LINKING TRAVEL BEHAVIOUR UNDER WEATHER UNCERTAINTY TO SOCIAL NETWORK CHARACTERISTICS: A GLASGOW CASE STUDY

Dr Tim Ryley
Loughborough University

Dr Alberto Zanni
Loughborough University

1. INTRODUCTION

Recent studies have provided evidence that extreme weather events will become more frequent as a consequence of climate change (see for example Love et al., 2010), and the winters of 2009/2010 and 2010/2011, were particularly severe in the UK (with winter 2009/2010 being the coldest for 31 years), causing a number of disruptions not only to travel, but also to electricity and water supply. Travel disruptions, in particular, were estimated to cost £280m per day to the UK economy during the severe spells (Prior and Kendon, 2011a, b).

It is useful to observe that when travellers face uncertainty, irrespective of the main cause of it, they therefore need suitable resources to predict the likely conditions of the transport system prior to a trip. Personal experience and exchange of information with other trusted individuals becomes an effective way of reducing its occurrence and consequences (Barton, 2011; Bonsall, 2004). The latter, in particular, is of great interest and, as demonstrated by Schwanen (2008), in the context of household allocation of activities, travellers often react and cope with uncertainty not individually but as members of a social network. Schwanen identifies social networks and in general, social proximity, as an important source of support for households in the planning of activities and related trips.

This paper examines traveller responses under weather uncertainty. A major internet-based travel behaviour survey was conducted in 2011/2012 with 2,027 respondents in London and Glasgow, as part of a wider FUTURENET (Future Resilient Transport Networks) research project that investigated climate change adaptation on the 2050 UK transport network and how to make the transport systems more resilient. The paper focuses on the 990 Glasgow-based respondents within the FUTURENET travel behaviour survey. The survey contains socio-demographic, attitudinal and transport variables, plus a novel social network analysis section that collected information on individuals within the respondent's social circle.

