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The relation between travel behaviour, ICT usage and social networks. The design of a web based survey

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Abstract

The relatively recent developments in Information and Telecommunication Technologies (ICT) arose the interest of both researchers and policymakers about how these technologies could shape travel. Several hypotheses have been put forward relating the use of ICT and travel behaviour. These include substitution of travel; complementarity or induction; modification or neutrality. This topic has been the subject of relevant research efforts, with a strong focus on the role of telecommuting as a way to reduce travel and its negative environmental impacts. The relation between ICT usage and other motives of travel have not been so thoroughly researched. One of these is social travel. More recent technological developments, in particular the development of the Web 2.0 and social media, as well as the dissemination of smartphones and related web applications increase the potential usefulness of ICT to influence social travel behaviour. Particularly relevant in this context is the study of the role of social networks and their characteristics in influencing mobility patterns. The work presented here is the design of a web-based survey aimed at studying the relations between ICT and social media usage, social networks and social travel. The survey was designed to be applied to university students, because they are stronger users of social media and ICT devices. Specifically, it aims to investigate a series of potential research questions related with the effect of ICT on social travel, its interaction with social networks, and, how the perception of its usefulness influences its usage. The survey structure and its relations with the previous literature in these subjects are presented. Finally, the results from a pilot already implemented in 3 cities – Lisbon, Granada and Zagreb are presented and its role on the validation of the survey structure is discussed.

1. Introduction

The development of Information and Telecommunication Technologies (ICT), which became apparent in the 1990´s with the dissemination of mobile phones, personal computers and the Internet, continued its fast pace during the first two decades of the XXI century aided by development of the Web 2.0, social media and smartphones. These new technologies captured the interest of both researchers and policymakers about its potential to shape and possibly reduce travel and its negative impacts. The first studies with a strong emphasis on telecommuting were published in the early 1990´s (e.g., Mokhtarian, 1990; Kitamura et al. 1991; Pendyala et al., 1991). Several hypotheses have been put forward relating the use of ICT and travel behaviour. These include

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substitution of travel; complementarity or induction; modification or neutrality (Salomon, 2000; Mokhtarian and Salomon, 2002; Aguilera et al., 2014). Consequently, this topic has been the subject of continuous research efforts. The relation between ICT usage and other travel purposes have not been so thoroughly researched. One of these is social travel. Recent technological developments increase the potential usefulness of ICT to influence social travel behaviour. Particularly relevant in this context are the concepts of activity fragmentation and multitasking, greatly supported by the dissemination of ICT devices and internet access, and the study of the role of social networks and their characteristics in influencing mobility patterns. Here we present the design of a web-based survey aimed at studying the relations between ICT and social media usage, social networks and social travel. The survey was designed to be applied to university students. They are stronger users of social media and ICT devices and constitute a convenient sample without requiring relevant resources to be surveyed. Specifically, the survey aims to investigate a series of potential research questions related with the effect of ICT on social travel, its interaction with social networks, and, how the perception of its usefulness influences its usage. This paper is organized as follows: in the second section a literature review is offered, followed by the research questions aimed to be addressed by the survey; the survey structure and the results from a pilot already implemented in 3 cities – Lisbon, Granada and Zagreb are presented; and finally, its role on the validation of the survey structure is discussed in the conclusions.

2. Literature review

In general, the hypothesis relating travel behaviour and the use of ICT comprehend the following relations (Salomon, 2000, Mokhtarian and Salomon, 2002; Aguilera et al., 2014):

- Substitution;
- Generation, either by complementarity or by stimulation;
- Modification;
- Neutrality.

The conclusions attained so far portray a more complex picture. Tilahum and Li (2015) found effects of substitution, more contacts by mail, phone or other communications reduce face-to-face meetings. Kamargiani and Polydoropoulou (2014) found that a more intense of use of social media leads to more social travel. Wang and Law (2007), Nobis and Lenz (2009) and Van der Berg et al. (2012) found evidences of a complementary relationship between contact frequencies by different modes. More recently Van der Berg et al. (2013) found evidences of substitution. Yuan et al. (2012) found that people with higher cellphone usage have a larger activity spaces and their spatial behaviour is more random. Kenyon (2010) found no evidence of a link between virtual and physical mobility. Schwanen and Kwan (2008) found that internet and mobile phone enhance spatial flexibility, although ICT seems to create some constraints. Carrasco and Miller (2009) found that the effect between social activities and the use of ICT is mode specific, telephone is complementary but email appears to have no effect; they argue that it could have a substitution effect for long distance social contacts. Thulin and Vilhelmon (2005) found that ICT usage complements both physical contacts and phone calls. Lee-Gosselin and Miranda-Moreno (2009) found that mobile phone usage was positively associated with activity and trip levels and internet usage had the opposite effect. Zhang et al. (2005) found simultaneous effects of complementarity and substitution between travel and ICT usage, although the former were dominant.

