

****FIRST DRAFT****

Chapter Number

ARE FACE-TO-FACE AND ICT MODES OF COMMUNICATION MUTUALLY INTERDEPENDENT? A MULTILEVEL PATH ANALYSIS INCORPORATING SOCIAL NETWORK DYNAMICS AND SOCIAL INTERACTION HISTORY

Fariya Sharmeen

*Eindhoven University of Technology, Eindhoven, the
NETHERLANDS*

Theo Arentze

*Eindhoven University of Technology, Eindhoven, the
NETHERLANDS*

Harry Timmermans

*Eindhoven University of Technology, Eindhoven, the
NETHERLANDS*

Abstract

The interaction between the use of Information and Communication Technology (ICT) and travel and transportation has been an important issue in transportation research. ICT may substitute work trips and enhances non-work travel. Particularly for social activity and travel behaviour existing studies suggest that ICT has complementary effects: ICT enhances social travel or increases efficiency in scheduling the activity by introducing flexibility into it or does both. However, with changing life events social network and associated travel may change for each ego-alter combination. These disaggregated effects ultimately bring in changes to the overall travel schedule of the ego and eventually to the

local travel demand. The paper takes these dynamic effects into consideration and argues on the interrelationships between the modes of social communication. The study shows that causal interferences between face-to-face and ICT modes of communication can be in either direction. It is not necessarily from ICT to face-to-face as was assumed in the contemporary researches in the field. Using the event based retrospective data collected in 2011 in the Netherlands a multilevel Structural Equation model of social interaction frequency is estimated. Results show that dynamics of a social network influences dynamics of social interaction. The study confirms the hypothesis that the modes of social interaction (face-to-face and ICT) have a mutual causal relationship. They substitute and complement each other. Considering network dynamics induced by life-cycle events, face-to-face interaction substitutes ICT interaction and ICT interaction complements face-to-face communication.

Introduction

A social network evolves as one passes through important stages of life. Not all childhood friends become the friends for a lifetime and people tend to gain and loose colleagues as they change jobs. Moreover, with increasing popularity and introduction of ways to keep in touch with one's social world, the mode and frequency of social communications might change over time as well. With this concept in mind, this study investigates how social communication patterns change and interact among the various modes of communication with changes in social network.

To investigate the dynamics of social interaction patterns, it is important to know the history of social interaction between the ego and alter. By doing so, we can account for the dynamics in social interaction and the effects of social network dynamics and secondary effects of life-cycle events. Life-cycle events bring about changes in individual's activity and home locations, thereby increasing the probability to meet new people and expand the social network. Similarly, some old contacts may get less communication owing to changes in time budget or perhaps geographical distance. Further, to compensate for lost social and emotional needs, caused by the network members with whom the ego lost touch, an ego might become eager to make and communicate with more new friends. Presumably, there will be changes in the social network and social communication pattern.

The relationship between face-to-face contact and use of ICT (Information and Communication Technology) methods of contact has been a popular research theme for quite some time now. Research shows that ICT contacts, first of all, are not independent from face-to-face interactions (Dijst 2009; Kwan et al 2007; Tillema et al 2010). There could be four possible ways by which ICT can interact with leisure activities and travels: substitution, complementary, neutrality and modification (Salomon 1986). Further, researchers found that social travel and ICT communication are complementary to each other (Mokhtarian 2002; Senbil and Kitamura 2003; van den Berg et al 2010). However, in most of the contemporary research only one-way interaction from ICT to face-to-face communication has been assumed and modeled. Evidently, increasing ICT contact would trigger new face-to-face contact and also enable additional face-to-face interactions as people would have increasing virtual space to schedule and plan new social events. We

argue that the effects could also be the other way around. Increasing face-to-face communication with an alter may lead to more ICT communication with him/her as well. Further we argue that these communication options and particularly the company of social interaction, however, is dynamic and changes with spatial context (Sharmeen and Ettema 2010) and over lifetime (Sharmeen et al, 2010).

In that context, the objective of the study is to investigate the dynamics of social interaction with the dynamics of social network and to test the causal interferences between the modes of social interaction

The remainder of the paper is organized as follows. First, the theoretical construct is outlined with a description of the concept and a brief review of contemporary research in the subject is discussed. Secondly, the details of the data and methodology used for the present analyses are provided, followed by a discussion of the analyses and results. The paper is completed with some concluding remarks.

