

Deploying traditional and smartphone app survey methods in measuring door-to-door travel satisfaction in eight European cities

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## Deploying traditional and smartphone app survey methods in measuring door-to-door travel satisfaction in eight European cities

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### Abstract

This study describes the lessons learned from designing, deploying and analysing the results from different travel satisfaction survey tools which measures the travellers' door-to-door travel satisfaction. The travel satisfaction measurement survey tools tested consisted of two types of smartphone applications (a satellite navigation app and a game app), an on-line survey, a paper-based semi-structured questionnaire and a focus group questionnaire. Each of the measurement tools comprised the same set of basic questions, but in different formats, aimed at exploring the pros and cons of each tool among different groups of travellers. The data collection was carried out at eight different European cities and five FIA motorist networks. 5,275 valid responses were gathered from the survey. Further analysis results show that different survey methods performed better in different sites. The satisfaction that was gathered via main trip leg does not necessarily correspond with overall satisfaction of the door-to-door journey. The results of this study highlight the need for more inclusive, complete, door-to-door, travel survey measurements.

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**Keywords:** Door-to-door journey; travel satisfaction; multimodal measurement; smartphone app survey; on-line survey; paper-based survey

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### 1. Introduction

In the last decade, there have been a surge of studies which investigate various aspects of passenger travel experience (e.g. Friman and Gärling, 2001; Stradling et al., 2007; Diana, 2008; Páez and Whalen, 2010; Susilo et al., 2012; Ettema et al., 2012; Friman et al., 2013). However, previous studies tend to focus on a particular travel mode and/or a particular trip purpose and often ignore the impact of access and egress legs on the overall journey satisfaction. This may lead to unfair evaluation of service provision by public transport operators and can undermine the quality of interchanges and last-mile facilities on passenger overall travel satisfaction (Susilo and Cats, 2014; van Hagen, 2015; Susilo et al., 2015a,b). Eurobarometer (2013), for example, shows, among railway travellers in 26 EU Member States, that the relationship between railway journey satisfaction and the passengers' satisfaction with the railway station is not linear. Muconsult (2003, cited by van Hagen, 2015) estimated that passenger satisfaction with stations determines about 25% of the score awarded to the total train journey satisfaction.

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One of the main reasons that the access and egress trip legs have been overlooked in the past is because it was considered too complicated and demanding to ask respondents to fulfil such surveys for the sake of travel satisfaction survey. Most of public transport operators and public transport watchdog organisations, the ones who were responsible of such survey in the past, did not see those trip legs as a part of their responsibilities. With the increase importance of providing inclusive transport by the local and national authorities and also with the emerging mobile and GPS technologies, measuring door-to-door journeys in a cheaper and reliable way, without providing so much workload and intrusions to the respondents, seems now to be within a reaching distance.

In the last decade, there has been a surge in the number of trials and studies which investigate the potential use of these new technologies to complement and replace the standard, paper-and-pencil, as an alternative of standard household or personal travel surveys (e.g. Wolf et al., 2004; Stopher et al., 2008; Greaves et al., 2014; NCHRP, 2014; Cottrill et al., 2013). Whilst some travel diary apps have proved themselves as a promising alternative in capturing individual movement overtime and space, some of the problems remain. These include the issue of battery life time, the trip and activity inference methods and the accuracy of the reading itself (Cottrill et al., 2013; Prelipcean et al., 2014, 2015). Whilst there have been a lot of survey app developments in the last decade, to our knowledge, there has not been any app that was developed to measure the travel satisfaction of individual's door-to-door journeys. In an effort to create a standardised, inclusive, transport service provision that meets all Pan-European's travellers' needs and standards, a standardised quality monitoring tool is required. Thus, a door-to-door travel satisfaction measurement tool that works in different European countries' contexts is needed.

This study describes the lessons learned from designing, deploying and analysing the results from different travel satisfaction survey tools which measure travellers' door-to-door travel satisfaction. This activity is a part of METPEX (MEasurement Tool to determine the quality of the Passenger EXperience) FP7 project. The travel satisfaction measurement survey tools tested consisted of two types of smartphone applications (a satellite navigation app and a game app), an on-line survey, a paper-based semi-structured questionnaire and a focus group questionnaire. Each of the measurement tools comprised the same set of basic questions, but in different formats, aimed at exploring the pros and cons of each tool among different groups of travellers. The data collection was carried out at eight different European cities, i.e. Bucharest (Romania), Coventry (UK), Dublin (Ireland), Grevena (Greece), Rome (Italy), Stockholm (Sweden), Valencia (Spain) and Vilnius (Lithuania), and five FIA motorist networks, i.e. German, Polish, French, Spanish and the British motorist associations.

In the next section, we will describe the questionnaire and the overall survey design. Then we will present dynamic questionnaire assignment method among different combination of user groups and travel modes. It is followed by discussion on the data collection activities and the survey results. Further descriptive analyses on the results collected by different tools are then presented. This is followed by an ordered logit model analysis to measure the differences of reported travel satisfaction among different survey tools. The article closes with a summary section.

## **2. METPEX project and questionnaire formulation**

This study is part of METPEX FP7 EU project ([www.metpex.eu](http://www.metpex.eu), METPEX, 2012), which aims to develop a Pan-European standardised measurement tool to measure passenger experience across whole journeys, whilst taking into account wider human socio-economic, cultural, geographic and environmental factors.

The earlier stage of the research comprised desktop research, stakeholder consultation and a small size experiment among approximately 550 respondents across 8 different European cities. The results of the trial survey were used to identify the variables that could be used to better monitor and evaluate the passenger experience during door-to-door journeys by public and active forms of terrestrial transport, with special attention towards the needs of vulnerable groups, such as older people, lower income groups, rural dwellers, children and those with both physical and cognitive disabilities (METPEX, 2013; Cats et al., 2014; Susilo and Cats, 2014; Woodcock et al., 2015; Susilo et al., 2015). Therefore, the challenge of this study is to design data collection methods which: (1) provide useful data for transport operators and other interested parties to base their decisions upon; (2) reflect the diversity of customer experiences across a number and combination of transport modes; and (3) in a range of formats that is suitable and attractive to travellers.

In order to create a single standardised passenger satisfaction survey (PSS) that accommodates different conditions within EU-28 countries, the measurement survey needs to be adapted into 5 different survey methods:

1. Paper-and-pencil
2. On-line questionnaire
3. Real-time questionnaire, embedded in a route navigation (SbNavi) app for IOS and Android
4. Real-time questionnaire, embedded in a dedicated Android Game app.
5. Focus group

These five different tools have their own advantages and disadvantages in terms of different target groups and technological support systems. All measurement tools consisted of a similar set of questions (with the focus groups asking more detailed questions relating to specific user groups, whereas the game app did not ask the specific questions related to the user groups and travel modes). In addition, all measurement tools (with the only exception of the Game app) should contain the indicators that are able to measure the travel satisfactions of 11 user groups whom use one or a combination of the 10 different travel mode classifications, as shown in Table 1 below.

Table 1. Definitions of target User and travel Mode groups

User Groups included in the survey	Travel Mode Classifications used in the survey
<i>Communication Impaired Travellers</i> : Those who answered either hearing impairment, visual impairment or speech and communication impairment	Bicycle
<i>Commuter</i> : Those who commute regularly or those who answered commuting to work or commuting back to home as the main purpose of their trip.	Demand Responsive Transport
<i>Low Income Travellers</i> : Those who answered the level of income was below the average of their country <sup>1</sup>	Mobility Vehicles
<i>Mobility Restricted Travellers</i> : Those who had any kind of mobility impairment. Those who need using either a wheelchair, crutches or a walker.	Pedestrian
<i>Over 64 years old Travellers</i>	Private Vehicle
<i>Rural Dweller</i> : Those who stated that lived in a rural or rather rural area.	Public Transport Rail
<i>Traveller with children</i> : Those who answered “Escorting children as the main purpose of their journey”	Public Transport Road
<i>Traveller with dependents</i> : Those who answered “Escorting dependents” as the main purpose of their journey. A dependent might be someone under the age of 18 or that needs someone else help to move around.	Public Transport Tram
<i>Under 24 Travellers</i>	Public Transport Underground
<i>Visitors</i> : Those who answered “Visiting the city-Tourism” as the main purpose of their journey.	Waterborne vehicle
<i>Female Travellers</i>	

From the earlier desktop research, stakeholder consultation and a small size experiment, more than 1,000 users groups, travel modes and context specific indicators were gathered. It was obvious that it was impossible to ask the users to provide an answer to all of these indicators. Thus, several rounds of Multi Criteria Analysis among experts and stakeholders were carried out to set weights to the indicators. A ranking model (see Figure 1 below) was devised whereby 0 required the automatic exclusion of the variable and 3 automatic inclusion, depending on the set of categories being focused upon. Numbers 1 and 2 represent the recommendation to either exclude or include the variable based on the size of the survey.