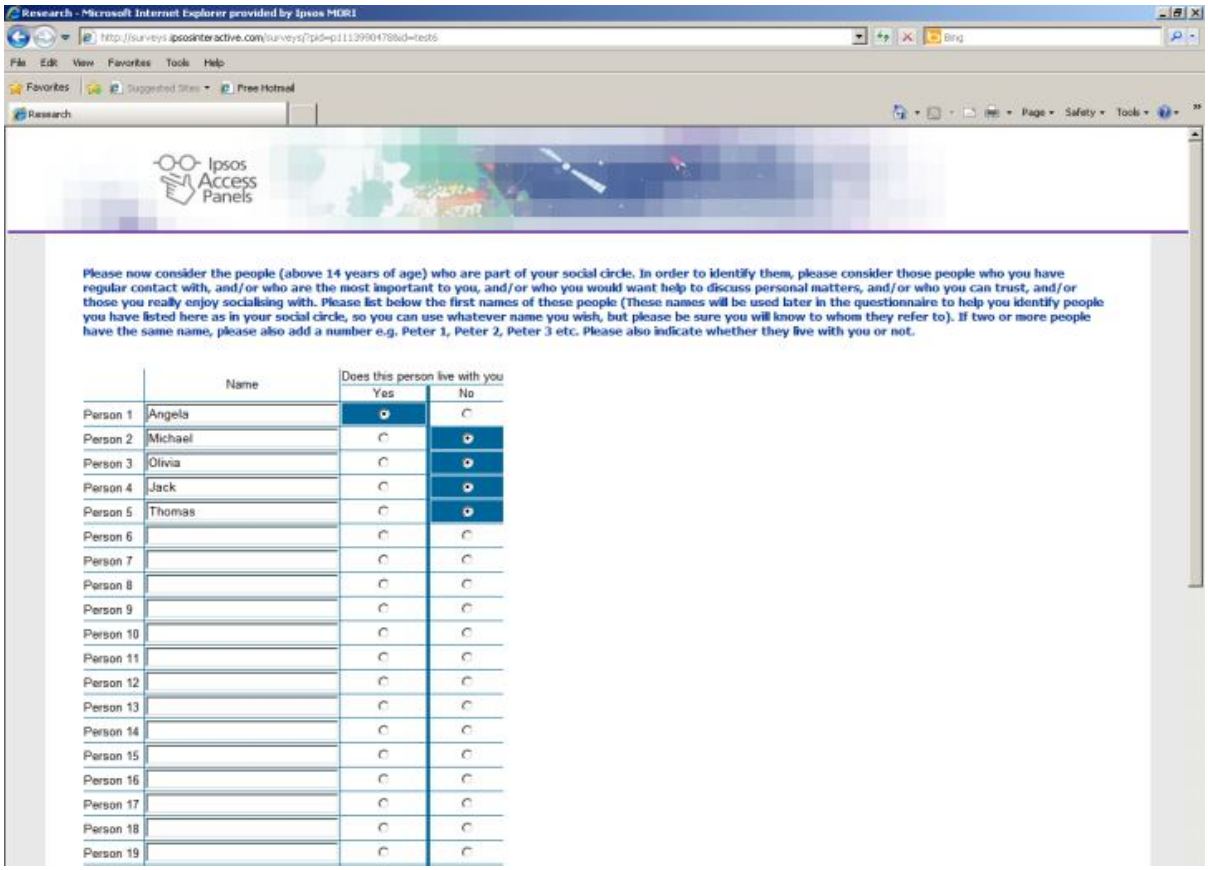
2. METHODOLOGY

An internet-based survey instrument was developed through two workshops (March 2010, January 2011) attended by a number of experts in both travel behaviour and social network analysis, and two pilot tests (November/December 2010 and April 2011) on a combined sample of 170 respondents. The main survey was distributed between August 2011 and February 2012, to over 2,000 respondents, split between the United Kingdom cities of London and Glasgow. Quotas were set for age, gender and socio-economic characteristics of respondents. Internet surveys have been a popular tool among researcher in recent years. They possess in fact considerable cost and time advantages over equivalent mail, phone or face to face surveys. However, they seem to generally produce lower response rates and fail to cover those segments of the population that are not connected to the internet.

The travel behaviour survey contained a social network analysis section, a stated preference experiment on long-distance travel, experience of travel under weather uncertainty, and environmental attitudes, in addition to the usual questions relating to personal/household demographics.

Initially there is a summary of the Glasgow sample and background transport characteristics in terms of general car and public transport use. The social network characteristics of respondents are then examined. The interest is in social networks when they translate into social influence and therefore affect travel behavior. In order to assess respondents social networks, a simple name generator was used, as survey participants were asked to provide the list of persons “they have regular contact with, and/or who are the most important to them, and/or those they would want help to discuss personal matters, and/or those they can trust, and/or those they really enjoy socializing with”. For each of the contacts, respondents were then asked to indicate whether the particular person lives with them, the type and length of relationship, and the type and frequency of contacts (by various means like face-by-face, phone, SMS, email, chat). Respondents were also asked to indicate which of their contacts they turned to for advice on travel decisions, and, in particular, who (and why) they would contact if they were experiencing an uncertain situation (like a service delay or cancellation) prior or while travelling. Figure 1 shows a screen shot of one of the social network analysis questions.

Figure 1. An example of a screen shot for the social network analysis question asking whether the people within the social circle live with the respondent (note: the five named examples are fictitious)



Cluster analysis was applied to the Glasgow sample to generate eight groups from seven socio-demographic and social network variables: age, gender, employment status, children in household, ethnic origin, size of the respondent's social network, and those in the respondent's social network living within the local neighbourhood. These cluster groups are linked to general travel behaviour, travel decision-making (referring to their social network or not), and an attitudinal statement relating to response to an official warning not to travel.

3. ANALYSIS

3.1 Summary of the sample

After a number of thorough checks (on consistency across sections and engagement with the survey), the usable dataset was composed of 2,027 respondents: 1,037 from London and 990 from Glasgow. Selected background socio-demographic characteristics of the Glasgow sample are:

- Gender: 42% males & 58% females.
- Age: 51% aged 18-39, 39% aged 40-59 & 10% aged 60.
- Status: 51% of respondents are working full time, 12% part-time, 9% are retired, 9% are in education, 7% unemployed, 5% home-maker, 4% self-employed & 3% not working (health issue / disability).
- Area: Full postcodes were collected for all respondents, covering 30 Glasgow postcodes ('G'). The three postcode areas with the highest number of respondents were G41 (67), G12 (64) and G42 (63).

