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Abstract:
This study investigates how different travel satisfaction survey methods influence the reported level of door-to-door travel satisfaction among travellers. 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. Each of the measurement tools comprised similar set of questions, but in different formats, aimed at exploring the pros and cons of each tool among different group of travellers. In total, 5,275 valid responses were collected during the survey period from eight European cities and five FIA national motorist networks. The analysis results with ordered logit model of travellers' reported overall satisfaction showed that the travel satisfaction reported by different survey methods and different travel modes and user groups, correlated with distinct groups of key determinants. The relationship between and within these key determinants, however, was far from straight forward. Some were more complex than others. Some issues that are mostly discussed by policy makers and users may not be the ones that directly correlate with the users' overall travel satisfactions. Consistent with previous studies, the travellers' mood and previous experience influenced the reported overall journey satisfaction.

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1. Introduction

Providing an accessible and inclusive transport service for all is important to ensure that people are not excluded from reaching places of employment, health, education and leisure services, and – simultaneously - ensuring equal life opportunities for diverse communities. However, different travellers have different needs and priorities and these influence their satisfaction relating to various quality factors of provided services. In order to provide a transport service that meets individual travel needs, it is important to understand the factors that underlie travel satisfaction for different individuals. Thus, 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; Susilo and Cats, 2014).

Stradling et al. (2007), for example, found that non-instrumental variables such as cleanliness, privacy, safety, convenience, stress, social interaction and scenery play a significant role in influencing traveller satisfaction with journeys. Also, punctuality and reliability are likely to be at the top of a commuter's priority list (DfT, 2011), while safety, reliability and service frequency are particularly important for women (Tranter, 1995). Although adults on a low income will share the same broad travel needs as the general population, previous studies show that this group are associated with a lower level of car-ownership (e.g. Giuliano and Narayan, 2003; Hine and Mitchell, 2003), more walking and frequent use of public transport, and are less likely to chain non-work trips to their commute trips than their higher socio-economic group counterparts (Clifton, 2003; BMRB, 2004, etc.). For older people mobility is much more closely connected with health and well-being (Banister and Bowling, 2004): mobility and the ability to get out of the home are essential to their quality of life (Farquhar, 1995; Andrews et al., 2014). Further, being unable to drive/travel independently is one of the strongest predictors of increased symptoms of depression among older people (Marottoli et al., 1997), and an individual's ability to use the transportation system freely has long been defined as one of the seven important areas in the Instrumental Activities of Daily Living (IADL) of the elderly (Fillenbaum, 1985).

Despite the complexities that underlie an individual's activity-travel participation and satisfactions that relate to them, previous studies have focused on a particular travel mode and/or at particular trip purpose, and often ignored the impact of access and egress legs on the overall journey satisfaction. This may lead to an inaccurate evaluation of service provision by public transport operators and can undermine the quality of interchanges and last-mile facilities on passenger overall travel satisfaction. Eurobarometer (2013) shows, among railways travellers in 26 EU member states, that the relationship between railway journey satisfaction and the passengers' satisfaction with the railway station is not linear. Often stations are simply regarded as change points - places where passengers have to change as quickly and efficiently as possible from one mode of transport to another. However, some authorities, such as Netherlands Railways, have the view that stations are places that need to be transformed into dynamic urban portals that not only facilitate a speedy transfer but also make the stay at the station more enjoyable (van Hagen, 2015). Thus, while passengers want travel to be safe, frequent, and reliable, Iseki et al. (2007) found that security and interchanges design and maintenance, such as visibility, the absence of graffiti, and the presence of a seating area, restroom, and shelter significantly influence

passengers' travel satisfaction. Muconsult (2003, cited by van Hagen, 2015) estimated that passenger satisfaction towards stations determines about 25% of the score awarded to the total train journey satisfaction.

Beside the lack of comprehensiveness in measuring journey satisfaction, there is also a lack of knowledge on how different travel satisfaction method measurements influence the reported level of satisfaction. Susilo and Cats (2014), for example, found that there is a 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. This is consistent with findings based on a similar question asked years after a trip occurred (Pedersen et al., 2011). Similarly private car travellers reported significantly lower travel satisfaction levels in retrospective reports.

In order to address this problem, this study aimed to investigate how different travel satisfaction survey methods (during and post-trip) influence the reported level of door-to-door travel satisfaction among travellers. 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. Each of the measurement tools comprised similar set of questions, but in different formats, aimed at exploring the pros and cons of each tool among different group of travellers.

In the next section, we will describe the survey and the tool design and the data collection activities. The descriptive and correlation analyses of the collected datasets from 8 different cities and five FIA's national networks are then presented. This is followed by multivariate analyses which are employed to measure the impacts of different survey methods towards the overall travel satisfaction reported. The article closes with a summary section.

2. METPEX Project and Survey Description

This study is a part of METPEX FP7 EU project (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 early 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 were used to identify the variables that could be used to better monitor and evaluate the passenger experience during journeys by public and active forms of terrestrial transport, with special attention toward 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 et al., 2014; Susilo and Cats, 2014). Based on this, a set of questionnaires were developed and consisted of five following sections:

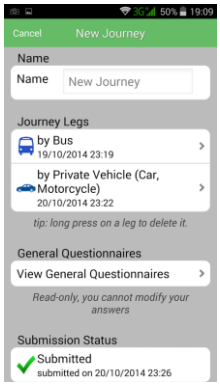
- Individual attributes (i.e. socio-demographic, mobility behaviour)
- Attitudes (i.e. travel preferences, mobility-related opinions)

- 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.)

The questionnaire was then translated into 5 different survey methods:

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

The detailed content descriptions and design considerations of these five tools can be seen in METPEX (2014). 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). For every each specific user group and travel mode combination, each respondent was asked to answer 50-75 questions in total, which required an individual to spend approximately 20-30 minutes to complete the whole questionnaire. The survey tools were available 10 different languages - English, French, German, Spanish, Italian, Greek, Swedish, Lithuanian, Polish and Romanian.



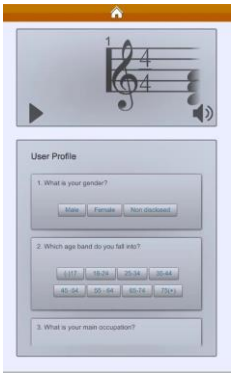


Figure 1: a) Snapshot of navigation app interface b) Snapshot of Game app interface

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 target groups were calculated based on the socio-demographic and travel mode distribution in each test group/city. 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 chance to win an iPad. In other cities, stakeholders' and membership networks (e.g. FIA, Bucharest, 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 on a main railway station and coffee shop.

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 1 below). 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.

Table 1. 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	51	281	9	46	24
Coventry	336	207	86	6	28	9
Dublin	467	146	284	8	29	0
Grevena	267	124	57	3	2	81
Rome	729	143	501	0	22	63
Stockholm	842	144	226	176	222	74
Valencia	501	17	430	13	41	0
Vilnius	247	152	55	16	24	0
FIA networks	1475	0	1475	0	0	0
TOTAL	**5275**	**984**	**3395**	**231**	**414**	**251**

As can be seen from Table 1, 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%), were attracted the lowest response rates. This low response rate, however, varied in different countries, and it is important to note that the Game app contained a fewer number of questions, which were less complex and thus more user friendly, than the SbNavi app. This may be why the former attracted a higher number of respondents than the latter. 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.

The distribution of the respondents among different socio-demographic groups and travel modes can be seen respectively in Table 2 and Table 3, below. 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. Pedestrians and cyclists were also more difficult to capture than rail-based travellers. This

latter is probably because many of the recruitment processes focused on the main interchanges where the travellers' main travel modes were rail/road based public transport. It is also important to note that it is very difficult, if not impossible, for pedestrians, cyclists and car drivers to participate in real-time survey alternative (e.g. using the apps) whilst travelling.

Table 2. Distribution of valid respondents, by socio-demographic characteristics[1]

City	Comm. Impaired	Commuters	Low Income	Mobility Restricted	Elderly	Rural dwellers	Travelling with children	Travelling with dependent	Under 24	Visitors	Women
Bucharest	11	76	49	19	21	21	20	2	32	31	83
Coventry	9	67	11	5	16	16	7	1	58	44	74
Dublin	8	209	40	9	10	24	5	3	45	7	78
Grevena	2	8	35	12	38	28	31	0	56	20	35
Rome	8	165	115	22	40	44	4	5	143	32	129
Stockholm	9	110	76	55	31	13	54	3	109	9	151
Valencia	9	62	113	19	49	4	14	2	32	29	127
Vilnius	9	33	31	9	20	3	15	1	22	4	76
FIA networks	150	221	197	57	44	133	29	25	106	157	356
TOTAL	**215**	**951**	**667**	**207**	**269**	**286**	**179**	**42**	**603**	**333**	**1109**

Table 3. Distribution of valid respondents by travel mode[1]

City	Private vehicle	PT Road	PT Rail (Tram, Rail, Underground)	Pedestrian and Bike	PT Waterborne	Demand Responsive Transit	Mobility Vehicles
Bucharest	58	104	153	30	0	18	2
Coventry	87	82	87	44	0	8	0
Dublin	22	310	91	13	1	1	0
Grevena	68	133	8	50	5	1	0
Rome	182	171	328	20	1	0	5
Stockholm	131	129	286	55	3	16	0
Valencia	131	107	60	162	0	0	0
Vilnius	46	133	3	36	0	4	1
FIA networks	540	293	422	130	20	17	53
TOTAL	**1265**	**1462**	**1438**	**540**	**30**	**65**	**61**

Further distribution analysis on the survey results by each city are described in Section 3 and comprehensive multivariate analysis to explore the unique behaviour across different survey methods and travel modes are described in Section 4.

