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Originally published in:
Transportation Research Procedia 32, https://doi.org/10.1016/j.trpro.2018.10.018

Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 32 (2018) 99–109

Transportation Research Procedia

www.elsevier.com/locate/procedia

International Steering Committee for Transport Survey Conferences

Explaining socially motivated travel with social network analysis: survey method and results from a study in Zurich, Switzerland

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Abstract

It has been hypothesized that a crucial factor to understand and explain socially motivated leisure travel is understanding the spatial distribution of individuals' contacts. Still, only little is known about their actual link. Egocentric social network analysis (SNA) allows one to gather data about where and with whom individuals undertake their social activities. SNA therefore provides a way to study socially motivated leisure travel.
This paper presents a data collection effort in the canton of Zürich, Switzerland, which combines a mobility survey with a name generator and interpreter to gather information about individuals' egocentric social networks. A higher number of contacts leads to a higher response burden, which in turn increases item non-response. Subjects with low income and education generally name fewer contacts. With regards to travel behavior, the frequency of face-to-face meetings decreases sharply with distance to the residential location of contacts and face-to-face meetings are generally not substituted by other modes of communication (although increased usage of video chat is observed at long distances). Distance to social contacts is, therefore, an important factor in social leisure travel.

Keywords: social network; leisure travel; social network analysis; egocentric social network analysis; name generator; transport survey; mobility survey

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10.1016/j.trpro.2018.10.018

1. Introduction and related work

1.1. Social Networks and Travel Behavior

Social network analysis originated from sociology and only gained attention in the field of transport research relatively late. Axhausen (2005) argues that the historical increase in leisure travel relates to the increasing spatial spread of social networks. The latter has become possible due to the seminal drop in transport and telecommunication costs. Building on this work, Axhausen (2007) develops a set of more detailed, testable hypotheses on the link between individuals' social networks and travel behavior. These include the relationship between the generalized costs of travel and communication with the size of an individual's social network geography as well as an individual's number of contacts. Since then, the interdependence between individuals' social networks and their travel behavior has been the focus of some studies with the goal to better understand and model social interaction. Carrasco and Miller (2005) develop a conceptual model of social activity-travel behavior that includes individuals' social contexts as explanatory variables. Using structural equation modelling, they find that physical distance is not sufficient to explain with whom people socialize and that characteristics of individuals' social network need to be considered. Furthermore, internet and communication technology (ICT) usage has a complementary rather than supplementary effect on social activity-travel. However, the authors point out that the effects they found need to be controlled by personal and socio-economic characteristics. In a survey in the Netherlands, van den Berg et al. (2009) collected data on ego-centric social networks and analyze it in relation to travel demand using linear regression models. The authors find that the relationships between socio-demographic variables and network size, social category, geographic distance, and contact frequency are not strong. However, for face-to-face meetings they find a satisfactory model fit (van den Berg et al., 2009). Carrasco et al. (2009) point out that characteristics of egos, alters, and their personal networks might contribute to a better understanding of where people perform social activities with others.

Activity travel research also began to explore social network analysis as a possible way to improve the modelling of leisure travel in activity based demand models. Hackney and Axhausen (2006) develop a microsimulation of social networks. This microsimulation is embedded in the geographic space in which maintaining social contacts is a trip-generating activity. The framework could be extended to more realistic networks when distributions of relevant agent characteristics (e.g jobs and residential locations) are available. Arentze and Timmermans (2008) argue that due to interactions between people, social networks and activity-travel patterns coevolve over time. The authors conducted first simulations of this process. Dubernet (2017) has recently attempted to improve leisure destination choice in a simulation model. For a comprehensive literature review on social networks and activity travel behaviour refer to Kim et al. (2017).