These mixed results support the argument that ICT affects travel in different manners, since some travel determinants are not influenced by ICT, or are influenced in ways that do not reduce travel (Aguilera et al. 2012). Focusing specifically on leisure activities, Mokhtarian et al. (2006) argue that the primary effect of ICT is to expand individual choice sets. They´ve found several dimensions of leisure activities which ICT could impact, e.g. location, dependence/independence both location and temporal, fragmentation, planning horizons, multitasking, solitary versus social. ICT use reflects also gender roles, as Ren and Kwan (2009) and Schwanen and Kwan (2008) found. Contrary to women, men take advantage of the Internet to perform more new activities and they show a complementarity between Internet leisure usage and leisure travel (Ren and Kwan, 2009).

More recently, Pawlack et al. (2015) presented a series challenges about the relations between ICT usage and travel. These include issues related with:

- Causality, in a society where ICT is becoming omnipresent, the decision to use ICT devices could be strategic to increase the efficiency of travel, thus muddling the causal relations between ICT and travel behaviour;
- ICT as a moving target, the way that ICT technologies change and evolve and the way that they are available in different social and spatial contexts, change its relations with travel;
- Measurement issues, it is not clear what would be the best ways to measure ICT usage;
- Context specificity, there is a low number of cross national studies, and since different social groups and different countries will relate ICT and travel differently, socioeconomic, cultural and geographical contexts matter and transferability of results might be problematic;
- Time use and activity planning of activities, ICT allows for quicker, more accurate and personalized travel arrangements, although it's not making travel planning more spontaneous.

Relevant here is also the concept of activity fragmentation (Ben-Elia et al., 2014), as well as multitasking (Kenyon and Lyons, 2007). Line et al. (2011) argue that technology enables people to better accommodate the uncertainties in activity and travel scheduling, contributing also to a more fluid time space coordination of activities. Several studies looked at the composition and characteristics of social networks and social travel (Carrasco et al., 2008; Lin and Wang, 2014; Axhausen, 2008; Arentze and Timmermans, 2008) and also its relations with ICT and land use patterns (Wang and Lin, 2013; Kwan, 2007). Carrasco and Miller (2006) have shown the usefulness of social networks to study travel behaviour. Social network characteristics are also relevant to study the relationship of ICT usage and social activity participation (Carrasco and Miller, 2006). Roy et al. (2012) argue that different modalities (physical versus e-communication) create different social networks. Also personal network measures like density, homophily and heterogeneity influence the number of weekly shared trips (Sadri et al., 2015).

There are still relevant gaps that we intend to address with our work. The first one is related with the technological evolution of ICT and its implications on behaviour. The majority of the studies reviewed here, rely strongly on telephone and e-mail usage as ICT related technologies. Aspects like social media, video or text chats usage are less covered. The perception of ICT utility and its effective usage to increase travel efficiency has also received less attention. Thus this is also a gap that we intend to address.

Since the survey described here will be a web survey it is relevant to discuss its advantages and pitfalls. The use of web based surveys has been growing steadily due to its perceived advantages (de Abreu e Silva and Davis, 2015). Particularly, web based surveys reduce application costs, data imputation errors and allow faster data processing; they increase the possibilities of customization, dynamic program based controls and allow for the automatic error detection (de Abreu e Silva and Davis, 2015). Besides these advantages, they present also several disadvantages. In general web surveys' respondents tend to be younger and wealthier, with higher education levels and technologically savvy (Nitsche et al., 2014). Since the survey is aimed at university students, this is not a disadvantage in our specific study. Other issues more relevant to this study, with implications in the survey design are related with response and dropout rates (Bonnel and Madre, 2006; Bayart and Bonnel, 2008). When designing a web based survey, care should be taken to reduce respondent burden and consequently drop-out rates. Cognitive demands associated with the questionnaire could lead to survey breakoff (Peytchev, 2009; Lenzner et al., 2010). As a result, the amount of questions, its format, type and sequence should be carefully balanced taking into consideration not just the research objectives but also respondent burden and drop-out rates.