2. Theory and literature review

2.1 Theory and Concept

Drawing from previous literature (Salomon 1986; Mokhtarian 1990; Van den Berg, Arentze, and Timmermans 2008) the interaction between ICT (virtual) and physical travel behavior can be defined into four categories:

1. Substitution: ICT replacing travel
2. Complementary: this could be either enhancement (ICT stimulating trips) or improving operational efficiency (ICT facilitating more efficient travel)
3. Neutrality: ICT and travel having no interaction effects
4. Indirect: ICT may influence land use which will further affect travel

We assume these interaction effects between ICT and face-to-face communication, being the primary reason of social travel. Mokhtarian (1990) concludes that the most important impact of ICT on travel behavior might be the flexibility it brings in to decide on the time, place and mode of travel. The impact is of key importance particularly in social activity-travel behavior, comprising mostly non-mandatory activities.

The direct interaction effects between ICT and travel is illustrated in figure 1. We extend the concept presented by Salomon (1986), where he illustrated the interaction between modes of communication across time, assuming an exponential growth. The total communication pattern can be divided into three distinct areas:

- The share of transportation, presented by the lower section of the graph
- The interaction zone presented in the middle section
- The ICT communication zone of the upper section of the graph

The interaction zone is divided by the 'no interaction' line. The area above the no interaction line represents 'enhancement' and the area below the line defines 'substitution' effects of interaction between ICT and travel. When at a certain point of time an important

life-cycle event is introduced the communication patterns might get modified. There might be an increase (upward shift) of the graph, a decrease (downward shift) or there might be no change at all. The modifications are represented by introducing dotted lines in the interaction zone of the graph.

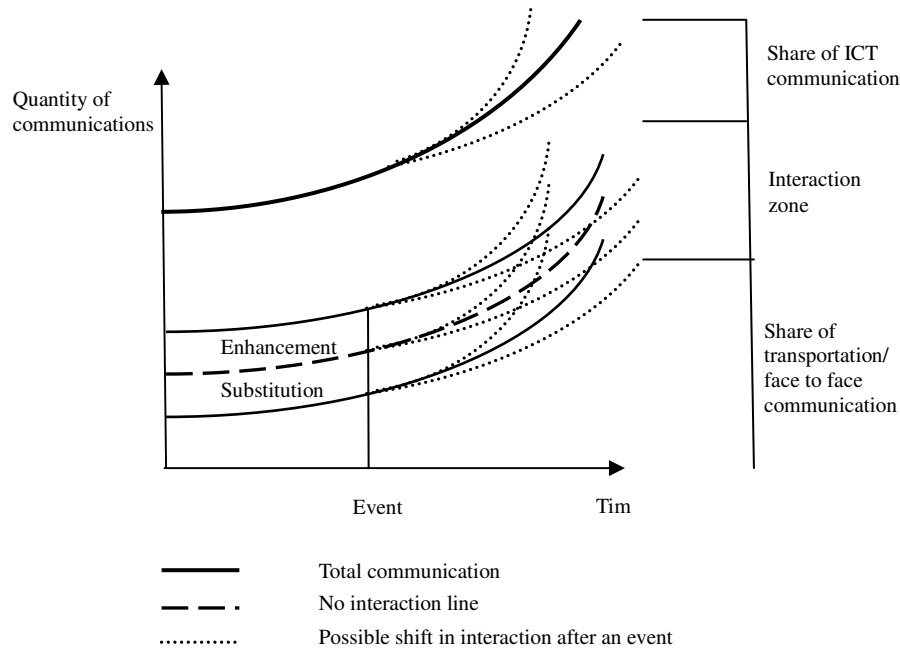


Figure 1: Dynamics of social communication with life cycle events (based on Salomon, 1986)

With respect to social interaction, contemporary research shows that the effects between ICT and physical travel are complementary (discussed in section 2.2 in detail). However, in a dynamic context, life trajectory events, when they occur, may change physical or social distance between ego and alter. The ego might also make new contacts and has to adjust the social travel schedule accordingly. There could be the following three scenarios:

1. There might be no influence of the event on some (ego-alter) ties.
2. The ego might decide to either substitute travel or enhance the communication with existing contacts using ICT to accommodate new contacts or adjust to the new time/money budget.
3. The ego might decide to reduce communication with some alters because the social network has expanded or the time/money budget has shrunken down. An

ultimate reaction might be that the total communication declines and the alter gradually disappears from the ego's social network.