Collecting data on social networks for transport research has been one of the foci of the dissertations of Frei (2012) and Kowald (2013). Frei (2012) uses an egocentric survey to collect information about subjects' social networks. His survey focuses on the core social support network and the network of leisure contacts. It includes questions about relationship type, duration of contact, contact frequencies by different modes of communication and the locations of contacts' homes and the last meeting location. In the analysis, the author mainly focuses on spatial distances in social networks and the number of social ties. Kowald (2013) uses a snowball survey that not only allows to gather information about the egocentric social network, but also about the broader network structure. The survey also includes basic socio-demographic information about contacts, which allows the measuring of the homophily between the subjects and their contacts. The author also analyzes communication patterns in social networks and the geographical spread of contacts and identifies distances to leisure contacts and communication strategies as a primary interest for transport planning. From a descriptive analysis, the author concludes that face-to-face meetings are most important (concerning frequency) up to 20 km and telephone and email contact gain in importance with increasing distance.

The social network part of the survey presented in this paper mainly builds on the above mentioned surveys by Kowald (2013) and Frei (2012). However, the online mode and the design of the survey allow the collection of more information about subjects' socio-demographics, attitudes and their mobility behaviour. Specifically, the questionnaire not only includes questions on available mobility tools (private car/ motorbike, public transport, and car sharing), but also on the estimated kilometres driven by car, the number of estimated public transport trips, and the destinations of recent flights. This will allow for an investigation of the link between individuals' social networks and travel behaviour more directly.

1.2. Collecting Social Network Data

Egocentric social network analysis focuses on individual subjects (egos) and persons with whom they have a direct relation (alters) (Wasserman and Faust, 1994). A popular technique to gather such information are name generators and subsequent name interpreters (e.g. Campbell and Lee, 1991). Name generators are questions to elicit a fraction of a subjects' social contacts that are of interest to the study and thus define the social network boundaries. Name interpreters are questions with the purpose of collecting information about the characteristics of the contacts that are named in the name generator (Marsden, 2005).

There are various challenges in collecting social network data that have already been discussed in transport literature. Carrasco et al. (2008) identify three key challenges: defining the network boundaries, participants' ability to recall network members (that are of interest for the phenomenon under study), and the response burden. They did so by mainly referring to Marsden (1990) and Marsden (2005). Concerning the subject of socially motivated travel, the name generator has to be suitable to elicit the fraction of contacts that influence subjects' travel behaviour. For this purpose, Frei (2012) describes two name generators that are based on the name generators used by Burt (1984) and Fischer (1982), which are also used in this study. The first name generator asks subjects to name persons with whom they discuss important problems, are in regular contact, or who they can ask for help. The second name generator asks for additional persons with whom the respondent is in regular contact during leisure time. The name generator thus follows the exchange approach of delineating social networks, which has the advantage of a rather consistent interpretation by respondents (van der Poel, 1993). Combining Frei's two name generating questions into one question was attempted in a pre-test of the survey but did not deliver desirable results as fewer contacts were named (Guidon et al., 2017).

1.3. Information About the Study

The survey is part of a project focusing on societal consequences of mobility in the canton of Zürich, Switzerland. The Institute of Science, Technology and Policy at ETH Zürich conducted the data collection in summer 2017. The goal of the project is study the effects of mobility on civic engagement and social capital and the relationship between mobility and individuals' social networks.

The survey data was gathered using an online survey that consisted of two separate parts. Part 1 focuses on travel behavior, ownership, and usage of mobility tools, civic engagement and attitudes towards specific transport policies. Part 2 is the egocentric social network survey. Subjects for the second part were recruited from the participants of the first part. The first part of the survey was fielded between 9th of June and the 28th of August. A random sample of 12000 addresses was drawn from the registry of residents of the canton of Zürich by the Cantonal Statistical Office (which belongs to the Department for Economic Affairs). Following a similar approach as Huber et al. (2017), subjects were invited via a postal letter to participate in an online survey. The access to the first online survey was sent by a postal letter in three waves on 9th, 21st and the 23rd of June with a reminder letter two weeks later to those respondents who have not answered the questionnaire by that time. The second part of the survey started with the first wave on the 20th of June. The invitation to the second part was sent in several waves depending on when the respondents finished the first questionnaire. Again, a reminder letter was sent two weeks later. The sixth and last wave was sent on the 31st of August.