3. Survey objectives and research questions

Based on the literature review, and in order to increase our knowledge about the relationships between ICT and social media usage, social networks and social travel behaviour among university students we have designed a specific survey to be administered in three cities – Lisbon in Portugal, Granada in Spain and Zagreb in Croatia. These cities have different socioeconomic and demographic characteristics, and therefore the survey will contribute to the increase of cross cultural studies on this matter. The defined research questions are ambitious in terms of its broadness. They are the following:

- What is the relationship between ICT's usage and face-to-face social activities in university students? Does it present a complementary relationship, increasing the frequency of face-to-face social activities?
- Are these relationships between ICT usage and face-to-face social activities similar in the different socioeconomic contexts of the 3 cities analyzed?
- Does the type of residence environment present any kind of influence on the relations between ICT and face-to-face social activities? For example, are students living in more urbanized, dense and accessible areas use ICT in a different way than students living in more suburban or rural areas where ICT could play a substitution role on face-to-face social activities?
- Which is the effect of ICT's usage on the size and complexity of the social networks? Do more intensive users of ICT present more complex and large social networks?
- Which is the effect of using ICT on the effectiveness of planning and developing face-to-face social activities? Do university students, as millennials or net geners (Kamargiani and Polydoroupoulou, 2014) use intensively ICTs on the several stages of travel and activities (activity planning, during travel and during the activity)? And what is the use that they make of ICTs and what ICT's are used and how often?
- Which is the effect of using ICT on satisfaction about social relationships? Does ICT usage is associated with an increase in the level of satisfaction with social and face-to-face relationships or, there is no relation between both items?
- Which is the relationship between ICT usage and travel behaviour? Does ICT usage is related with a more intense use of public transportation and other soft modes (walking or cycling) in social travel?
- Does the ICT utility perception present any influence on social travel habits and social mobility? For example, the perception of the utility of ICT for transportation increases its use, and an increased use of ICT for travelling increases social related mobility?

4. Survey description

The questionnaire was developed taking into consideration both the research questions presented in the previous section and the specific particularities of a web-based survey. Its design was strongly influenced by the medium used for its implementation and

the sampling frame: university students. These two aspects led to the design of a questionnaire that would be easy and quick to answer. Reducing the cognitive burden as much as possible and the time needed to fill the questionnaire due to the lower attention span of young people were two operational objectives aimed at reducing drop-out rates. The great majority of questions were formulated as multiple choices (with the possibility to select one or more options from a list of answers), rating scales questions (i.e., matrix scale questions), reducing the need to write input data and therefore decreasing the time needed to answer the survey. Open-ended (where the respondent is requested to input the answer) referred mainly to short numerical answers (e.g., respondent's age, number of family members, respondent's residence location) and were kept as few as possible. These options come at the cost of having fuzzier information, since respondents are asked to select intervals and not give precise answers. On the other hand, this reduces cognitive burden. Asking respondents to give precise values on, for example, the number of hours spent online would most likely result in biased responses, although giving the illusion of precision, and would potentially increase the drop-out rates. Also, some of the information asked in this survey would require different surveying techniques in order to collect precise and detailed data. One example is the case of social network characteristics, where techniques used to elicit them in a detailed way (see Carrasco et al., 2008 for a detailed description of these methods). Due to the scope of the research questions the decision taken was to collect less detailed and precise information but cover all of the relevant dimensions.

The survey consists of 32 questions divided into 14 groups, corresponding to different pages presented to the respondents. The survey structure is the following:

- The first five groups of questions are considered as the introductory part of the survey. They include questions aimed at characterizing the respondents residential and school location, socioeconomic characteristics and access to transport.
- After this component several groups of questions are directly linked the research objectives. They are organized in the following groups:
  o Group of questions about the ownership and use of ICT devices and use of social media;
  o Group of questions about the characteristics of the respondent's social network (ego-based), e.g., size, connectedness, spatial distribution and, intensity and mode of contact;
  o Group of questions about the social activities performed in the previous week, both on the weekend and the weekdays, its location and the transport modes used;
  o Group of questions about the use of ICT for different purposes and in different contexts in social travel and activities;
  o Group of questions about the use of video calls and chats and the perception of ICT usefulness for travel.
- Group of questions is about the respondents' income.

