**THE ROLE OF INFORMATION COMMUNICATION TECHNOLOGY (ICT) IN TRANSPORTATION SYSTEM**

**BY**

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**ABSTRACT**

*Information and Communication Technologies (ICT) have considerable importance for transport systems, as they provide access to travel information, planning tools, opportunities to share transport modes, to work at-a-distance, compare transport mode cost, make payment, improve safety and health, and to communicate travel patterns. Over the past decade, there has been massive growth in the availability of transportation ICT, in particular smartphone applications. There is considerable evidence that ICT has profoundly changed the ways in which transport systems are perceived and used, and mobilities performed; with far-reaching implications for transport mode choices and transport demand. Against this background, this paper seek to elaborate the role of ICT in Transportation System.*

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**INTRODUCTION**

Information and communication technologies (ICT) are now underlying virtually all transport systems. In particular websites, social media and chats have been found to influence transport system (Line, Jain & Lyons 2011), raising the question as to how ICT affects the growth, structure, and sustainability of the transport sector. ICT can increase the interest in more sustainable forms of transportation such as public transport, walking or bicycling; they can substitute travel, or initiate growth in transport demand. Salomon (1986) was the first to raise this question, linking the emergence of telecommunication opportunities to an increase in transport demand. Senbil and Kitamura (2003) later suggested more complex relationships, i.e. that ICT could have four potentially contradictory outcomes: substitution, complementarity, modification and neutrality. These categories refer to growth/decline in trip numbers, changes in spatial and temporal travel patterns, or a ‘no net’ impact. While the implications of ICT for transport behavior continue to be a research focus (Kim 2017; Thomopoulos, Givoni and Retrieved 2015; Wagner et al. 2004), there is no comprehensive understanding of these interrelationships, particularly in light of the growth in smartphone and app availability since 2007 (i.e., the year the iphone was introduced; Apple 2007).

**RELATIONSHIPS BETWEEN ICT AND TRANSPORT SYSTEM**

Interrelationships of ICT innovations and changes in transport demand have been debated for more than three decades (Line et al. 2011; Salomon 1986; Senbil & Kitamura 2003; Thomopoulos, Givoni & Rietveld 2015; Wagner et al. 2004). The basis of discussions has however changed fundamentally over time, as ICT opportunities constantly evolved, specifically with the development of the smartphone. Wagner et al. (2004) and Banister and Stead (2004) were the first to comprehensively discuss the complexity of ICT and transport interrelationships, considering ICT demand responses as well as spatial and temporal distribution outcomes. Specifically, this included ‘living’, ‘working’ and ‘producing’, the latter comprising logistics, manufacturing systems, customized services, retailing and distribution, teleshopping, distance working and self-employment. Wagner et al. (2004) and Banister and Stead (2004) concluded that ICT would stimulate travel, as new ‘opportunities’ for transport became available, though ICT would also substitute for travel, as a growing number of tasks could be carried out at-a-distance.

Aguiléra, Guillot & Rallet (2012) provided new insights regarding the potential of ICT innovations to stimulate and substitute transport demand. Of particular importance is their finding that ICT changes the nature of transport demand, as it adds “new value to physical presence”. In their view, travel no longer addresses instrumental needs; it makes up for “relational deficits”. This is confirmed by Cohen-Blankshtain and Rotem-Mindali (2016) who noted that ICT lead to some travel substitution, though both physical and virtual activity types grow.

**ICT AND TRANSPORTATION SYSTEM: A CONCEPTUALIZATION**

**1. Travel information, planning and routing**

Transport information systems have seen major advances in recent years, and travelers have profited from a wide range of apps developed to facilitate travel and to make in particular public transport systems more reliable. One of the most important innovations is the integration of different transport modes (e.g. tram, train, subway, bus), with apps informing about the closest departure location, departure time, arrival time, and cost. One of the first of these integrative systems (9292), introduced in the late 2000s in the Netherlands, already triangulated the user’s current position to recommend the next starting point for a journey by public transport to any destination in the country. This system allowed travellers to use their smartphones for navigation, while also addressing the problem of delays: by pushing a button, the system recalculated the next best connection (Gössling 2010). More recent apps (Moovit, Moovel) also include payment options, delay control, a greater range of transport modes (including rental bikes

or car sharing), as well as cross-border destination choices. Quixxit claims to integrate 15 transport choices, including train and air travel. Transit App offers alternative transportation, rhetorically asking: “Public transit not cooperating? … easily request an Uber, reserve a car2go or grab the closest bike share”. Apps such as Hailo App or Mytaxi offer standardized taxi request services. Overall, there is an emerging integration of different transport mode choices, as well as a growing number of specialized services on the basis of peer-to-peer, for profit, not-for-profit, or city council/government funded ICT solutions.

Private transport also increasingly relies on the support of websites and apps. One of the most notable innovations has been Google’s digitalization of the world’s transport infrastructure (Google maps), allowing calculation of physical distances, identification of public transport connections, and comparison of travel times. Information includes transport flows and the speed of movement in specific road sections in real time. This has been further developed into routing advice, with for instance Waze informing about the ‘best’ route, including “police alerts, accidents, road hazards or traffic jams” based on information shared by drivers.

