MOBILE ICTS AND MOBILITY. A CRITICAL REVIEW OF LITERATURE

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ABSTRACT

The question of the relationship between the diffusion of communication tools and the physical mobility of individuals is not new and arose with the arrival of the fixed telephone and, more recently, the development of the Internet and especially the e-commerce. The extraordinary diffusion of individual and especially portable communication tools, like the mobile phone, has recently given a new impetus to this topic in the fields of transportation economics, geography and sociology. This article proposes a critical synthesis of the questions that have been explored by the literature, from the debate between complementarity and substitution to more recent analyses in terms of individuals' activity schedules and social networks. The conclusion discusses some issues that we think should be better explored.

Keywords: Mobile phone, ICT, mobility, substitution, complementarity

INTRODUCTION

The issue of the links between the development of information and communication technologies (ICTs) and individual travel behaviour is not a new one (Massot, 1995; Mokhtarian, 2009; Salomon, 1985). It was raised, in particular, with the arrival of the fixed telephone in the home (Claisse and Rowe, 1993), then, more recently, with the development of the Internet and, in particular, online shopping (Golob and Regan, 2001). The spectacular spread of personal communication devices, especially portable ones such as the mobile phone, has recently given new impetus to this topic in the fields of transport economics, geography and sociology. This paper provides a critical analysis of the issues that have been explored in the recent literature, in order to highlight those which we consider worthy of further attention.
Our main observation is that in spite of the changes that have occurred in the ownership and uses of ICTs, the most important issue has remained substantially unchanged. The principal concern today, particularly in the field of transport economics, is still the opposition between complementarity or even generation effects and substitution effects: do ICTs stimulate or reduce travel demand? In spite of a large amount of empirical research, the answer is still fairly unclear, even though the idea of complementarity or generation dominates (Mokhtarian, 2009). It would be difficult to hold the contrary view, as surveys do not show any marked reduction in travel (except during specific periods of greatly increasing energy prices). The approach which opposes complementarity and substitution nevertheless suffers from some serious limitations. To avoid excessive complexity, it is generally forced to consider only a single technology (for example online shopping), and only individual effects (when household effects are probably just as important), focus on a single trip purpose (for example shopping), and furthermore consider only a single dimension of travel (for example the number of daily trips but not the distance or vice-versa) (Krizek and Johnson, 2003). The first part of this paper examines this research in greater depth and explains why the researchers have found it so difficult to take account of the wealth and complexity of the possible interactions between ICTs and travel.
The second part of the paper examines a more recent literature which, in our view, provides a way of moving beyond the debate between complementarity and substitution. The approach in question, which essentially originates in the sociology and geography of time (Hägerstrand, 1970) and which is starting to influence transport socioeconomics (Schwanen and Kwan, 2008), considers a wider range of qualitative interactions that relate to individuals' spatiotemporal and relational behaviour. The researchers in question consider that it is not so much the relationship between the use of technologies and the number of trips which is of interest as the potential changes in the nature of trips and their circumstances as a result of the gradual changes in our lifestyles these technologies bring about. The changes in question involve our social networks (both private and professional), the way we conduct our activities both in space and time, and the way we perceive and experience the time we spend travelling. These researchers take the view that mobile ICTs will gradually enrich our spatial and temporal practices as much as they will increase travel (or more broadly nomadism) (Ling and Haddon, 2003). The aim is no longer to find out whether there has been an increase or decrease in travel, but rather the question is approached in a different way: do individuals employ different strategies to organize their journeys? Above all, we must not ignore the implications of these changes, for example the activities, particularly the travel, of each of us influences and is influenced by other persons. The conclusion identifies some of the issues that we think should be better explored.

A RECURRING UNANSWERED QUESTION: SUBSTITUTION, COMPLEMENTARITY OR GENERATION?