2. Survey Method

2.1. Survey Protocol

Subjects received an invitation letter for an online survey including a small, symbolic incentive (a ball pen with the ETH Zürich logo). In this letter, they received an invitation to take part in the survey via a web address as well as an access code. The option to participate via a paper-and-pencil version of the survey was mentioned to allow participation for subjects without access to a computer with an internet connection (mainly people of old age). This approach is based on findings by Sterret et al. (2017), who show that coverage bias due to survey mode decreased over the last few years, but still leads to significantly different results. Thus, to sample the broader population they propose

to use mixed-mode survey designs (Sterrett et al., 2017). One reminder letter was sent to subjects who did not actively refuse to take part or had not completed the survey after two weeks.

At the end of the first part, respondents were asked whether they wanted to participate in the second part when receiving an incentive of CHF 10 for completion. If they were willing to do so, they received a letter with the invitation to the second part of the survey about social networks. The CHF 10 incentive was enclosed in the letter. After two weeks, the subjects who had not completed the second survey and did not actively refuse to take part, received a reminder letter again.

2.2. Survey Contents

The first part of the survey aimed at respondents' socio-demographics, mobility, social capital, and political and environmental attitudes. If possible, standardised instruments were used: for the environmental attitudes a scale described in Diekmann et al. (2009) was employed. Social capital was measured with the instrument developed by Freitag et al. (2016). For a detailed account of the sources of the questions refer to the appendix. The second part consisted of two name generating questions, a name interpreter, and additional questions regarding lifestyle and feeling of personal safety. A separation of the survey in two parts was necessary because of the comparatively high response burden (to reach an average response time between 25 and 30 minutes per part). For a more detailed description of the contents, refer to the appendix.

The questions in the name interpreter were chosen to be as concise as possible as they are repeated for every contact, which makes limiting the response burden even more critical. Nevertheless, spatial information needs to be exact enough for subsequent geocoding (at least at the municipality or town level). In this study, the exact address was asked to get a most accurate position of the residential location of the alters. This leads to more heterogeneity in the accuracy of the alters' locations (as geocoding was sometimes only possible at the municipality level), but in turn improves the accuracy of the analyses. Asking only for the town or the municipality could be a workable strategy to decrease the response burden and a trade-off between spatial accuracy and response burden should be considered.

3. Results

3.1. Response Behavior

An overview of the response rates and the realized sample is given in Table 1. As expected due to the source of the addresses, the contact rate (CON1) was high with 98.2% for the first part. The response rate for the first part was 20.7% (RR1), including partial answers even 21.9% (RR2). The refusal rate (REF1) was 2.8% and the cooperation rate (COOP2) 22.4%. For the second part, 1705 respondents from the first part agreed to take part in a second survey. This equals a recruitment rate of 68.8%. For this second part, the contact rate was 100% (CON1). Due to the cash incentive, the response rates of 81.3% (RR1) and 90.1% (RR2) are high, which was to be expected due to the pre-recruitment and the cash incentive. This is also indicated by the low refusal rate of 0.3% (REF1). Therefore, the sample for the second part consists of around two thirds of the complete responses of part 1 (the survey outcome rates were calculated according to the definitions provided by The American Association for Public Opinion Research (2016)).

Table 1. Response rate and sample size

	Part 1			Part2		
	Online	Print	Total	Online	Print	Total
Complete responses	2387	91	2478	1345	42	1387
Partial responses	137	13	150	143	6	149
RR1 [a]	0.20	0.64	0.21	0.82	0.77	0.81
RR2 [a]	0.21	0.73	0.22	0.90	0.87	0.90
Sample size	11858	142 [b]	12000	1650	55 [b]	1705

[a] The figures correspond to the RR1 and RR2 response rate as defined by the American Association for Public Opinion Research (The American Association for Public Opinion Research, 2016). RR1 is calculated as the number of complete interviews divided by the number of interviews (complete plus partial) plus the number of non-interviews (refusal and break-off plus non-contacts plus others) plus all cases of unknown eligibility. RR2 counts partial interviews as respondents.

