

## 8. Activity Based Modeling: Intra-Household Interaction, Attitudes and Telecommunication Use

東京大学大学院新領域創成科学研究科社会文化環境学専攻  
46879 Ahmed Ibrahim Ibrahim Mosa

### Abstract

Household members interact in many ways during their daily activity- and travel-related decision-making. Consequently, the activity-travel patterns of all household members become interdependent. There has been an increasing realization that such household interdependencies have to be accommodated explicitly within activity-based models for accurate forecasts of travel patterns and for the realistic evaluation of the impacts of policy actions. As a result, during the last few years, there have been a significant number of studies aimed to modeling the household interactions. However, critical gaps exist in some key areas. For example, regarding joint participation on activities, many gaps still exist in understanding the activity engagement behavior. The purpose of this study is to investigate the intra-household interactions, particularly; the joint activity and travel participation decision, and the role of individuals' attitudes, mobility resources, and internet and communication technology-use (ICT) in joint activity and travel participation decisions.

### 1. Introduction

Activity-based approaches are increasingly being recognized as a powerful methodology to model human travel behavior because of their realistic representations of the complete activity schedule of individuals over a period of a day or a longer unit of time (Bhat and Koppelman, 1999). The activity-based approach differs from trip based analysis by accounting explicitly the fact that the demand for travel is derived from the need to participate in activities distributed in space and time Pas and Harvey (1997).

In fact, household members interact in many ways during their daily activity and travel related decision-making. Individuals undertake both independent and joint activities/travel as part of their overall daily activity-travel patterns. The joint activity pursuits are often motivated by social factors such as desire for companionship and altruism (i.e., enabling activity participation of the mobility-constrained), or by resource constraints (i.e., limited vehicle availability) Townsend (1987). Undertaking joint activities with household and/or non-household members introduces strong linkages among the activity-travel patterns of the individuals involved. As a result during the past few years, there have been a significant number of studies aimed to modeling household interactions (Vovsha *et al.* 2004; Bradley and Vovsha, 2005; Scott and Kanaroglou, 2002).

While most of these studies have examined the household interactions associated with the daily activity-travel patterns of individuals in developed countries. In contrast to these substantial literature, relatively little research has examined inter-personal dependences in daily activity and travel behavior of individuals in the developing countries. Therefore, not much is known about individuals' motivations, needs, commitments, and constraints that shape the overall activity and travel patterns of individuals in the developing countries. And, unfortunately, the assumption that the behavioral basis underlying household joint participation of activities and travel of individuals in developing and developed countries are similar may be not adequate. Further, data from conventional activity-travel surveys often used in these studies. Conventional activity-travel

surveys often do not identify the activity/travel companions explicitly, hence requiring the analyst to use operational definitions based on space-time matches to identify joint episodes. Such a matching procedure, however, will not be applicable in identifying individuals' non-household companions in activity/travel participation.

In light of these discussions, the main purpose of this study is to contribute to the growing body of literature by investigating the intra-household interactions, particularly; the joint activity participation choices of individuals in developing country, and the role of culture norms, beliefs, social roles, mobility resources, and Internet availability in joint activity participation decisions.

## **2. Research Motivations**

This study has two motivations: First, from current travel behavior and the associated intra-household interactions in Cairo, as a study area, undertaking joint travel with household and/or non-household members constitutes approximately 41.3% of all travel patterns (total 21 million. trips around 9 million. are joint trips), according to the 2001 Household and Personal Trip Survey Results (Greater Cairo Transport Mater Plan, CRETATES, 2001). Further, the empirical results indicate that 80% of all females travel patterns are joint travel. However, it is noted that females over the age of 6 years make 1.2 trips per person per day, compared with 2.1 trips made by males. This reflects a greater degree of gender based travel patterns and task allocation particularly for Cairo people. Also it reflects a significant influence of culture norms on travel behavior and the interaction between household members. Second, explicit representation of joint activity-travel decisions is important from policy implementation and practical perspective, since the level of joint participation in travel and activity patterns can strongly influence vehicle occupancy levels, trip-chaining and mode choice and thus have significant implications for congestion, air-quality, and demand estimation for transit. For instance, how a household with one car share the activities and the vehicle across household members can determine the mode choice and timing of the various trips in the household. Consequently, ignoring studying within-household interactions that results in joint travel and activity participation, can lead to an overly and misleading demand estimates.