The first page of the survey is an introduction which explains in detail the goal of this research and includes other relevant information to the respondents (related to anonymity and data protection, voluntary response and sampling frame) as well as the identification of the research team that is conducting the survey. The respondents were asked about their age, gender, degree, professional activity, residential status and location, as well as the campus/faculty location. Location data will allow link the survey with data characterizing land use and transport data at both the study and residence areas. By this way it is possible to enrich the spatial dimension of the collected information, particularly the aspects related with the social networks and social activities while keeping at minimum the number of questions that potentially increase respondent burden.

Some of the questions raise issues about the transferability and compatibility of concepts and definitions. The first ones are related with the definition of the place of study. In Lisbon, IST has only 3 campi, whereas both the universities of Granada and Zagreb have several faculties/campi located in different places. Also, regarding the information about the location of the respondent's residence there is the need to adapt the questionnaire to the different characteristics of the 3 cities in order to collect information that allows the geocoding of the residence location. In Lisbon the postal codes are sufficiently precise to do that, whereas in Zagreb and Granada the respondents are asked to give the name of the city/municipality and the name of the streets in the nearest intersection. The survey has also questions about the household aimed at characterizing the respondent's household: size, number of cars and education levels and job occupation of the students. The last component of the socioeconomic characterization is related with the access to transport by the respondent – driver's license, pass ownership and car availability.

To investigate the ownership and use of ICT, several electronic devices that could be used to communicate (including computers, tablets, mobile phones and gaming consoles) are listed and respondents are asked to indicate its ownership and frequency of use (from less than once a week to every day, with the option of reporting not owning the devices). The categories of frequency of use, in the previous week (considering both weekdays and weekends), of social media and web based social networks (e.g., Facebook, Twitter, Hi5, LinkedIn) and instant messaging/chats and video conference applications (e.g., Viber, Skype) are asked. These categories consider both the daily frequency and the average total number of hours. Anchoring these questions to a specific period allows increasing its accuracy and at the same time permits its direct association with the reported number of social activities (also anchored in the previous week).

Examination of the respondents' social networks was carried out in order to investigate the connection between the size and complexity of the respondent ego based social network, its social activities and the use of ICT. Therefore, each respondent was asked about the number of close friends and acquaintances. Close friends are specifically defined in the questionnaire as people, outside of the direct family, with whom the respondent discusses important problems, whom he/she stays in regular contact or whom he/she could ask for help. Acquaintances are defined as people with whom the respondent stays in contact every now and

then and are not as intimate as close friends. Respondents are also asked about the size of their biggest web based social network, and the number of people belonging to their inner circle in this web based social network (people whom they contact almost every day).

To collect information about the topology of the respondents' social network there is a question about the degree of connection between close friends and acquaintances. The following question explicitly asks about the residential location of the respondent friends and acquaintances relative to its residence. In this way it is possible to build measures describing the social network spatial structure. Next, the respondents are asked to state their level of agreement with a series of statements describing mode and frequency of contact with their friends and acquaintances.

Respondents are then asked about the number of face-to-face social activities they engaged during the past week (for both weekdays and weekend), by choosing among a series of categories ranging from *2 or less* social activities to *more than the 30*. In order to additionally examine spatial distribution of social activities for both weekends and weekdays relative to the students' main spatial anchors (residence and university) respondents are asked to choose between several of statements about the prevalent location of their social activities. The transport options used for the previous week social trips ordered by their intensity of use are also asked.

The following question aims to collect information about the use of ICT in social travel. Once again for realism purpose this question is anchored in the previous week. Respondents are asked about the frequency of different uses of ICT during several stages of their social travel and activities: in the planning stage, during the trip and during the activity. The potential uses of ICT that were considered are:

- The use of both synchronous (e.g. chat, phone calls) or asynchronous (e.g. mail) ways to define the "where" and "with whom" the social activity takes place;
- The use of ICTs to look for travel alternatives; get information about traffic conditions, buying tickets, reserving places or vehicles;
- The use of ICT during the trip either to inform others or as way of activity fragmentation or multitasking;
- The use of ICT during the social activity also as potential way of activity fragmentation or multitasking.