[1] 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.

3. Descriptive Analysis

As shown in Table 4 below, overall, there was a fair distribution of gender across different test sites, with Coventry having the lowest and FIA network having the highest proportion of women amongst their samples. 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 the FIA respondents had the highest. Experiencing disruption 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.

As can be seen from Figure 2, 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.

Focussing on the main travel mode of the journey (see Figure 3)[2], respondents from Dublin, Bucharest and Stockholm had the highest proportion of public transport travellers (77%, 70%, and 69%, respectively), whilst respondents from FIA network, Valencia and Coventry had the highest proportion of private car use (37%, 28%, 28%, respectively). Dublin, Rome and Coventry (17%, 13%, 11% respectively) had the highest proportion of respondents who combined their private car trip with public transport trip (e.g. Park and Ride). Chi-square tests showed that different survey method has significantly different distribution of main travel mode. A significant amount of leisure and shopping trips were carried out on foot, whilst a significant amount of commuting trips used the bicycle, private car and public transport, and a significant amount of tourism trips were carried out using the private car and public transport.

[2] Trips were classified into one of five trip mode categories – Car/MC, PT, Bike, Car/MC+PT or Walking - based on the following criteria:

- If the trip contains a private vehicle trip stage (car as driver, car as passenger or motorcycle or scooter) and does not include a public transport trip stage, then the trip is classified as **Car**.
- If the trip contains a public transport trip stage (underground, light rail train, tram, trolley bus, suburban train, bus) and does not include a private vehicle trip stage, then the trip is classified as **PT**.
- If the trip contains a bike trip stage and does not contain any private vehicle or public transport trip stage, then it is classified as **Bike**.
- If the trip contains both private vehicle trip stages and public transport trip stages then it is classified as **Car+PT**.
- If the trip consists of walking trip stages only then it is classified as **Walking**.
- If the trip does not fit in any of the above categories then it is classified as **Other** (e.g. Demand responsive transport/Mobility scooter/Waterborne).

Table 4. Distribution of sample by test sites

		Bucharest	Coventry	Dublin	FIA	Grevena	Rome	Stockholm	Valencia	Vilnius	Average
Gender[1]	Male	44.0	↑ 34.5	49.3	↑56.7	49.1	45.7	44.2	36.1	34.8	**46.7**
Age[2]	18-24	19.2	↑ 33.6	28.3	17.4	23.2	25.4	24.9	↑14.0	17.8	**21.8**
	25-34	↑ 34.5	22.3	23.1	29.6	13.1	16.5	24.7	↓12.6	30.8	**23.9**
	35-44	18.7	↑ 12.2	20.8	23.5	↑23.6	21.1	17.1	21.8	14.2	**20.2**
	45-44	↑ 9.5	11.0	13.7	16.9	13.5	19.2	13.8	↑21.0	13.8	**15.5**
	55-64	7.5	11.3	8.1	9.7	7.1	8.9	↑ 5.2	9.4	↑11.7	**8.6**
	65-74	8.0	6.0	4.3	↑ 3.0	↑13.9	7.4	6.3	11.2	9.3	**6.4**
	>75	2.4	2.7	.6	↓ .1	5.6	1.2	1.2	↑10.2	1.2	**2.1**
Education	Less than high school	↓ 1.7	2.7	3.0	8.8	22.1	11.2	9.9	↑31.5	4.5	**10.5**
	High school	↑ 29.7	43.2	37.7	41.7	47.6	↑54.3	51.7	53.3	33.6	**44.9**
	Bachelor degree	↑ 45.0	32.7	29.3	29.8	21.3	24.8	26.4	↑13.6	39.7	**28.4**
	Postgraduate qual.	23.6	21.4	↑30.0	19.7	9.0	9.6	12.1	↓ 1.6	22.3	**16.3**
Occupation[3]	Full time emp.	↑ 55.7	43.5	52.5	54.0	↑15.0	37.2	37.8	32.1	47.8	**44.1**
	Part-time emp.	6.1	13.1	8.6	10.6	↓ 4.1	↑13.4	11.2	9.0	7.7	**10.1**
	Unemp.	3.9	↑ 2.4	3.0	8.0	10.5	2.9	4.2	↑17.6	9.7	**6.7**
	Student	12.4	17.9	15.8	8.0	19.9	21.4	↑ 27.4	8.2	↑7.3	**15.2**
	Pensioner	10.7	9.8	↑ 4.1	6.6	19.5	9.1	6.4	↑23.4	10.1	**9.6**
Income[4]	Under average	40.1	40.2	35.1	↓26.5	41.2	47.3	40	↑66.9	51.4	**40.0**
	Above average	20.2	20.8	↑21.4	21.1	9.4	8.6	21.3	↓ 5.4	8.1	**16.6**
Disability	Yes	22.9	17.6	11.3	↑27.5	9.0	↓ 8.6	12.9	19.6	12.6	**17.8**
Area of residence[5]	Rather urban or urban	87.8	50.0	55.7	61.6	↓46.8	59.0	70.1	↑92.6	78.1	**66.3**
	Neither rural nor urban	↓ 3.4	22.0	22.5	18.5	↑34.5	25.2	15.4	4.0	12.6	**17.5**
Type of building[6]	Terraced house	3.6	↑ 27.1	16.5	16.5	↓ 2.2	6.9	13.3	3.4	4.5	**11.8**
	Detached/ semi det. House	13.6	54.5	↑63.2	26.6	28.5	16.5	14.0	↓ 2.6	14.2	**24.4**
	Medium or large building (>5 hh)	77.9	↓ 13.1	16.7	41.8	61.0	59.8	66.9	↑92.2	76.5	**54.4**
Living with[7]	Single	15.6	19.3	24.8	19.5	24.3	22.2	↑ 30.9	↓14.0	29.1	**22.0**
	Partner/ married	↑ 32.1	28.0	26.6	28.8	28.5	26.6	↓22.4	24.0	23.5	**26.8**
	Partner/ married 1 or more children	22.1	15.8	↓13.1	33.3	↑34.8	20.7	19.5	32.1	27.9	**25.3**
	Shared household	18.7	25.3	↑27.2	6.2	9.7	16.5	19.8	↓ 1.6	7.3	**13.6**
Cars[8]	Number in HH	0.86	1.36	1.29	↑1.52	0.96	1.46	↓0.85	1.01	0.93	**1.22**

[1] Not showing the categories Female and Non-disclosed.

[2] Not showing <17 age years old

[3] Not showing Self-employed, Working student, Housewife/Husband and Other

[4] Not showing Average income

[5] Not showing No disability

[6] Not showing Small building apartments

[7] Not showing Single with 1 or more children

[8] The category 5 or more cars has been considered as 5.5 cars when averaging the number of cars per HH.