## **3. Research Objectives**

The objectives of this study are as follows:

1. Analyzing the intra-household interactions by modeling household members' joint participation choice of daily activity and travel patterns. This objective differs from priori literature in the following respects:
  - a) It analyze explicitly intra-personal trade-offs between solo and joint in-home and out-of-home activity participation decisions, and the possible substitution patterns between them.
  - b) It captures the inter-personal trade-offs between solo and joint with whom (with household members, with others, with household members and others) for out-of-home activity participation decisions.
2. Exploring the relationships between telecommunication use and household members' joint participation choice in daily activity and travel. Specifically, the current study aims to investigate the linkages between levels of household virtual and physical mobility and individuals' daily joint activity and travel participations.
3. Investigating the role of individuals' daily activity and travel patterns in joint activity and travel participation choice. Particularly:
  - a) To examine the daily time allocation to physical and virtual activities and travel,
  - b) To examine the daily time allocation to maintenance and recreational activities, for in-home as well as out-of home activities,
4. Investigating individuals' attitudes, perceptions, and desires towards their joint activity and travel and the role their attitudes play in their daily joint activity and travel participations. The

key premise of this objective is as follows: Joint activity itself has an intrinsically positive utility that contributes to the demand for it. The goals of this research are to better understand the causes and effects of that affinity for joint activity.

#### **4. Data**

In order to achieve the objectives of the study, a highly disaggregated data concerning activity episodes and related attributes in greater Cairo region is needed. Therefore, as a first step, intensive activity diary and telecommunication survey have been implemented and spanned the period from December 2005 to January 2006.

The survey was administrated in three academic and research institutions in Cairo, Egypt. Particularly; Egyptian national institute of transportation, Ain-shams University, and the Information and Technology Institute (ITI). Potential respondents were drawn at random from the three locations. Respondents were contacted first by face to face interview to solicit their participations. Respondents who agreed to participate received the relevant survey sheets and diary. In addition, a comprehensive explanations of the diary sheets and how can they enter the diary were done. Further, full instructions sheet were also submitted to them. Those potential respondents who agreed to participate were requested to arrange that all of their household members above 12 years old to complete the diary. After two of three days, this was followed by a pre-call to the all respondents agree to participate, which involved checking if they understood the instructions and if there any difficulties to complete the questionnaires. To our knowledge, this is the first attempt to conduct an activity diary and telecommunication survey in the Arab world. Therefore, much care has been taken during the design of the survey instruments to avoid any conflict with the respondents' tradition and culture issues. Moreover, it was crucial to maintain a user-friendly format of the survey instrument. Particularly: 1) it has to take no more than 20-30 minutes in total per day to from the respondent complete, 2) to be intuitive to complete, following natural thought process whilst working in the user's natural language, 3) to be easily learnable, and understandable, 4) to prompt the user to record all of the information needed in every stage, eliminating anxiety regarding what information they should include and maintaining data quality. Therefore, comprehensive discussions have been carried out with some researchers in the University of Tokyo in order to derive the key principles for the design and administration of the diary instrument. As indicated in Table 1, Key principles in this regard were that leave behind, convenient day, two-day full activity diary, with open time intervals and pre-coded activity scheme, is required to avoid the problem of respondents demand and to provides the necessary detailed data for the study. The final activity diary instrument consisted of 6 parts. The first two parts concerned with various individual and household characteristics, the third part of the survey instrument aimed to collect general data about the physical activities of the respondents, the fourth part of the instrument concerned with internet availability, internet use, attitudes towards virtual activities, the fifth part and one of the instrument cores concerned the actual activity diary. For each successive activity, respondents were asked to provide information about the type of activity (Based on 42-category classification system), the start and end times of activities, location of participation and geographical location, with whom the activity was pursued and for whom data was also collected. For the travel activities the information also included the transport mode and location of transfer. The six part of the diary asked the respondents to record all of their daily telecommunications.

A secondary data source obtained from the Greater Cairo Transportation Master Plan Study provided zonal-level transport level of service and demographic data for each of the Traffic Analysis Zones (TAZ).