We hypothesize that the third scenario is probable for weaker ties and with stronger ties either of the first two scenarios are realized. The hypothesis was confirmed in Sharmeen (et al 2012) by means of empirical data analysis. Moreover, we argue that the relationships between face-to-face and ICT are interdependent. In other words, any of them can substitute or complement the other. The causal direction is not only from ICT to face-to-face as assumed in most of the contemporary studies. We, therefore, redefine the dynamic interaction effects between ICT and social travel behavior as

1. Substitution: a decrease in one mode of communication is compensated by the other
2. Complementary: this could be enhancement (e.g. ICT stimulating trips), improving operational efficiency (e.g. ICT facilitating more efficient travel) or decline (e.g. decline in face-to-face contact with an existing alter would result in a decline in ICT communication).
3. Neutrality: ICT and travel having no interaction effects
4. Indirect: e.g. ICT may influence land use which will further affect travel

The objective of the present study is, hence, twofold:

- Firstly, to investigate the effects of changes in ego's social network due to a life-cycle event on the changes in social interaction frequency with alters and
- Secondly, to test the interdependencies between the modes of social interaction.

The concept is presented in figure 2. The effects of dynamics of social network and associated travel have not been explored in transportation research yet. To that end we contribute by developing a conceptual framework and exploring the effects.

2.2 Review of empirical literature

Social activities and associated travel are not an individualistic but rather a collective phenomenon. It involves a number of aspects to consider, for instance, time, place, duration, travel/communication mode, and most importantly negotiation on these aspects with the travel/activity company, i.e. the social network member. Recent empirical evidence strongly suggests that an understanding of social networks is imperative to explain discretionary travel behavior. In this section, we will review this research.

There have been quite a few studies in the travel behavior research community to explore the relationship between social interaction and travel behavior. Carrasco et al (2006) in his research analyzed social network data collected in Toronto. He concluded that the propensity to perform social activities has a strong association with the activity-travel behavior process. He noted that the overall propensity to perform social activities suggests a complementary and not a supplementary effect on travel, with the exception of instant messaging. Kowald et al. (2010) explored social interaction modes and the relation with geographical distance and leisure travel. They noted that face-to-face contacts are of high importance for each distance class, yet phone and e-mail contacts become more important

as distance increases, especially between 20 to 70 km. They also noted that the findings are similar to those of Axhausen and Frei (2007). However, they did not state the nature of the relationship between interaction modes.

Van den Berg et al. (2010) presented their analysis on the role of ICT in social interaction using social interaction diary data collected in the Netherlands. Using a path analysis, they tested the links between ICT use and social travel and found that social travel is mediated by ICT and effects tend to be complementary.

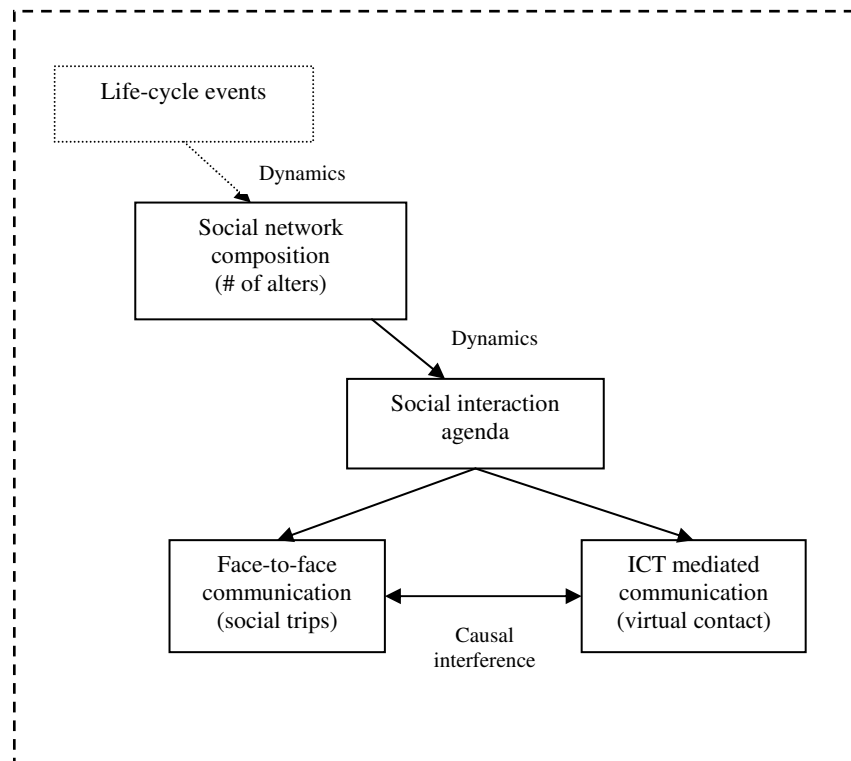


Figure 2: Conceptual Framework

Larsen et al. (2006) conducted exploratory research using detailed analysis of qualitative data collected in the UK. They noted that mobile phones and e-mails are becoming increasingly necessary to arrange social meetings. They used the terms 'flexible punctuality' and 'perpetual coordination' to explain that social meetings are increasingly flexible and that young adults constantly change their plans on the move. Their theoretical explanation to explain the dynamics in the short term also applies to the mid and long term and they argue that social meetings are indeed flexible and for coordination/compensation people frequently use different models of interaction.