Table 4. Distribution of sample by test sites *(continued)*

		Bucharest	Coventry	Dublin	FIA	Grevena	Rome	Stockholm	Valencia	Vilnius	Average
Trip purpose[1]	Commuting to work	28.7	25.8	↑33.6	16.2	↓ 5.8	32.8	26.8	28.3	25.5	**24.2**
	Commuting back home	6.6	8.7	↑24.9	7.2	1.0	12.0	9.4	↓ 0.6	17.1	**9.4**
	Work related	10.9	8.9	10.3	10.5	↑13.3	10.5	10.6	↓ 5.0	7.7	**10.0**
	Education	8.5	14.5	9.0	7.4	↑17.9	16.6	13.9	↓ 6.4	7.4	**10.8**
	Shopping	7.0	8.7	4.3	12.2	9.4	↓4.1	12.1	11.7	↑13.2	**9.6**
	Leisure	17.1	21.1	12.0	23.9	↑32.5	↓9.9	18.7	26.6	11.0	**19.3**
	Visiting the city-Tourism	10.1	8.2	↓ 1.9	↑15.7	9.7	5.7	2.9	10.3	2.9	**8.8**
Frequency[2]	Daily	46.7	36.3	45.2	22.8	↓19.9	57.2	31.4	↑65.5	38.1	**38.3**
	Weekly	↓ 17.0	22.6	25.1	21.1	25.1	21.4	↑ 35.9	23.2	32.4	**24.5**
	Monthly	4.4	4.8	6.6	8.3	↑12.7	3.7	6.5	↓ 1.6	8.9	**6.3**
	Ocassionally	28.5	35.1	22.7	↑43.8	40.1	17.4	24.6	↓ 9.2	17.8	**28.8**
Duration[3]	<10 min	↓ 1.5	13.1	2.4	3.6	13.9	2.5	7.5	↑14.4	7.3	**6.1**
	11-30	18.5	30.1	↓15.4	19.2	23.2	20.9	36.8	↑59.1	36.8	**27.4**
	31-60	↑ 45.5	26.2	32.3	↓17.4	18.0	45.3	39.9	↓17.4	38.1	**29.9**
	61-120	9.7	20.2	↑34.0	12.3	10.5	26.3	9.0	↓ 5.8	10.9	**15.2**
	>2h until 4h	7.3	8.0	12.6	16.3	↑17.2	2.5	3.2	↓ 2.4	3.6	**8.8**
	>6 hours	15.8	2.1	3.2	↑30.4	12.0	2.6	2.9	↓ 1.0	1.6	**11.7**
Legs	Avg. number	2.3	2.0	↑2.5	↓1.7	2.1	2.0	↓ 1.7	2.2	2.3	**2.0**
Modes all legs[4]	Bicycle	2.0	2.5	0.8	↑4.1	↓ 0.2	0.6	2.6	2.0	1.3	**2.1**
	Pedestrian	35.8	32.9	36.1	↓13.4	46.6	19.6	31.5	↑66.4	52.8	**32.2**
	Private vehicle	↓ 8.2	20.9	8.5	↑29.7	16.1	19.5	12.0	12.3	10.4	**17.4**
	PT Rail	4.3	↑20.3	9.2	17.7	1.2	16.5	11.6	↓ 0.6	1.1	**11.0**
	PT Road	23.3	19.5	↑39.6	19.7	30.9	22.3	19.2	↓11.5	31.5	**23.0**
	PT Metro+Tram	↑ 23.3	2.1	5.1	8.7	1.6	20.7	21.3	7.1	↓ 0.5	**11.4**
	Other	3.0	1.9	0.8	↑6.5	3.4	0.6	1.8	↓ 0.2	2.4	**2.7**
Mode main legs[5]	Bicycle	4.4	2.6	0.2	↑4.5	↓ 0.0	1.1	4.0	3.3	2.2	**3.0**
	Pedestrian	4.1	11.7	2.7	4.3	19.2	↓ 1.7	6.0	↑32.0	13.9	**8.3**
	Private vehicle	15.9	28.2	↓ 5.5	↑36.6	25.7	25.7	21.0	28.5	20.6	**26.0**
	PT Rail	9.9	27.3	16.4	22.4	1.9	↑28.6	18.2	↓ 1.1	1.3	**17.5**
	PT Road	28.5	26.6	↑70.8	↓19.9	49.8	24.2	21.6	23.3	59.6	**30.2**
	PT Metro+Tram	↑ 31.8	1.0	3.9	6.2	1.1	17.8	26.1	12.0	↓ 0.0	**11.8**
	Other	5.5	2.6	0.5	↑6.1	2.3	0.8	3.1	↓ 0.0	2.2	**3.2**
Disruption?	Yes	13.6	28.9	41.1	13.5	↓ 1.1	↑41.7	14.8	3.0	5.3	**19.0**

[1] Not showing Mainly/somewhat workplaces

[2] Not showing Escorting dependents, Escorting children and Medical/social care appointments.

[3] and [4] not showing DK/NA

[5] The group Other is composed by Waterborne, Mobility vehicle and Demand responsive

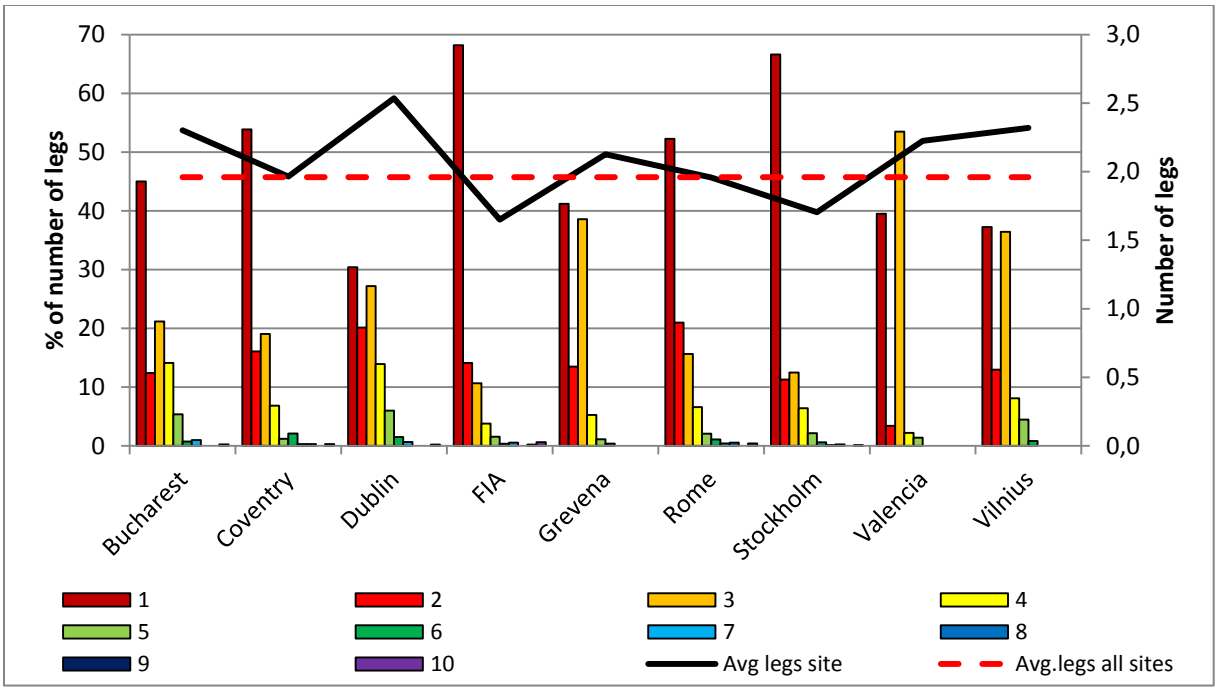
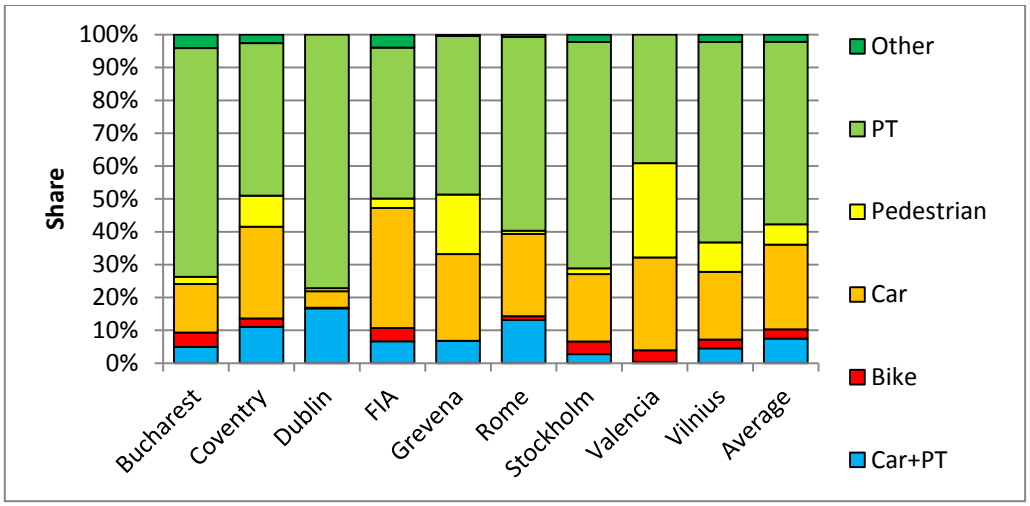


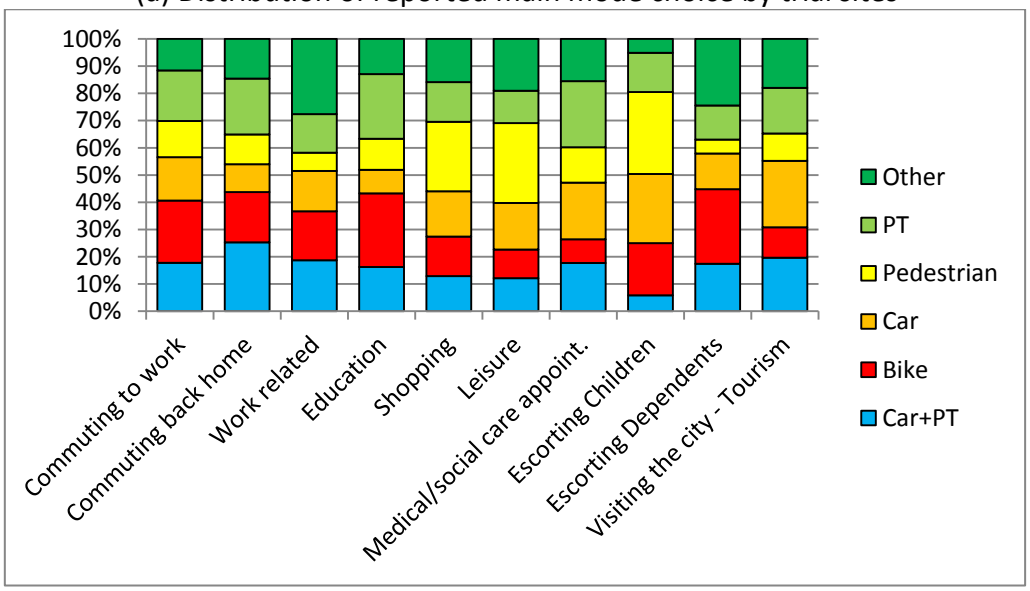
FIGURE 2: Distribution of reported trip stages by trial sites

In terms of reported overall travel satisfaction, on average tourists/visitors, travellers with children and the elderly reported the highest travel satisfaction, whilst commuters, younger travellers and rural dwellers were least satisfied (see Figure 4a). However, across different survey methods, this only applied among respondents who participated in paper based and on-line surveys (the majority of the respondents). Surprisingly, the communication impaired, mobility restricted and low income travellers reported the highest travel satisfaction via the sbNavi app, whilst tourists/visitors and the elderly reported the lowest travel satisfactions. Those with communication impairments significantly reported higher travel satisfaction (via focus group methods) than commuters, rural dwellers and women (who reported the lowest).