[b] Equals the number of individuals who requested and received a printed version of the questionnaire.

On average, respondents who completed the first survey online needed 32.5 minutes. The median was 28.8 minutes (excluding surveys that took longer than 120 minutes, partial answers and responses with consent refusal). This is in line with the assessment of the response burden according to Axhausen and Weis (2010), which resulted in 553 points. Compared with other surveys, the response time and the estimated response burden both show that the response burden of the survey was comparably high but still reasonable for respondents.

The second survey about the egocentric social networks had higher variance in the response time: a standard deviation of 34 minutes compared to only 15.6 minutes in the first survey. This can be explained by the different amount of contacts stated by the respondents. On average, respondents needed 46.2 minutes, the median was 36.6 minutes (excluding surveys that took longer than 240 minutes, partial answers and responses with consent refusal).

3.2. Item Non-response Rate

Item non-response rates for part 1 of the survey are low, since for most of the questions an answer was requested (which meant that a pop-up message would be displayed when a participant did not answer a question). Nevertheless, specific questions exhibited high item non-response rates. The questions about the availability of parking spaces at the place of employment (Q2.10) and the educational institution (Q2.12), and the questions about religious affiliation (Q6.3) exhibited item non-response rates close to 30%. In case of the parking question, subjects might simply not have known the answer and an option to indicate that should have been added. However, the high item non-response rate for Q6.3 is surprising when comparing it to other sensitive questions in the survey. A possible explanation could be that religion is perceived as something private and a question about the specific religious community is perceived as inappropriate. Still, following this argumentation, the rate for household income (which is also considered private in Switzerland) should also have been elevated, which was not the case. On the other hand, the household income questions used categories of income ranges which might is perceived as more discrete. The question about the preferred political party (Q14.11) shows an item non response rate of 9%. This is not surprising as people might not feel affiliated to any party and thus skipped this question. In general, it is not surprising that sensitive questions receive higher non-response rates as they are not only subject to normal sources of reporting errors but also have the additional problem where respondents simply do not want to tell the truth (Tourangeau and Yan, 2007).

Overall, part 2 of the survey (the social network part) exhibited a higher item non-response rate, especially in the name interpreter questions (Q20.1 – Q20.20). Item non-response increased with the number of alters that were named in the name generator (see Fig. 1). Answers to the name interpreter questions were requested. This request indicates that inattention is no explanation for higher item non-response rates for subjects who named more contacts. Subjects seem to have used item non-response as a strategy to decrease their total response time (as name interpreter questions are repetitive the response burden can easily be anticipated). Question Q20.7 (alters' home addresses), which is also the question with the second highest response burden, was skipped most often. In this case, however, this might not be due to the high response burden. Question Q20.17 (address of the last meeting) had the same response burden, but

a much lower item non-response rate. Thus, it is more likely that indicating a contact's home address raised privacy concerns (as the contacts could potentially be contacted even though it was explicitly indicated that the data would not be used for that purpose) or that the address data might have been unknown to the respondents. The questions about the contact frequencies by different modes of communication (Q20.10 – Q20.15) exhibited a low item non-response rate as they were filtered by Q20.9 (modes of contact used for communication). For a detailed account of the response burden and item non-response, refer to the appendix.