<sup>1</sup> The income level list for each site can be found in METPEX (2014b)

Variables considered by METPEX tool	TOOL				TRIP MODE				TRAVELLERS POPULATION GROUP									
	Computer based application	Web based questionnaire	Semi-structured questionnaire	Focus group protocol	PT ROAD VEHICLES	PT RAIL VEHICLES	BICYCLE	PRIVATE CAR	PEDESTRIANS	WOMEN	TRAVELLERS/PARENTS WITH CHILDREN	COMMUTERS & EMPLOYED	LOW INCOME	ELDERLY	MOBILITY RESTRICTED & DISABLED	YOUNG	TOURISTS/VISITORS & FOREIGNERS	
SECTION 1: Prerequisite data for identifying the characteristics of the journey and first reaction on overall assessment of whole journey experience																		
Journey's attributes																		
➤ Transport mode for the representative trip	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
( Walking																		
( Cycling																		
( Private car																		
( Bus																		
( Trolleybus																		
( Tram																		
( Metro																		
( Train																		
( Taxi																		
➤ Other transport modes used for the whole journey	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
( Specify:																		
➤ Other journey's attributes	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	
( Origin/ departure place	0	3	3		3	3	3	3	3	3	3	3	3	3	3	3	3	
( Destination	0	3	3		3	3	3	3	3	3	3	3	3	3	3	3	3	
( Total journey's time duration	0	3	3		3	3	3	3	3	3	3	3	3	3	3	3	3	
( Departure time	0	3	3		3	3	3	3	3	3	3	3	3	3	3	3	3	
( Day of the week	0	3	3		3	3	3	3	3	3	3	3	3	3	3	3	3	
( Number of days ago	0	3	0		3	3	3	3	3	3	3	3	3	3	3	3	3	
( Estimation about the total cost of the journey	1	0	1		3	3	3	3	3	3	3	3	3	3	3	3	3	

Fig. 1: Sample page of Multi-criteria analysis in order to prioritise and select the indicators (source: METPEX, 2014)

Based on this, 600 questions in total were selected and distributed into five sections, in dynamic and multi-server architecture manners, according to the location of the survey (which was identified as a different campaign per test site), nature of the survey (retrospective vs real-time), users groups and travel modes used, with rules as shown on Figure 2, on page 5:

- Individual attributes (i.e. socio-demographic, mobility behaviour)
- Attitudes (i.e. travel preferences, mobility-related opinions)
- Contextual variables (i.e. temporal, weather conditions, trip purpose, subjective well-being indices)
- Specific user groups and travel modes specific questionnaires
- Travel experience factors (e.g. availability, travel time components, information provision, reliability, way-finding, comfort, appeal, safety and security, customer care, price, connectivity, etc.)

To limit the respondents' burden, it was decided that, for each specific user group and travel mode combination, each respondent was asked to answer 50-75 questions, maximum, which should only require the respondent to spend approximately 20-30 minutes, in total, to complete the whole questionnaire. In order to do this, the internet based and the SbNavi app survey tools have a capability to select and generate a questionnaire which is presented to the respondent dynamically.

The rules of the questions on deployment are as shown in Figure 2, on page 5. The initial baseline questions cover, amongst other things, journey details and include control questions related to travel modes and user groups. This step provides detailed information on transport modes or on individuals with distinct travel needs and enables the PSS to overcome the challenge of acquiring both general travel experience information and information on specific individual groups. Tier 1 questions cover information at a high level on the satisfaction of each component of the transport experience. Tier 2 questions represent a focus on a particular sub-set of travel satisfaction selected at random. This structure is intended to enable the PSS to acquire both general information about the journey, as well as very detailed information about specific aspects whilst maintaining a practical limit on the number of questions a participant is asked – thereby responding to the concern about developing an overlong tool.

In order to deploy the questions as planned as shown in Figure 3, a dynamic survey concept is implemented. In technical and survey design terms, this means that there is one integrated main platform (server) where:

- The survey is described using XML. This description specifies each question's type (e.g. multiple choice, text, integer value, etc.), the visual components to be used in the questionnaire (e.g., checkbox, radio button, combo-box, slider, etc.) or the default response, amongst other things.
- A campaign, being a collection of surveys, is also described using XML. The description identifies its name, type and the set of surveys it contains.
- The surveys can be generated either statically (manually), or dynamically (e.g., with a query followed by an SQL-to-XML script-based conversion). Alternatively, the XML may be replaced with JSON format messaging (more Java friendly, for Android platforms).
- The passenger's response is also in XML and uploaded with strong encryption to the central servers.

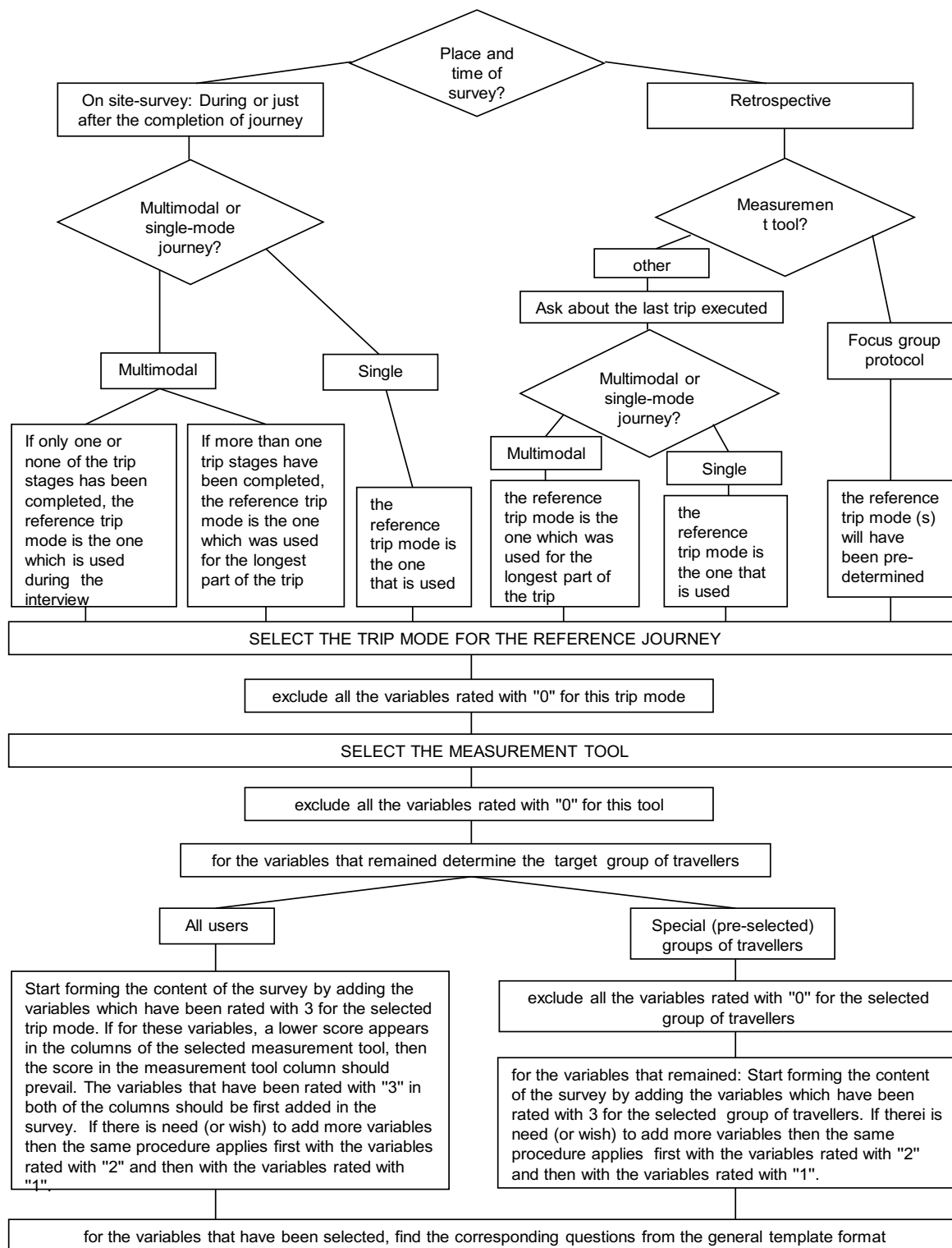


Fig. 2. Flowchart of indicators deployment within METPEX system (source: METPEX, 2014)