The use of chat and/or video calls is also examined. Respondents are asked to express the degree in which they use (from *never* to *always or almost all times*) chats and video calls for different motives. The motives considered here include maintaining contacts between the respondent and their friends or acquaintances, family members and people who live far away. Afterwards respondents are asked to express their level of agreement with a series of statements about their satisfaction with their social activities, their perceptions about ICTs and its usefulness on transport and the role that ICTs have on travel behaviour.

The final questions focus on the respondents' available income and its sources. They were purportedly included in the final part of the survey to avoid biasing answers and because questions about income tend to increase survey drop-out levels. The final version of the questionnaire, after including the changes introduced after the pilot could be accessed at https://fenix.tecnico.ulisboa.pt/downloadFile/282093452024881/SurveyMonkey_79202002.pdf.

5. Pilot results

A pilot survey was applied to a total of 52 students in the Lisbon (11 PhD students), Granada (21 bachelor students) and Zagreb (20, bachelor, master and PhD students). The perceived response time as reported by the respondents was around 12 minutes and in some cases less than 10 minutes, but the measured average time was higher, 18 minutes. The characteristics of the pilot sample in each place were the following:

- Lisbon – 30.6 years old, 63% male, all in the same campus/faculty. 63% just study, 27% live with their parents, 100% have a driver's license, 46% own a transit pass and 45% have daily access to a car;
- Granada – 22.4 years old, 81% male, all from the same campus/faculty. 67% just study, 29% live with their parents, 86% have a driver´s license, 86% own a transit pass and 29% have daily access to a car;
- Zagreb – 22.1 years old, 55% male, one respondent from a different campus/faculty. 45% just study, 55% live with their parents, 55% have a driver´s license, 65% own a transit pass and 15% have daily access to a car.

Although the sample should not be considered as representative of the different socioeconomic characteristics of the different places, it shows some variability that could be related both with the students interviewed and with the specific characteristics of the different cities and universities.

Regarding the possession of ICT devices and its use, the majority of the respondents own a laptop and use it on a daily basis. In the responses we detected an issue related with a difficulty of interpretation between the definitions of smartphones and cell phones. It might be the case that issues related with the questionnaire translation might contribute to this problem (the students in Granada answered differently). To solve this issue, it was decided to include, together with a precise description of these devices, a picture of a smartphone and of a cell phone.

In general, the collected answers show a good variability of the data, with some exceptions which will imply adjusting some of

the categories. The cases where this happens are related with the size of the biggest network in social media and the number or social activities during the weekends. Since one of the objectives of the pilot survey was also to test the possibility of building relevant constructs related characterizing the social networks of the respondents and their use of ICT, exploratory factor analysis was employed. The obtained results, although based in a small dataset, show the emergence of meaningful patterns, pointing to the adequacy of the questionnaire to extract the information needed to fulfil the enunciated objectives. The first factor analysis was relative to the characteristics of the respondents' social networks and its spatial dimension. Three factors emerged, one relative to the size of the social network (close friends and acquaintances) and two other factors related with the spatial and social closeness of close friends and a more spatially dispersed social network. Table 1 presents the results, the loadings more relevant for the factors interpretation are highlighted in bold and italics.

Table 1. Exploratory factor analysis – respondents' social networks and its spatial dimension.

Questions/Statements	Component		
	1	2	3
Number of close friends	0.360		*0.717*
Number of acquaintances	-0.266	0.256	*0.723*
My close friends are also friends with each other	*0.755*		0.193
My close friends are also friends/acquaintances to my acquaintances	*0.694*	0.137	
My acquaintances are also friends/acquaintances of each other	0.236	*0.614*	0.172
My close friends live close to me (e.g. in my neighborhood)	*0.687*	0.182	-0.241
My close friends live in my city/municipality but not close to me		*0.815*	0.288
My acquaintances/ not so close friends live in my city/municipality	0.187	*0.753*	-0.323

Method: Principal Component Analysis, Varimax rotation, KMO=0.591, Total variance explained=61.2%, loadings smaller than 0.1 are omitted

A second analysis was focused on different possible uses of ICTs at different stages of social travel and activities, ranging from the planning stage, trip and the activity. Interesting patterns emerge about the use of ICTs in this context. Regarding the planning stage there is a clear substitution between different technologies. A stronger use of phone calls is associated with a lower or inexistent use of social media. The results are presented in Table 2.