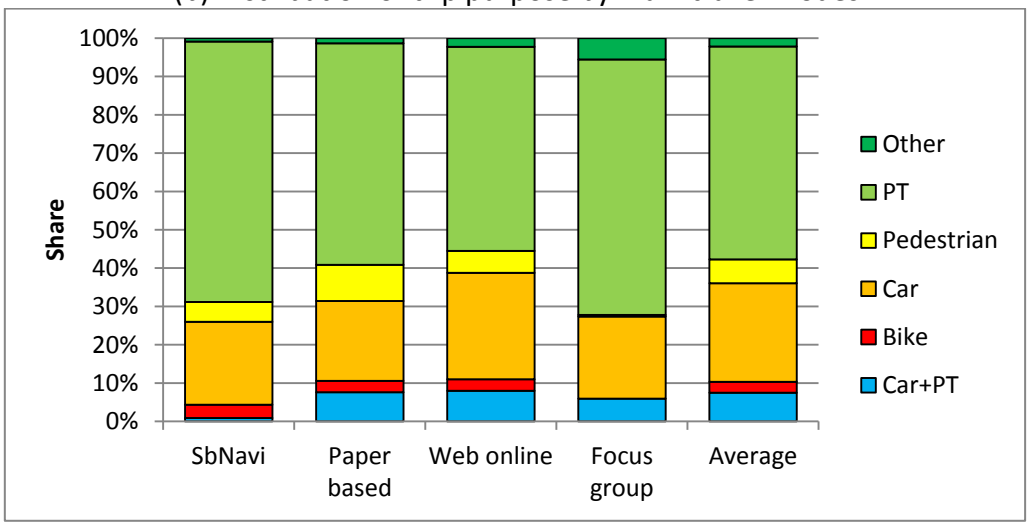
Interestingly, when comparing travel satisfaction for different travel modes as the main travel modes (Figure 4b) and as travel mode in any trip legs (Figure 4c), the order is dissimilar. The main travel modes, pedestrians, waterborne, demand responsive and private vehicle were reported as providing the highest travel satisfaction, whilst the tram, public transport road and underground modes were reported as providing the lowest travel satisfaction. Meanwhile in terms of the whole door-to-door journey trip legs, private vehicle legs were reported to have the highest travel satisfaction, followed by pedestrian, demand responsive and waterborne legs; the public transport road and rail modes were reported as the least satisfying among all other travel modes. This difference highlights the importance of understanding and measuring the dynamic of an individual's travel satisfaction from door-to-door, and not only focus on the main trip leg, which most of NGO and authorities tend to do. Consistent with previous graphs, different survey methods in conjunction with the influence of different sample characteristics resulted in differences in the order of travel satisfaction across different travel modes.



(a) Distribution of reported main mode choice by trial sites

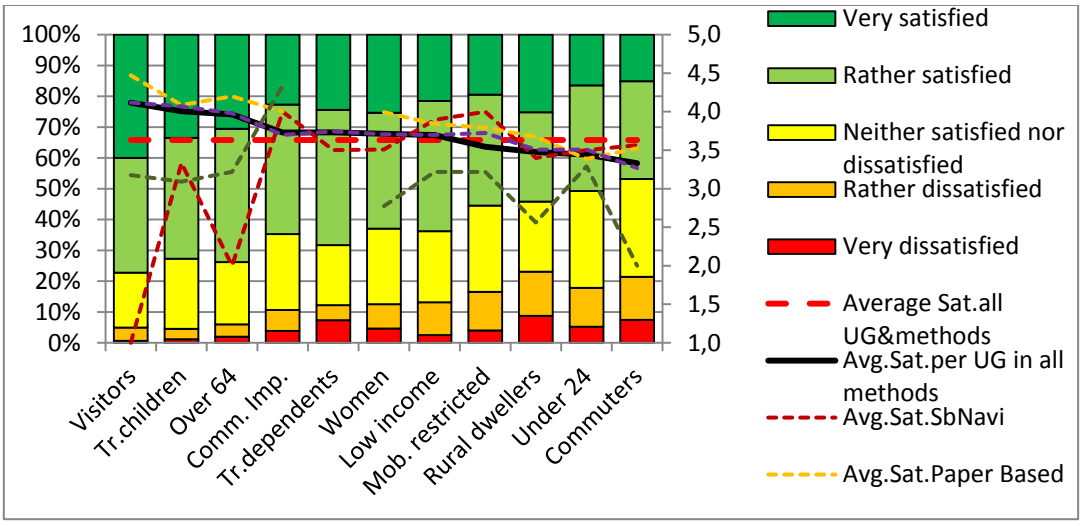


(b) Distribution of trip purpose by main travel modes

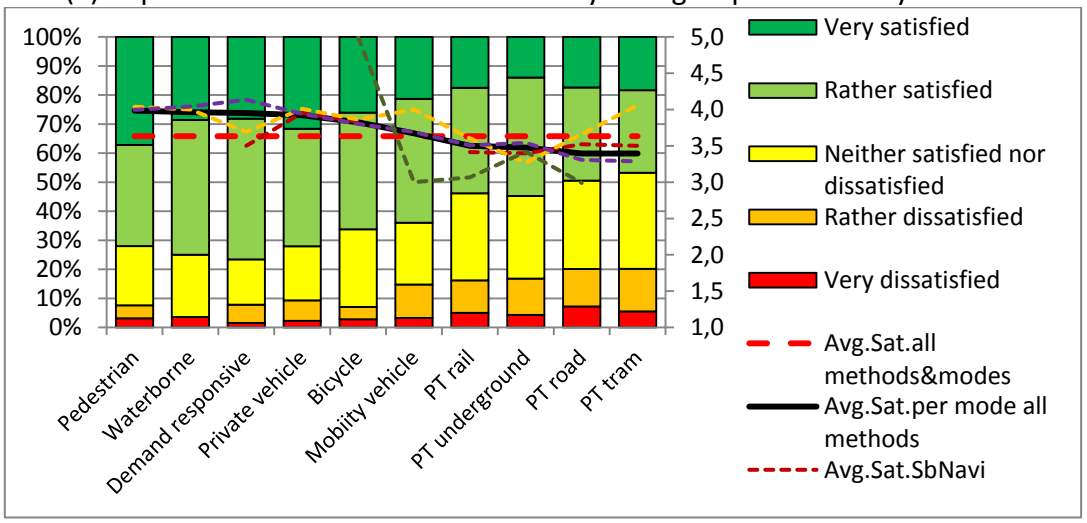


(c) Distribution of reported main mode choice by survey method (Note: No main travel mode data recorded for game app)

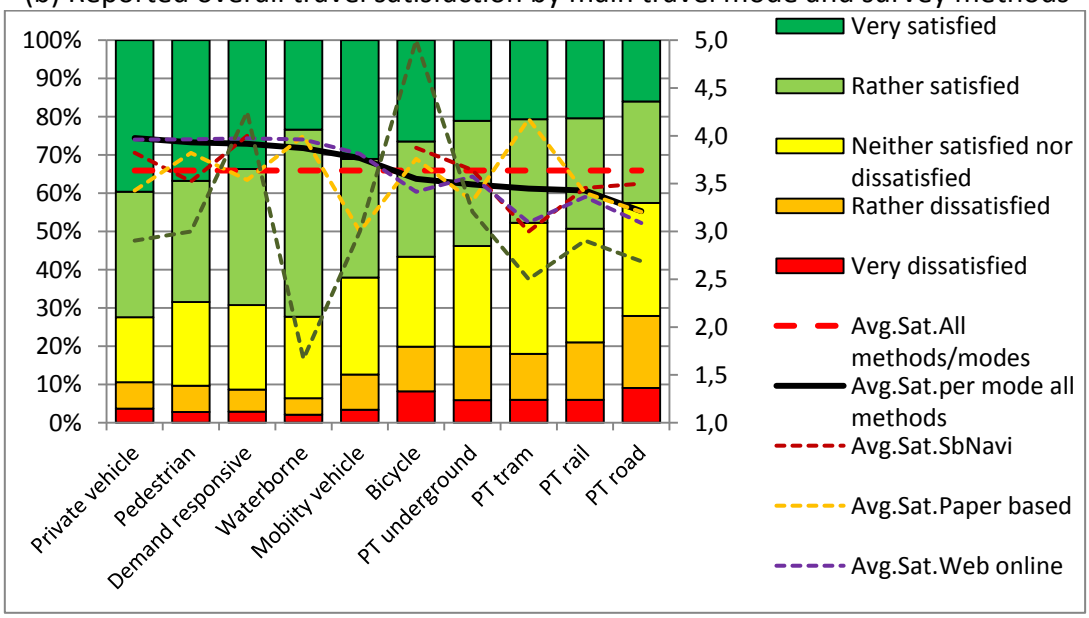
FIGURE 3: Distribution of reported main mode choice by trial sites and survey app



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



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



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

FIGURE 4: Overall travel satisfaction by user groups, travel modes and survey methods

Previous studies (e.g. Ory and Mokhtarian, 2005; Cantwell et al., 2009) reported that the level of travel satisfaction is a function of travel distance; the longer he/she travelled, the less satisfied he/she become. However, as can be seen from Figure 5 below, this relationship only applied until 90 minutes of travel. Once the trip became longer than 90 minutes, the level of satisfaction increased and was relatively steady for longer trip durations. Presumably this is due to the purpose of longer trips - perhaps geared up for leisure and other special trips - and travelers will have prepared themselves for a longer amount of travel time.