Then, the app-server and back-end communication protocol, used to provide a questionnaire to the app user (survey responder) from the application's point of view, is as follows:

- Step 1: Upon the user's request, the survey tool places a query to a survey server. Based on the user's demographics and profile the user is subsequently assigned to one of the available active campaigns.
- Step 2: A survey is randomly chosen, out of the list defined in the campaign, and it is loaded (in XML/JSON). Note here that, if the user (based on its profile) is not compatible with the particular campaign, i.e., if he is a Greek male and the campaign is for French females, then the application should not launch the questionnaire.
- Step 3: The questionnaire form is dynamically generated from the survey description.
- Step 4: When the user completes his/her response, the application uploads / posts the response (in XML/JSON).

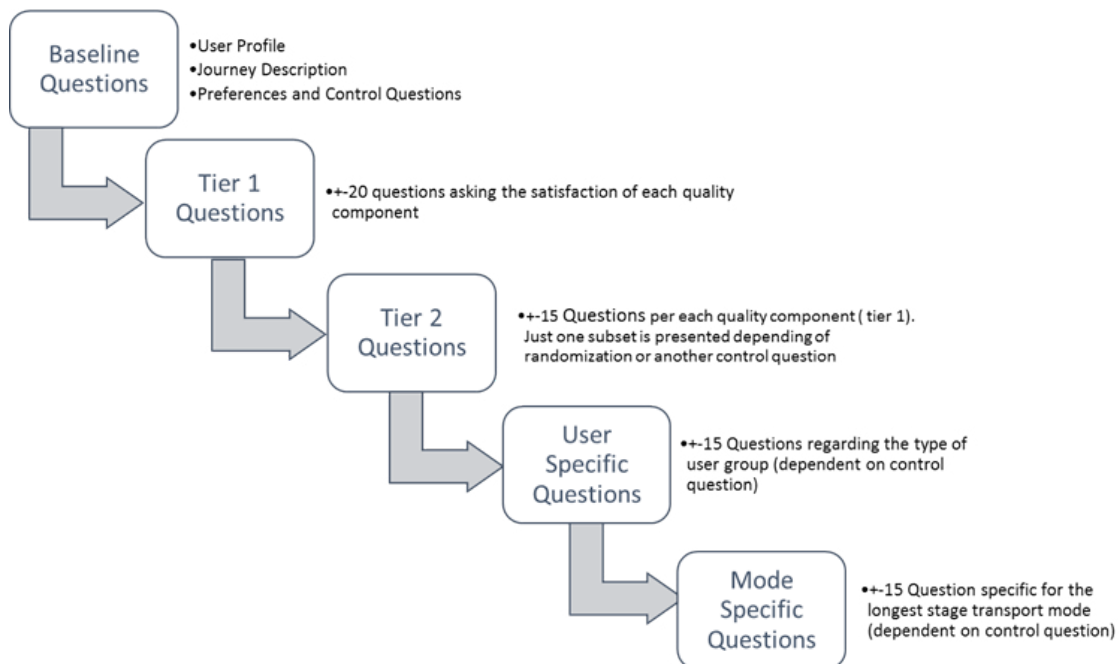


Fig. 3. Flowchart of indicators deployment within METPEX system (source: METPEX, 2014)

This integrated dynamic back-end system acts as the “central hub<sup>2</sup>”, the registry point of all organisations, campaigns and surveys. All surveys will be accessed by the survey app through that central hub. Organizations (i.e., transport stakeholders, policy makers, consultants, etc., the company's customers, in general) will register in this hub and may define and enable (launch) their individual campaigns and surveys (questionnaires) at will. The local survey organiser also would be able to identify the participant who has completed the survey and provide the reward as what they have been promised, if any.

A standardised survey procedure, with check and re-check along the survey period was adopted. The main steps and measures that were adopted before, during and after the survey execution can be found in Figure 4. The preparation period involved different tasks: submission of a survey plan including targeted sample size per User groups and Travel modes, the recruitment method and location; language translation of the tools; conceptualization of the survey's promotion and tools improvement and familiarization.

<sup>2</sup> In METPEX project the central hub was called “Backend system”.

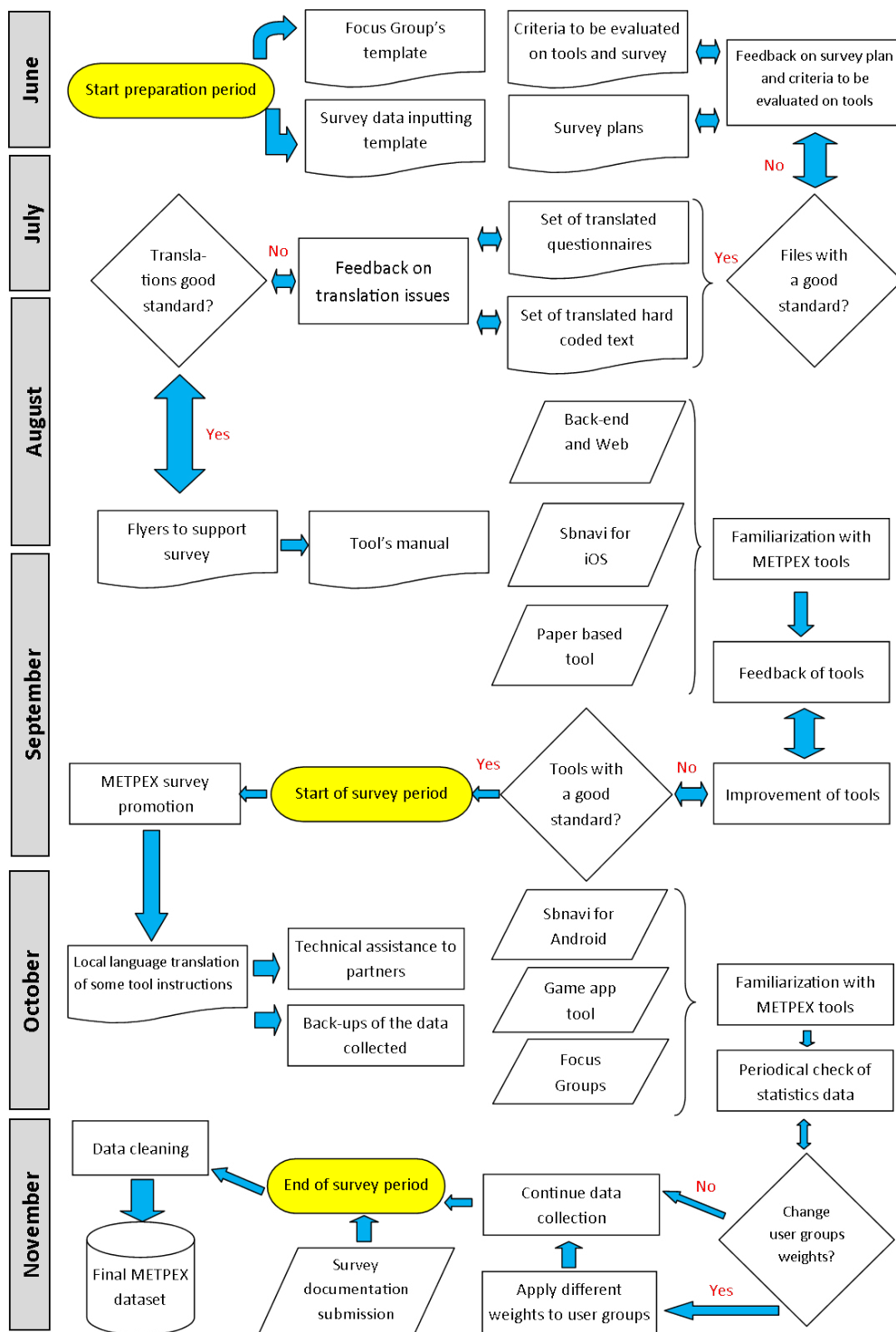


Fig. 4. Work flow diagram of activities

The survey tools were deployed in 10 different languages, i.e.: English, French, German, Spanish, Italian, Greek, Swedish, Lithuanian, Polish and Romanian. Since the original question had to be translated from English into 9



languages, it was conceived to be jargon free, unambiguous and as clear as possible. These to avoid the following potential problems:

- a) Lexical and syntactic ambiguity. This happens when a word has more than one meaning or when a sentence can have more than one structure. An example is the translation of “trip leg”, which could be literally translated into Spanish as “pierna de viaje” and in French as “jambe” when it should be translated as “etapa del viaje” and “étape de voyage”, respectively.
- b) Lexical and structural mismatching. Words that in the local language do not exist and therefore the translator must choose between a borrowing from another language, a neologism, or providing an explanation. For example, the a single word “safety” in English represents both “safety from the danger” and “sense of security”, which in Swedish are usually represented by two different two words, either “säkerhet” or “trygghet”, respectively.
- c) Another main problem was the quality of the whole sentence. Some of the sentences, although understandable and grammatically correct, did not sound natural when translated into local languages. This is a known problem of translations that may arise due to the paradox of having to choose between a grammatically correct translation, with the risk of changing the original meaning of the statements/questions, or rephrasing the questions to a more locally-acceptable one with the peril of changing the interpretation of the original one. To reduce the impact of this problem, a reverse translation check was implemented. At final check stage, at least 20 randomly selected questions were reversed translated back-and-forth into English and 9 other languages to ensure the quality and the consistency.”

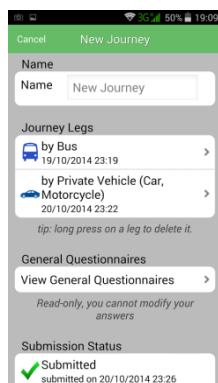
The surveys were locally promoted via media campaigns and the distribution of survey flyers. In parallel partners had time to read the manual of the tools, test them and familiarize with them while providing feedback for their further improvement.

During the survey period the manual for the tools were translated into some local languages and the dissemination campaign for the survey was launched. Partners were able to periodically check statistics about the profile of travellers they were collecting. In case the numbers of a specific User group were far from reaching their sample target, partners could manage the quotas by prioritizing the targeted group. The prioritization of certain groups could be made by modifying in the back-end system the weights applied to a given User group. This prioritization was applicable for the on-line and apps tools, only.

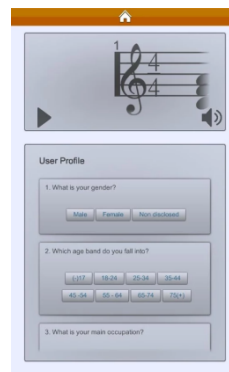
The snapshots of METPEX tools’ interfaces and also of the back-end system can be seen at Figure 5, on page 9.

### 3. Survey deployment and management

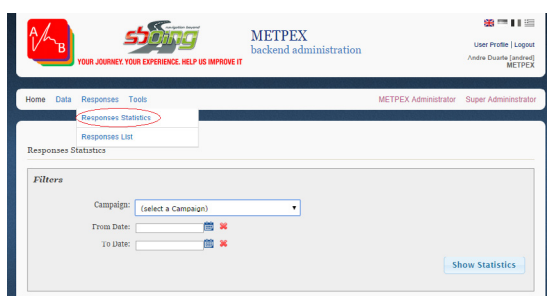
The data collection was carried out in eight different European cities - Bucharest, Coventry, Dublin, Grevena, Rome, Stockholm, Valencia and Vilnius, and five FIA motorist networks (Germany, Poland, France, Spain and the United Kingdom), between September and November 2014. The recruitment method varied depending on the city and the collection method. The size and proportion of the target groups were calculated based on the socio-demographic and travel mode distribution of those groups in each city. The standard random number generator method with the following parameters was adopted: confidence level (95%), confidence interval (3-5%), % picking a choice ( $p=50\%$ ). In some cities, economic incentives were offered to attract more respondents, for example, Stockholm offered a cinema ticket whilst Coventry offered a cup of coffee and a chance to win an iPad. In other cities, stakeholders and membership’s networks (e.g. FIA, Bucharest and Dublin) were used to promote the survey. There were also cities which developed a strong media campaign to encourage online survey participation (e.g. Valencia). Others received strong support from their local stakeholders and were able to carry out surveys on board or in stakeholders’ premises - for example, Dublin carried out on-board surveys and Coventry was allowed to set up a stand and coffee shop on a main railway station.



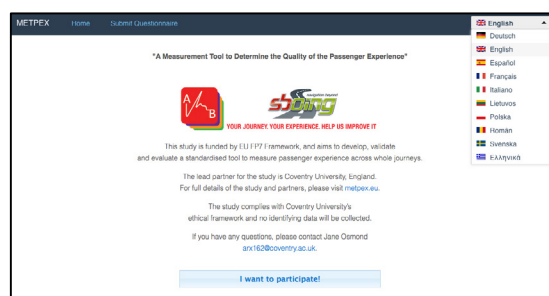
a) Snapshot of navigation app interface



b) Snapshot of Game app interface



c) Back-end interface



d) Web on-line alternative interface

Fig. 5. The interfaces of various on-line survey tools deployed and its back-end (questions deployment and data management) system

#### 4. Survey results

In total, 6,360 completed responses were collected during the survey period. After the data had been cleaned and double checked for consistency and reliability across different sections, the total number of valid samples was 5,275 (See Table 2, on page 10). The results were 984 responses from the paper-and-pencil survey, 3,394 responses from the on-line web survey, 231 responses from the SbNavi app, 414 responses from the game app and 252 responses from the focus group method.

As can be seen from Table 2, the traditional on-line (64%) and the paper-and-pencil (19%) methods attracted the highest number of respondents (total 83%), whilst the more technologically driven methods game app (8%) and SbNavi (5%), attracted the lowest response rates and highest dropout rates. This low response rate and high dropout rates, being the latter of up to a 75% in Valencia and Bucharest for the SbNavi. However, the rates varied from country to country, and it is important to note that the Game app contained a fewer number of questions, which made it less complex and thus more user friendly, than the SbNavi app. In addition, users' appetite to have a more entertaining app was also evidenced in our trial by having a higher participation rates for the Game app, even though it was launched much later than the SbNavi app.

Another common concern among many trial sites was the requirement of a high speed internet connection to download and complete the apps and on-line questionnaires. Sometimes, maybe because it took too long to wait for a response from the server, the app crashed and/or the respondents gave up the survey and cancelled their participation. Although many of these connectivity/communications problems were due to the local internet connection of the client, it is something that needs further analysis in future versions of the tools. A record from the backend server shows that it only had 5% utilization and 5.5 msec ping time to Google, throughout the trial period.

Overall, although there was a consistent agreement among respondents and surveyors that the tools were attractive, the questionnaire was found to be too long and complicated. It is also apparent from the survey feedback that - despite a surge in technology adoption and penetration in Europe in terms of smartphones in the last several years - the acceptance of a smartphone app as a survey tool was low. There were also significant privacy and data

protection concerns expressed among potential respondents (e.g. Rome) in terms of installing an unknown app.

