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The impact of the Internet on human activity–travel patterns: analysis of gender differences using multi-group structural equation models

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ABSTRACT

The widespread use of the Internet for conducting various types of activities may be leading to considerable change in people's activity–travel patterns. Past studies, however, have left many issues unaddressed. Using an Internet-activity diary dataset and multi-group structural equation modeling, this study examines the complex interactions between different types of Internet and physical activities, with a special focus on gender differences and Internet maintenance and leisure activities. The results indicate that the impacts of Internet activities on people's activity–travel patterns are significantly different across gender. In general, Internet use for maintenance purposes has a greater impact on women's activity–travel in the physical world, while Internet use for leisure purposes affects men's physical activities and travel to a greater extent. Further, breaking Internet activities down into different categories reveals some hidden patterns that would not have been detected if these different types of Internet activities were lumped together as a single category.

1. Introduction

With the rapid growth in the number of people with Internet access and in the range of transactions that can be accomplished online, where and when people's everyday activities can be performed may be undergoing significant change. For instance, as many activities no longer need to be performed at certain places or times (e.g., through E-shopping), more time may become available for undertaking other activities and more flexible spatial and temporal arrangements of human activities may become possible (Kwan, 2002; Schwanen and Kwan, 2008). The increasing use of the Internet may therefore lead to changing human activity–travel patterns.

Recent studies have examined the impact of information and communication technologies (ICTs) on human activity–travel behaviors with different focuses and approaches. One of the focuses of these studies is on the relationships among activities, travel, and telecommunications (such as the Internet and cellular phone) (e.g., Choo and Mokhtarian, 2007; Farag et al., 2007; Ferrell, 2005; Gould and Golob, 1997; Kim and Goulias, 2004; Kwan, 2007; Mokhtarian and Meenakshisundaram, 1999; Ren and Kwan, 2007, in press; Scrinivasan and Athuru, 2004; Senbil and Kitamura, 2003). Results from these studies indicate that the impact of ICTs on people's activity–travel patterns is highly complex, often involving substitution, complementation, and modification (Kwan et al., 2007; Mokhtarian, 1990; Salomon, 1985). Although past literature has shed some light on the complex interactions between people's Internet use and activity–travel patterns, many important questions remain unanswered.

Compared to other ICTs, such as the cellular phone, the Internet allows people to conduct a greater range of activities in cyberspace – which include e-mailing, Web surfing, blogging, online shopping, online banking, watching movies or videos, listening to music, sharing photos, online auctions, news groups, chat rooms, real-time voice and video communication, and many others. This suggests that its impact on activity–travel patterns could be more significant and complex. However, most studies to date either focus on the impact of specific Internet use (such as telecommuting or E-shopping) or do not differentiate the Internet from other communication technologies. They are therefore inadequate for revealing the role of the Internet in changing human activity–travel patterns.

Further, activity–travel patterns of different social groups may be impacted upon differently by the Internet in that people use the Internet to meet their specific needs. For instance, gender differences in Internet activities were observed in a recent study by Ren and Kwan (2007), which suggests that men and women may have significantly different activity–travel patterns due to their specific patterns of Internet use. To date, few studies have

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addressed the following questions: Does the Internet facilitate women to engage in more leisure activities and encourage men to participate in more household related activities? Does the Internet, as other domestic technologies (e.g. washing machine), reinforce the gender division of domestic labor by changing the means by which women conduct household activities? It is important to answer these questions in order to fully understand how the Internet shapes the geographies of people's everyday life in the Internet era.

Using an activity-Internet diary dataset, this study examines the complex interactions between different types of Internet and physical activities (and travel) with a special focus on gender differences. This paper is organized as follows. A brief literature review will be provided in Section 2, which is followed by a description of the study area, dataset, and analytical methods in Section 3. Analysis of the results will be elaborated in Section 4, and finally conclusion and future research directions will be provided in Section 5.

2. Past research on activity–travel patterns and ICTs

2.1. Activity-based approaches

Activity patterns are summary characterizations of all attributes of an individual's daily activities and trips. These characteristics include the timing, duration, location, frequency and sequence of activities, and the travel time and distances of trips. Studies on human activity patterns normally rely on data collected through the use of activity–travel diary, which provides detailed record of a person's activities and travel for various periods of time (from one day to several weeks). Using these data, it is possible to gain significant insight about the everyday life of a particular time and place, as well as the interaction between people's daily life and the local geographic and social context.