For a long time the relationship between ICTs and travel has been considered in a direct manner, i.e. in a way that was relatively isolated from other parameters, in particular the major determinants of travel behaviours (income, residential location, activities, etc.) Research attempted to evaluate whether ICTs use would cause individuals to reduce the amount they travelled, keep it at the same level or even increase it. Expectations, in some cases contradictory, were associated with this evaluation. Thus, environmentalists expected that ICTs would reduce travel-related congestion and pollution costs. ICTs were therefore enrolled in the service of sustainable development. At the same time, these technologies have often been accused of weakening social ties by favouring a reduction in face-to-face contact. The complementarity/substitution debate thus brings together important issues for society but has a number of limitations (Schwanen et al., 2008).

ICT use reduces travel demand

This idea is based on the very strong spatiotemporal representation that surrounds the development of ICTs. According to this representation, telecommunications make it possible to do at a distance what individuals formerly did when near each other, making it possible to substitute virtual relationships for physical relationships. This representation provides support for naïve views about the role of telecommunications in interactions and has attracted much criticism (recently on cyberspace) (Musso, 2008). It is nevertheless constantly given new life by the spectacular and continual progress of communication technology, which never fails to provide a background for the idea of substitution, which holds that ICT use leads individuals to reduce the number of trips they make.

One aspect is that ICTs can encourage individuals to perform some of the activities which previously required a journey from a fixed location (in particular their home). It is thought that telecommuting, either in one's home or in telecentres near one's home, will eliminate commuting trips. Since the 1970s, the idea of telecommuting has been reappearing regularly in spite of unfulfilled expectations. The development of online shopping took its place at the start of the years 2000 with the same approach (making purchases at a distance instead of in a shop) and the same expectation of solving urban travel problems (Rallet, 2001). The same approach and expectations were then extended to other service activities: health (telehealth), administration (online administration), teaching (online learning) as well as leisure activities (Mokhtarian et al., 2006).

Another aspect is that these technologies can reduce the need for face-to-face encounters in both the private and professional sphere by improving the quality of relationships at a distance. When combined, the wide variety of ICTs allows increasingly high quality interaction at a distance – emails, instant messaging, forums, videoconferencing, etc. They allow people to be permanently available (the ability to be in touch anywhere and at any time, the abolition of borders) and therefore reduce the need for face-to-face meetings. They would also eradicate changes in relationships brought about by residential mobility.

There is no doubt that communication at a distance means it is possible to avoid some trips, and it is even trivial to make the statement. However, the issue is not this but the links between telecommunications and travel behaviour as a whole, as has been shown by the literature on complementarity and generation.

The use of ICTs goes hand and hand with, and even stimulates, travel demand

ICTs reduce some trips, but some remain, either through necessity (going to work) or choice (going shopping), and others are stimulated. With regard to shopping, the Internet may play a complementary role with regard to shops (Rallet, 2001). It is very often used to find out about a product and its availability before going to a shop. It can also be used to discover the existence of products which one then goes to buy (Douma et al., 2004). In addition, a recent study by Farag et al. (2007) has shown that in Denmark online shoppers made on average more shopping trips (all other things being equal) than those who did not shop online.
It is not certain that substitution occurs in the professional sphere either. Douma et al. (2004) have shown that ICTs are often used before leaving for work and after returning home, in order to answer emails or prepare for the day's or next day's work. This may make it possible for someone to change their departure or arrival time in order to spend less time travelling, but it does not reduce their amount of travel. The same applies to professional trips (Arnfalk and Kogg, 2003). We can say the same about the private sphere, the substitution effect probably being at least counterbalanced by the enlargement of networks (in terms of the number of contacts and geographical size) that ICTs permit. Larsen et al. (2006) thus predict that ICTs will be responsible for an increase in the number of distant contacts and therefore long distance journeys, so long as the cost of long-distance travel remains low, in particular because of low-cost operators.
More generally, as ICTs are not able to reproduce faithfully all aspects of a face-to-face meeting, interpersonal relations still involve face-to-face meetings (Torre and Rallet, 2005). Following Jaureguiberry (1994), Ascher (1995) and Guillaume (2000), we can even take the view that as a result of the compensation effect, ICTs add new value to physical presence. The purpose of travel is thus not primarily to satisfy instrumental needs but to make up for a relational deficit. Face-to-face exchanges tell one's interlocutor that he or she is receiving special attention: they meet the need to create links with shared intersubjectivity. We cannot therefore expect to see a reduction in the number of direct meetings, rather an increase: because ICTs increase the number of interlocutors and the size of social networks they create needs for face-to-face meetings and hence travel.