Table 2. Summary of valid number of respondents, by used survey methods

City	Number of collected response	Paper and Pencil	Web On-line Survey	SbNavi App	Game App	Focus Group
Bucharest	411 (600)	51 (40)	281 (440)	9 (40)	46 (40)	24 (40)
Coventry	336 (500)	207 (100)	86 (100)	6 (100)	28 (100)	9 (100)
Dublin	467 (600)	146 (150)	284 (150)	8 (50)	29 (50)	0 (20)
Grevena	267 (375)	124 (100)	57 (140)	3 (20)	2 (20)	81 (95)
Rome	729 (700)	143 (280)	501 (245)	0 (55)	22 (50)	63 (70)
Stockholm	842 (880)	144 (200)	226 (200)	176 (200)	222 (200)	74 (80)
Valencia	501 (600)	17 (458)	430 (20)	13 (20)	41 (20)	0 (82)
Vilnius	247 (600)	152 (200)	55 (200)	16 (100)	24 (100)	0 (0)
FIA networks	1475 (1500)	0 (0)	1475 (1460)	0 (20)	0 (20)	0 (0)
<b>TOTAL</b>	<b>5275</b> <b>(6355)</b>	<b>984</b> <b>(1528)</b>	<b>3395</b> <b>(2955)</b>	<b>231</b> <b>(605)</b>	<b>414</b> <b>(600)</b>	<b>251</b> <b>(487)</b>

Note: The amounts in the bracket are the target numbers that were stated on the survey plan of each city.

Table 3. Distribution of valid respondents, by socio-demographic characteristics<sup>3</sup>

City	Comm. Impaired	Commuters	Low Income	Mobility Restricted	Elderly	Rural dwellers	Travelling with children	Travelling with dependent	Under 24	Visitors	Women
Bucharest	11 (0)	76 (0)	49 (120)	19 (40)	21 (90)	21 (57)	20 (40)	2 (0)	32 (84)	31 (0)	83 (306)
Coventry	9 (0)	67 (100)	11 (40)	5 (40)	16 (40)	16 (0)	7 (50)	1 (0)	58 (100)	44 (0)	74 (100)
Dublin	8 (0)	209 (50)	40 (50)	9 (40)	10 (40)	24 (0)	5 (50)	3 (0)	45 (40)	7 (0)	78 (50)
Grevena	2 (0)	8 (0)	35 (50)	12 (20)	38 (88)	28 (40)	31 (45)	0 (12)	56 (50)	20 (20)	35 (50)
Rome	8 (0)	165 (0)	115 (110)	22 (35)	40 (100)	44 (0)	4 (0)	5 (0)	143 (30)	32 (100)	129 (300)
Stockholm	9 (0)	110 (50)	76 (50)	55 (40)	31 (40)	13 (0)	54 (50)	3 (0)	109 (40)	9 (0)	151 (50)
Valencia	9 (0)	62 (0)	113 (71)	19 (82)	49 (114)	4 (0)	14 (22)	2 (0)	32 (42)	29 (79)	127 (190)
Vilnius	9 (0)	33 (40)	31 (30)	9 (30)	20 (30)	3 (0)	15 (30)	1 (0)	22 (30)	4 (0)	76 (40)
FIA networks	150 (N/A)	221 (N/A)	197 (N/A)	57 (N/A)	44 (N/A)	133 (N/A)	29 (N/A)	25 (N/A)	106 (N/A)	157 (N/A)	356 (N/A)
<b>TOTAL</b>	<b>215</b> <b>(0)</b>	<b>951</b> <b>(240)</b>	<b>667</b> <b>(521)</b>	<b>207</b> <b>(327)</b>	<b>269</b> <b>(542)</b>	<b>286</b> <b>(97)</b>	<b>179</b> <b>(287)</b>	<b>42</b> <b>(12)</b>	<b>603</b> <b>(416)</b>	<b>333</b> <b>(199)</b>	<b>1109</b> <b>(1086)</b>

Note: The amounts in the bracket are the target numbers that were stated on the survey plan of each city.

<sup>3</sup> The total number of respondents by different UG (user groups, Table 2) and TM (travel modes, Table 3) are different with the total number of samples (Table 1) since the Game app did not record specific detailed questions for different UG.

The distribution of the respondents among different socio-demographic groups can be seen respectively in Table 3. In the recruitment stage, the respondents were sampled according to the socio-demographic and travel mode distributions in each respective city. However, almost all cities did not manage to reach some of the target of specific socio-demographic and travel mode groups. For example, mobility restricted and elderly groups proved to be more difficult to recruit than other traveller groups, especially in Rome, Valencia and Bucharest. Presumably this is because, at some cities, these traveller groups are not travelling as frequently as other groups. Further distribution analysis on the survey results by each city are described in Section 5 and comprehensive multivariate analysis to explore the unique behaviour across different survey methods are described in Section 6.

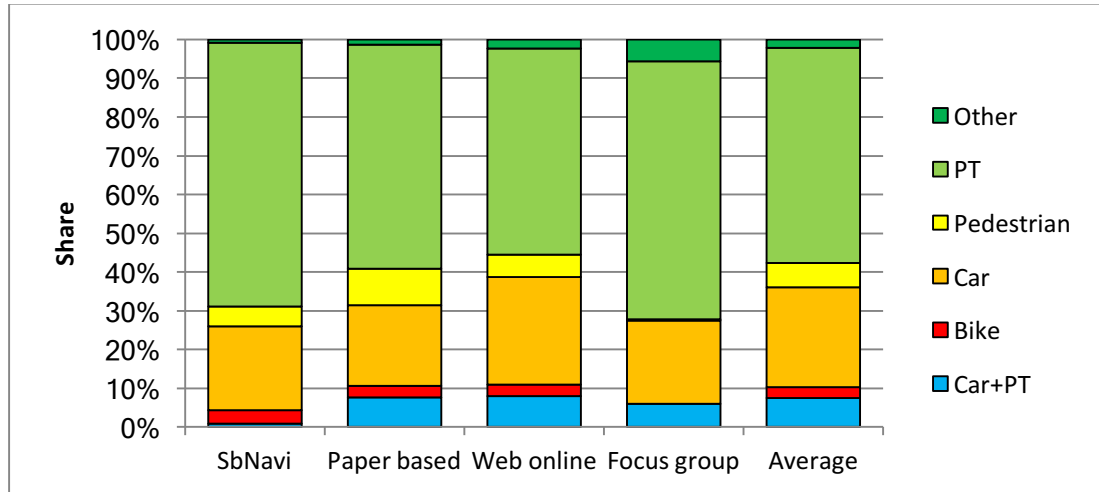
## 5. Descriptive analysis across different survey tools

Overall, gender across different test sites was fairly equally distributed. The majority of respondents were less than 55 years old, high school (or less) educated, full time employed and lived in urban areas. Stockholm respondents had the lowest car ownership rate, whilst FIA respondents had the highest. Experiencing disruptions was very common amongst Rome travellers (which had the highest share of railway users), whilst Grevena travellers experienced the least. Overall, Dublin had the highest share of public transport road users, whilst FIA motorists had the highest proportion of private car and bicycle use. Respondents from Valencia had the highest proportion of pedestrians. Dublin travellers reported the most complex journey pattern, i.e. a higher number of trip legs per journey (on average 2.54 trip legs per journey), whilst FIA motorists respondents reported the lowest (on average 1.65 trip legs per journey). Overall, the respondents made an average of 1.96 trip legs per journey.

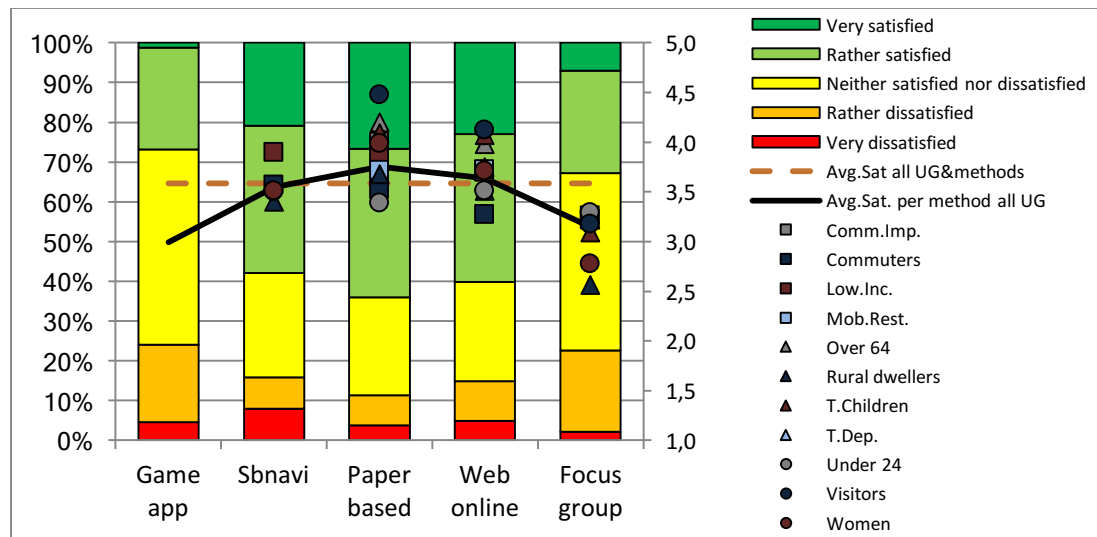
As shown in Figure 6a, different survey methods have a significantly different distribution of main travel modes (a series of Chi-square tests have been employed to confirm this). On average, tourists/visitors, travellers with children and the elderly reported the highest travel satisfaction, whilst commuters, younger travellers and rural dwellers were the least satisfied. However, these trends are not consistent throughout different survey methods.