Dijst (2009) used a Tripartite Situatedness framework to analyze the relationship between ICT and social network. He extensively reviewed the literature and analyzed ICT use data from a number of countries. He reports a complementary relationship between ICT and frequency of contacts yet a substitutive relationship prevails between ICT and the time budget spent on social ties. He also shows that with increasing geographical distance ICT communication declines, with an exception of e-mail. This might be associated with the low cost of maintaining e-mail contact.

Using bi-variate correlation analysis Tillema et al. (2010) showed a positive correlation between the frequencies of ICT and face-to-face contacts. Further, they conducted ordered probit analysis of a two day travel diary of 662 respondents. The results demonstrate that both face-to-face and ICT communication frequencies decline with increasing physical and relational distance to the network members. Although this was a cross-sectional data analysis, we assume a similar effect when physical and social (relational) distance increases among the same ego-alter tie as a result of a life cycle event. Therefore we find it to be important to include the effect (decline) in the theoretical construct (section 2.1).

All the above studies strongly suggest that the social network and the analysis of social interaction frequencies are important to understand and explain travel behavior. They also explore different dimensions of social interaction patterns and the corresponding associations at a certain point in time and individual state. We argue that these interaction patterns are dynamic and change with changes in social networks triggered by life cycle events. In this paper, we explore these dynamics.

3. Data and Methodology

The focus of this paper is on the dynamics of social networks and social interactions. One of the main challenges of analyzing dynamics of social networks is the lack of data. Panel data demand huge resources, while detailed retrospective questionnaire surveys about the history of social networks pose heavy respondent burden and are likely to have memory-bias. Therefore, we used a classification of events and asked people about one particular event (the one occurred in the recent past) and the changes it caused in their social network and social travel.

The data was collected using an event-based questionnaire survey. To cope with respondent and memory bias and also to reduce respondent-burden, we grouped the questions according to lifecycle events. Respondents were asked to pick any one event from a list that was the most recent one. 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 behavior in response to the lifecycle event in question. The survey was different in the sense that we did not aim for all events, but rather we aimed at collecting detailed information on the effects of one particular recent event. The respondents were asked if there was any change in the social network as a result of the event. If yes, they were forwarded to a table where they had to list existing ties where a change occurred as well as

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 (distance or contact frequency), they were not asked these details. Yet, some respondents did mention those as well. We also asked the respondents to report the size of their present social network according to type of relationships (those they share important information with, discuss personal problems, have regular contacts with, ask help during emergency or daily necessities).

The survey was conducted in September 2011 among 703 respondents. The majority of the respondents were recruited by a survey organization having a dedicated panel, representative of the Dutch population. In addition to that a number of University students were sent out invitations, using the list of newly admitted students at the Eindhoven University of Technology. Respondents were selected based on the question whether any of the stated events had occurred in recent years in their life. Only if the answer was affirmative, the respondent could proceed with the questionnaire.

In this chapter, we present the results of one retrospective questionnaire focusing on five important lifecycle events, namely, marriage, residential relocation, change of job, starting university and children of the household starting school, defined as follows:

1. Residential relocation: change of residence
2. Getting married/divorced/cohabitation: change in civil status
3. Children starting school: any of the children of the household started school, who was not going to school before.
4. Starting new job: the respondent started a new job that involves a change in the workplace.
5. Starting University: respondents who have joined the University for higher education

It was the second part of the questionnaire. For this study, we analyzed the data collected about any change in the ties after the stated event. The phrasing of the question (translated) was as follows:

‘Please provide the following information for the relationship that you have gained or those that have changed as a result of the event (e.g. name of event). We will not ask any personal information (such as name, home location) to ensure your privacy. New contacts: You may meet new people after you went through an important event (e.g. name of event). We mention them as the new members of your social network. If you have any new contacts, please fill 'none' in the 'before' column to indicate a new contact.

Changed ties: After an event (e.g. name of event), there may occur some changes in the frequency of interaction with your social ties. With some people you may have fewer or perhaps no contact at all. Here, we would like to know more about those ties through the following questions. You can fill 'none' in the column 'now' to indicate that it is a lost contact. Also fill in these fields for the changed (e.g. change is frequency, distance, etc.) social ties.

Have you changed or new contacts? (yes or no). If yes, please give details on the

alters.' Details were organized with the following attributes of the alters: age, gender, relationship, highest achieved education, last contact date, distance to home location: now and before, length known, relationship strength, frequency of communication face-to-face: now and before, frequency of communication with ICT: now and before.