The limitations of the debate

The attempt to establish a "direct" link between ICT use and the number of trips encounters four major limitations. To begin with, it is difficult to take account of possible cross effects (generation for some trips and substitution for others): Mokhtarian et al. (2006) who were concerned with leisure travel, have shown that trip-making is mostly linked to trip purpose, the characteristics of the individuals and the leisure activities in question. The large number of situations means that it is almost impossible to reach a conclusion on a purely quantitative basis.
Next, long-term effects may diverge from short term effects, in particular because individuals gain familiarity with these technologies and may start to combine them, or because the equipment rate increases and the available functionalities change rapidly, as for example, has been the case with mobile telephones.
Moreover, the correct measurement scale is not necessary that of the individual, the household may be better. The study by Schwanen and Kwan (2008) described, amongst other things, the possible effects on the distribution of tasks, and therefore travel, between spouses: for example, some couples call each other every evening to decide who should collect the child from the nursery and perform other tasks (shopping, housework, etc.)

Last, the observed changes in travel behaviour may depend on a great many parameters in addition to ICTs. Some examples are the cost of transport and the locational strategies of actors. However, in these areas ICTs play at most a moderate role, and it is difficult (and no doubt presumptious) even to try to identify the specific impact of ICTs on the number of daily trips, which is primarily determined by powerful spatiotemporal constraints (location and hours of work, opening and closing times of schools, etc.) (Green, 2002). In any case it is very difficult to see how we can reason on an "all other things being equal" basis.
In view of these limitations it is not surprising that empirical research that attempts to measure whether ICTs reduce travel or not has reached contradictory conclusions, or conclusions which are convincing for only a very specific part of the population, for example hypermobile executives (Lenz and Nobis, 2007). The value of this work lies more in the fact that it reveals the great complexity of the links between ICTs and travel and hence considers the margins of manoeuvre available (or not) to individuals and therefore society in order to reduce travel as a result of ICTs (would it be a good idea to extend telecommuting? etc.)
This research is also of interest because it suggests that ICT use should first of all be seen in terms of the enrichment of existing activities before more radical breaks with the past are considered. In fact, current research strongly confirms that such enrichment takes place. It shows that adolescents engage in hypercoordination (they use their mobile telephone to intensify their ties with their peer network and attempt to be more independent, that parents (particularly mothers with young children) engage in micro-coordinataion and check their children have arrived home safely, or remain in contact with their children if they are divorced and that children lay a great deal of stress on the safety benefits of owning a mobile telephone (Ling and Yttri, 2002). In the professional sphere, mobile devices may be used to facilitate the management of staff who already travel, but have not yet given rise to a new approach to travel and, more broadly, the organization of work within the firm (Moeller, 2006). In short, nothing revolutionary has occurred, the use of mobile devices at present merely accentuates practices that exist already. But new urban communications networks are being put in place as a result of these practices which are not at the present time very spectacular. Once they have been put in place and their use has developed, the devices will permit new practices and innovation in our relationship with space and travel. This must provide the basis for the construction of a new analysis framework.

A NEW ANALYSIS FRAMEWORK

The issue of the links between ICTs and travel must obviously be considered in other terms than simply how they have affected the number of trips. While this is obviously a legitimate question, we cannot hope to consider it as a direct relationship. We need first of all to consider the issue within a wider analysis of the links between ICTs, individuals' activity schedules and their deployment in time and, in particular as we are concerned with travel, in space (Schwanen and Kwan, 2008). The relationships with the construction and maintenance of the social network must also be considered. In addition, travel behaviour and especially (but not only) the use of travel time, must be questioned in relationship with mobile ICT use and also with the decision to own one or more mobile devices.