Modeling human activity patterns has been helpful for discovering the interconnectedness of a person's daily activities and the interaction between these activities and those undertaken by other members of the same household. One of the major advances made in this research area is the shift from trip-based modeling to activity-based modeling (e.g., Bhat and Koppelman, 1999; Golob, 1998, 2000; Golob and McNally, 1997; Goulias, 2002; Kitamura, 1988; Kwan, 1999; Lu and Pas, 1999; Pendyala and Goulias, 2002). Activity-based modeling takes people's daily activities and the associated trips as the fundamental analytical entities. It considers travel as a demand derived from the need to undertake activities at different locations. When compared with trip-based models, such as the four-step transportation model, activity-based models provide better frameworks for addressing the complexity of activity–travel behaviors as they consider a wider range of factors and interactions. For example, since an individual's daily activity arrangement is often influenced by other household members, the effect of the decision-making of household members (especially the female and male heads) on both individual and joint activity–travel participation can be taken into account (e.g., Chandraskharan and Goulias, 1999; Fujii et al., 1999; Gliebe and Koppelman, 2002; Golob and McNally, 1997; Townsend, 1987; Van Wissen, 1989). Results from previous research indicate that men and women tend to perform disproportionate shares of particular household tasks, and that paid work and child care responsibilities significantly affect the tradeoff between joint and individual activities.

Although these studies are not directly related to people's Internet activities, they shed important light on conceptual and operational issues that need to be addressed. Further, based on past results, it can be expected that the Internet will not evenly affect activity–travel patterns across different social groups because the adoption of the Internet will be influenced by people's individual, household, and socio-demographic attributes.

2.2. ICTs and activity–travel patterns

To date, researchers have considered the impact of ICTs when investigating human activity patterns. Generally, existing studies can be classified into two groups. The first group concerns the interrelations between the general use of ICTs and activity–travel patterns. Empirical studies suggest that ICT use has a complex impact on activity–travel patterns. For instance, Mokhtarian and Meenakshisundaram (1999) conducted a longitudinal study to examine the relationships among different modes of communication over a six-month period. The study found a net generation of overall communication activities. Senbil and Kitamura (2003) found that telecommunication devices (such as home phones and cellular phones) affect different activities in different ways: substitution for work-related activities, complementation for discretionary activities, and neutrality for maintenance activities. Choo and Mokhtarian (2007) proposed a comprehensive model to simultaneously estimate the relationships among local phone calls, travel, infrastructure and cost, economic activities, and land use. The results indicate a complementary relationship between local phone calls and travel. Another study conducted by Kim and Goulias (2004) suggested that the impact of ICTs is influenced by the locations where they were used.

The second group of studies focuses on the impact of some specific use of the Internet on travel behavior, such as telecommuting and E-shopping (e.g., Bagley and Mokhtarian, 1997; Balepur et al., 1998; Farag et al., 2007; Ferrell, 2005; Gould and Golob, 1997; Koenig et al., 1996; Mokhtarian and Salomon, 1997; Mokhtarian et al., 1995). The major research question is whether telecommuting or E-shopping can lead to a significant reduction in travel. Since telecommuting and E-shopping relaxes the traditional space-time constraints associated with people's daily activities, people with Internet access can rearrange their activities over space and time; and this may lead to much more complex outcomes than a reduction in their physical activities (Couclelis, 2004). In the context of telecommuting, Koenig et al. (1996) demonstrated that non-commute trips have a potential negative impact on home-based telecommuting. As for center-based telecommuting, Balepur et al. (1998) observed a slight increase in commute-related trips due to lunch-time trips made from home to telecenters and a significant shift in transportation modes from other modes to driving-alone. Similarly, studies on E-shopping also suggest that the impact of home shopping is multifaceted.

Although the interrelations between ICTs and activity–travel patterns have been examined in the past, some important issues still need to be addressed. First, how the Internet alters human activity–travel patterns has not been fully revealed yet. Compared with other communication technologies, the Internet allows people to conduct a greater range of activities. As such, its influence would differ from other technologies. In order to fully study the impact of the Internet on people's daily activities and travel, activity–travel diaries that collect detailed information about people's physical and Internet activities are needed. Due to the lack of such required data, much of existing research either focuses on one type of Internet use (such as telecommuting) or fails to differentiate the Internet from other communication technologies. Therefore, the interaction between particular Internet activities and people's activity–travel patterns in the physical world calls for more research.

Second, few of these studies to date specifically examine the role of gender in shaping a person's activity–travel patterns. Often, gender is treated as an exogenous variable in existing models and does not play a role in determining the causal structure of the