Visitors, traveling with children and with dependents, for example, reported the highest travel satisfaction via the paper and pencil and online survey, whilst commuters and under 24 reported the lowest travel satisfactions. Those with low income significantly reported higher travel satisfaction (via SbNavi app) than rural dwellers and women (who reported the lowest). Overall, the responses that were recorded via paper-based method have the highest reported travel satisfaction, whilst the respondents who reported their travel satisfaction via game app and focus groups methods reported the lowest satisfaction, despite of their socio-demographic groups (Figure 6b) and travel mode used in the given trip leg (Figure 6c).

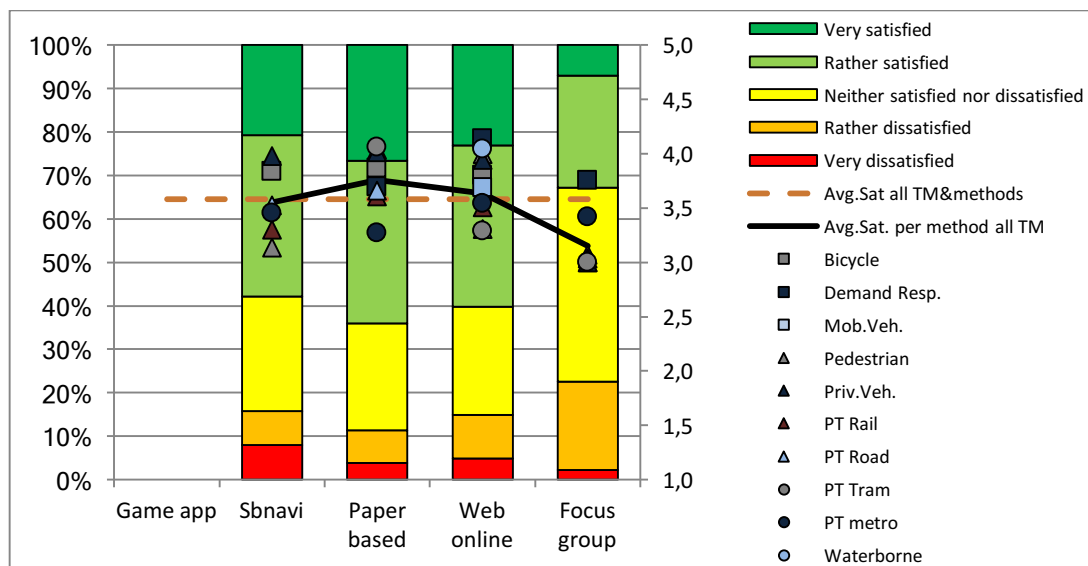
This trend, however, is not held when we focus on the reported travel satisfaction of the main trip leg. If we only focus on the main trip leg, the reported travel satisfactions that were collected via SbNavi and paper and pencil have the highest average values, whilst the ones that were gathered via focus group have still the lowest. This difference highlights the importance of understanding and measuring the dynamic of an individual's travel satisfaction from door-to-door, and not only focusing on the main trip leg, which most of NGO and authorities tend to do. Previous studies (e.g. Pedersen et al., 2011; Susilo and Cats, 2014; Susilo et al., 2015) have highlighted the systematic tendency to report higher satisfaction levels immediately after the completion of a public transport or cycling trip stage when compared with a retrospective satisfaction report. In contrast, private car travellers reported significantly lower travel satisfaction levels in retrospective reports.



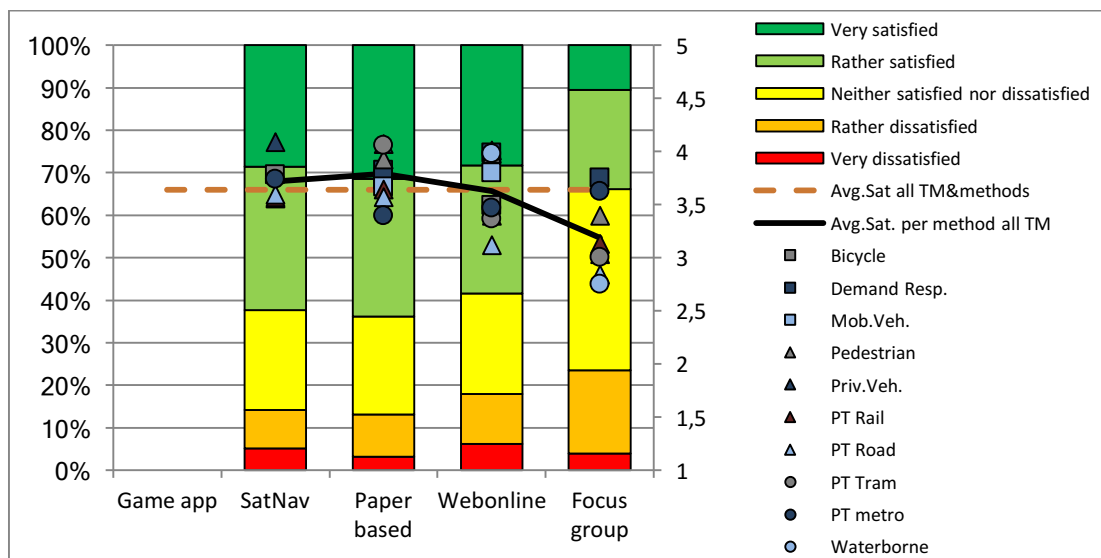
(a) Distribution of reported main mode choice by survey method (Note: No main travel mode data recorded for game app)



(b) Reported overall travel satisfaction by user groups and survey methods



(c) Reported overall travel satisfaction by main travel mode and survey methods



(d) Reported overall travel satisfaction by travel modes, regardless whether the given mode were used as the main travel modes, and survey methods

Fig. 6. Overall travel satisfaction by user groups, travel modes and survey methods

Figure 7a shows the correlation between the reported overall journey satisfaction and the reported satisfaction on each trip leg, subjective well-being spectrums, individual's socio-demographic, and trip characteristics, by different survey methods. Across different survey methods, the subjective well-being factors are the ones which consistently correlated (at 0.3) with the reported overall travel satisfaction, whereas the socio-demographic variables are the ones which have almost no meaningful correlation with the reported overall travel satisfaction.

The overall travel satisfaction reported via the sbNavi (Figure 7b) correlated ( $>0.5$ ) with travellers' satisfaction with their main and previous (access) trip legs, whilst the overall travel satisfaction reported via the game app survey method (Figure 7c) correlated with users' loyalty towards certain modes. Socio-demographic and trip

characteristics variables have no significant correlation with the reported overall travel satisfaction in both methods. However, the socio-demographic and travel characteristics of the travellers, such as income, age, education level, disruption, and frequency do influence the access and egress trip legs of the journeys recorded by sbNavi app. Only for web-based (Figure 7e) and focus group (Figure 7f) surveys all trip legs' travel satisfactions correlated with the overall travel satisfaction. Although, at web-based survey, the correlation between the access trip legs and the overall travel satisfaction reported is only significant at 0.3 level. The overall travel satisfaction that is reported via paper-based (Figure 7d) only shows a 0.3 correlation level with the main trip leg, and not with access and egress trip legs.