What are the implications of spatiotemporal continuity?

The true novelty of these technologies probably does not lie in the fact that they can be used in mobility. Indeed, they are not only, or even primarily, used during travel or outside the normal locations of daily life (home, work, school). Surveys show that the most important

location for mobile telephone use is the home, whether this is for reasons to do with cost (unlimited subscriptions, favourite numbers, etc.) or in order to "protect" one's privacy. The link between these technologies and travel should not therefore be seen as only, or even primarily in terms of use when travelling, and doing so in our view constitutes another failing of existing research into the links between ICTs and travel. Uses when travelling are, in fact, relatively commonplace (mainly keeping oneself occupied during the journey and letting people know if one is late) and would not give an idea of how these devices can change our daily lives, both with regard to our relationship with space and time and in our relationships with other people, in both the professional and private spheres, but much more in the combination between their personal nature and their portability, which means they are almost permanently available for use (on condition one is in a zone with coverage).

Above all, mobile communications networks provide greater spatiotemporal continuity, therefore there are potentially fewer breaks between locations and when performing certain activities. A growing number of activities, both private and professional, are no longer associated with particular locations. In other terms, mobile ICTs provide new possibilities for performing activities, in particular during journeys or more broadly nomadically (when in transit in an airport, in a hotel, etc.)

This change provides new possibilities for performing many types of spatially disjoint activities: communicating, obtaining information, coordinating with others, making a transaction, etc. In particular, it increases the range of activities that can be performed in many locations or situations, in particular (but not exclusively) during travel. However, in reality these activities may be limited in number either because of social norms (telephoning in some places is prohibited or frowned upon), personal limitations (we shall return below to the question of the acceptability of being reachable on a virtually permanent basis because of mobile telephony) or because the conditions for using them are poor (for example in public transport during the rush hour). These changes are still too recent for us to be able to characterize them. But we must construct an analysis framework which allows us to perceive changes as they occur and therefore direct our research in relevant directions. We shall now examine this issue by considering three dimensions.

The spatiotemporal distribution of activities

The first dimension involves the spatiotemporal distribution of daily or more exceptional activities for individuals and households. One possibility to consider is that activity schedules will be rearranged. Already, some researchers take the view that improvisation is becoming more prevalent and that a shift is taking place towards "real time" operation with greater flexibility in both private and professional spheres (Aubert, 2004). Along with other researchers, we take the view that social and institutional limits apply and that individuals construct resistance strategies (Belton and De Coninck, 2006; Green, 2002). This is not to say that this type of change is not taking place, but it requires other changes beforehand, in the social sphere, at individual level and perhaps also in travel conditions and behaviour.

Although mobile ICT devices, in particular mobile telephones, have become extremely widespread, individuals' activity schedules remain highly structured, both spatially and temporally, by social and institutional norms that have remained largely unchanged (Green, 2002). Even if timetables and work places are becoming more varied, the model of the single place of work remains dominant and to a very large degree determines the behaviours, particularly the travel behaviours, of those with professional occupations (Aguilera et al., 2010). In France, it is still the case that most shops and services are closed on Sundays, schools close at around 5pm, and there is no primary school on Wednesdays, etc. These

