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Complementarity and substitution between physical and virtual travel for instrumental information sharing in remote rural regions: A social network approach



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ABSTRACT

International development practitioners are highly optimistic that mobile phones can improve the lives of the inhabitants of remote rural areas in developing countries with an underdeveloped transportation infrastructure. However, the instrumental role of telecommunication is unclear in contexts where residents' information-sharing networks are strongly geographically constrained by their limited mobility. Empirical research on the interactions between telecommunication and travel in rural areas of developing countries is lacking.

This study analyses physical and virtual contact patterns within 1270 instrumental information-sharing relationships reported by the inhabitants of the Pulau Pangung and Sumber Rejo rural subdistricts of Indonesia. In 2013, we implemented an exogenous mobility intervention. In 2014, we administered a network survey in 16 randomly selected farming groups to map local residents' egocentric and sociocentric physical and virtual travel networks.

By comparing the observed networks with simulated random networks, analysing the relationship characteristics and their history, and performing a regression analysis with fixed effects, we examine the complementarity and substitution between telecommunication and travel in the creation and maintenance of social networks. By examining the effects of the exogenous intervention, we can explain the mechanisms underlying the uncovered associations.

The results suggest path dependency between physical and virtual travel in remote rural areas. The implication for transportation policy is that physical mobility is a precondition for the creation of virtual information-sharing links. Instrumental communication relationships that do not socially require regular physical co-presence can be partially substituted by virtual travel only after virtual links have been created through physical mobility. Therefore, in contrast with general expectations, mobile telephony in remote rural regions is more practical if the transportation infrastructure is adequately developed. The paper concludes with a discussion of the potential contribution of the sociocentric network perspective to transportation research.

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1. Introduction

In remote rural areas of developing countries with an inadequate transportation infrastructure, new information communication technologies (ICTs) are expected to augment local residents' links to the external society by increasing virtual travel as a substitute for physical travel (Arunachalam, 2002; Bhavnani et al., 2008; Donner, 2005, 2006, 2008, 2009; Ilahiane and Sherry, 2012; Juma, 2010; Overà, 2006). However, despite ICT pundits' enthusiasm, rigorous research on whether the proliferation of new technologies facilitates contact beyond the limited physical mobility of residents of remote areas remains lacking. It is unclear whether newly available mobile phones can serve as substitutes for physical travel and face-to-face meetings or whether virtual communication must be stimulated by physical mobility.

The relationship between transportation and ICTs has been studied extensively in highly industrialised urban contexts (Golob and Regan, 2001; Mokhtarian, 2009, 1990, 2002; Salomon, 1985, 1986; Urry, 2002; Wang and Law, 2007). In particular, transportation researchers have given substantial attention to the impacts of telecommunications on physical travel (more so than the impacts of physical travel on ICT usability). Based on previous studies, some researchers have concluded that it is futile to attempt to understand the relationship between physical travel and ICT through traditional activity-travel behaviour research methods that consider the number of directly substituted or generated trips (Aguilera et al., 2012; Kwan, 2007; Mokhtarian, 2002). It seems fruitful to broaden the analytical framework of traditional transportation analyses and explore how ICTs help to reshape the spatial organization of people's everyday interactions, face-to-face social contact, and the construction and maintenance of social networks (Aguilera et al., 2012; Hanson, 1998; Kwan, 2007; Larsen et al., 2009, 2007a; Mascheroni, 2007).

The main question of the study is as follows: "What is the relationship between physical and virtual contact in the information-sharing networks of the residents of rural areas in developing countries?" Using original empirical social network data and a social experiment conducted in southern Sumatra, this study specifically aims to answer the following sub-questions regarding the travel behaviour of mobile phone users and their communication partners at the interpersonal relationship and network levels:

- (1) Are mobile phones used as substitutes for physical travel within the range of physical mobility?
- (2) Are mobile phones used for virtual information exchange beyond the range of physical mobility?
- (3) Do the residents of remote rural areas more frequently or less frequently visit the people who call them?"

2. Previous research on transportation and ICTs in remote rural areas

With every new wave of ICTs, transportation researchers have questioned whether these new technologies will decrease the need for transportation by partially substituting physical travel with virtual travel. We have a limited understanding of the relationship between travel behaviour and ICT usage (Aguilera et al., 2012; Kwan, 2007), but available empirical evidence in the transportation literature mostly supports complementarity rather than substitution; i.e., increasing intensity of virtual and physical travel seem to go hand in hand in industrialised regions (Lenz and Nobis, 2007; Mokhtarian, 2009; Nobis and Lenz, 2009).

By contrast, international development practitioners are highly optimistic that ICTs can serve as substitutions for an underdeveloped transportation infrastructure in vast rural areas of developing countries, and international donors have strongly supported the development of ICT infrastructure in the most disadvantaged regions of the world (Foss and Couclelis, 2009). In these regions, the suddenly ubiquitous mobile phone is typically the first and only ICT (Bhavnani et al., 2008), and among all modern ICT technologies, a basic mobile phone is considered to be the most successful tool for enhancing the opportunities of local inhabitants (Foss and Couclelis, 2009).

However, little rigorous empirical evidence is available regarding the relationship between physical and virtual travel and social networks in areas where the predominant mode of communication previously involved walking to face-to-face meetings. Similar to the research in other academic fields, most research on travel and ICTs is conducted in WEIRD (Western, Educated, Industrialised, Rich and Democratic) contexts, although most people in the world are not WEIRD (Henrich et al., 2010). One study in Greece compared the relationship between women's use of ICT and their physical travel in urban and rural areas (Polydoropoulou and Tsirimpa, 2013). Women living in more remote regions were less likely to substitute physical travel with online activities, possibly because of better traffic conditions in remote areas and their limited familiarity with ICTs. Similarly to other studies in Western settings, the authors examined the interaction of ICTs and physical travel in telecommuting and teleshopping—activities that are still significantly less relevant, if available at all, in vast agrarian regions of developing countries. A small number of academic studies examined the relationship between travel and ICT use in non-Western urban settings (Mosa, 2011; Padayhag and Fukuda, 2011; Wang and Law, 2007); however, empirical studies in non-industrialised rural settings are still lacking.

Information technologies of the 21st century were expected to promote social equity by connecting those who are "off the road" (Hanson, 1998). The most geographically marginalised people are the inhabitants of the rural areas of developing countries. Most of these people are employed in agriculture, and their well-being is constrained by inadequate access to markets and information (Central Intelligence Agency, 2016; Matouš et al., 2013; Pretty et al., 2010; Todo et al., 2010). A number of economic studies have reported that mobile ICTs play an instrumental role in increasing the accessibility of distant

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