**Table 1 Summary of the diary instrument properties**

<b>Property</b>	<b>Possibilities</b>	<b>Decision</b>
<b>Diary type</b>	Full activity diary Out-home activity Diary	Full activity diary
<b>Time horizon</b>	Leave behind Recall *	Leave behind
<b>Frequency</b>	One-day two-day or multi day	Two-day (weekday & weekend)
<b>Timing</b>	Designed day diary Convenient day diary **	Convenient day diary
<b>Time interval</b>	Closed interval Open interval	Open interval
<b>Activity reporting</b>	Pre-coded scheme Open-coded scheme	Pre-coded scheme
<b>Form</b>	Paper and Pencil Computer-assisted	Paper and pencil

## 5. Research Methodology

The study objectives are explored at the most detailed level using a series of statistical and econometric discrete models which include: (a) cluster analysis statistical techniques, (b) discrete multinomial mixed-logit models, (c) ordered probit models.

The proposed mixed modeling approach entails the modeling of the following two dimensions: (1) the solo and joint in and out-of-home activity and travel participation models. (2) the out-of-home solo and joint “with whom” activity and travel participation model.

The analysis of “joint with whom” activity participation extend the modeling framework to accommodate intra-individual and inter-individual variation in unobserved determinants of joint activity and travel choice. Particularly, it involves the modeling of the decision of household members to participate in activity and travel as (1) solo, (2) joint with only household members, (3) joint with only non- household members (i.e., friends, colleagues), and (4) joint with combinations of household and non- household members.

The modeling effort in this study may be distinguished from previous related studies in several ways. First, the current modeling effort accommodates heterogeneity in responsiveness to solo and joint activity and travel participations. Therefore, the study is able to accommodate the intra-individual variations in joint activity and travel participation, where some of prior literature assumed homogeneity in responsiveness to attributes of solo and joint alternatives across individuals. Second, the models determine the possible sources of any solo and joint preference heterogeneity that may exist. Third, the model explicitly captures correlation between members of the same household and within-person over different episodes. Correlations due to shared unobservable factors (including habits, lifestyle, social and culture norms) among joint and solo activity and travel participation are also analyzed, whereas, much of the prior literature treated different episodes even among the same household as mutually independent. Fourth, it is more disaggregated as it captures the dependent variable at a person-level (rather than at a role-level (head/spouse) or segment level (male/female)). Fifth, the current study uses two-day activity and travel dairy data, therefore, the models are able to address intra-individual and dynamic transition in daily joint and solo activity participation over a multi-day period.

The models for desired joint activity entail the modeling of how much individual wants to participate in joint activity with his family compared to what he is doing now. respondents were asked to rate the amount of joint activity they want compared to the present, on a five-point scale

from “much less” to “much more”. Five types of activities were of interest in this question, going out for shopping activities, going out for cinema, theater, or sport, hanging-out or out-dining, going out for social visits, and doing activities at home.

## **6. Summary of the Results**

### *6.1 Solo and Joint Activity and Travel Participation*

The empirical results support many of our hypothesis regarding joint activity and travel participations. Household traditions and beliefs, social roles, and lifestyle were found to be the main factors which affect joint activity and travel. Furthermore, the results suggested additional two inter-related motivations behind joint activity and travel namely opportunity and sociability.

Opportunity refers to the ability of the household to engage in different in and out-home activities, which is strongly related to the household levels of virtual as well as physical mobility.

Sociability refers to the degree of social networks between the household and the wider social world beyond the household.

The most salient findings show that across the sampled population, the sensitivity to joint in-home activity participation increases as the percentage of females inside the household increases. That is households with high percentage of females are more likely to engage in joint in-home activities. This could be attributed to the role specification and task allocation inside the household, in the sense that most of out-of-home household activities are allocated to the male head of the household. Moreover, this result may represent a tendency for households with higher percentage of females to be more oriented to in-home activities.

The opposite pattern is observed for those belonging to household with Internet access at home, the results indicate that household members with access to the Internet at home are more likely to engage in joint out-of-home activity participation due to their wider social networks, and connectivity to a wide horizon of activities opportunities. This is intuitive, and reflects that internet use have a complementary impact on household sociability out-side the home, and the higher propensity to participate in community-oriented activities.

