CHAPTER 7

Dynamic social networks and travel

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Introduction

A social network is a representation of an individual's social connectedness. Fields as distinct as health, psychology and marketing are involved in social network research. A recent promising addition is the field of travel behaviour. In travel behaviour research, traditional factors of interests are facets of travel choice (such as frequency and transport mode) and ownership of mobility resources (such as car, bicycle, discount cards, period travel passes). Gradually, the concern shifted from trip-based to activity-based approaches to model travel properly as a derived demand from the activities that people conduct in space and time. The attention also shifted from individuals to households. Consequently, joint activity scheduling, task allocation, and resource allocation were incorporated in the choice models (Borgers et al. 2002; Ettema et al. 2004; Schwanen et al. 2007; Zhang et al. 2005). However, joint activities do not only involve household members, but may also include members of a person's social network. Often, we negotiate with our friends and family about where to go for holidays, who should host the New Year party or what movie to go to this weekend. Each individual is part of social networks and individual behaviour will be influenced by peer groups. Spatial behaviour analysis is incomplete without an understanding of this social dimension. To better understand people's activity-travel patterns, we need to understand how people select and organize their social contacts, adding a whole new dimension of transport behaviour modelling research. However, there is another distinct, and often ignored, feature of personal social networks: it is dynamic. It changes with time and with life course. In this Chapter, we emphasize the need to explain social networks and corresponding activity behaviour in a dynamic perspective. We conclude the chapter with a discussion of constraints and benefits of incorporating these dynamics and suggest directions of future research.

Towards Dynamics

The relationship between social networks and travel has been the subject of an increasing number of studies in recent years (Carrasco and Miller 2005; Hackney and Axhausen 2006; Han et al. 2011; Páez et al. 2008; Silvis et al. 2006; van den Berg et al. 2009). Most of these studies have examined the cross-sectional relationships between characteristics of social networks and facets of physical and virtual travel. However, the contemporary challenge in activity-travel behaviour analysis is to move beyond single-day approaches to dynamic activity-based models, focusing on adaptation to demographic, social and policy changes. The next challenge is to incorporate social network dynamics as the evolving nature of social networks and corresponding activity travel agendas have not been addressed in any detail in transportation research and beyond.

Why do we need to move towards dynamics of social networks? Social networks induce, alter, and even constrain travel. This effect is not static; it evolves continuously. We do not have the same social networks all our life. Our circle of friends, neighbours and contacts keeps changing as we age and life cycle events (e.g. marriage) happen. To understand how long-term behaviour and preferences change, it is imperative to understand these patterns in a dynamic setting. Assuming social networks are constant over time would fundamentally be erroneous in the first place and could result in flawed predictions of travel demand models. Studies show that social networks may induce adaptation in activity and travel choices. It is therefore imaginable, that changes in social networks can induce changes in activity-travel choices as well. For instance, Arentze and Timmermans (2008) conducted numerical simulations and argued that participation in social networks may lead to adaptation of aspirations and diffusion of knowledge, which in turn may trigger changes in activity-travel choice behaviour. Han et al. (2011) elaborated and extended this approach and demonstrated that the exchange of information and the formation of network-specific aspiration levels can influence choice set formation and destination choice behaviour. Páez and Scott (2004), Hackney and Axhausen (2006) also used simulation approaches to demonstrate the possible effect of social networks on activity choices.

There are a number of ways through which social networks may affect transportation choices (Figure 7.1). First, social networks provide travel companions for social and leisure trips in particular. Individuals need to discuss and find agreement with their companions in decisions on the when, where and how aspects of activity and travel. Secondly, social networks are an important source of information. Not only for short term travel choices but also for long terms decisions, such as finding a new home or job (Connerly 1985, 1986; Dawkins 2006; Granovetter 1995), social networks play a key role. Thirdly, networks form an individual's primary source of social and emotional support, ranging from painting the house to child/elderly care (Lai 2001; Wellman and Frank 2001). Fourthly, peers have an influence on evaluations of choice options. Whether for novelty or approval seeking individuals tend to put value to how their alters or the society in general perceive their choice options (Abou-Zeid and Ben-Akiva 2011; Abou-Zeid et al. 2013; Schmöcker et al. 2013). ICT and social media support and shape the social interactions involved. With the growing influence of ICT in our lives, getting in touch or planning an activity is faster and easier (Mokhtarian 2002; Senbil and Kitamura 2003; Dijst 2009; Tillema et al. 2010; van den Berg et al. 2010). Despite the growing influence of ICT, face-to-face contacts and hence the geographic distribution of social contacts is still an important factor in the formation and maintenance of social relationships. If we or members of our social network move, we travel more or less, further or closer, weekdays or weekends to socialize with them. When social networks change it potentially brings changes in any or all of the ways, eventually changing individual's activity and travel patterns.