Different correlations towards different combinations of trip legs may also be influenced by the nature of the survey tools. The SbNavi app allowed travellers to report travel satisfaction whilst travelling, in real time. This allowed the respondents to evaluate their travel and also their previous trip legs, i.e. access trip leg. In contrast, the web-based survey respondents completed the survey post-trip. Thus, they were more focus on their main trip leg, but also the subsequent trip legs, the last mile of their final destination. The paper-and-pencil method, however, were mostly distributed in the main interchanges, where people were in a hurry and so may only result on a focus on the main (i.e. which is also likely the most recent) trip leg. Focus group respondents retrospectively evaluated trips in a group discussion, thus detached from their trip and with more time to evaluate each trip leg. Like the travel satisfactions that were reported by the SbNavi method, the reported access and egress trip legs of focus group respondents correlate with the respondents' socio-demographic characteristics and with the conditions of the trips. An ordered logit model was employed to further analyse the correlations between different groups of variables and to investigate how different survey tools together with individual and travel characteristics correlate with different level of reported individual's travel satisfaction.

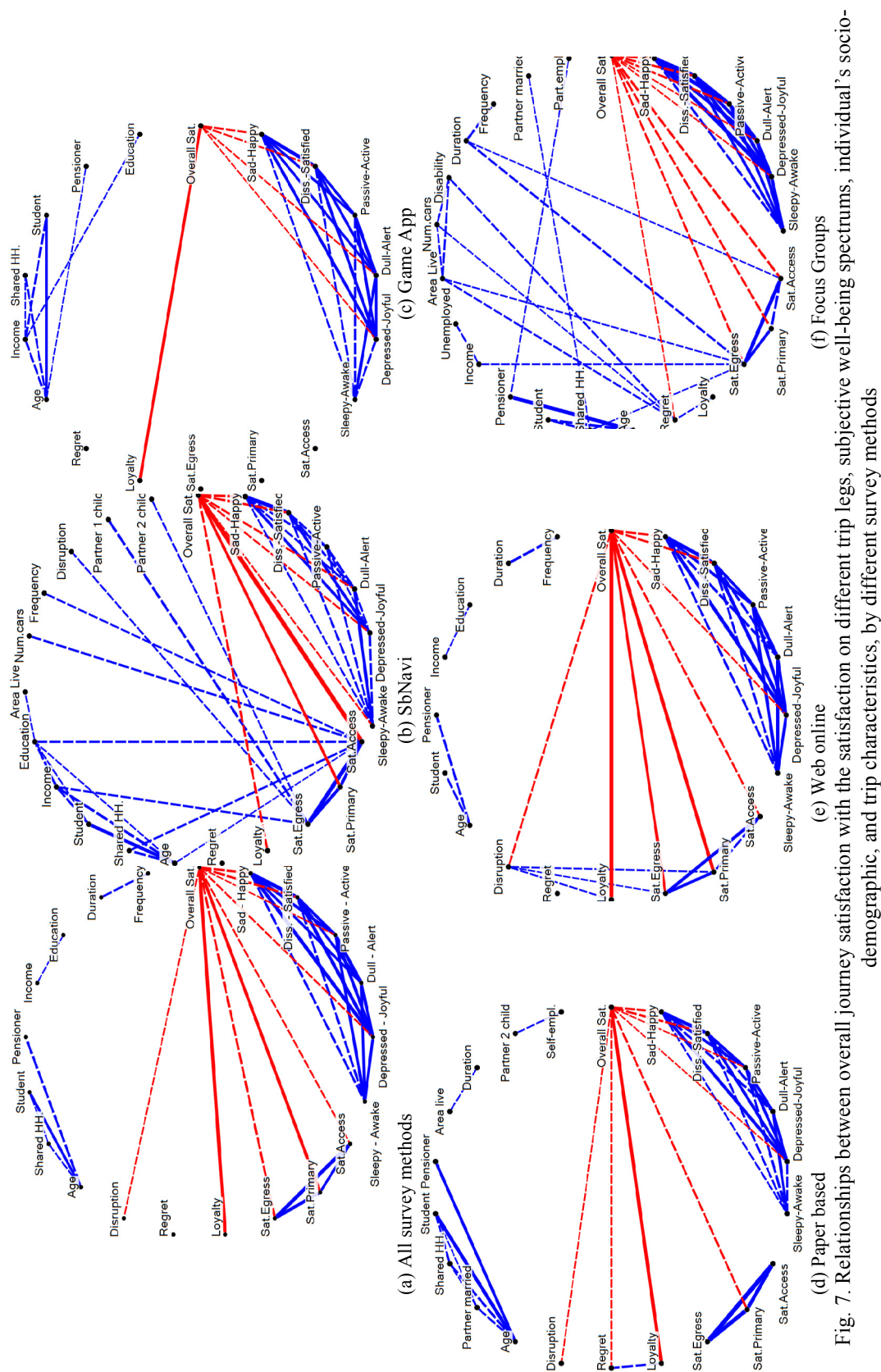


Fig. 7. Relationships between overall journey satisfaction with the satisfaction on different trip legs, subjective well-being spectrums, individual's socio-demographic, and trip characteristics, by different survey methods



## 6. Multivariate analysis across different test sites

In this section an ordered logit model is employed to explore how individuals who used different survey tools reported different levels of satisfaction. Therefore there are 8 city-specific models with the reported “overall travel satisfaction” as the dependent variable ranging from 1 (very unsatisfied) to 5 (very satisfied). The explanatory variables used in the models reflect a combination of subjective well-being indices, travel modes, individual socio-demographics and the impact of different survey methods (as dummy variables of different cities). Due to the absence of data collected by each method in every site some caution is needed to interpret the results between sites.

As can be seen at Table 4, most of socio-demographic variables and travel parameters are insignificant in influencing the reported overall travel satisfaction. Although there are some local trends that can be observed, such as that Rome travellers dissatisfaction is positively correlate with travel distance, whereas the younger travellers are the ones who are most dissatisfied in Coventry. At most observed sites, experiencing a disruption during journeys is negatively correlated with the reported travel satisfaction. In line with previous studies (Ettema et al., 2012; Friman et al., 2013), subjective well-being factors significantly correlated with the reported overall travel satisfaction. For example, at most test sites, being happy and satisfied with one’s life positively correlate with reported travel satisfaction, whereas, at some sites, being awake corresponds with a lower travel satisfaction.

In terms of survey methods, only Stockholm, Bucharest, Grevena and Coventry had valid samples for all five survey methods. Overall, responses collected via the game app (and SbNavi in Stockholm) reported a significantly lower travel satisfaction than other survey methods. At the same time, paper-and-pencil methods responses reported a higher travel satisfaction than the reference case (web on-line) in Bucharest, Coventry, Dublin, Rome and Vilnius. Survey methods were not found significant in influencing the reported travel satisfaction in Vilnius and Grevena. A fact that may be due to the small sample size from these two sites. However, focus group participants in Rome, Grevena and Bucharest reported a lower travel satisfaction than their fellow respondents.

## 7. Conclusions

This study aims to describe the lessons learned from designing, deploying and analysing the results from different travel satisfaction survey tools which measure the travellers’ door-to-door travel satisfaction. Five survey tools were tested. Each of the measurement tools comprised the same set of basic questions, but in different formats. The data collection was carried out at eight different European cities, i.e. Bucharest, Coventry, Dublin, Grevena, Rome, Stockholm, Valencia and Vilnius, and five FIA motorist networks, i.e. German, Polish, French, Spanish and the British motorist associations. It was assigned and discussed the dynamic questionnaire assignment method among different combination of user groups and travel modes. 5,275 valid responses were gathered from the survey activities and analysed. The multivariate analysis results show that, after all other variables have been controlled for, different survey methods performed better in different sites. The socio-demographic variables and the trip characteristics were less relevant in terms of influencing the reported overall travel satisfaction. Bad travel experiences and travellers’ well-being, however, were found as some of the few variables which were consistently significant in influencing the overall travel satisfaction. Overall, the study demonstrates that the survey method matters in influencing the level of travel satisfaction reported by the travellers. Furthermore, the satisfaction that was gathered via main trip leg does not necessarily correspond with overall satisfaction of the door-to-door journey. Surveying with different survey methods, however, was not without concerns. In addition to the complexity of measuring and analysing dynamic, door-to-door, multimodal, travel satisfaction, without asking the travellers to validate their data, it became hard to define the ground of truth (which devices/methods would be referred as the truth). How the different combination of variables influence the travel satisfaction differently would be the possible next step of study. Structural equation modelling will be used to examine traveller satisfaction for each trip leg, the nature of the trip purpose and also the experience of access and egress trip legs.