features structure and impose strong constraints on daily activities and greatly restrict people's margins of manoeuvre for rearranging them, particularly in real time.
This does not mean that there have not been any changes. There have, and some of them are very important both at the individual and collective levels. For example, the Internet means that it is increasingly common, at least in some occupations, to work at home, or at least read and answer one's business emails, even on Sunday. However, genuine telecommuting is barely on the increase as a result of strong resistance, particularly from firms. There is also, obviously, resistance from individuals: in particular, it is not at all certain that the majority desire "permanent improvisation" models (to caricature the situation somewhat) or unlimited reachability (Aguiléra et al., 2009). However, we can observe some lessening of rigidity, particularly as a result of mobile telephones, for example there is less pressure to be on time and less prior organization of the time and place of meetings, particularly in the private sphere. In addition, reachability does not mean immediate availability: people can answer their phone call but to say that they are not available for the moment (Weilenmann, 2003).
Another possible effect, which affects travel more directly, is the increase in trip chaining, i.e. making a sequence of trips without returning home (Srinivasan and Raghaevender, 2006). One can easily imagine the optimization of travel, whether in the professional sphere (in particular for those making rounds), or in the private sphere where people are no longer compelled to return home to take a telephone call (Ling and Yttri, 2002). Finally, we can expect that owning a mobile telephone, due to the fact that it reassures parents, will help young people to become more autonomous, in particular allowing them greater freedom to travel (Ito et al., 2005). Such changes in travel behaviour need to be examined with reference to the processes by which individuals adopt these technologies: has learning to use these technologies resulted in a change, even slight, in certain travel behaviour?
It is obvious that travel plays, and will continue to play, an important role in the changes in lifestyle brought about by the spread of mobile ICTs. We need to examine the influence of mobile ICTs on the way individuals experience travel situations and what happens in them (what activities do people perform?). But, as we have already pointed out, we must not simply list activities and assess possible changes in relation to the situation without these technologies, but consider links with the broader reshaping of an individual's entire activity schedule.
In addition, we need to examine the ability to travel. In our view, this is important if not essential in order to be able to make activity schedules more flexible. It is not enough for individuals just to be informed in real time in order to be able to react to an unforeseen situation or a change, they need to be able to modify the activities they have planned and therefore have a degree of flexibility in their travel. The capacity to create intermediaries will probably also be very important for increasing the flexibility of lifestyles (Guillot, 2008). By intermediaries we mean individuals whom can call on to help one change one's activity schedule in the event of a change or an unforeseen event (for example a neighbour who can collect the children from school if necessary). This need is obviously not new, but mobile ICTs mean that in theory it is possible to call on intermediaries at shorter notice and with less uncertainty.

Social networks

The second dimension relates to the possible impact of mobile ICTs on social networks and then on the need for face to face interactions, especially for leisure purpose (Axhausen, 2002), Indeed, the use of ICTs is supposed to transform social networks not only in terms of their size (number of members) and quality (strong/weak ties) but also, which is also important with regard to travel, their spatial extension.

Several studies have underlined negative consequences (Coget et al., 2002 , Daft and Lengel, 1984, Hiltz, 1986; Sproull and Kiesler, 1986 ; Turkle, 1995Young, 1998). In particular, the use of ICTs impoverishes the relations and increases impersonal communications. However, other have demonstrated that the social network becomes larger (in terms of size) and also more extended spatially with the use of ICTs (Schwanen and Kwan, 2007). In addition, J.A. Carrasco and E.J. Miller (2006) have shown a positive correlation between the use of ICTs and the propensity to perform social activities and especially out-of-home social activities. Recently, J.A. Carrasco et al. (2008) have pointed out the links between the use of ICTs, and two aspects of social networks that are on the one hand the social accessibility and on the other hand the agency (the extent to which an individual maintain social network given the practical constraints that limit the accessibility of others). However, no study has explicitly made the relationship between this potential transformation of social networks and travel behaviour. A hypothesis is that the increase in the size and spatial extension of networks would tend to have a non-negligible impact on both private and professional long distance travel (Larsen et al., 2006) but also the need for travel for everyday purposes and especially to perform social activities. A considerable amount of further research is required in this area to refine and confirm these hypotheses especially in the case of mobile ICTs which permit the emergence of a connected presence for the members of each network (Licoppe, 2004). The result is the development of micro-coordination (for instance between the members of a couple) which can favour the flexibilisation of lifestyles and thus produce changes in termes of everyday travel behaviour (Ling and Yttri, 2002).