<Insert Figure 7.1 here>

Figure 7.1: Interactions between social networks and activity-travel behaviour

The importance of dynamic personal networks has been long acknowledged in the field of sociology and demographic research (Hummon 2000; Snijders et al. 2010; Watts 1999), but it is not readily evident how such research can be elaborated to fit the agenda of transportation

research. Here, we summarize contemporary efforts and in the next section we illustrate an empirical example of modelling social network dynamics in transportation research.

Approach and Major Findings

Sharmeen et al. (2010) focused on long term dynamics of social networks in the transportation literature. The motivation of this work stems from the simple notion that social networks are not invariant over time or over the life course of an individual. The key feature of the research is, therefore, long term dynamics. Life cycle events are assumed to be triggers of these dynamics.

Conceptual Framework

A central concept of the research is that dynamics of social networks are related to life cycle events, and have an effect on the activity and travel behaviour dynamics. The conceptual framework, therefore, is concerned with the following three domains:

1. The life-cycle domain
2. The social network domain, and
3. The activity and travel domain

It states that all these three domains are dynamic and interrelated. Change in any one domain can have an effect on the others. For example, when a person gets married (a life-cycle event), (s)he gets new in-laws and friends, as a result of which his/her social network may change. Since the person has a partner now the household maintenance jobs (such as grocery shopping, picking up/dropping off dry cleaning, etc.) can be distributed between the partners. Associated with the new social network, there can be new social visits and recreational activities. These have a direct impact on the activity and travel needs of the person. The effect can also be direct, for instance when the activity-travel schedule changes due to a job change. Let us consider the three domains as three parallel lines running along with each other as presented in Figure 7.2.

Certainly causality may also be in reverse direction. For instance, marriage and conjugal relationships and new jobs can be mediated through social networks, changing activity and travel behaviour may necessitate relocation, etc. However, the scope of the research is limited to investigate, firstly whether social networks change with life cycle events and secondly if they do, whether this has any effect on activity and travel needs. Investigating the causalities of life cycle events is beyond the scope of the research. Given this focus, the data collection is aimed at changes in social networks. The purpose of Figure 7.2 is to convey that these three domains are interrelated. This is an area not put forward before in the literature. Although all three domains can influence each other, the research focuses on social network changes occurring after a particular life-cycle event.

The framework is developed to capture these notions. Life-cycle changes are assumed to have an effect on social networks and activity-travel needs. Events may bring in changes in individual's time budget or location status or both. For instance, residential relocation includes a change of address and a modified geographical distance with all existing social network members. For some ties, these changes are substantial and will cause a change in interaction frequency. As a result, the tie may eventually disappear from the ego's active social network. Similarly, events may add new ties in the network. Therefore, effects of an event on the number of lost ties and number of new ties are expected.

Events may also have an effect on time budget. This may induce stress in the overall equilibrium bringing the system out of balance. Individuals then need to reschedule their activity-travel agenda. Hence, the effects of events on activity-travel needs are also taken into consideration.

In terms of social network dynamics, the framework assumes that there is a threshold of social network size. An ego cannot keep on adding ties indefinitely. Since the time the ego needs to maintain those ties is limited, at some point some ties should fade away. With this assumption, the model tests the effect of new ties on lost ties. Furthermore, the interdependencies between

social network dynamics and activity-travel needs are investigated. Details of the framework and investigation are reported in Sharmeen et al (2014a).

<Insert Figure 7.2 here>

Figure 7.2: Conceptual framework representing three domains of interrelated dynamics.

Source: (Sharmeen et al. 2010)

Data Collection

Perhaps the most difficult aspect of investigating social network dynamics is to obtain the data. Ideally, panel data would be needed, but such surveys are very demanding. Therefore, in this research project we used an event-based retrospective survey to serve the purpose (see Chapter 2; also see Ohnmacht 2004). Respondents were pre-screened based on life cycle events. They were asked to choose one recent event from the event list provided at the beginning of the survey. Recent events were defined as events that took place within the past two years. If multiple events were experienced, then the respondent was asked to choose the most recent one to answer the questions. If they qualified, respondents were forwarded a set of questions related to the event. To capture such effects in the data, we carefully chose the period of two years so that respondents would have a new settled activity-travel pattern comparable to their pre-event agenda. Events were selected based on a literature review (Bidart and Degenne 2005). Presumably, all five events have an impact on social network and social interaction patterns because time and money budgets and social needs are changed.