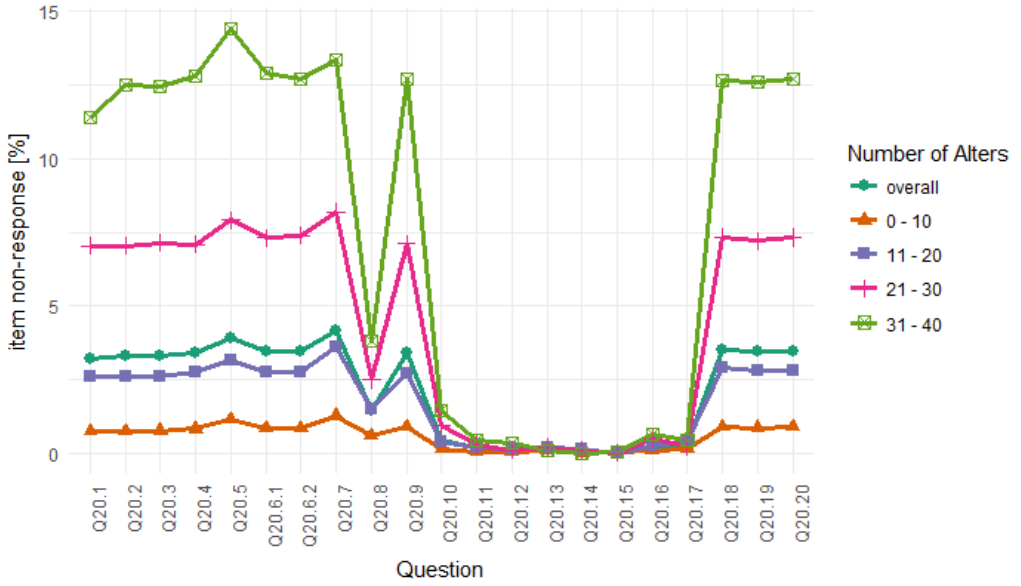

Fig. 1. Item non-response of name interpreter (questions 20.01 – 20.20). Question Q20.6.1 filtres questions 20.7 and question Q20.9 filtres questions Q20.10 – Q20.17.

3.3. Number of contacts

On average, respondents named 14.7 contacts. 8.7 was the average of alters named in the first name generating question that aimed at the core social support network (see Table 2). The number of contacts remains stable for different socio-demographic characteristics. As an exception, respondents that live in low-income households and respondents with a low education reported a significantly lower number of contacts. In general but only slightly different, respondents in higher income households also named a higher number of contacts – except the highest income category. Additionally, female respondents and respondents with a university or University of Applied Sciences (UAS) degree or a general qualification for university entrance tended to name more contacts. Moreover, all groups exhibit a high standard deviation of the number of contacts, which reflects the high heterogeneity in sizes of social networks. Although a very similar name generator as Frei (2012) was used, the number of reported contacts is higher. In Frei's survey, respondents named an average number of 12 contacts (with a median of 11), but with a relatively low number of core contacts (only 6 on average). This might be due to the online mode of this survey and the higher number of text fields that were provided to report the contacts (40 instead of 32). The survey by Kowald (2013) that used a slightly different name generator (the order of the name generating questions was reversed) even resulted in an average of 21.9 contacts. This reflects how slight changes in the name generator and the survey mode lead to different outcomes regarding the number of named contacts. This is in line with results of Campbell and Lee (1991), who state that network size and characteristics are most strongly affected by the name generator used.

Table 2. Number of contacts by socio-demographic characteristics

	Median		Mean		SD	
Variable	Core	All	Core	All	Core	All
Age						
Up to 30	9	14	8.8	15.3	4.6	8.1
30 to 40	7	13	8.2	14.0	4.6	7.9
40 to 60	8	13	8.7	14.6	4.9	8.3
60 and older	8	13	8.9	14.9	5.5	9.1
Sex						
Female	9	15	9.4	16.3	5.1	8.3
Male	7	11	8.1	13.3	5.0	8.4
Education						
Less than secondary school	4	7	6.6	11.3	6.3	12.3
Secondary school	6	12	8.0	13.9	5.4	7.4
Vocational training	7	12	8.1	13.8	4.9	8.0
General qualification for university entrance	8.5	15	9.2	15.6	4.9	8.2
University or UAS degree	8	14	9.2	15.5	5.2	8.9
Income						
Less than CHF 2000	6	14	8.2	14.5	5.7	9.6
CHF 2000 – 6000	7	12	8.2	13.5	5.4	8.2
CHF 6000 - 10000	8	13	8.8	14.8	5.0	8.3
CHF 10000 – 14000	8	13	8.9	14.9	5.2	8.7
More than 14000	8	14	9.0	15.5	4.9	9.0
All	8	13	8.7	14.7	5.1	8.5