Table 4: Estimation results for the overall satisfaction model across different test sites

	Bucharest		Coventry		Dublin		Grevena		Rome		Stockholm		Valencia		Vilnius	
	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.
Very to rather Diss.	-5.664	.000	-7.008	.000	-4.348	.000	-4.468	.001	-4.770	.000	-4.621	.000	-4.215	.009	-1.394	.373
Rather to nor Sat/Diss.	-3.989	.000	-4.679	.000	-2.856	.003	-2.734	.044	-2.553	.000	-3.232	.000	-2.072	.139	.105	.943
Nor Sat/Diss. to rather Sat	-1.002	.324	-2.713	.024	-8.25	.379	.370	.783	-4.32	.532	-7.00	.358	.665	.629	3.546	.015
Rather to very Sat.	2.167	.035	.162	.891	1.343	.153	2.677	.048	2.139	.002	1.728	.024	3.411	.014	6.605	.000
Male	-1.159	.504	.275	.371	.065	.745	.001	.998	.113	.454	.116	.505	.395	.062	.224	.501
<24	-3.79	.543	-1.871	.016	-1.072	.101	-.134	.892	.393	.356	-.164	.702	-.697	.191	-1.209	.087
25-44	.151	.751	-1.821	.014	-1.228	.046	-.457	.525	.333	.304	-.045	.907	-.015	.969	-.232	.724
45-64	.103	.836	-1.557	.038	-.597	.319	.872	.202	-.022	.945	.145	.712	.482	.188	.212	.748
Income below	-.371	.328	-.438	.342	.280	.402	-1.393	.046	-.039	.893	-.392	.161	.254	.580	.282	.692
Income average	-.049	.885	-.552	.171	.302	.282	-1.025	.116	-.338	.234	-.291	.221	.201	.663	.225	.735
<high school	1.602	.113	-.488	.670	.551	.466	.919	.336	.747	.045	-.235	.564	1.669	.052	-.100	.913
High school	.325	.449	1.190	.008	-.085	.750	1.030	.179	.359	.202	-.076	.784	1.218	.136	-.588	.330
Bachelor	-.120	.710	1.140	.004	-.157	.542	.904	.219	.169	.549	-.155	.585	.954	.252	-.759	.172
<10 min	.295	.809	2.061	.004	.755	.313	2.749	.006	.039	.951	.199	.708	.134	.880	2.576	.022
11-30 min	-.473	.344	.909	.161	.976	.037	.207	.802	-.665	.163	-.297	.519	.079	.926	1.588	.099
31-60 min	-.857	.069	1.056	.096	.546	.190	.974	.140	-1.370	.003	-.711	.118	.296	.735	1.602	.089
61-90 min	-.786	.212	.129	.847	.240	.581	.443	.550	-1.692	.000	-1.132	.039	-.438	.655	.327	.742
91-120 min	.155	.846	.315	.661	-.424	.379	.264	.743	-2.244	.000	-1.201	.086	.614	.559	-.883	.519
2-3 hours	1.258	.219	2.907	.005	-.270	.587	-.457	.447	-1.134	.121	-.631	.383	1.097	.351	1.891	.159
Daily	-.529	.198	-.701	.064	-.819	.012	-.915	.196	-.905	.000	-.394	.115	.361	.290	-.078	.881
Weekly	-.109	.805	-.059	.881	-.145	.656	-1.571	.011	-.716	.006	-.077	.741	.074	.844	.293	.580
Monthly	-.477	.438	-1.324	.035	-.265	.560	-1.176	.028	-.172	.686	.326	.394	.178	.825	.436	.517
Disruption-Yes	-1.752	.000	-1.599	.000	-1.964	.000	.452	.730	-1.196	.000	-1.596	.000	-1.672	.003	-1.080	.097
No car	-.397	.311	-.915	.027	-.505	.090	-2.003	.002	-1.469	.000	.084	.767	-.664	.088	-.073	.894
One car	-.242	.484	-.449	.166	-.320	.183	-.604	.244	-.107	.541	.230	.362	-.300	.305	.270	.566

	Bucharest		Coventry		Dublin		Grevena		Rome		Stockholm		Valencia		Vilnius	
	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.
Partner/married Single with children	-.527	.162	.482	.293	-.302	.295	-.826	.190	-.190	.407	.092	.702	-.327	.340	.469	.331
	-.024	.976	2.249	.024	-1.769	.039	-3.228	.008	-.280	.532	-.469	.208	-.737	.052	-1.369	.065
Partner/married children Other	.624	.130	.794	.157	-.631	.087	-.289	.645	-.182	.468	.064	.832	-.218	.538	.238	.652
	.267	.481	-.006	.990	.224	.463	-.227	.694	-.887	.001	.154	.550	-.205	.640	.158	.759
Unemployed Student Other	-1.285	.063	-.101	.937	.306	.697	1.145	.206	-.242	.601	.825	.105	-.643	.049	-.087	.880
	.808	.180	-.225	.661	-.699	.086	-.355	.692	-.199	.602	.234	.422	.596	.269	.206	.779
Terraced/Detached/ Semidet. House Small/Med. Building	-1.105	.765	.145	.722	-.022	.940	.067	.904	.408	.047	.339	.149	-.230	.413	-.024	.951
	-.704	.051	-1.564	.012	-.559	.092	1.236	.030	.341	.126	.799	.001	-.489	.296	.013	.977
Happy Satisfied	-.349	.341	-1.822	.015	-.179	.691	.578	.186	.165	.352	.338	.106	-.039	.873	-.505	.275
	1.424	.000	-.200	.621	.654	.015	-.323	.625	.953	.000	.480	.047	.810	.022	.753	.039
Active Alert	.609	.058	.768	.055	1.173	.000	.466	.481	.861	.000	.729	.002	-.184	.587	1.673	.000
	.138	.646	1.162	.002	.075	.746	-1.112	.102	.419	.027	-.029	.892	-.207	.572	-.094	.793
Joyful Awake	.077	.780	.290	.453	-.212	.381	1.405	.007	-.139	.470	-.023	.923	.097	.779	.818	.032
	-.817	.009	-.049	.897	.174	.508	1.189	.062	-.302	.119	.244	.265	.789	.028	.634	.086
Start_Workplaces Finish_Workplace ArealiveUrban	.374	.221	-.878	.019	.208	.368	-1.161	.023	-.286	.144	.456	.032	.052	.884	1.120	.003
	.197	.628	-.294	.382	.291	.219	.440	.436	.232	.273	.023	.913	.456	.154	-.116	.774
Sat Nav	-.624	.035	-.613	.080	.458	.039	.436	.300	-.099	.542	-.348	.045	-.823	.000	-.157	.621
	.147	.785	-.263	.381	-.174	.419	1.287	.054	-.123	.494	.141	.567	.891	.025	.965	.023
Game app	-.0644	.0504	-1.141	0.245	3.076	0.012	-1.251	0.330	(N/A)	(N/A)	-0.556	0.014	0.166	0.825	(N/A)	(N/A)
	-1.901	0.014	-1.893	0.005	-1.195	0.105	(N/A)	(N/A)	-2.844	0.000	-1.296	0.000	-2.622	0.000	0.821	0.199
Paper-based Focus groups	0.770	0.045	1.849	0.000	0.771	0.003	-0.136	0.813	0.500	0.080	-0.040	0.881	0.369	0.471	0.826	0.079
	-1.915	0.002	-0.332	0.888	(N/A)	(N/A)	-1.027	0.072	-1.274	0.000	-0.795	0.059	(N/A)	(N/A)	(N/A)	(N/A)
-2 Log Likelihood	645.09		504.51		948.73		418.55		1639.96		1275.07		871.14		374.47	
Df	43		43		42		42		42		43		42		41	
Pearson Chi-square	1270.01		870.11		1416.36		736.25		4267.71		2401.62		1646.41		609.86	
McFadden Ps. R-sq	0.213		0.305		0.251		0.237		0.188		0.158		0.126		0.276	
N	329		261		406		220		697		575		472		212	

## Acknowledgements

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