During sampling, we aimed to have an equal representation of each type of life cycle event. However, after correcting for non-response and eliminating incomplete questionnaires, we obtained between 18% and 21% responses for each life cycle event. The average response rate was 56%. Table 7.1 presents a summary.

The web-based and paper-based surveys were administered in September 2011 in the Netherlands. The survey was divided into four parts seeking information about socio-

demographics of the respondent, the present social network, changes and new contacts (if any) in the personal social network and in activity-travel behaviour in response to the life-cycle event in question. The first part collected socio-demographic details of the respondent including an estimate of the size of their present social network according to type of relationships. The second part asked details about their close ties. Close ties were defined as those individuals with whom important information is shared, personal problems are discussed, help during emergency or daily necessities is asked and with whom regular contact exist. Respondents could mention up to 25 ties. Details include socio-demographics of the alter, geographical distance, frequency of interaction, relationship strength (on a five point scale) and duration (in years).

In the third part, respondents were asked whether any change in the social network occurred as a result of the event. If yes, they were forwarded to a table where they had to list existing ties that involved a change and new ties that were formed. Furthermore, for each listed tie they had to fill out the type of change (geographical distance, frequency of contact per mode both before and after the event), the socio-demographics of the alter, information about the tie (strength, length known) for each of the alter where a change occurred. They also reported new ties and lost ties here. If there were no changes with a tie, they were not asked these details. The fourth part of the survey asked about changes in activity-travel schedules before and after the event. In this survey, new ties were not included, because information about distance change was not available for new ties. It only concerns those ties that existed pre-event and did not changed post-event.

Aiming at broadening our view from static to dynamic social networks, this survey has systematically considered changes in social networks, social interaction and activity-travel patterns with life cycle events. The purpose of the data collection was to test and validate the conceptual framework, i.e. the existence and nature of the interdependencies between the identified domains by means of empirical data. First, we investigated the effects of life cycle events on social networks, social interactions (including effects of ICT) and activity-travel

behaviour. Then, in an integrated framework, we explored the dynamic interrelationships between the domains of social networks and activity travel profiles, triggered by life cycle events.

Table 7.1: Summary of life cycle events

Type of life cycle event	# participants	# Completed questionnaire	# Non-response	% completed questionnaire	% of total completed questionnaire
Relocation	231	135	96	58.4	19.2
New job	244	150	94	61.4	21.3
Change in civil status	194	134	60	69	19.1
Starting university	226	131	96	57.9	18.6
Children start school	351	153	198	43.6	21.8
Total	**1,246**	**703**	**543**	**56.4**	**100**

Summary of Findings

We identified three interrelated domains of life cycle events, social network and activity-travel behaviour and argue that understanding dynamic repertoires of these three interconnected domains is crucial to predict long-term travel demand. The general approach was to test and validate the conceptual framework (Figure 7.2), i.e. the existence and nature of the interdependencies with empirical data. First, we investigated the effects of life cycle events on social networks, social interactions (including effects of ICT) and activity-travel behaviour. Then, in an integrated framework, we explored the dynamic interrelationships between the domains of social networks and activity travel profiles, triggered by life cycle events.

Social interactions may involve a decoupling between persons in space and time to some extent (Carrasco et al. 2008), since one does not need to be in the same place and time to communicate with each other owing to the growth of electronic means of communication (e.g. via e-mail, mobile telephone, online social media). To some extent because distance still matters in the maintenance of social networks (Dijst 2009; Mok et al. 2010). Our first set of analyses investigates face-to-face social interaction frequency after changes in geographical distance and contexts (accessibility, density) due to life cycle events. Owing to these changes social interaction mode and frequencies may change among two actors. At first, we investigated how geographical features and changes in geographical distance affect social interaction frequency. Additionally, we tested if the history of interaction frequency might have an effect. We developed an ordered logit model of face-to-face social interaction frequency incorporating homophily, accessibility and path dependence attributes (Sharmeen et al. 2014b).