The distribution of the number of contacts is shown in Fig. 2. It can be observed that it is right-skewed. The small peak at 40 contacts is due to the maximum number of fields in the name generator (which means that some respondents might have named even more contacts).

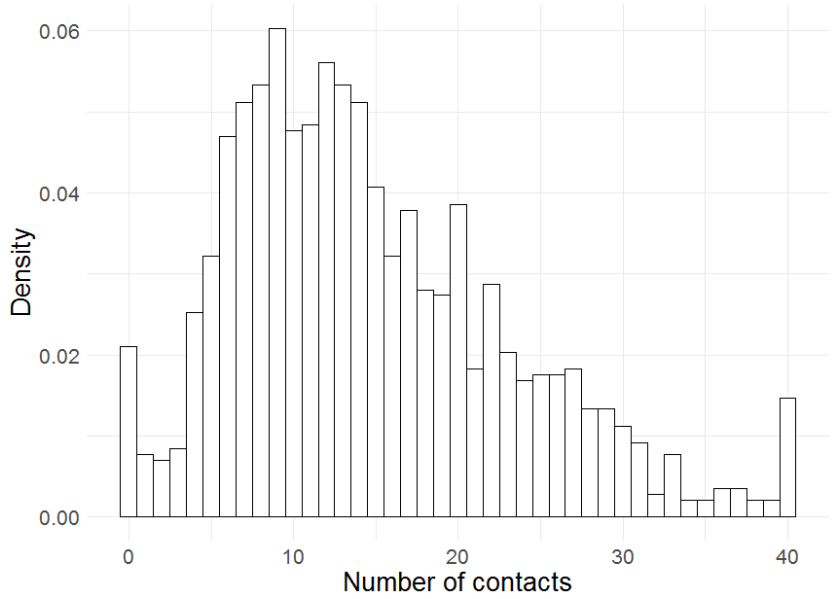

Fig. 2. Degree density distribution (all contacts)

3.4. Communication Patterns in Social Networks

To discover how the spatial distribution of individuals' contacts affect their travel behavior, the frequency of face-to-face meetings concerning the distance between individuals and their contacts is analyzed. The meeting frequency is compared to contact frequency with ICT communication modes to address potential complementarity or substitution. Fig. 3 and Fig. 4 show the contact frequency per year by different modes of communication between egos and alters depending on the crow-fly distance between their home locations. The frequencies are plotted at the means of the distance deciles and are shown on a logarithmic scale. This allows for comparison to the study results of Frei and Axhausen (2009) and Kowald (2013). Regarding absolute communication frequencies, all modes decrease if only contacts are considered that do not live in the same household (a distance of 0). Overall, contact modes follow different trends: while physical meetings show a steady decrease with distance, SMS and email are constant and seem to be independent of distance. Chat, defined as all kinds of internet-based communication except email and video chat (such as Skype), is also not strongly affected by distance. It shows a slight increase in communication frequency for increasing distances after decreasing until 10 km. Video chat is not used for contacts that live closer than 70 km to the subject, but then steadily increases with increasing distance and even surpasses face-to-face meetings and SMS for very long distances. Although face-to-face meetings decrease sharply with distance, they remain substantial even for very long distances.