The socio-demographic characteristics are therefore to be expected, fairly representative of the Glasgow population, although is a high proportion of female respondents. This is despite a quota (minimum of 40% male or female) and shows the expected higher responses from females to internet surveys.

3.2 General travel behaviour amongst the Glasgow population

There is a real contrast in the Glasgow sample between those who do and do not use a car. Indeed, there are three distinct groups roughly equal in size: 32% of respondents who never use a car, 34% of respondents who use a car more than five times per week, and the 34% in-between (occasional car use). These statistics are naturally linked to ability to drive; 70% of respondents hold a driving licence.

Many within the Glasgow sample are regular public transport users. Just over a third of respondents travel by bus (366, 37%) and around a fifth take the train (197, 20%) at least once a week. Glasgow has 134 respondents (14%) that use the underground system at least one day a week. For the other sustainable transport modes, most individuals (649, 66%) walk at least 3 days a week. As expected, cycling is a minority travel mode, although 163 (17%) of respondents do cycle at least once a month.

3.3 Social network characteristics

From the name generator questions, respondents reported information on 6.4 contacts each on average in the Glasgow sample. Respondents could name up to 30 members of the social circle; 17 respondents named the full 30 members available, whilst 99 respondents did not list anyone (it is acknowledged that some of these respondents, although a tiny minority, given the number of consistency checks, may have express a protest response to a question which may seem to intrude in their privacy). The most frequent number of contacts listed was five (219 respondents, 11%). Around half of respondents named between three and seven contacts (470 respondents, 46%); most respondents had between one and eleven individuals within their social circle (776 respondents, 78%).

For one of the questions about their social network, respondents listed the location of those within their circle for up to their first ten members. Figure 2 shows the location of individuals in Glasgow.

Figure 2. A graph to show the location of members of the 990 respondent's social network in Glasgow (Note: the x-axis is the numbered person from 1-10 in the social network and the y-axis is the number of alters)

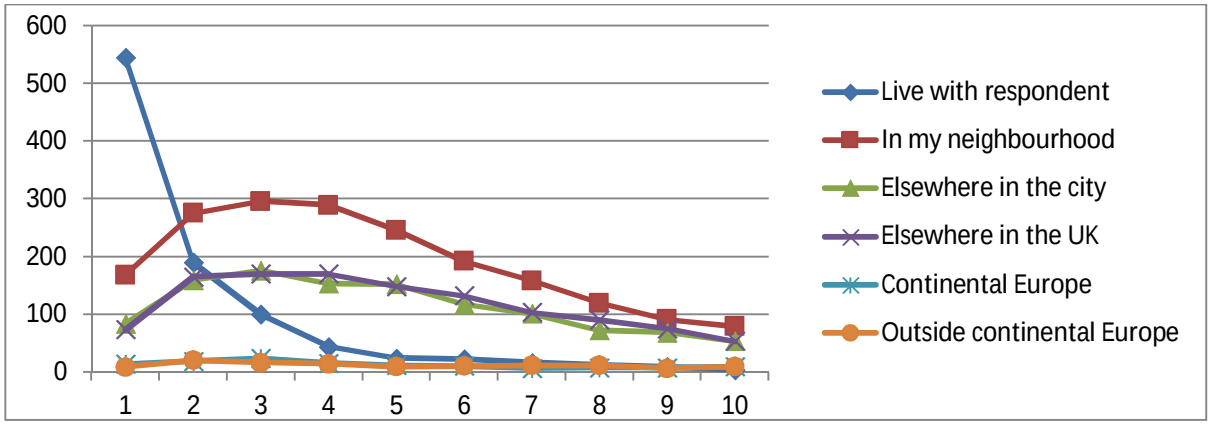


Figure 2 shows the dominance of the first person in an individual's social network living with them, often as a wife / husband / partner. For those in the social network not living with the respondent, there is an importance of the surrounding neighbourhood. There are a greater proportion of social network members within the local neighbourhood in Glasgow than in London.