Events were selected based on literature review (Bidart and Degenne 2005). Presumably all these events have an impact on social network and social interaction patterns because time and money budgets and social needs are changed. We analyze how all these changes have affected social interaction patterns. The question this study addresses concerns the effects of changes in social network on social interaction and the interrelationships between the modes of communication. We investigated the nature and the relation between possible changes in ICT and face-to-face contact frequencies.

For the purpose of the paper we re-structured the data according to ego-alter tie so that each case represents one tie where a change occurred. The new contacts were not included in the study because there is no history of communication frequency to compare with. The unit of analysis is therefore tie not ego. Table 1 presents the number of cases (ego-alter ties where a change occurred) according to the type of event as used in the analysis. The event of starting the University is over-represented in the sample of ties where a change occurred. The respondents in this case were young students who reported more ties where a change occurred than others. Also this may be due to the fact that at young age a personal social network is more flexible (Degenne and Lebeaux 2005). After re-structuring the data and removing missing cases, we had 1012 cases (ties) for the analysis.

Structural Equation Modeling (SEM) is a powerful tool to model complex causal associations. We had a number of endogenous variables in two separate levels of variable sets. Hence SEM seemed the most appropriate method for the analysis. SEM constitutes two components: a measurement and a structural model. In the study we were only modeling causal relationships among directly observed variables. Thus the model has only the structural component, also known as the path analysis. The results of path analysis using LISREL are discussed in the next section. We modified the final model and removed those relationships that were not significant on a 0.1 significance level. Figure 2 shows the structure of the final model and Table 2 presents the results. The interpretation of the results is organized in four sub-sections below. At first the influence of exogenous variables on endogenous variables is described followed by a discussion on the effect of endogenous variables on each other.

There are several measures employed to assess the goodness-of-fit in SEM. Some take parsimony into account and others do not. In most cases they do not agree (Fabrigar et al 2010). Fit indices can be divided into general goodness of fit indices and parsimony fit indices. The first category indices states broadly if the model fits the data better than any other model. Parsimony fit indices address the issue that the model may only be fitting the noise of the data and will not be representative for population-wide application. However chi-square, although has many difficulties associated with it, is an essential statistic to report along with the Root Mean Square Error of Approximation (RMSEA) and associated

p-value (Hooper et al 2008). The value of Chi-square divided by the degree of freedom is an acceptable measure of model fit, which should be less than 2. Also the RMSEA should be less than 0.05 to indicate a good fit (Golob 2003; Washington, Karlaftis, and Mannering 2009). Given the complexity of the model we report the stated two indices. The measures show that the model is acceptable. The reduced R-squares show that the explanatory power of the exogenous variables is fair.

4. Results and Discussion

4.1 Sample characteristics

Since each of the respondents had multiple alters to report, we opted for a multi-level structural model. There are two levels in the structure, namely the person level and the tie level. The person level represents the characteristics of the ego. The tie level represents the characteristics of the ego-alter tie. The main endogenous variables viz. the social interaction frequencies belong to the tie level. The model accounts for history dependence to take the dynamics of social interactions over time into account. Hence there are also two variables representing the history of social interaction at the tie level defined as exogenous ones.

Moreover the model takes the dynamics of a social network into account. Therefore it includes the measure of the lost and new social network members. They are defined as the contacts that the ego lost touch with or gained associations with after the particular life-cycle event that the ego experienced in recent past. The number of network members that are lost or gained depends on ego's socio-demographic characteristics. Hence they are also endogenous but at the person level. Thus the model has endogenous and exogenous variables at both the levels. A detailed distribution of the variables is presented in Table 1.

Sample characteristics show that the data is over represented by young (age less than 30 years) and male. Average working hour per week is 13 (approximately). Since more than 70% of the respondents had a driving license, a combined variable of car availability and driving license is calculated. Approximately 63% of the respondents have a driving licence and also at least one car available in the household. For 38% respondents the event is fairly new (took place less than a year ago) and approximately 39% have a close social network of less than or equal to 25 members. The average number of lost ties due to the said event is 2.39 and the average number of new ties due to the event is 3.40.

On the tie level, comparative variables are formulated to better represent the relationship between ego and alter and for ease of interpretation, for instance, age difference instead of age. Since these variables are about the relationship between ego and alter, such formulations are more informative. In the sample, 42% of the ties are of different age group and approximately 53% are of different gender. Approximately 19% of the ties are weak (rated 1 and 2 on a scale of 5) and 44% (rated 4 and 5 on a scale of 5) of the ties are strong. 40% of the ego and alters know each other for less than two years and 20% of them know each other for a long time (more than 10 years). Relationship status of 75% of the ties are

friends or family, as opposed to neighbours, colleagues, acquaintances and miscellaneous other types.