Compared to Frei and Axhausen (2009) and Kowald (2013), the frequency of private chats is higher and ranks as second most important contact mode by frequency regardless of distance. It has replaced the telephone as the second most important mode by frequency which can be explained by the increased ICT use since then. Private chats become more frequent than face-to-face meetings at a distance of 6 km. The change in the importance of private chats can most likely be attributed to the wide dispersion of smartphones that has only taken place after Kowald's survey, which was fielded in 2011 (Kowald and Axhausen, 2014). For the other communication modes, the absolute contact frequencies are comparable.

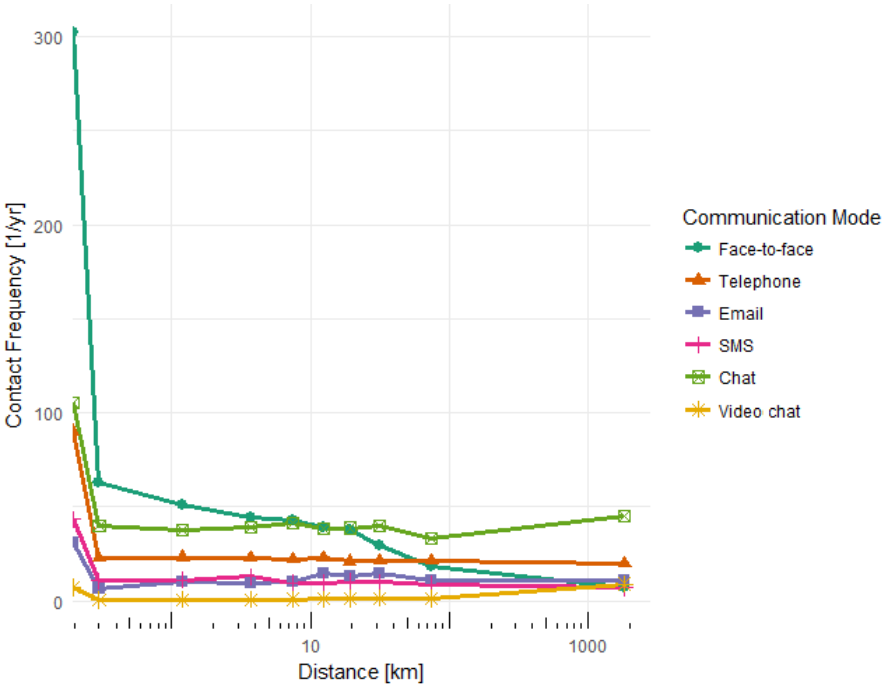

Fig. 3. Communication frequencies in egocentric social networks (all contacts)