More over, households with higher percentage of female’s fraction are more likely to engage in joint out-of-home activity and travel with their households’ members rather than engage in solo or joint with non-household members. The opposite pattern is observed for those belonging to households with high percentage of high education student inside the household. The results indicate that household members with high education are less likely to engage in joint activity and travel. Furthermore, they are less likely to participate in joint activity and travel with their households’ members due to their independent lifestyle. This implies that individual level of education plays a significant role in determining to what extent household members engage in activity and travel together. On the other hand, the positive heterogeneity in the mean parameter estimate of the joint out-of-home activities with combinations of household and non-household members with respect to household with Internet access at home covariate suggests the presence of strong positive effect to increase the propensity to engage in joint out-of-home activities with combinations of household and non-household members for individuals belong to household with Internet access at home. This is intuitive, and reflects that internet use has a complementary impact on household sociability out-side the home.

### *6.2 Desired Joint Activity Attitudes*

This task of study was to examine individuals’ desired joint activity measured on a five point likely scale bounded from “much-more” to “much-less”. Three factors were found to influence desired joint activity with family members in every desired joint activity models; fraction of females inside the household, spouse variables, and fraction of high education individuals inside the household. As the fraction of females inside the household increase the propensity to be more oriented to participate in more in-home joint activities increase. On the other hand, household with more higher education individuals are more likely to be oriented towards out-of-home

activities. This is an indicator that educational levels inside the household greatly impact their lifestyle and their social networks.

The influence of daily amount of both physical and virtual joint activities were powerful and universal in every desired joint activity model, the corresponding amount of joint activity measure was by far the most significant variable in the model. The effect of the daily amount of joint activity can be grouped into three broad categories; complementary, substitution and saturation. In the following paragraphs we discuss these effects in brief.

*Complementary*-The more frequent one currently participate in joint out-of-home recreational activities, the more one will want to increase one's amount of joint activity in this category, and the more individual use internet frequently with his family for recreational purposes the more he desires to increase his going out for recreational with his family.

*Substitution*-The more individual use internet frequently with his family for maintenance purposes the more he desires to reduce his going out for shopping with his family.

*Saturation*-The more frequent one currently participate in joint out-of-home maintenance activities, the more one will want to decrease one's amount of joint activity in this category.

## 7. Conclusion

The results support many of our hypothesis regarding joint activity and travel participations. Household traditions and believes, social roles, and lifestyle are found to be the main factors which affect joint activity and travel. Furthermore, the results suggested additional two inter-related motivations behind joint activity and travel namely opportunity and sociability. Opportunity refers to the ability of the household to engage in different in and out-home activities, which is strongly related to the household levels of virtual as well as physical mobility. Sociability refers to the degree of social networks between the household and the wider social world beyond the household.

## REFERENCES

1. Bhat, C.R. and F.S. Koppelman. A Retrospective and Prospective Survey of Time-Use Research. *Transportation*, Vol. 26, No. 2, 1999, pp. 119-139.
2. Pas, E.I., and A.S. Harvey. Time Use Research and Travel Demand Analysis Modeling. In P.R. Stopher and M.E.H. Lee-Gosselin (eds.) *Understanding Travel Behavior in an Era of Change*, Pergamon, Oxford, 1997, pp. 315-338.
3. Townsend T.A. 1987. *The Effects of Household Characteristics on the Multi-day Time Allocations and Travel Activity Patterns of Households and Their Members*. Unpublished Ph.D. Dissertation, Northwestern University, Evanston, IL.
4. Vovsha, P., E. Peterson, and R. Donnelly. A Model for Allocation of Maintenance Activities to the Household Members. Presented at 83rd Annual Meeting of the Transportation Research Board, Washington, D.C., 2004.
5. Bradley, M., and P. Vovsha. A Model for Joint Choice of Daily Activity Pattern Types of Household Members. *Transportation*, Vol. 32, 2005, pp. 545-571.
6. Scott, D. M., and P. S. Kanaroglou. An Activity-episode Generation Model that Captures Interactions between Household Heads: Development and Empirical analysis. *Transportation Research Part B*, Vol. 36, 2002, pp. 875-896.