

The Impact of ICT on Activity Patterns



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Description of project

The advancement of modern information and communication technology (ICT) such as broadband and mobile internet connection, mobile phone and laptop have an impact on the way in which individuals schedule activities and trips through substitution, modification or changes in constraints. Similarly, an individual's range of optional activity patterns may be impacted by ICT. ICTs may change the demand for dwellings, facilities, stores, and workplaces with respect to their location, design, and functional specifications, and may lead to innovative forms of spatial organization, such as new combinations of functions or new types of facility. However, a comprehensive insight of the impacts of ICT on the total activity pattern and individuals' options is currently lacking. Such insight is necessary to support urban and transport policies aimed at the development of new land-use concepts based on the integration of ICT into daily activity patterns.

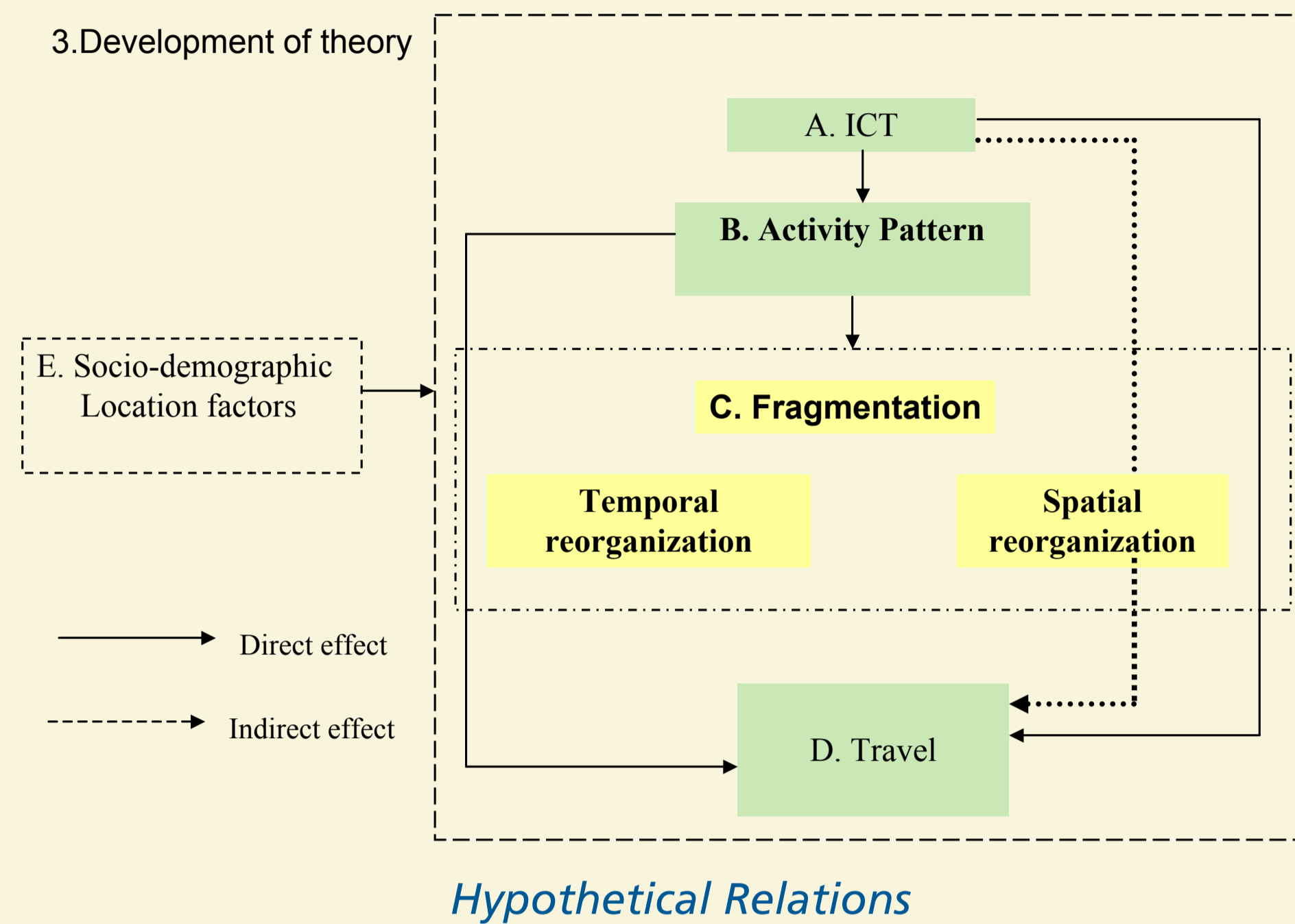
Aim

The objective of this project is to examine the various impact of ICT on daily activity pattern and quality of the range of feasible activity pattern. There are several hypotheses that guide this project, including:

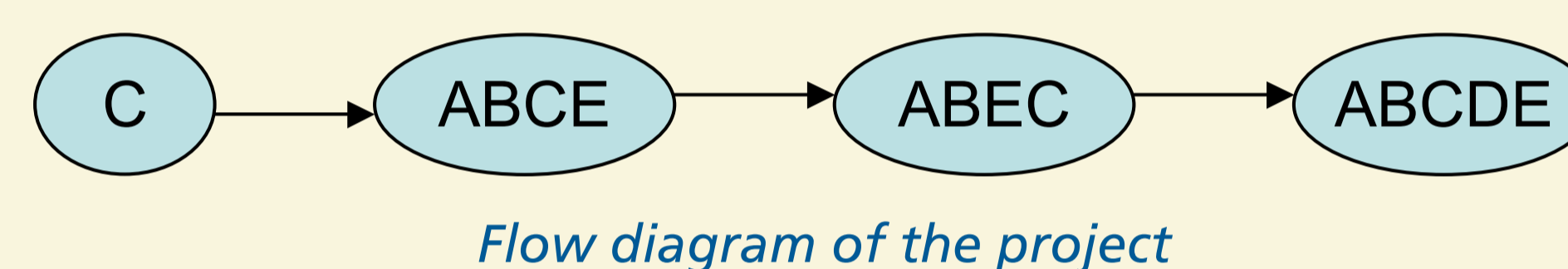
1. ICT will lead to a fragmentation of activities in time and space
2. The use of ICT will lead to new combination activities
3. The use of ICT will lead to an increased travel demand

Data

This project uses data from a survey conducted among one- earner and dual earner households residing in the central part of Netherlands (Utrecht-Amersfoort- Hilversum region). It consists of activity-travel- communication diary for two days and questionnaire about socio- demographic (age, gender and employment status etc) and ICT availability. In total, 740 respondents completed the questionnaire by online or in a mail-out/ mail back paper-and-pencil format.



Stages of the analysis



Ongoing research papers

1. Anything, anywhere, anytime? Developing measurement instruments to assess the spatial and temporal fragmentation of activities (joint paper, in progress)

Objectives:

- to develop the more sophisticated fragmentation measures (part C)
- to apply it existing travel diary data

2. Impacts of ICT on fragmentation of work activity (in progress, the abstract is submitted to ERSA 2008)

Objective:

- to investigate the fragmentation behaviour:
- whether different classes of fragmentation pattern exist

- if exist , the classes of representative pattern correlate with the ICT use, socio-demographic and location factors

Methodology :

- k-means clustering algorithm
- Multiple discriminant function analysis

The following research questions will be addressed in coming papers;

- How do ICT blur boundary between work and non-work activities?
- How the concept of fragmentation of activity associated to travel?
- The use of ICT will lead to an increased travel demand
- What is the causal relationship among activity fragmentation, ICT and travel?

Table 1 Description of fragmentation measures

Dimension	Symbol	Measures	
		Description	Value
Temporal fragmentation	E	A total number of episodes of a certain activity in a given day	$1 < E < \infty$
	T_index	Temporal Index of activity fragmentation : to measure the distribution of fragment into different sub-tasks of a certain activity	$12 < T_index < 1$
	I	Temporally weighted standard distance : to measure the spread of activity time	$0 < I < \infty$
Spatial fragmentation	N	A total number of activity locations	$1 < N < \infty$
	S_index	Spatial Index of activity fragmentation : to measure the distribution of fragment across different locations	$10 < S_index < 1$
	R	The standard distance of activity locations : to measure the spread of activity locations	$0 < R < \infty$
	SDE	Cluster index: to measure the pattern of the fragments	$0 < SDE < \infty$
		Standard deviation ellipse: to describe the orientation of the fragments	$0 < \tau < 1$
		Shape index: to quantify the shape of the fragments	$0 < \tau < 1$