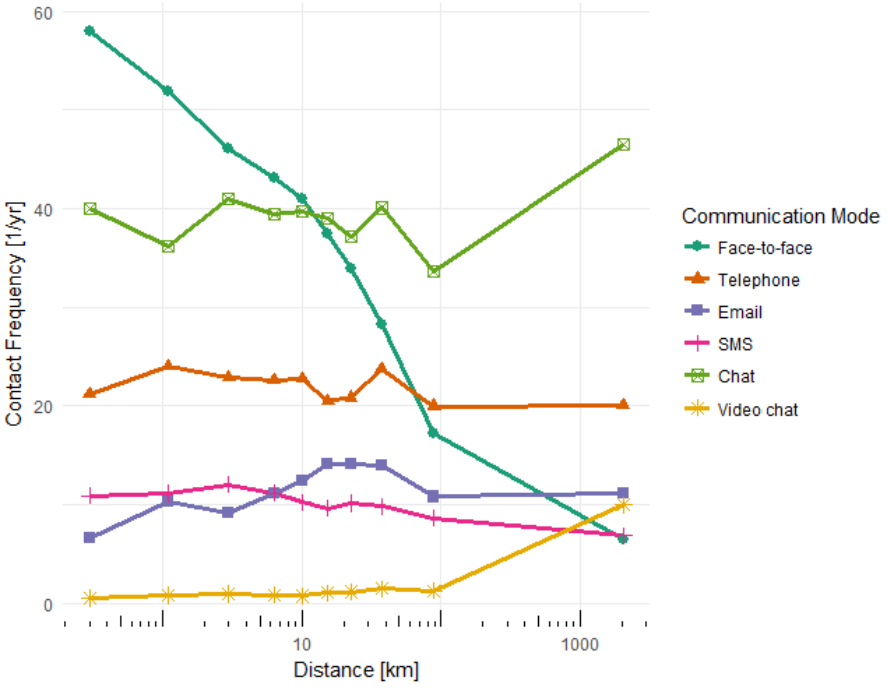

Fig. 4. Communication frequencies in egocentric social networks (contacts with distance > 50 m, i.e., contacts not living in the same house or household)

4. Conclusion

This paper describes a possible way to combine egocentric social network analysis with a traditional mobility survey. Because of the high response burden, the survey was split into two parts. Participants of the second part were recruited at the end of the first part, and an incentive of CHF 10 was offered. In this way, a high recruitment rate of 69.1% was obtained. Although surveying in such a way increases the selection bias for the second part, the additional bias is limited because of the high recruitment rate. Moreover, it is a way to deal with the high response burden that is associated with adding a social network analysis to a survey.

The number of reported social contacts is stable across socio-demographic characteristics (except for individuals living in extremely low-income households and subjects in the lowest education class). However, the standard deviation of the number of contacts is high, which means that there is high heterogeneity in social network sizes between subjects. Thus, the chosen socio-demographic characteristics do not seem to be good indicators of the social network size. This might have implications for the efforts to create synthetic social networks for activity-based transport demand models. A more detailed analysis will reveal the connection with other characteristics of the respondents such as their civic engagement, lifestyle, their place of residence, and political attitudes.

Compared to the survey described by Frei (2012), the total number of contacts that respondents named is higher, which might be due to the online mode or the fact that more text fields were provided in the name generator. However, it also underlines the sensitivity of the number of contacts that are named towards the name generating questions. This finding is highlighted by the fact that the number of contacts named was substantially higher in Kowald (2013) even though the name generator was only slightly different from the one that was used by Frei (2012) and this survey.

Face-to-face meetings lead to travel and are an essential part of social leisure travel. Previous studies and the analysis of the survey data presented in this paper have shown that face-to-face meetings are the most critical form of communication in social networks, and still exhibit a substantial frequency for contacts that live very far away. The contact frequency by private chats become higher than the frequency of face-to-face meetings at a distance of 6 km between home locations of egos and alters, which partly reflects the resistance that distance poses for physical meetings. However, ICT communication frequencies are mostly independent of distance and remain constant, which suggests that there is generally no substitution of face-to-face meetings by ICT. For very long distances, video chat becomes substantial. Also, there is a slight increase in private chats, which could be interpreted as a compensation of the lower frequency of face-to-face meetings. The high frequency of face-to-face meetings at shorter distances, their sharp decrease with distance, and the observation that there is no substitution by other modes of communication underlines the importance of spatial proximity or travel for individuals to maintain their core social support and leisure networks. This has implications for the subject of social travel, as face-to-face meetings require some form of travel when the contact does not live in the same household. The connection between mobility behavior and the social network characteristics of the survey will thus be subject to future analyses.

There are two significant challenges for future studies on social networks and travel behaviour: limiting the response burden and increasing data quality. The high response burden of social network surveys requires researchers to offer incentives to limit non-response and dropout rates, which increases the costs. It also makes a combination with existing transport surveys difficult. It would, therefore, be worthwhile to develop simplified instruments that preserve the information of interest. This could, for example, be achieved by aggregating spatial information (e.g., by asking for the town or municipality of residence instead of a detailed address in the name interpreter). If detailed spatial information is required, subjects could be assisted with maps or other appropriate tools.

Appendix A. Survey Questionnaire, response burden and share of missing values

The appendix is available online: https://www.ethz.ch/content/dam/ethz/special-interest/dual/istp-dam/documents/ISTP/Research/Mobility/Publications/TRP_Appendix.pdf (March 2018).

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