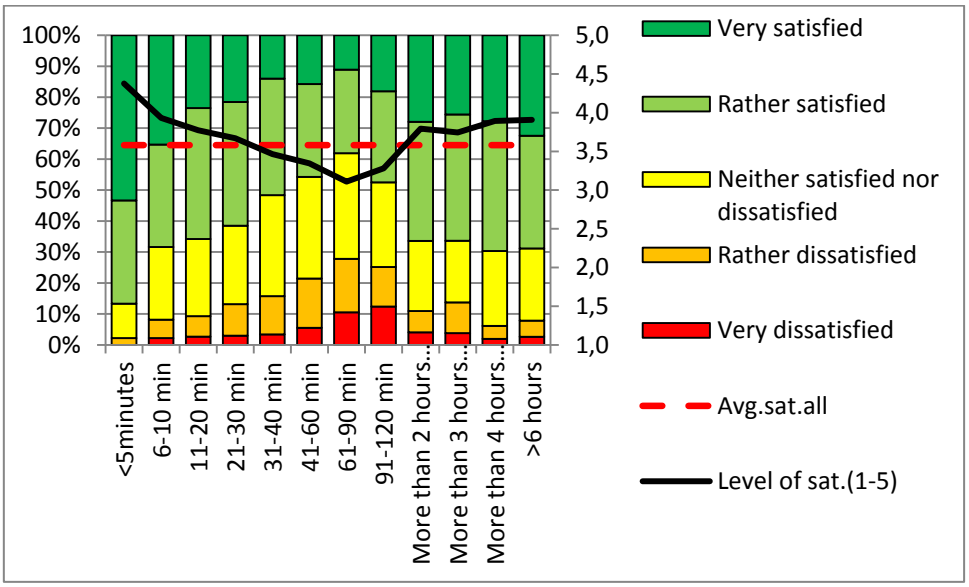


FIGURE 5: Overall travel satisfaction by trip duration

Cross-correlation by travel mode and survey methods

A correlation matrix was constructed in order to identify the travel experience aspects that were most strongly correlated to overall trip satisfaction, as well as the extent to which various travel experience aspects were inter-correlated. Figures 6 and 7 present cross-correlation matrices for different travel modes and survey methods, with each aspect of experience represented as a node and the correlation between two items illustrated by a link. The cross-correlation graphs were visualized using the NodeXL excel add-in and offered an intuitive glimpse of the relationships between the various factors. The line thickness corresponds to the degree of correlation. Correlations with the overall journey satisfaction are highlighted using red solid lines. Correlations among other sub/categories are displayed in blue. Correlations above 0.5 are shown with a solid line and those between 0.3 and 0.5 with a dashed line. The correlation coefficients are always positive with the exceptions of OS-Regret and Regret-Loyalty.

As can be seen from Figure 6, the overall travel satisfaction of different travel modes significantly correlate with different service attributes. Whilst the road based public transport users' travel satisfaction significantly correlated with punctuality and reliability factors (Figure 6b), the railway users' overall travel satisfaction highly correlated (correlation > 0.5) with punctuality, accessibility in terms of reaching the station (public transport proximity), and air temperature and ventilation inside vehicles (air comfort on-board) (Figure 6a). Tram users, on the other hand, also appreciated the cleanliness of the vehicle (Figure

6c), whilst the overall travel satisfaction of underground users correlated with many factors, apart from time table information provision and fare flexibility: but none of the factors had a correlation higher than 0.5 with the users' overall travel satisfaction. In contrast, the overall travel satisfaction of waterborne public transport users (Figure 6i) significantly correlated with timetable information provision and also with the frequency of the service. Presumably this is because, compared to other modes, waterborne public transport mode is the one which usually has a lower service frequency.

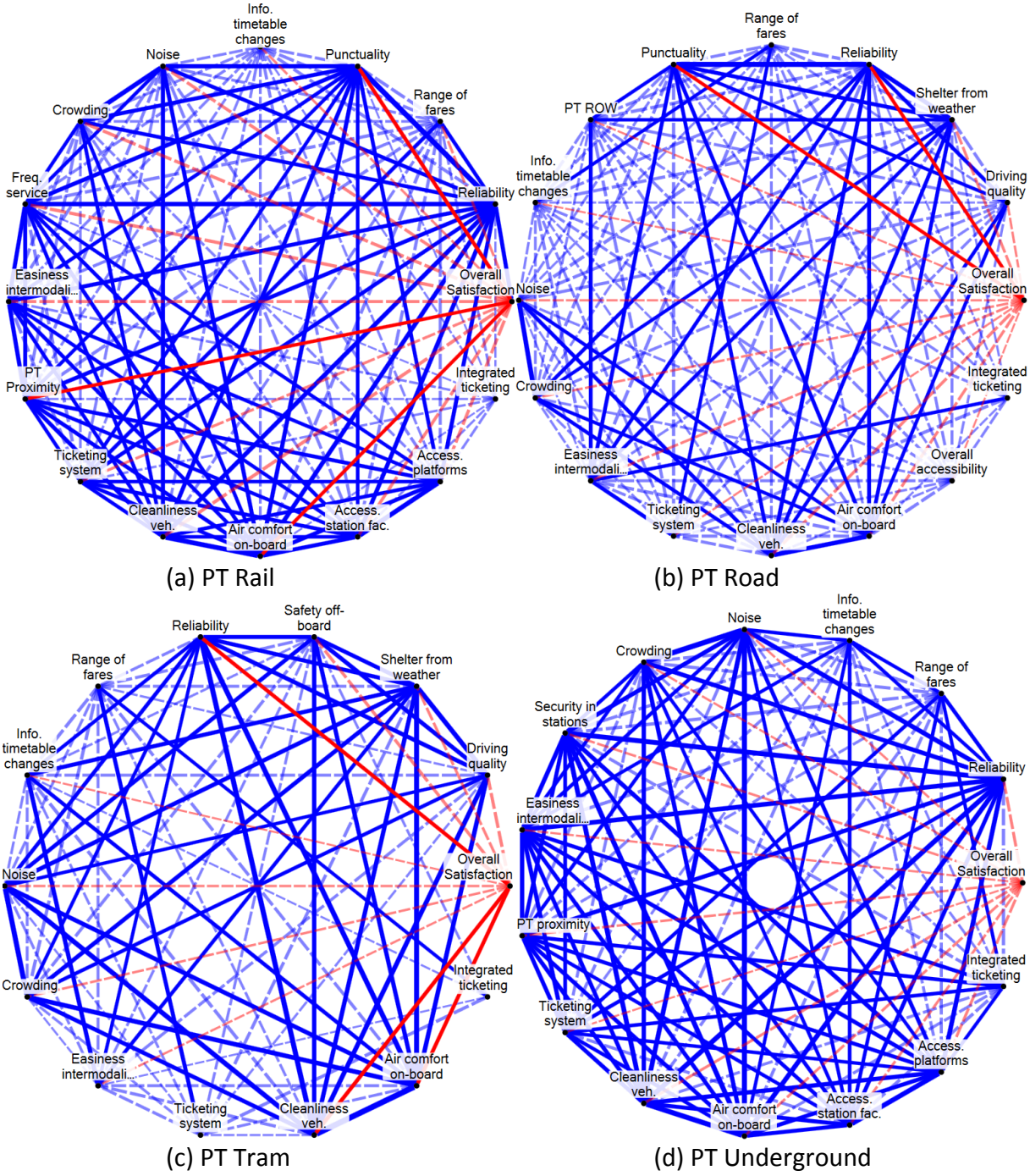


FIGURE 6: Cross-correlations among travel experience aspects and overall satisfaction on trip stages for different travel modes

Looking at cross-correlations among private/personal based travel modes (bicycle, walking, private car, mobility vehicle, and demand responsive transport, Figure 6 e-h), there were significantly less factors that directly influenced overall satisfaction, and none of them had direct correlations (> 0.5) with the reported overall satisfactions. This highlights that for the non-public transport modes, the components and factors that influenced the travellers' overall satisfaction was much more complex.