Table 2. Exploratory factor analysis – respondents use of ICT in the planning stage of activities/travel.

Statements	Component	
	1	2
I use Phone call or chats to arrange with friends/acquaintances to meet (location and/or schedule)	0.234	*0.823*
I use SMS or mail to arrange with friends/ acquaintances to meet (location and/or schedule)	*0.749*	-0.111
I use social networks (e.g. Facebook) to arrange with friends/acquaintances to meet (location and/or schedule)	0.400	*-0.658*
I use the web to search for possible venues for the social activities	*0.668*	

Method: Principal Component Analysis, Varimax rotation, KMO=0.509, Total variance explained=58.8%, loadings smaller than 0.1 are omitted

In the stage prior to the trip, two types of ICT usage are clearly shown, one more passive, using ICT´s as a source of information, and other, clearly active where ICT´s are used to buy tickets or reserve taxis/shared vehicles. Table 3 presents the results of the factor loadings of this analysis.

Table 3. Exploratory factor analysis – respondents use of ICT in the pre-travel stage.

Statements	Component	
	1	2
I use the web/apps to check for the best way to go to the social activities (mode and/or route)	0.169	*0.845*
I use the web/apps to search for public transport schedules		*0.876*
I use the web/apps to keep me updated about traffic conditions		*0.696*
I use the web/apps to buy tickets	*0.778*	
I use the web/apps/phone calls to call a taxi or reserve a shared car	*0.891*	0.112

Method: Principal Component Analysis, Varimax rotation, KMO=0.581, Total variance explained=68.4%, loadings smaller than 0.1 are omitted

Regarding the possible activity fragmentation and multitasking during both the trip and activities two patterns of multitasking emerge, one related with a more active use of social media, essentially related with posting on social media websites and a second dimension related with a more utilitarian use of ICTs and with a stronger use of older technologies (phone and SMSs). The results

are presented in Table 4.

Table 4. Exploratory factor analysis – respondents use of ICT in the travel/activity stage.

Statements	Component	
	1	2
During the trip I use the web/apps/phone calls to keep friends posted about possible changes and delays, suggest changes in the meeting location and arrival time	*0.738*	0.131
During the trip browsing the internet or play online games	*0.790*	
During the trip posting online on social networks	0.251	*0.777*
During the trip make phone calls/chat or texting	*0.691*	0.166
During the activity browsing the web	0.493	*0.551*
During the activity posting about the ongoing social activity	-0.102	*0.901*

Method: Principal Component Analysis, Varimax rotation, KMO=0.666, Total variance explained=62.1%, loadings smaller than 0.1 are omitted

In general, the reactions from the pilot survey respondents were positive, and no one indicated any specific issue in which the survey was considered as inadequate. This, in conjunction with the results variability is a positive indication that the survey, when applied will allow us to collect data relevant enough to answer the research questions advanced here.

6. Conclusions

This work describes the design of a web survey aimed at studying the relations between ICT usage and social travel amongst university students in a cross cultural context. The survey design was based on an extensive literature review about the relations between ICT usage and travel behaviour and social networks. This allowed us to identify several gaps in the current research which then guided the definition of the research questions. The particular characteristics of the survey also guided its design since concerns related with drop-out rates, respondent fatigue and cognitive burden where considered as critical because of the implementation medium and the targeted respondents. A pilot was implemented. It showed that the preliminary version was globally adequate needing only small adjustments.

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References

Aguiléra, A., Guillot, C., Rallet, A., 2012. Mobile ICTs and physical mobility: Review and research agenda. Transportation Research Part A: Policy and Practice 46(4), 664-672.

Arentze, T., Timmermans, H. 2008. Social networks, social interactions, and activity-travel behavior: a framework for microsimulation. Environment and Planning B: Planning and Design 35(6), 1012-1027.

Axhausen, K. W., 2008. Social networks, mobility biographies, and travel: survey challenges. Environment and Planning B: Planning and Design 35(6), 981-996.