There was also an attempt to examine correlations between the number of social network members that live in the neighbourhood and the level of car use (as driver) and amount of walking undertaken. This is to test if individuals with fewer neighbourhood contacts will drive more (have a larger sphere of influence) and walk less. There is statistically significant negative correlation (at the 99% level) between driving and neighbourhood contacts, which confirms this relationship, but there could be no link established for walking.

3.4 Cluster analysis of the socio-demographic, spatial and social network information

Cluster analysis was applied to the 990 Glasgow respondents. It was considered appropriate to generate similar-sized groups of between 50 and 250 individuals (between five and ten group solutions), large enough for further analysis and small enough to have a sufficient number of clusters. A hierarchical technique of clustering was applied as it is the only one to permit categorical data. Ward's method, a hierarchical clustering algorithm, has been used to identify clusters of individuals within the two samples. Ward's method calculates the sum of squares (distance) between an object in the first cluster and an object in the second cluster, which is then summed across all variables. This method optimizes the production of clusters of approximately equal size. In deciding how many clusters should be formed, there is no standard objective procedure; the procedure is, instead, subjective but guided by the 'stopping rule', which involves selecting the number of clusters which most appropriately represents the dataset (Hair et al., 2005).

For the Glasgow sample, seven socio-demographic and social network variables were input: age, gender, status (in employment or not), children in household, ethnic origin (white or non-white), size of the respondent's social network, and the number of the members of the respondent's social network living within the local neighbourhood. The key characteristics of the final eight population segments are shown in Table 1.

Table 1. Key characteristics of the population segments in Glasgow

Group	N (%)	Key characteristics (including % within group)
1	100 (10.1%)	Group with most non-workers (43%), a high number of social network contacts (all have at least 9 contacts in their social network) & in the local neighbourhood (92% have at least 4 contacts within the local neighbourhood) and has the highest proportion of respondents (joint with group 5) with children (32% have at least one child).
2	101 (10.2%)	Particularly young (53% aged 17-34), & female (69%) group, with most respondents without children (83%) and a high number of social network contacts (all have at least 9 contacts in their social network), although many of these contacts are not in the local neighbourhood (70% have 0 or 1 contact within the local neighbourhood).
3	159 (16.1%)	Group with the highest proportion (joint with group 8) of white respondents (90%)
4	153 (15.5%)	Group with the highest proportion of females (70%) and workers (74%).
5	167 (16.9%)	Group with the lowest number of individuals within their social network (all have two or fewer contacts) and has the highest proportion of respondents (joint with group 1) with children (32% have at least one child).
6	82 (8.3%)	Group considered to have the most typical or 'average' characteristics within the Glasgow sample (i.e. without particularly high or low values for all of the variables when compared against the other groups generated).
7	177 (17.9%)	Most male-dominated group (58%), has the highest proportion in a non-white group (13% - the remainder are white) and lowest proportion of contacts within the local neighbourhood (all have 1 or fewer contacts within the local neighbourhood).
8	51 (5.2%)	Most respondents (85%) are aged 35-64, has a high proportion of workers (73%) and the highest proportion (joint with group 3) of white respondents (90%)
Total	990 (100.0%)	

The cluster analysis generated distinct groups for travel behaviour data analysis mainly based on the number of individual within a social network and the proportion those within the same neighbourhood as the respondent. More specifically for Glasgow, there is a cluster group with many locally-based members (1) that can be contrasted with a group with few local members (2). There are also low 'social' (5) and neighbourhood (7) focused groups, plus a typical group (6) and one consisting of middle-aged workers (8).

Cross-tabulations have been undertaken for these eight cluster groups against the general travel behaviour categories for Glasgow respondents (34% regularly, 34% occasionally and 32% never use a car). The groups with the highest proportions of regular car users were clusters (8) and (1) with 43% and 42% regular car users respectively; these groups have middle-aged individuals and respondents with children. Cluster group (2) has the highest proportion of occasional car users (45%), typically consisting of young females. The proportions of those that never use a car are fairly even across the clusters, between 28% and 35% for the eight groups.