Geographical distance between the home locations of ego and alter is represented by comparative measures before and after the event. Social network studies also show that when an ego moves, those alters who were geographically close previously are more likely to disappear from the network of important relationships than those who are already distant (Degenne and Lebeaux 2005). Thus two variables were computed to characterize change in geographical distances, namely, recently distant and already distant. Recently distant means the home locations of an ego and alter were within 15 km before the event, which has become more than 30 km after (30% of the cases). On the other hand, already distant ties were always more than 30 km away (14% of cases). For the remaining cases, either there are no changes in geographical distance or the ego and alter were always within 15 km apart. Interaction frequency was measured both before and after the event in terms of number of times of face-to-face and ICT-contact per month. The 6-level categorical variable with which frequency was measured, was transformed by taking mid points of the categories as follows:

- Daily : 30
- 2-3 times a week: 13.5
- Once a week: 4.5
- 2-3 times a month: 2.5
- Once a month: 1
- Less: 0.5
- Not at all: 0

This was done to convert the variables from an ordinal to an interval level, so as to ensure coherence with the SEM assumption. The sample shows that average face-to-face interaction frequency was 10 times per month before the event and 9 times per month after the event. On the contrary ICT contact frequency was approximately 6 times per month before the event and approximately 7 times per month after. Hence on average face-to-face communication frequency reduces and ICT frequency increases after life-cycle events.

4.2 The Path model of social interaction dynamics

The model presents the causal relationships among the variables by means of a path analysis (figure 3). The objective of the study is to investigate the dynamics of social interaction with the dynamics of social network and to test the causal interferences between the modes of social interaction. Parameter estimates are presented in Table 2.

4.2.1 Effect of socio demographics

Face to face communication frequency has a positive relationship with young individuals. For male the probability of both face-to-face and ICT communication frequency is positive, with ICT having a larger coefficient. Working hour has a negative association with face-to-face interaction. This is plausible because the more hours one works the less time

one has for social activities. Number of young children in the household has a negative effect on ICT communication. People having car mobility option (car in the household and driving license) have a positive probability to engage in both face-to-face and ICT communication. Having a small close social network increases the probability of ICT communication.

Table 1: Sample characteristics

Variables	Description	Type	%
Exogenous variables			
<i>Between level (person characteristics)</i>			
Age	Age of ego less than 30 years	Categorical	72.2
Male	Ego is male	Categorical	61.8
#Working hr	Number of working hours per week	Continuous	12.75
#Child in HH	Number of child (under 18) in the household	Continuous	0.62
Car+License	Having car in the household and the ego has driving license (yes)	Categorical	62.6
New event	Event took place <= 12 months ago	Categorical	38.3
Small SN	Size of close social network < 25 persons	Categorical	38.5
<i>Within level (tie characteristics)</i>			
Age difference	Ego and alter of different age group (yes)	Categorical	42.1
Gender difference	Ego and alter of different gender (yes)	Categorical	52.6
Tie strength: Strong	Relationship strength between ego and alter (strong)	Categorical	44.4
Tie strength: Weak	Relationship strength between ego and alter (weak)	Categorical	18.7
Less known	Alter known for less than two years	Categorical	40.5
Long known	Alter known for more than ten years	Categorical	20.2
Friends or Family	Alter is a friend or a family member	Categorical	75.7
Recently distant	Home locations close before event (<15km away) distant after (>30km away)	Categorical	30.0
Already distant	Home locations were always distant (>30km away)	Categorical	14.0
F2F frequency before	Face-to-face communication frequency per month before the event	Continuous	10.04
ICT frequency before	ICT communication frequency per month before the event	Continuous	5.83
Endogenous variables			
<i>Between level (person characteristics)</i>			
#Lost ties	Number of ties lost after the event	Continuous	2.39
#New ties	Number of new ties after the event	Continuous	3.40
<i>Within level (tie characteristics)</i>			
F2F frequency after	Face-to-face communication frequency per month after the event	Continuous	9.29

Young people have the probability of both losing ties and making new ones. The probability of making new ties is however stronger. This implies that young people are more responsive to social network dynamics. Male also has a positive probability of making new ties. Working hours and having children in the household both reduce the probability of both the amount of lost ties and new ties. This is plausible since having young children in the household and longer working hours pose a restriction on an individual's social activity time. If the event is fairly new the probability of losing ties and making new ties increases. Based on a descriptive analysis Sharmeen et al. (2012) found that right after the event there is a big change in social interaction frequency. This suggests that a change in social network is also probable. Having a small close social network has a negative effect on the number of new ties. This may reflect a preference of people to have a selective social network. They do not make new friends readily.