The findings (of the study reported in detail in Sharmeen et al. 2014b) imply that urban densities influence social interaction/activity frequency differently. Effects of distance to transport infrastructures also vary. Moreover, number of shopping (non-grocery) facilities within one kilometre of ego's residence influence social interaction/activity frequency positively. However, the quantities of café/restaurants and attraction facilities in the same radius (within 1 km radius around the postcode) have a negative effect on social interaction/activity frequency. The main take away from these findings is that local accessibility indicators affect social interaction frequencies. Therefore local geographical attributes should be taken into due consideration to better explain the social interactions and travel. These factors can contribute in creating sociable cities and cohesive communities, as argued in recent studies (Farber and Li 2013; Farber et al. 2013).

In terms of the long-term dynamics in face-to-face social interactions, one of the major findings of the aforementioned study is that social interaction/activity frequency is path dependent. Individuals tend to maintain their social ties with similar frequencies as they did

before. However, when life cycle events have taken place, social preferences, needs and aspirations may change or get constrained. Previous studies support the finding that individuals keep the frequency of social interaction with family and stronger ties on a similar level (Sharmeen et al. 2012). This implies that it is unlikely that ties with whom one meets daily would disappear from the social activity agenda.

However, changes in geographical distance triggered by life cycle events have significant influence on social interaction frequency. Frequency of contact decreases with ties that become distant after an event. Analysis of the interaction effects of distance changes between actors and type of life cycle events reveal some interesting results. For instance, social interaction frequencies with ties who are geographically close after a life cycle event are influenced by the type of event. If it is residential relocation, the meeting frequency increases whereas the opposite is the case for events related to a change in work/study hours. The findings add to the literature in sociology about distance decay (also see Chapter 5) in social relationships (Dennis 1977).

Secondly, we investigated the dynamics of interaction between physical and electronic modes of communication with alters (Sharmeen et al. 2013b). The relationship between face-to-face and ICT contact frequency was found to be of a complementary nature in previous research. However, in most of the studies, it was found or assumed that ICT use has an effect on face-to-face communication. In Sharmeen et al (2013c) we allowed for the endogeneity effects between the modes of communication with a multilevel path analysis model (Hox and Kreft 1994; MacKinnon 2008; Mueller 1996). We found evidence that the effects could also be in the other direction. In line with contemporary researches, we found that ICT has a complimentary effect on face-to-face communication. Adding to it, we found that face-to-face communication has a substitution effect on ICT interaction frequency in a dynamic context.

Moreover, there were some important findings regarding the dynamics of social network due to life-cycle events. The most intuitive one is that the number of new ties has a negative effect on the number of old ties. As more and more new members are added to one's personal

social network, the loss of existing ties becomes more probable. Next, the relationships between lifecycle events and dynamics of time allocation to activity and travel was investigated (Sharmeen et al. 2013a). Using path analysis, we analysed the effect of several lifecycle events on changes in activity and travel time allocation. Significant and susbtantial impacts of lifecycle events on time allocations was observed. Moreover, the effects are varied in direction and magnitude according to the type of event.

The findings confirm the three hypotheses regarding lifecycle events and activity travel dynamics. Events related to subsistence activities, such as new job and starting university, obviously affect time allocation to subsistence activities. Events related to big household changes, such as residential relocation and children starting school, influence time allocation to maintenance and leisure activity-travel. Events related to changes in civil status, which potentially changes the social network size and composition, such as, getting married/separated/divorced/beginning co-habitation, influence the time allocation to maintenance and leisure activities. We also have found evidence that all events affect time allocation to leisure activities in varying intensity and direction. This is most likely because leisure activities are the most flexible and discretionary of all. However, this finding also acts as an indicator that lifecycle events are associated with social networks since they are key in most leisure activity planning. Any change in leisure activity time allocation potentially means change in the type and pattern of maintenance of social networks, which in turn affects their size and composition. Consequently, dynamics of social networks are associated with dynamics of activity travel behaviour.

Furthermore, the relationships between social network dynamics and activity travel needs in response to life cycle events was examined. The framework presented in Figure 7.2 was tested using a structural equation model (Sharmeen et al. 2014a). The results confirm the expectation that activity and travel dynamics are influenced by life cycle and social network dynamics. Moreover social network and activity travel dynamics are interdependent, i.e. a change in one leads to a change in the other. Furthermore, the study finds that travel needs are for the most part

influenced by activity needs. Most socio-demographic and life cycle event variables have a direct impact on activity needs, which in turn generate travel needs.

These findings are consistent with the notion that activity generates travel. Travel does not have an impact on activity needs. We find this to be valid in a dynamic model as well. Furthermore, the findings related to social networks suggest that there is a optimum size for personal networks. The optimum may vary among individuals and perhaps also throughout life stages. A detailed study of this concept is needed and remains on the future research agenda.