Bayart, C., Bonnel, P., 2008. Comparison of web and face-to-face household travel survey-application to Lyon case, Presented at the European Transport Conference, Leeuwenhorst, 6-8 of October 2008.

Ben-Elia, E., Alexander, B., Hubers, C., Ettema, D., 2014. Activity fragmentation, ICT and travel: An exploratory Path Analysis of spatiotemporal interrelationships. Transportation Research Part A: Policy and Practice 68, 56-74.

Bonnel, P., Madre, J.-L., 2006. New Technology: Web-Based., in *"Travel Survey Methods Quality and Future Directions"*. In: Stopher P., Stecher, C. (eds.), Elsevier, Amsterdam.

Carrasco, J. A., Miller, E.J., 2006. Exploring the propensity to perform social activities: A social network approach. Transportation 33, 463–480.

Carrasco, J. A., Hogan, B., Wellman, B., Miller, E. J., 2008. Collecting social network data to study social activity-travel behavior: an egocentric approach. Environment and Planning B: Planning and Design 35(6), 961-980.

Carrasco, J. A.,Miller, E. J., 2009. The social dimension in action: A multilevel, personal networks model of social activity frequency between individuals. Transportation Research Part A: Policy and Practice 43(1), 90–104.

de Abreu e Silva, J., Davis, M., 2015. A4 - Respondent/survey interaction in a world of Web and Smartphone apps. Workshop Report, Transport Research Procedia 11, 289-296.

Hjorthol, R., Gripsrud, M., 2009. Home as a communication hub: the domestic use of ICT. Journal of Transport Geography 17(2), 115-123.

Nitsche, P., Widhalm, P., Breuss, S., Brändle, N., Maurer, P., 2014. Supporting large-scale travel surveys with smartphones – A practical approach. Transportation Research Part C, 43, 212–221.

Kamargianni, M., Polydoropoulou, A. 2014. Investigation of the Effect of ICT Usage on Adolescent Females' Travel Patterns and Mode Choice Behavior, presented at the 5th International Conference on Women's Issues in Transportation (WIiT) - Bridging the Gap, Paris, France, 14-16 April, 2014.

Kenyon, S., Lyons, G., 2007. Introducing multitasking to the study of travel and ICT: Examining its extent and assessing its potential importance. Transportation Research Part A: Policy and Practice 41(2), 161-175.

Kenyon, S., 2010. The impacts of Internet use upon activity participation and travel: Results from a longitudinal diary-based panel study. Transportation Research Part C: Emerging Technologies 18(1), 21-35.

Kitamura, R., Nilles, J. M., Conroy, P., Fleming, D. M. 1991. Telecommuting as a Transportation Planning Measure: Initial Results of California Pilot Project. Transportation Research Record 1285, 98-104.

Kourounioti, I., Polydoropoulou, A., Kamargianni, M., Tsirimpa, A., 2015. Does Social Networking Substitute for or Stimulate Teenagers' Travel? Findings from a Latent Class Model, presented at the 3rd International Choice Modeling Conference (ICMC), 10-13 May, 2015, Austin, Texas.

Kwan, M.-P., 2007. Mobile Communications, Social Networks, and Urban Travel: Hypertext as a New Metaphor for Conceptualizing Spatial Interaction. The Professional Geographer 59(4), 434-446.

Lee-Gosselin, M., Miranda-Moreno, L. F., 2009. What is different about urban activities of those with access to ICTs? Some early evidence from Quebec, Canada. Journal of Transport Geography 17(2), 104–114.

Lenzner, T., Kaczmireck, L., Lenzner, A., 2010. Cognitive Burden of Survey Questions and Response Times: A Psycholinguistic Experiment. Applied Cognitive Psychology 24, 1003-1020.

Lin, T., Wang, D., 2014. Social networks and joint/solo activity–travel behavior. Transportation Research Part A: Policy and Practice 68, 18-31.

Line, T., Jain, J., Lyons, G., 2011. The role of ICTs in everyday mobile lives. Journal of Transport Geography 19(6), 1490-1499.

Mokhtarian, P. L., 1990. A typology of relationships between telecommunications and transportation. Transportation Research Part A: Policy and Practice 24, 231-242.