4.2.2 Effect of social network

A social network is represented by the tie level, in the model. For the ego-alter relationship, we considered the difference and similarity in socio-demographics. The model shows that difference in age has a positive effect on face-to-face communication and a negative effect on ICT communication. On the other hand, opposite gender has a negative probability of keeping in touch with ICT mode of communication with each other. ICT frequency decreases in both newly distant and already distant ties, with already distant ties having a higher coefficient. This implies that distance in general has a negative effect on ICT communication frequency.

Any increase in geographical distance with existing ties would make a decrease in ICT communication more probable. Previous research has reported similar results (Tillema, et al 2010). In terms of relationship strength, stronger ties have a negative effect on face-to-face frequency and a positive effect on ICT communication, implying a substitution effect. If the tie is strong and because of a change the face-to-face contact has become infrequent, people like to compensate for it by communicating through other modes. Long known ties on the other hand show an opposite effect, which is counter intuitive. However this is after controlling for the effect of tie strength. Similarly, an opposite effect on ICT-contact can be observed for weaker ties and less known ties. Also if the tie is friend or family as opposed to neighbors, colleagues and other relations, the probability of ICT communication decreases.

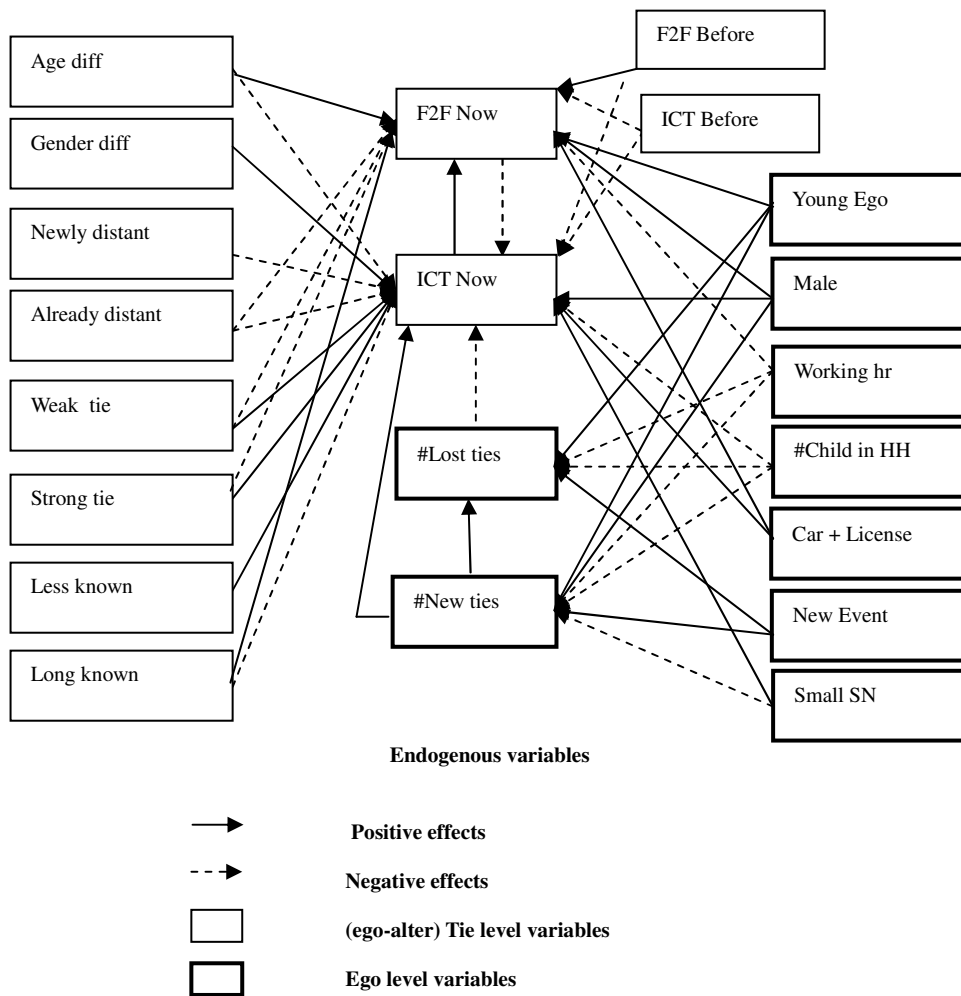


Figure 3: Path analysis of social network and social interaction dynamics

4.2.3 History dependence and the effects of network dynamics

The history of face-to-face communication (variable 'F2F freq before') with the alter has a positive effect on face-to-face interaction and a negative effect with ICT communication. Thus, if the ego had a high number of social meetings with an alter it still remains high after the event, whereas the ICT communication may go down. On the other hand, history of ICT communication (variable 'ICT freq before') has a negative effect on both face-to-face and ICT communication frequency, implying that if an ego had a high ICT interaction frequency with an alter, both face-to-face and ICT communication decreases after the event. The latter may represent more social-media based ties, though cannot be interpreted conclusively.