2 Descriptive statistics of fragmentation measures of each pattern

Description	Symbol	Representative Patterns of Fragmentation						Significant level [ANOVA]
		Pattern 1 (N=215)		Pattern 2 (N=440)		Pattern 3 (N=237)		
		Mean	SD	Mean	SD	Mean	SD	
Temporal Fragmentation								
Total number of episodes for work activity on the day	E	19.3	11.9	12.3	7.92	5.03	5.17	p=0.000
Number of episodes at stationary location	E _{stat}	18.3	10.8	11.9	7.62	4.65	4.65	p=0.000
Number of episodes at non-stationary location	E _{nonstat}	1.01	2.95	0.4	1.23	0.38	1.36	p=0.000
Total time spent on work activity [min]	T	650.2	112.3	449.6	70.6	113.2	91.1	p=0.000
Distribution of work episodes across subtasks	T_index	0.47	0.19	0.47	0.20	0.72	0.27	p=0.000
Spread index of work episodes [km]	I	2.78	6.16	1.64	4.52	1.18	3.93	p=0.001
Spatial Fragmentation								
Total number of work locations	N	1.72	1.07	1.46	0.83	1.00	0.72	p=0.000
Number of non-stationary work location on the day	N _{nonstat}	1.85	1.30	1.51	0.92	1.07	0.81	p=0.000
Distribution of work episodes across locations	S_index	0.85	0.22	0.89	0.20	0.88	0.22	p=0.136
Spread index of work locations [km]	R	5.76	12.68	2.70	6.85	1.46	4.84	p=0.000

Table 3 Socio-demographic descriptors of representative patterns

17 variables, 3 groups N=684 ^a	Pattern 1 (Spatially Fragmented work) N=212 ^a		Pattern 2 (Temporally Fragmented work) N=437 ^a		Pattern 3 (Hardly Fragmented work) N=235 ^a		Wilks' Lambda ^b	F ^c	Sig ^d
	Mean ^e	Std. Deviation ^e	Mean ^e	Std. Deviation ^e	Mean ^e	Std. Deviation ^e			
Individual & Household & Location variables^a									
Male [D]	0.63 ^a	0.48 ^a	0.45 ^a	0.50 ^a	0.48 ^a	0.48 ^a	0.965 ^a	16.1 ^a	0.000 ^a
Age (years) ^b	45.6 ^a	10.3 ^a	44.9 ^a	10.7 ^a	47.7 ^a	11.2 ^a	0.983 ^a	5.22 ^a	0.006 ^a
Household type: Single [D]	0.18 ^a	0.39 ^a	0.21 ^a	0.40 ^a	0.25 ^a	0.43 ^a	0.996 ^a	1.62 ^a	0.199 ^a
Household type: with partner & child [D]	0.32 ^a	0.47 ^a	0.35 ^a	0.48 ^a	0.29 ^a	0.45 ^a	0.997 ^a	1.52 ^a	0.219 ^a
Household Income: High [D]	0.34 ^a	0.30 ^a	0.39 ^a	0.40 ^a	0.41 ^a	0.49 ^a	0.984 ^a	7.28 ^a	0.001 ^a
Urban degree: Less [D]	0.37 ^a	0.48 ^a	0.38 ^a	0.49 ^a	0.39 ^a	0.45 ^a	0.993 ^a	3.13 ^a	0.044 ^a
Commute distance [km]	15.2 ^a	17.6 ^a	10.7 ^a	15.3 ^a	10.0 ^a	15.5 ^a	0.984 ^a	7.16 ^a	0.001 ^a
Part-day home worker [D]	0.22 ^a	0.41 ^a	0.16 ^a	0.37 ^a	0.06 ^a	0.24 ^a	0.974 ^a	11.9 ^a	0.000 ^a
Office-worker [D]	0.38 ^a	0.30 ^a	0.40 ^a	0.40 ^a	0.23 ^a	0.42 ^a	0.892 ^a	33.6 ^a	0.000 ^a
ICT usage variables^a									
Non-work ICT duration [min]	24.6 ^a	40.7 ^a	34.2 ^a	52.2 ^a	40.2 ^a	57.1 ^a	0.988 ^a	5.30 ^a	0.005 ^a
Non-work communication ^c	23.1 ^a	30.7 ^a	24.0 ^a	27.2 ^a	28.5 ^a	28.7 ^a	0.994 ^a	2.48 ^a	0.084 ^a
Frequency of land line calls: High [D]	0.31 ^a	0.46 ^a	0.17 ^a	0.37 ^a	0.14 ^a	0.35 ^a	0.973 ^a	12.1 ^a	0.000 ^a
Frequency of land line calls: Low [D]	0.14 ^a	0.35 ^a	0.11 ^a	0.31 ^a	0.09 ^a	0.29 ^a	0.997 ^a	1.52 ^a	0.265 ^a
Frequency of mobile calls: High [D]	0.23 ^a	0.42 ^a	0.12 ^a	0.33 ^a	0.11 ^a	0.31 ^a	0.981 ^a	8.72 ^a	0.000 ^a
Frequency of mobile calls: Low [D]	0.09 ^a	0.29 ^a	0.11 ^a	0.32 ^a	0.13 ^a	0.34 ^a	0.998 ^a	1.00 ^a	0.368 ^a
Possession of PDA [D]	0.10 ^a	0.30 ^a	0.11 ^a	0.31 ^a	0.07 ^a	0.26 ^a	0.998 ^a	1.10 ^a	0.332 ^a
Possession of laptop [D]	0.32 ^a	0.47 ^a	0.24 ^a	0.43 ^a	0.26 ^a	0.44 ^a	0.996 ^a	1.98 ^a	0.139 ^a

