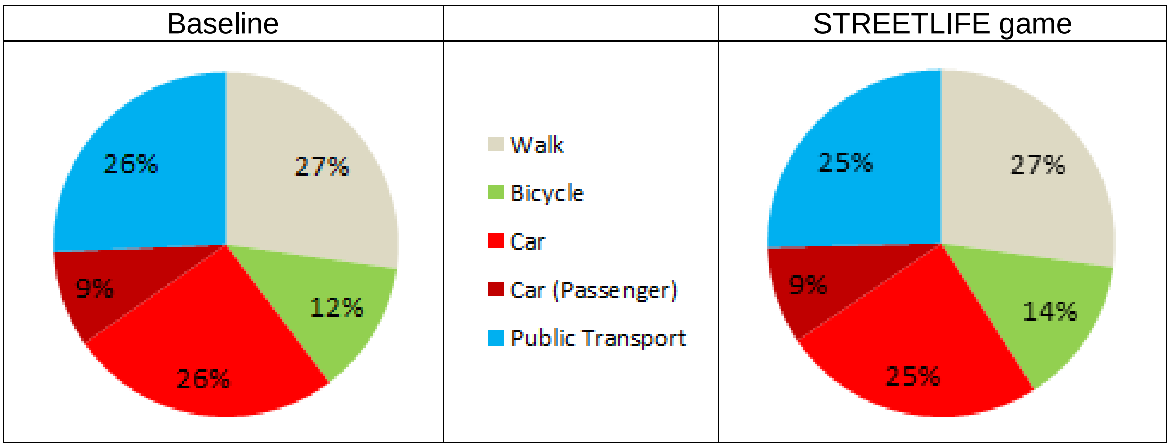

Figure 10: Berlin Modal split simulated

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 2 Carbon emission can be easily calculated; values in Table 3 could be derived from the simulation output.

Table 3: 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 [4] – not distinguishing between different car engine types. Factors of public transport modes have been provided by Berlin public transport operators.

5 CONCLUSIONS

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.

Crowd sourced data has been used to evaluate and to enrich available statistics on Berlin cycling safety. Existing dangerous hot spots have been confirmed; new could be revealed; the concept of Berlin dedicated cycling roads has been proved. However, respective STREETLIFE data collection can be considered as one promising proof of concept in order to improve data bases on cycling safety. Future activities and initiatives targeting at cycling safety improvements need a central and publicly funded administration and management.

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.

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