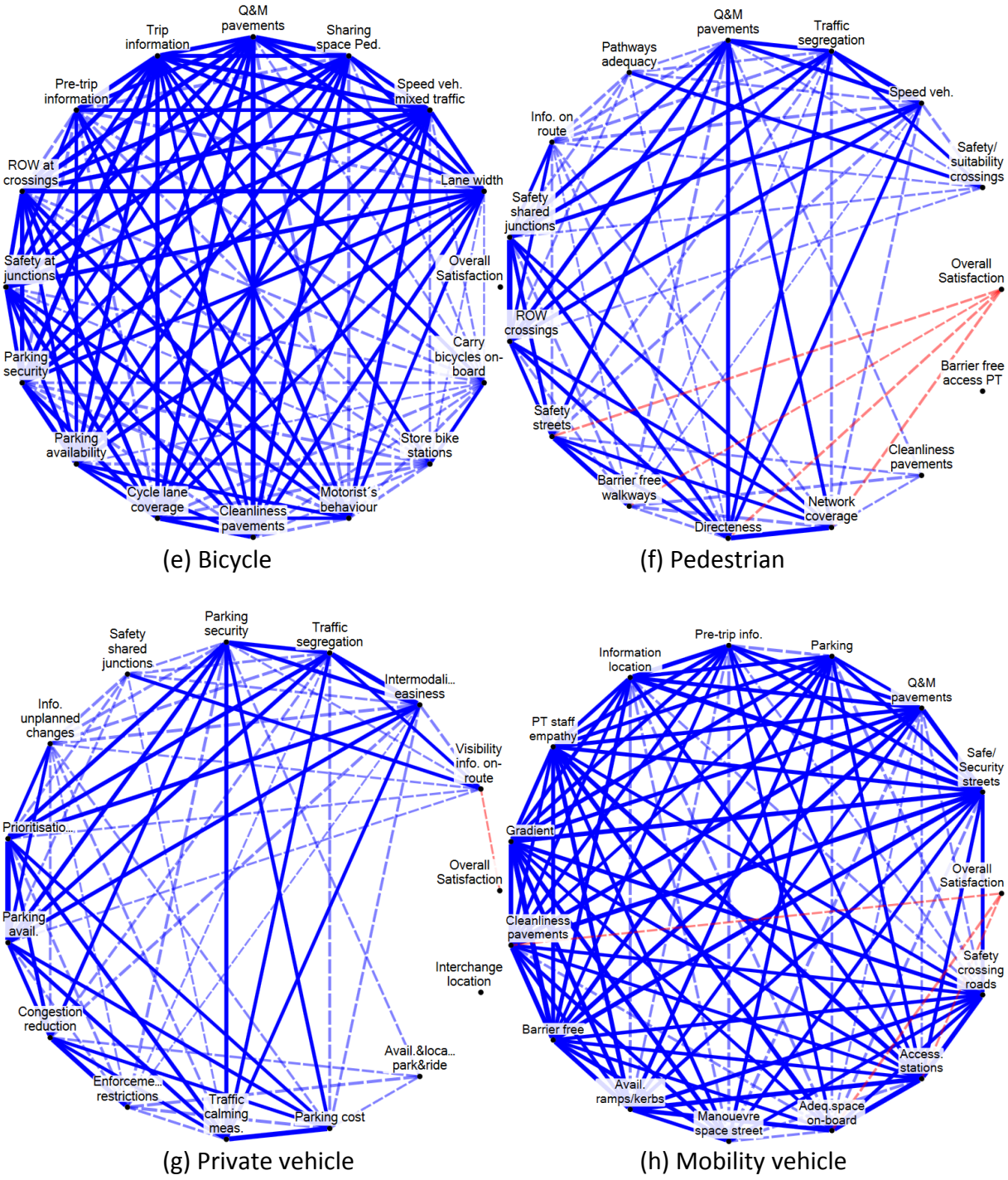
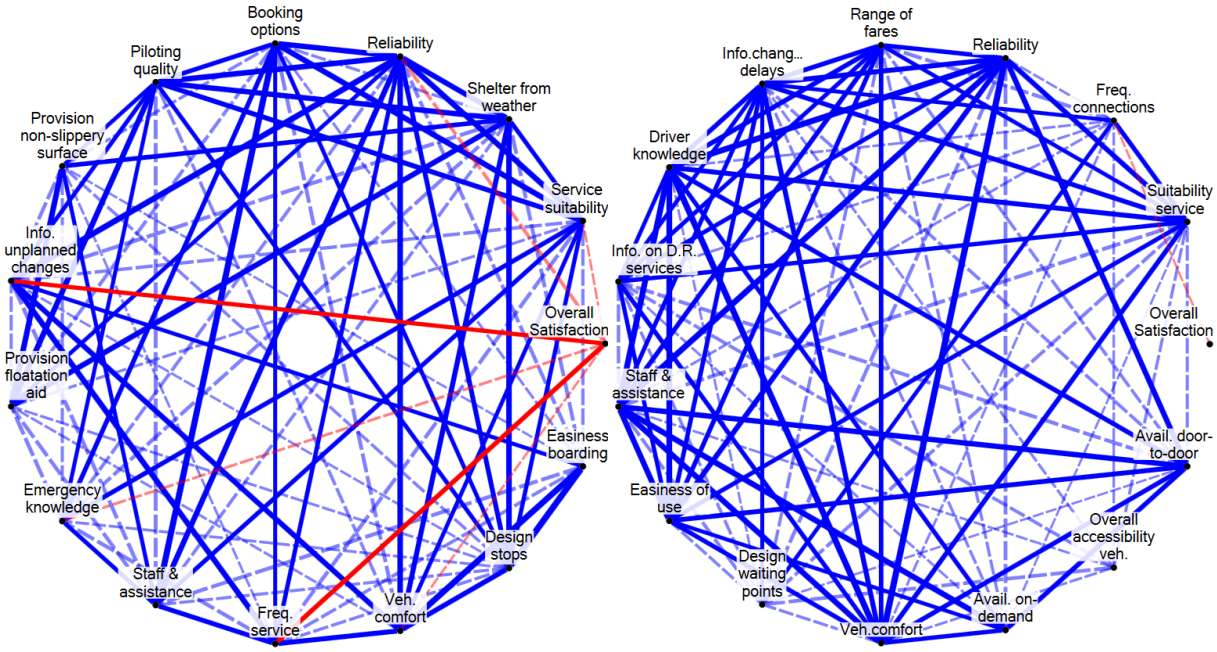


FIGURE 6: Cross-correlations among travel experience aspects and overall satisfaction on trip stages for different travel modes *(continued)*



(i) Waterborne (j) Demand Responsive Transport

FIGURE 6: Cross-correlations among travel experience aspects and overall satisfaction on trip stages for different travel modes *(continued)*

For example, private car users' overall travel satisfaction (Figure 6g) directly correlated with the availability and visibility of travel related information, and no other factors. The most frequently discussed issues, such as parking availability and security, disruption related information, inter-modality, and prioritisation, correlated with the availability and visibility of travel related information, but not directly with car users' overall travel satisfaction.

As for demand responsive transport users (Figure 6j), their overall travel satisfaction was only directly correlated with service frequency: whilst other factors correlated with this factor, they did not correlate directly with overall travel satisfaction. Pedestrians' overall travel satisfaction (Figure 6f) was positively correlated with safe and barrier-free streets and direct and extensive pedestrian path coverage. As for mobility vehicle users (Figure 6h), their overall travel satisfaction directly correlated with cleanliness of the pavement, accessibility of public transport stations, and available space on board public transport. This is in line with previous studies (e.g. Hine and Mitchel, 2003), which found that lack of accessible stations, and lack of space on board the bus increase the probability of travel cancellation. Figure 6e shows that for cyclists, none of the factors included in this analysis correlated with cyclists' overall satisfaction, higher than 0.3. This was because slow mode travel satisfactions are highly influenced by non-instrumental variables - such as ambience of the cycle path, confidence and sense of safety in fast moving traffic – that are very difficult to measure and generalise in tangible ways (e.g. Alfonzo, 2005).

Across different survey methods, as can be seen from Figure 7, the respondents' overall travel satisfaction which was measured using different survey methods correlated with different factors. Most of the subjective well-being factors consistently correlated (at 0.3) with the reported overall travel satisfaction, despite the survey methods used. The overall

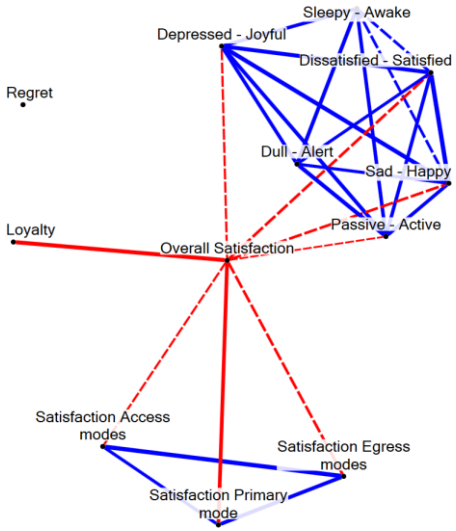
travel satisfaction reported via the sbNavi correlated (>0.5) with travellers' satisfactions towards their main and previous trip legs, whilst the overall travel satisfaction reported via the game app survey method correlated with users' loyalty[3] towards certain modes. The overall travel satisfaction reported via the on-line survey highly correlated (>0.5) with users' loyalty toward particular mode, their satisfaction towards the main and subsequent trip legs, whilst the overall travel satisfaction reported via the paper-and-pencil methods were only highly correlated with their loyalty towards particular travel methods.