Table 4 Discriminant function of fragmentation of work activity:

Function	Eigen-value	% of Variance	Canonical R	Wilks' Lambda	Chi-square	df	p-level
1	0.36	83.8	0.51	0.69	326.3	34	0.000
2	0.07	16.2	0.26	0.94	58.7	16	0.000
Discriminant variables							
Standardized discriminant function							
1							
2							
Socio-demographic & Location							
Male [D]			0.27			0.38	
Age			-0.18			-0.04	
Household type: Single [D]			-0.11			0.07	
Household type: with partner & child [D]			-0.05			-0.28	
Household Income: High [D]			0.07			0.28	
Urban degree: Less [D]			0.11			-0.17	
Commute distance [km]			0.11			0.22	
Part-day home worker [D]			0.77			-0.16	
Office-worker [D]			0.96			-0.40	
ICT usage variables							
Non-work ICT duration [min]			-0.22			-0.24	
Non-work communication			-0.11			0.10	
Frequency of land line calls: High [D]			0.21			0.44	
Frequency of land line calls: Low [D]			0.07			0.17	
Frequency of mobile calls: High [D]			0.10			0.20	
Frequency of mobile calls: Low [D]			-0.13			-0.07	
Possession of PDA [D]			-0.03			-0.31	
Possession of laptop [D]			-0.02			0.21	

Table 5 Structure matrix of discriminant functions

	Function	
	1	2
Office-worker [D]	0.551*	-0.426
Part-day home worker [D]	0.270*	0.102
Non-work ICT duration [min]	-0.124*	0.038
Household type: Single [D]	-0.100*	-0.023
Frequency of land line calls: High [D]	0.195	0.445*
Household Income: High [D]	0.099	0.432*
Male [D]	0.262	0.415*
Frequency of mobile calls: High [D]	0.161	0.398*
Commute distance [km]	0.145	0.353*
Possession of laptop [D]	0.034	0.242*
Non-work communication	-0.160	-0.201*
Age [years]	0.069	-0.179*
Household type: with partner & child [D]	0.069	-0.157*
Urban degree: Less [D]	0.128	-0.133*
Frequency of land line calls: Low [D]	0.077	-0.110*
Possession of PDA [D]	0.073	-0.090*
Frequency of mobile calls: Low [D]	-0.071	-0.080*

* marks each variable's largest absolute correlation with one of canonical function within each function