Interestingly, the number of new or lost ties does not have an effect on ICT communication frequency. However, number of lost ties has a negative effect on face-to-face interaction frequency and number of new ties has a positive effect. These findings imply that if one has more new friends he/she has more social trips. On the contrary and quite naturally if one has more friends that one lost touch with, he or she has less social trips.

Table 2: Results from Multilevel Path Analysis

	F2F freq now	ICT freq now	#Lost ties	#New ties
Intercept	8.6077*	6.4661*	1.2547*	1.8070*
Between Level				
Exogenous				
Young	2.31*	-0.43	0.71*	1.93*
Male	2.52*	3.18*	0.30	0.65*
Working hour	-0.04***	-0.02	-0.02*	-0.06*
Nr child in HH	0.26	-0.73*	-0.23*	-0.47*
Car + licence	1.55**	1.56**	-0.02	-0.30
New event	1.15	0.93	0.42**	0.61**
Small SN	-0.64	1.60*	-0.31	-1.18*
Endogenous				
#Lost ties	-0.65*	-	-	-
#New ties	0.66*	-	0.36*	-
R ²	0.24	0.20	0.33	0.39
Within Level				
Exogenous				
Age diff	1.36***	-3.44***		
Gender diff	0.58	2.57***		
Newly distant	0.84	-15.19*		
Already distant	-5.14	-28.10*		
Weak tie	2.32	-12.55**		
Strong tie	-25.99*	48.28*		
Less known	-2.84	41.03*		
Long known	9.48*	-17.97*		
Friends or Family	1.30	-39.43*		
F2F freq before	0.90*	-1.00*		
ICT freq before	-0.94*	-0.70*		
Endogenous				
F2F freq now	-	-6.52*		
ICT freq now	4.51*	-		
R ²	0.28	0.22		

*p < 0.01, **p < 0.05, ***p < 0.1

Goodness of fit statistics:

Chi-square/Degrees of Freedom: 1.14

Root Mean Square Error of Approximation (RMSEA) = 0.012

90 percent confidence interval for RMSEA = (0.011; 0.013)

P value for a test of close fit (RMSEA < 0.05) = 1.00

4.2.4. Inter-dependencies between endogenous variables

We hypothesize that a mutual causal relationship between face-to-face and ICT communication frequency exists. The results are in line with this hypothesis. Face-to-face

communication has a negative effect on ICT communication. On the other hand, ICT has a positive effect on face-to-face communication. The results, therefore, comply with existing empirical evidence that ICT has a complementary effect on social trips. In addition to that, the study provides evidence that face-to-face communication has a substitution effect on ICT. This is probable since face-to-face communication potentially yields ICT communication redundant.

Another important finding is the relationship between number of lost and new ties. Number of lost ties has no effect on number of new ties. Contrarily, number of new ties has a positive effect on number of lost ties implying that the more new ties one makes, the higher the probability of losing a tie becomes. This is plausible since one can maintain a certain amount of relationships at a given point of time. Hence if more new ties are being added to the social network the probability of losing more of the existing ties becomes higher.

5. Conclusion

The purpose of the study was to develop an understanding of the effect of social network dynamics on modes of communication with social network and to test the interdependencies between the communication modes. In the study, we investigated the dynamics of interaction between physical and virtual modes of communication in social networks. The results provide a direct input to the dynamics of social travel and activity behavior. By doing so, the paper contributes to the understanding of the relationship between the dynamics of social networks and travel. Prior research in transportation research has already examined the relationship between discretionary activity and travel behavior. This paper has added to the body of literature.

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 this study, we find evidence that the effects could also be in the other direction. In compliance with the contemporary researches, we also find that ICT has a complimentary effect on face-to-face communication. Adding to it, we also find that face-to-face communication has a substitution effect on ICT interaction frequency.

The study also provides some important findings regarding the dynamics of social network due to life-cycle events. Number of new ties has a positive effect on 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. The results are plausible.

There is some measurement error induced in the data due to conversion of the main dependent variables from categorical indices. Further the model parsimony fit could not be established. The model thus fits the data effectively but does so at the cost of parsimony. The population wide application of the model is thus an issue that needs further investigation.

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