Finally, we proposed a model to predict the formation of and changes in social ties among two actors in the population (Sharmeen et al. 2013c). The empirical analysis demonstrates how such a model can be estimated. Using the model and predictions, social networks for a population can be simulated and can be updated accordingly to accommodate changes of individual's and household's life cycle. The method and findings are relevant not only for long term travel behaviour analysis and prediction but also for human social behaviour in a more general sense.

The model derived from previous work (Arentze and Timmermans 2008; Arentze et al. 2012; Arentze et al. 2013) is based on fundamental theories and observations of social networks, such as homophily, reciprocity, transitivity and degree distribution (also see Chapter 4). To determine the social ties between two actors in the population it uses the random utility maximization assumption. The utility of a tie is measured by the degree of similarity between the actors and the geographical distance between them. A tie between two individuals is worthwhile only if the utility exceeds a threshold value for both persons involved. Thus the model predicts if a new tie emerges or not between two individuals. However, social ties and social networks are dynamic and may change especially in relation to life cycle events. Therefore, the model is extended to also predict behaviour in an adaptation stage in case a life cycle event occurred.

Findings suggest that the formation of new ties is influenced by homophily between the actors in the initial phase. In addition to that, geographical proximity influences the formation of

a tie. The effects however are minimized in the adaptation phase, in the sense that sensitivity to homophily declines or in some cases a marginal inclination towards heterophily can be observed. However, for existing ties the effects of heterophily become stronger.

The model and predictions can be used to simulate social networks for a population wide distribution (Arentze et al. 2013). One can create a social network in the initial phase and then update it accordingly using the type of life cycle events. Further existing social ties could be updated using the history effect predictions.

The empirical analyses provided evidence that these domains are interconnected (Sharmeen et al. 2014a). Social network dynamics affect activity-travel needs and vice versa. The numbers of lost and new ties and time allocations to activity and travel vary depending on the types of life cycle events (Sharmeen et al. 2013a). Moreover, the numbers of new and lost ties are interdependent indicating the existence of an optimal personal social network size. In terms of social interaction, it was found that face to face social interactions are influenced by change in geographical distance to alters and accessibility and urban density of an ego's home location (Sharmeen et al. 2014b). Furthermore, it was found that ICT and face to face social interactions influence each other in the long term (Sharmeen et al. 2013b).

Summarizing the findings, we observed that social networks are dynamic and so are the activity-travel choices, needs and aspiration levels. Evidently, they influence each other. These long term dynamics and their interdependencies are essential for a comprehensive understanding of travel behaviour. Modelling with the assumption of static or independent nature of what are actually dynamic dimensions should lead to biases in prediction. Social policies and travel demand forecasting models are designed for the long run, making these incorporations relevant. Of course, we are far from completely grasping the interactions and time dynamics; nonetheless the study indicates the relevance of the dynamics for transportation research and travel demand forecasting models.

Limitations

Most of the study limitations relate to the data and assumptions related to the data collection. Some typical errors and biases are associated with retrospective surveys, which were inevitable in this case. However, studies have shown that retrospective data can be useful if carefully collected. When studying mobility issues, panel data contain a higher risk of inconsistency and sometimes discontinuity related to nonresponse and selective loss of mobile respondents is employed (Solga 2001). On the other hand, studies show that with proper design and execution respondents can recall events and socio-demographics with a higher degree of accuracy (Behrens and Mistro 2010; Berney and Blane 1997). In order to reduce errors, the survey was carefully designed and administrated with the aim of reducing respondent burden, focusing on one particular recent event and the changes associated with it to ensure respondents have a clear idea when answering the questions. Three rounds of pilot testing were organized and detailed feedback reports from respondents and academics were taken into account to improve the design at each step. Applying possible and pragmatic measures, it was attempted to ensure that the responses have better consistency and as few errors as possible. Yet, it is likely that there are still errors and memory biases particularly in the area of reporting durations before the events for less important activities.

There were some missing data related to lifecycle events (key events such as child birth and details of residential moves) in the analysis. This was primarily due to lack of data. We acknowledge that situational changes may have occurred during the after-event period that are not recorded and hence cannot be included in the analysis. The objective of the chapter (and data collection) is to capture the effects of a major life cycle event to the activity-travel scheduling. People need some time to absorb and incorporate the effect of the event in their activity-travel budget. To capture such effects in the data, we carefully chose the period of two years so that respondents would have a new settled activity-travel programme comparable to their pre-event agenda. The survey was based on the above assumptions.