Different correlations towards different combination of trip legs may also be influenced by the nature of the survey tools. The sbNavi app allowed travellers to report travel satisfaction whist travelling, in real time. This allowed the respondents to evaluate their travel and also their previous trip legs. In contrast, the on-line survey respondents completed the survey post-trip. Thus, real-time surveys may make travellers more focused on not only their main trip leg, but also subsequent trip legs, until they reach 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 (most recent) trip legs. Focus group respondents retrospectively evaluated trips in a group discussion, thus detached from and with more time to evaluate each trip leg.

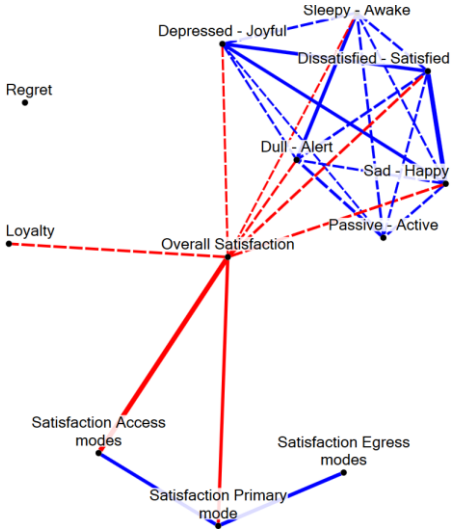
As for the game app, like also with other methods, the reported passengers travel satisfaction is strongly correlate with travellers' loyalty towards particular modes. This loyalty towards a particular travel mode could be interpreted as cognitive dissonance - where one aims to reassure or reconfirm his or her choices (Steg, 2005; Jacobsson-Bergstad et al. 2011; Susilo and Cats, 2014).

Nevertheless, it is also important to take into account that these discrepancies of correlations across different factors may also be due to the different proportion of main travel mode users across different survey methods (see Figure 3c). Thus, to analyse this further, multivariate analysis (an ordered logit model) was used to analyse the factors that correlated with the reported individual's travel satisfaction.

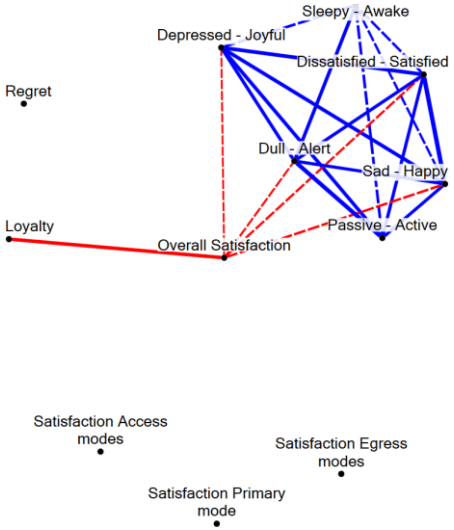
[3] 'Mode loyalty' in here refers to the unconditional preference that an individual may have towards a certain travel mode. This was inferred based on the agreement with the following statement: "I will travel with my current travel mode in any case, no matter what the conditions are"



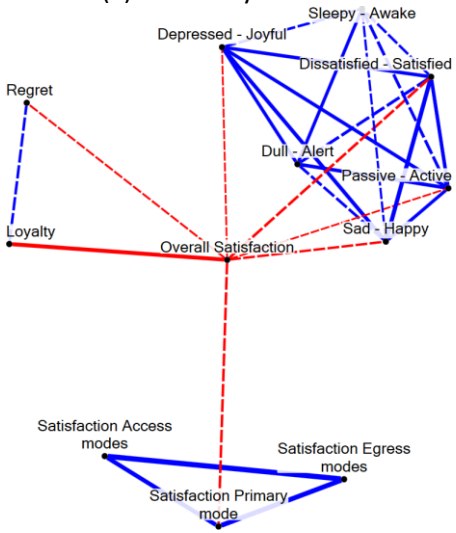
(a) All survey methods



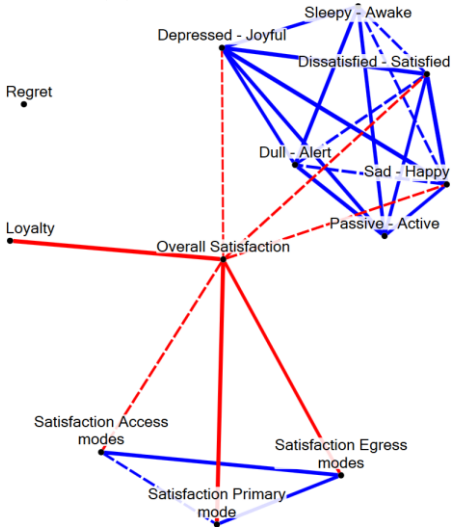
(b) SbNavi



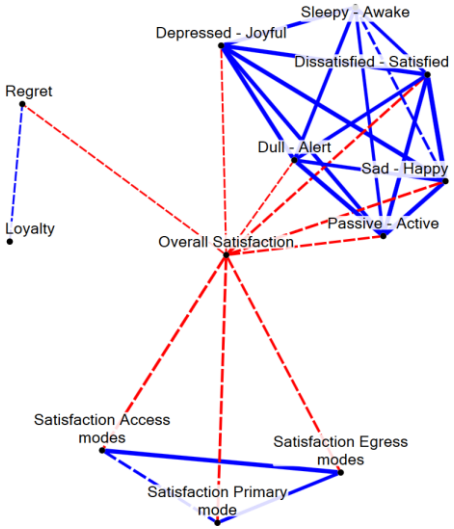
(c) Game App



(d) Paper based



(e) Web online



(f) Focus Groups

FIGURE 7: Relationships between overall journey satisfaction and satisfaction with various trip stages, subjective well-being spectrums, past experience and related trip appreciation factors, by different survey methods

4. Multivariate analysis

The previous analysis showed that within the trial site cities, survey methods and groups of travellers with different trip purposes reported different level of satisfactions. This is presumably because travellers have different needs and interests, thus they would display a different appreciation towards different determinant service attributes. To understand and to measure the impacts of each determinant factor in a more tangible and systematic way, multivariate analysis approach was adopted in this study.

A simple regression cannot be used in this case because the dependent variable, the overall journey satisfaction, is not a continuous variable. Multinomial logit and Ordered Logit models are the two most common models used to analyse individual selection over a specific set of choices. Multinomial logit assumes the probability of an individual choosing different choices following logistic distribution assumption but without any specific sequences/order, whilst ordered logit model assumes that the individual selection will follow a certain order. In this specific analysis ordered logit regression model is used. Given the fact that overall travel satisfaction is an ordinal variable, ranging from 1 (very unsatisfied) to 5 (very satisfied), ordered logit models was felt to be the most appropriate.

The reported "overall travel satisfaction" was used as the dependent variable. The explanatory variables used in the models reflect a combination of subjective well-being indices, travel modes and user groups, individual socio-demographics and the impact of different survey methods and location (as dummy variables of different cities).

It is important to remember that data gathered via smartphone applications was not identical with that collected via paper-and-pencil and on-line survey. The game app did not record travellers' socio-demographic and travel mode specific questions. The SbNavi app did record travel mode related questions, but it did not specifically ask individuals to identify themselves to which group of traveller they belonged to, but automatically assigned them with a specific questionnaire, based on basic information provided. Consequently, in order to analyse the impact of individual socio-demographic, travel mode, subjective well-being and detailed service attributes in terms of travel satisfaction, two different models were developed. The first model (M1) focused on analysing the influence of an individual's socio-demographic, travel duration, subjective well-being and chosen travel modes towards their overall travel satisfaction, and the second model (M2) focused on examining the impact of different survey methods, but, due to the data limitations, without individual travel mode and user group information. Table 5 presents the estimation results of M1 and part of the M2 estimation can be seen in Table 6.