3.5 Travel in uncertain situations

One question asked respondents who they would turn to for general travel advice (respondents could name more than one person) from their social network (and a couple of other options). The 99 people without anyone in their social network were not asked this question. Of those with a social network, most (473, 53% of the 891 naming a social network) turn to the first person within their network (P1). Another sizeable group within the survey sample are the 280 respondents (31% of the 891 respondents with individuals in a social network) who would not refer to anyone within their social circle when looking for general travel advice because they would take the decision themselves. The proportion of respondents in this category was highest (in order) in the following three cluster analysis groups: (8, 41%), (7, 40%) and (3, 35%). The highest group (cluster 8) is typically composed of middle-aged workers, whereas the second-highest group (cluster 7) has the lowest proportion of contacts within the local neighbourhood.

A range of attitudinal statements were asked of respondents. One of the most relevant for operators is how individuals respond to official warnings. It is interesting that 23% of the Glasgow sample (21% of the London sample) agreed with the following statement: During bad weather I normally attempt to travel even when an official warning of 'not to travel unless absolutely necessary' is in place (for example from the Police, AA, Met Office, Highways Agency or Local Council). The proportion is highest in the following cluster groups: (5, 26%), (1, 25%) and (7, 24%). Interestingly one of these groups (7) has the highest proportion of males, whilst another (5) has respondents with the lowest number of individuals within their social network.

4. DISCUSSION AND CONCLUSIONS

This paper has conducted some exploratory analysis of an extensive Glasgow travel behaviour survey, generating some useful transport statistics. In terms of general travel behaviour, three distinct and relatively equal-sized groups of car drivers (regularly, occasionally and never use a car) have been determined. Such groups are useful for targeting urban-based transport policy interventions. A novel social network analysis has shown the influence of those within an individual's social circle upon transport decision-making, particularly the "most significant other", often a spouse or partner. The role of social network members within the local neighbourhood has been demonstrated, and it would appear that car drivers are less likely to have social network members from within their local neighbourhood.

Splitting the Glasgow sample into sub-groups has also enabled some relationships to be examined. Those with high car use are more likely to be middle-aged respondents with families, whereas occasional car users seem to be young females. When facing travel uncertainty, as shown by this paper, some people turn to individuals within their social network for help and advice, whilst others make decisions on their own. The latter group, amongst the Glasgow sample, are typically those who are middle-aged and without social network members in their local neighbourhood. Finally, it is demonstrated that a sizeable group, around a fifth, within the population would still travel during weather uncertainty despite an official warning, an important message for transport operators.

Acknowledgements

The authors would like to acknowledge the UK based Engineering and Physical Sciences Research Council (EPSRC) for funding the 'FUTURENET' project (Future Resilient Transport Networks). The travel behaviour survey was conducted as one component of the FUTURENET project. The authors also acknowledge the market research company Ipsos MORI who conducted the data collection effect of the travel behaviour survey.

BIBLIOGRAPHY

Barton, D. (2011) People and technologies as resources in times of uncertainty. **Mobilities** 6, 57-65.

Bonsall, P. (2004) Traveller behaviour: decision-making in an unpredictable world. **Intelligent Transportation Systems** 8, 45-60.

Hair, J.F., Black, W., Babin, B., Anderson, R., Tatham, R.L., 2005. *Multivariate Data Analysis*, Sixth Edition. Pearson Prentice Hall, New Jersey.

Love, G., Soares, A., Püempel, H. (2010) Climate Change, Climate Variability and Transportation. **Procedia Environmental Sciences** 1, 130-145.

Prior, J., Kendon, M. (2011a) The disruptive snowfalls and very low temperatures of late 2010. **Weather** 66, 315-321.

Prior, J., Kendon, M. (2011b) The UK winter of 2009/2010 compared with severe winters of the last 100 years. **Weather** 66, 4-10.

Schwanen, T. (2008) Managing uncertain arrival times through sociomaterial associations. **Environment and Planning B** 35, 997-1011.