Travel behaviour, ownership and use of mobile ICTs

Although the use of ICTs while travelling should not constitute the new starting point for the analysis of the links between mobile ICTs and travel, we should nevertheless examine the role of travel, but this examination should consider more the decision to own mobile communications devices and their actual use and the way this changes.

On one hand, we can imagine that the forms taken by private and/or professional travel (evaluated in particular with reference to the frequency of trips and the variety of locations), play an important role in the decision to own one or more mobile communications devices (in particular whether ownership is perceived as imposed or chosen), even if the devices are subsequently used quite differently. This hypothesis can be made for both the private and professional spheres, where it is possible for the initial decision to own mobile communications devices to perform nomadic work practices more effectively leads to much more profound operational changes. These issues appear to have received little attention, particular with regard to the professional sphere.

In addition, we feel that it is imperative to examine the way individuals actually use these mobile devices (particularly which functionalities they use) with reference to the intensity and diversity of their daily travel behaviour and more occasional journeys (for example during their holidays). This is because it is probable that take-up of these technologies and the way their use evolves will depend on the forms taken by individual travel (or that of other household members such as the children). In particular, we can ask whether use is more sophisticated and more diversified when travel is more frequent and/or mainly involves different locations, or if on the contrary travel does not affect the type of use. It is also conceivable that the diversity of travel behaviour is linked with the creation of different strategies, in particular with regard to the times and places that individuals will be reachable. Another possibility is that travel behaviour mean that some ways of using the technologies in question evolve more rapidly (or differently), ultimately resulting not only in differing trajectories but also new norms in both private and professional spheres. In particular, it is

possible that the mobile telephone has profoundly modified people's attitudes when they are abroad both with regard to reachability (and availability) and the frequency with which they contact their friends and family. The analysis conducted by Aguiléra, Bonin and Guillot (2009) of survey data collected in the framework of the MOBITIC project shows that most people's use is trivial, which stresses the fact that the telephone has become accepted and that recharging it, turning it on and taking it with one have become part of daily life. It emerges from the study that in general individuals tend do be increasingly reachable, and that they all implement strategies to control this. They can do this either by technical means, for example using the vibration call alert function on their mobile telephone, ritualized means, for example, when they are at work fixing special times when they can receive or make calls, or tactical means, for example by only giving their mobile telephone number to a limited number of persons.

CONCLUSION

The question of whether ICTs will have an effect on personal travel behaviour is a legitimate question, but for several reasons it is somewhat futile. First, ICTs save some trips but generate others so the net effect is unclear. Second, the powerful determinants that influence travel are not affected by the rise of ICTs, or at least not in a way that will reduce the number of trips. Trip frequencies and purposes and the modes and routes involved may change, but the trips themselves will remain. Finally, the links between ICTs and trips cannot be considered in isolation from the organizational, economic and societal context in which they perform a coordination function.

In the second part of this paper we have presented a different approach towards the links between ICTs and travel behaviour. This approach attempts to find out whether ICTs modify the forms and nature of trips rather than their number. To do this the links between ICTs and travel behaviour are investigated by analyzing how the ownership of ICTs can influence social networks and the spatiotemporal distribution of both private and professional activities. This research area is developing rapidly but many empirical studies are still necessary. In particular, the links between ICTs and social networks have been relatively well explored but the relations with travel behaviour are still largely unknown. In addition, the hypothesis of a greater fragmentation of everyday activities and more generally a greater flexibility of time use has not been confirmed. Moreover, existing studies take in general into account only one type of device (for instance the mobile phone) but very little is known about the use of many ICTs. Existing travel survey can not be used to answer these questions and new quantitative and qualitative surveys are necessary.

To conclude, we can say that travel behaviour will change with the use of ICTs and especially mobile devices, but the changes will be subject to a number of conditions. The most important of these is that social conventions must be put in place to permit the adoption of the new interaction practices resulting from the use of mobile communications devices. This is a slow process, but major transformations in travel behaviour will depend upon it.

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