Table 5: Estimation results for M1 model (only significant variables are shown in the table)

	Bucharest		Coventry		Dublin		FIA		Grevena		Rome		Stockholm		Valencia		Vilnius	
	Estim.	Sig.	Estim	Sig.	Estim	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.
Very to rather Diss.	**-3.590**	0.003	**-6.811**	0.000	**-4.358**	0.000	**-4.249**	0.000			**-5.484**	0.000	**-4.736**	0.000				
Rather to nor Sat/Diss.			**-4.931**	0.001	**-2.904**	0.019	**-2.797**	0.000			**-3.331**	0.000	**-3.489**	0.000				
Nor Sat/Diss. to rather Sat			**-3.067**	0.030					**2.769**	0.046								
Rather Sat. To very Sat.	**4.293**	0.000					**1.500**	0.006	**5.214**	0.000					**4.530**	0.004	**5.948**	0.002
Male							**-0.388**	0.005										
<24							**-1.172**	0.014									**-3.433**	0.013
25-44							**-1.198**	0.008										
45-64							**-1.307**	0.004	**2.655**	0.002								
Income below					**0.747**	0.043												
Income average																		
Less than high school															**2.791**	0.003		
High school			**1.492**	0.002											**2.420**	0.008		
Bachelor			**1.511**	0.000											**2.020**	0.028		
<10 min			**1.826**	0.030			**0.732**	0.028	**4.104**	0.007							**3.113**	0.025
11-30 min					**1.212**	0.013												
31-60 min					**0.868**	0.048			**2.116**	0.005	**-1.463**	0.002						
61-90 min									**1.935**	0.019	**-1.724**	0.000						
91-120 min											**-2.186**	0.000						
2-3 hours			**3.047**	0.005														
Daily					**-0.950**	0.004	**-0.574**	0.002	**-1.739**	0.037	**-1.046**	0.000						
Weekly									**-2.443**	0.000	**-0.895**	0.001						
Monthly									**-1.357**	0.021								
Disruption-Yes	**-1.790**	0.000	**-1.484**	0.000	**-1.841**	0.000	**-1.088**	0.000			**-0.886**	0.000	**-1.547**	0.000	**-1.708**	0.003		
No car									**-2.106**	0.003	**-1.159**	0.000						
One car																		
Partner/married																		
Single with children			**2.748**	0.009					**-4.141**	0.001							**-2.418**	0.011
Partner/married children																		
Other							**0.849**	0.000			**-0.730**	0.007						
Unemployed															**-1.044**	0.006		
Student																		
Other																		
Terraced/Detached/ Semidet. House			**-1.538**	0.016					**1.452**	0.016			**0.567**	0.024				
Small/Med. Building			**-1.660**	0.034														
Happy	**1.543**	0.000			**0.674**	0.014	**0.710**	0.000			**0.846**	0.000			**0.733**	0.050		
Satisfied					**1.255**	0.000	**0.550**	0.000			**0.917**	0.000	**0.681**	0.006			**2.279**	0.000
Active			**1.430**	0.000			**0.292**	0.027			**0.500**	0.009						
Alert							**0.361**	0.005	**1.491**	0.007							**0.948**	0.036
Joyful	**-0.974**	0.003							**1.480**	0.028					**0.813**	0.028		
Awake	**0.643**	0.043	**-0.894**	0.026					**-1.130**	0.039			**0.495**	0.031				
Start- Workplaces					**0.498**	0.042	**0.315**	0.023										
Finish- Workplaces			**-0.839**	0.024			**0.407**	0.001							**-0.773**	0.001		
Area Live- Urban	**1.267**	0.021					**0.458**	0.000	**1.865**	0.009					**1.096**	0.018	**1.544**	0.002

Table 5: Estimation results for M1 model *(continued)*

	Bucharest		Coventry		Dublin		FIA		Grevena		Rome		Stockholm		Valencia		Vilnius	
	Estim.	Sig.	Esti.	Sig.	Estim	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.
TM Soft modes					**-1.595**	0.041												
TM PT Rail							**-0.406**	0.004			**-0.651**	0.002	**-0.780**	0.009				
TM PT Road					**-1.286**	0.017	**-0.448**	0.004			**-1.088**	0.000			**-0.727**	0.019		
TM Other	**-1.306**	0.010													**-3.138**	0.038	**3.008**	0.017
UG Comm. Imp																		
UG Low income																		
UG Over 64									**2.611**	0.009							**-3.037**	0.015
UG Rural Dwellers									**2.932**	0.001	**-0.869**	0.019						
UG Visitors	**2.277**	0.001	**1.241**	0.036							**-0.894**	0.039			**1.078**	0.048		
UG Commuters															**-0.788**	0.033		
UG Under 24																		
UG Other																	**-1.518**	0.031
-2 Log Likelihood	**617.10**		**480.81**		**916.76**		**3051.35**		**390.42**		**1593.39**		**1099.89**		**812.84**		**313.75**	
Df	**51**		**51**		**51**		**51**		**51**		**51**		**51**		**51**		**51**	
Pearson Chi-square	**1422.76**		**940.27**		**1412.63**		**6202.54**		**785.08**		**4403.89**		**2129.70**		**1321.72**		**763.88**	
McFadden Ps. R2	**0.230**		**0.274**		**0.262**		**0.143**		**0.283**		**0.187**		**0.132**		**0.125**		**0.320**	
N	**320**		**243**		**398**		**1324**		**220**		**678**		**489**		**452**		**189**	

Table 6: Estimation results for M2 model (only significant variables are shown in the table)

	Bucharest		Coventry		Dublin		Grevena		Rome		Stockholm		Valencia		Vilnius	
	Estim.	Sig.	Estim	Sig.	Estim	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.	Estim.	Sig.
SatNav					**3.076**	0.012					**-0.556**	0.014				
Game app	**-1.901**	0.014	**-1.893**	0.005					**-2.844**	0.000	**-1.296**	0.000	**-2.622**	0,000		
Paper-based	**0.770**	0.045	**1.849**	0.000	**0.771**	0.003										
Focus groups	**-1.915**	0.002							**-1.274**	0.000						
-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 Pseudo R-square	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	

As can be seen from Table 5, in most cases gender, age, income, employment status and level of education were found insignificant in influencing the reported overall travel satisfaction of the respondents. FIA respondents were the exception with males more likely to report a lower satisfaction rate, and travellers above 65 years reporting a higher level of travel satisfaction compared to other age groups. The Vilnius younger travellers (24 years old or below) also reported a lower travel satisfaction than travellers from other age groups, while in Grevena, those aged between 45-64 years old reported higher.

In Dublin, lower income travellers reported higher travel satisfaction, whilst in Coventry and Vilnius, the highest educated (postgraduate, the reference group) travellers were the most dissatisfied.

The correlations between travel distance and trip frequency in terms of reported travel satisfaction were not clear. In Bucharest, Stockholm and Valencia, travel distance and trip frequency were not found significant. In other cities, there were tendencies toward a longer travel distance correlating with a lower reported travel satisfaction, except for longer (2-3 hours) trips in Coventry. Presumably this is due to the nature of the travel - more likely related to leisure trips, which have different time and mood constraints. Dublin, FIA, Grevena and Rome travellers reported lower travel satisfaction towards their route/daily travels, and experience of a disruption during journeys also negatively correlated with 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, being happy and satisfied with one's life positively correlates with reported travel satisfaction. Being awake corresponds with a lower travel satisfaction in Coventry and Grevena, but in Bucharest and Stockholm, it correlated with a higher travel satisfaction. Presumably this is because the differences in the local culture in terms of expectation, perceptions and mood consequences. Further investigation on this matter would be a possible future research direction of this study.

There were tendencies showing that the public transport modes correlated with a lower reported travel satisfaction than with other travel modes, although this was not consistent throughout the different trial sites. Tourists/visitors seemed to report a higher travel satisfaction, compared with other groups of travellers, except for tourists/visitors in Rome.

In terms of survey methods, only Stockholm, Bucharest and Coventry had valid samples for all five survey methods (see Table 6). 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 in Bucharest, Coventry, Dublin, and Rome. Survey methods were not found significant in influencing the reported travel satisfaction in Vilnius and Grevena. This may be due to the small sample size from these two sites. Focus group participants in Rome and Bucharest, however, reported a lower travel satisfaction than their fellow respondents.

5. Discussion and Conclusion

Using 5,275 valid responses from eight European cities and five FIA national networks, this study examined factors that underlie travellers' door-to-door travel satisfaction and how different survey methods may influence the reported level of satisfaction among diverse groups of travellers. 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.

The results showed that the travel satisfaction reported by different survey methods and different travel modes users correlate with different key determinants. The relationship between and within these key determinants, however, was far from straight forward. For example, many policy makers believe that parking provision is important for the satisfaction of the door-to-door journey of car travellers. But the results show that private car users' overall travel satisfaction was more directly correlated with the availability and visibility of travel related information. Thus, the most frequently discussed issues, such as parking availability, security, and disruption-related information correlated with the availability and visibility of travel related information, but not directly with the car users' overall travel satisfaction.

The results also showed 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. This highlights the need for more consideration when using national journey travel satisfaction (e.g. Swedish public transport annual barometer, Passenger Focus' annual satisfaction report, etc.) which mostly focus on specific (often single) travel modes and trip legs. In the age of privatisation, these reports were used to evaluate the performance of the public transport provider, thus incomplete picture of the passenger travel satisfaction may lead to unfair judgment of the operator's performances. The results also showed that travellers' experience in interchanges and with infrastructure systems, in most cases, matter more than the ride quality on the main trip leg.

Surveying door-to-door travel satisfaction 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). On the other hand, having various different methods tested opened up various different opportunities, e.g. measuring the impacts of multimodal and interchanges planning and design, in real time, towards the users' appreciations and needs, which would be very difficult to be done with traditional paper-and-pencil surveys. Nevertheless, special needs travellers were more receptive towards focus group-like methods and real-time measurements, such as those provided by the game app and sbNavi, require a consistent data connection, which for some countries are still luxuries. It was 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 is still very low and uneven between user groups and countries. There were also significant

privacy and data protection concerns among potential respondents (e.g. in Rome) in terms of installing an app coming from an unknown source.

The next step will involve further detailed examination on the impact of trip leg complexity, and an investigation of familiarity and uncertainty in relation to trip satisfaction. 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 during trip legs. Further analyses on the focus groups results, especially among various groups of travellers with special needs, will also be a future step of this study.

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