We also assumed that life cycle events trigger long-term changes in social networks and activity travel needs. Although this assumption is based on literature review, there are other reasons that may bring in changes in social networks, which could not be incorporated in the study.

Social networks and interactions are a two-way street. In this research project, we only hear and include one side of the story. Similar life cycle events and changes may occur to the alters. Their home locations, urban density and accessibility features may also have an influence on social interactions and travel, which we could not account for. Neither do we have detailed information about social media use and their effects.

Challenges Remain

In recent years, researchers have addressed several aspects of the influence of social network on activity and travel planning, such as duration, frequency, start time, distance, mode choice, etc. The reported results are intuitive and demand due attention by researchers as well as policy makers and practitioners to incorporate the social context in activity and travel demand forecasting. However, it is a long way to completely understand the social dimensions of activity and travel. Therefore challenges remain . Here, we summarize the broader topics.

A first challenge is to incorporate social networks in application oriented travel demand forecasting models, so as to predict social and leisure travel demand with greater understanding. To see the big picture, we need to broaden our view from egocentric social networks (for an example see Chapter 3) to a population-wide projection (e.g. see Chapter 4). An agent based simulation environment is a potential platform to serve the purpose and should be utilized accordingly. Further, to simulate the potential of tie formation, the negotiation of a social meeting (mode choice, place, time etc) has been simulated in transportation research using multi-agent simulation. However our knowledge is still limited. In this study, we have extended ways to predict population-wide social network dynamics, which needs further modification, for instance,

incorporating geographical attributes, and sensitivity tests to assess the error and biases associated with replication.

Another predicament in social networks analysis is obtaining the necessary data. To get a good impression of the heterogeneity of activities, it is desirable to collect longitudinal diary data. Traditional travel diary surveys collect one or two days of travel data from participants. While cross-sectional travel diary surveys are useful in determining the overall average travel behaviour of the regional population, they do not capture repetitive patterns in social activities, for instance weekly routines of people. New GPS technologies and use of smartphones may provide a promising way of collecting longitudinal travel data without asking too much effort from respondents.

In addition, the study of the effect of ICT's on social activity-travel remains a topic for future research. Although this topic has been studied recently, the possibilities of ICT's are increasing rapidly. These changes will affect joint travel, for instance in arranging a joint trip (e.g. making reservations, buying tickets, checking routes, weather and travel conditions), making additional research necessary. With the growing influence of social media in individuals' social life, dynamics of social network has become important more than before. Possibly virtual social networks are more flexible, at least in terms of new ties, where social media plays an important role in information dissemination, publicity of social events, etc, having further impact in activity and travel needs. We could not incorporate the effects of social media in particular. This could be done by collecting information about virtual social networks, interaction and travel patterns. Further peer influence on travel choices could also be investigated by tracking information dissemination in social media. The possibilities of extension are therefore diverse and promising.

A further challenge is to link the a-spatial aspect of social network to the spatial one. There is a spatial facet attached to an individual's social network as far as travel and transportation is concerned. The distance and accessibility of the peers should matter in planning and maintaining social networks. In this chapter, we only had data from the ego, not from the

alter, which is a very relevant and possible future extension. Snowball sampling method can be used to collect the relevant information (an example for such a study is provided in Chapter 4). Alternatively targeted stated adaptation questionnaires could be designed to understand the role of geography and infrastructure on social interaction to a greater depth.

Moreover, studies have found support to the assumption that personal social network tends to change with major life cycle events. New ties are added and some old ties fade away. They also suggest that there is a threshold of the size of personal social network. The threshold may vary among individuals and perhaps also throughout life stages. A detailed study of this concept is needed and remains in the future agenda.

Finally, due consideration should be attached to social network dynamics in choice set development. In travel behaviour modelling identifying choice sets is a challenge as individuals are not aware of a universal choice set when selecting an activity-travel profile. They cannot even always consider all of those they are aware of, constrained by their habitual preferences (path dependence) or resource availability. Information about attitude and personality may assist to understand these characteristics. Moreover, the choice sets are dynamic and major change is induced by the evolving social networks.

The analysis of social networks has a far reaching potential in understanding almost all aspects of human behaviour. These potentials have been discussed for some time. A recently growing field of exploration is activity and travel behaviour. The literature of social networks and transportation literatures is nonetheless still at an exploration stage. There have been some commendable works already. Further comprehension and integration of the local social context, social externalities and social dynamics to the travel behaviour models remain on the contemporary agenda.

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