Mokhtarian, P. L., Salomon, I., 2002. Emerging Travel Patterns: Do Telecomunications Make a Difference?, in*"Pertpetual Motion: Travel Behavior Research Opportunities and Application Challenges"*. In: H. S. Mahamassani (ed.), Pergamon, Amsterdam, pp. 592.

Mokhtarian, P. L., Salomon, I., Handy, S. L., 2006. The impacts of ict on leisure activities and travel: A conceptual exploration. Transportation. 33(3), 263–289.

Nobis, C., Lenz, B., 2009. Communication and mobility behaviour – a trend and panel analysis of the correlation between mobile phone use and mobility. Journal of Transport Geography 17(2), 93-103.

Páez, A. Scott, D. M., 2007. Social influence on travel behavior: a simulation example of the decision to telecommute. Environment and Planning A 39(3), 647-665.

Pawlak, J., Le Vine, S. Polak, J. Sivakumar, A., Kopp, J., 2015. ICT and Physical Mobility, State of knowledge and future outlook, Ifmo, Munich.

Pendyala, R. M., Goulias, K. G., Kitamura, R., 1991. Impact of telecommuting on spatial and temporal patterns of household travel. Transportation 18, 383-409.

Peytchev, A., 2009. Survey Breakoff. Public Opinion Quarterly 73(1), 74-97.

Ren, F.,Kwan, M.-P., 2008. The impact of the Internet on human activity–travel patterns: analysis of gender differences using multi-group structural equation models. Journal of Transport Geography 17(6), 440-450.

Roy, P., Martínez, A. J., Miscione, G., Zuidgeest, M.H.P., van Maarseveen, M.F.A.M., 2012. Using Social Network Analysis to profile people based on their e-communication and travel balance. Journal of Transport Geography 24, 111–122.

Salomon, I., 2000. Can Telecommunications Help Solve Transportation Problems?, in *"Handbook of Transport Modelling"*. In: Hensher, D. A., Button, K. (eds.), Pergamon, Amsterdam, pp. 790.

Sadri, A. M., Lee, S., Ukkusuri, S. V., 2015. Modeling Social Network Influence on Joint Trip Frequency for Regular Activity Travel Decisions. Transportation Research Record 2495, 83-93.

Sasaki, K., Nishii, K., 2010. Measurement of intention to travel: Considering the effect of telecommunications on trips. Transportation Research Part C: Emerging Technologies 18(1), 36-44.

Schwanen, T., Kwan, M. P., 2008. The Internet, mobile phone and space-time constraints. Geoforum 39(3), 1362–1377.

Tilahun, N., Li, M., 2015. The Geography of Close Contacts and Face-to-Face Meetings, Proceedings of the 94th Annual TRB Meeting. Washington D. C., 11-15 January 2015.

Thulin, E., Vilhelmson, B., 2005. Virtual mobility of urban youth: ICT-based communication in Sweden. Tijdschrift voor Economische en Sociale Geografie. 96(5), 477–487.

van den Berg, P., Arentze, T., Timmermans, H., 2012. A multilevel path analysis of contact frequency between social network members. Journal of Geographical Systems 14(2), 125–141.

van den Berg, P., Arentze, T., Timmermans, H., 2013. A path analysis of social networks, telecommunication and social activity–travel patterns. Transportation Research Part C: Emerging Technologies 26,256-268.

Wang, D., Law, F. Y. T., 2007. Impacts of Information and Communication Technologies (ICT) on time use and travel behavior: A structural equations analysis. Transportation 34(4), 513–527.

Wang, D., Lin, T., 2013. Built environments, social environments, and activity-travel behavior: a case study of Hong Kong. Journal of Transport Geography 31, 286-295.

Wee, B., Geurs, K., Chorus, C., 2013. Information, communication, travel behavior and accessibility. Journal Of Transport And Land Use 6(3), 1-16.

Yuan, Y., Raubal, M., Liu, Y., 2012. Correlating mobile phone usage and travel behavior – A case study of Harbin, China. Computers, Environment and Urban Systems 36(2), 118-130.

Zhang, F., Clifton, K. J., Shen, Q., 2007. Reexamining ICT Impact on Travel using the 2001 NHTS Data for Baltimore Metropolitan Area, in *"Societies & Cities in the Age of Instant Access"*. In: Miller, H. J. (ed.), Dordrecht, The Netherlands, Springer, pp. 370.