Secondary effects of ICT for transport are for instance relevant in the context of sports events or disasters (for example through Twitter), as they can result in a “rush to the road” and concomitant congestion effects (Stephens et al. 2015: 498). Depending on the planned type of trip, weather forecasts (e.g. AccuWeather) can deter or attract visitors, as well as affect transport choices, for instance in the case of national park visits, specific activities such as skiing, hiking, sailing, swimming, or sun-bathing, or the choice of transport modes (Scott & Lemieux 2010).

**2. Sharing**

Collaborative forms of consumption, in which assets are shared between users, have grown rapidly over the past decade, including a wide range of services for shared-use mobility such as bike sharing, carpools or ride sharing, and the sharing of cars, taxi services, and parking. Services are Internet or app-based, and can be offered on the basis of a wide range of models of provision, including peer-to-peer, for profit, not-for-profit, or governmental (de Maio 2009) and representing commercial, negotiated, reciprocal or generalised exchanges (Dickinson et al. 2015). Emerging apps seek to co-ordinate the growing number of offers to share, by providing overviews of the range of services on the basis of a comparison of travel times and cost involved with the different transport mode choices (e.g. Moovel; Mymobilitymap). While the role of many apps is to coordinate supply and demand, many apps now also facilitate reservations and online payment.

Bike sharing systems have co-evolved with tracking and IT systems, and most systems require registration of users through an app or website, as well as identification when renting a bike. The Internet is also used for informational purposes, including YouTube clips such as “How to rent a Villo bike in Brussels, Belgium” (Fishman 2016).

Ride sharing and taxi services are increasingly based on peer-to-peer platforms (e.g. Uber, Lyft, Carma), which coordinate ride offers and requests on a commercial basis, involving private car owners. Given the global success of these ride-share platforms, new secondary platforms have already come into existence: Breeze is an example of a service offering access to a car for people considering to work for Uber. Taxi services are also coordinated through specific apps, such as Mytaxi for taxi requests, with an option to choose a specific driver (drivers can be rated), and to make payment online.

**3. Distance work**

Distance work, or telework, refers to work done at home or in another location for a physically distant firm. Distance working is dependent on ICT, and has the purpose to increase efficiencies, achieve better work-life balances, or to reduce commuting needs (Valenduc and Vendramin 2001). This form of work has grown rapidly and has been estimated to include 43% of US workers in 2016 (Forrester 2009). In comparison, Banister and Stead (2004) estimated this share was 6.1% in the European Union in 1999, indicating that there may have been considerable growth in distance work in recent years (see also Räsänen et al. 2010). Platforms for communication include content sharing (Buffer) and chat services (Hipchat), workplace video chat rooms (Sqwiggle), as well as Internet-based videoconferencing solutions (GoToMeeting). These are aided by apps such as Weekdone, a work-status reporting tool.

**4. Payment and price**

Transponder-based automatic toll charging (Bayne & Haville 1971) and vehicle recognition technology in combination with customer billing systems for cars (Randelman & Chance 1991) have been in use for decades. These systems collect fees for road, ferry or bridge use. Recent advances in payment technology have mostly been made in the area of public transport, where apps can be used to coordinate different transport modes while simultaneously allowing for payment (Moovel). Platforms and apps focusing on the comparison of cost structures of different transport modes are now available for most transport modes, and increasingly integrated. Air travel is still largely an area of its own, with aviation-specific sites for price comparison and bookings (Skyscanner). This, however, may be changing quickly, as Qixxit has already integrated flight purchase options. A number of sites and apps also focus on last minute travel deals, with for example LMT integrating flights, cruises, cars and a variety of holiday-related products and services. Last minute train deals include Amtrak for journeys in the USA, or Trainline in the UK. Various apps offer information on the cheapest fuel stations (Mehr-tanken, Waze), including information on opening times and navigation. Content is partially user-generated: “By working together to report prices at the pump, Waze drivers can always save some fuel money”. Overall, payment options are thus increasingly standardized, while price comparisons have become relevant in new areas, such as fuel purchases.

**5. Safety**

ICT is of growing importance for safety. Sites devoted to traffic safety include for instance Velodossier, a Belgian website allowing cyclists to upload videos that show dangerous traffic sections or inadequate urban transport designs. Through the videos, the situations faced by bicyclists become more urgent, influencing perceptions of transport systems. In other cities, platforms have been created to report transport infrastructure problems (e.g. broken glass on cycle tracks) or to recommend improvements .Often, these allow traffic participants to use smartphones to add markers at their location - triangulated by the app -, and to add information or photographs. Examples include ‘giv et praj’ (‘tip us off’) in Copenhagen, an Internet site/app run by the City council with feedback to users as to whether problematic sections will be improved, have been improved, or cannot be improved. In Germany, the website/app Stadtradeln offers a platform to communities who wish to involve citizens in the improvement of urban low-carbon transport infrastructure, i.e. specifically addressing bicyclists.

Finally, apps also afford learning and data collection. An example is The Traffic Agent, an app designed to "enable primary school children to map their route to school and register positive and negative spots along the way". The app is designed as a spy game for children, and helps transport planners to improve road safety, with the ultimate purpose to make a greater number of children walk and cycle to school.

**6. Convenience**

Convenience innovations for car drivers include a wide range of apps devoted to parking. This includes informational apps, comparing parking opportunities with regard to opening times, restrictions, payment options and cost (e.g. Parkopedia, BestParking), parking spot reservation and pre-payment (e.g. ParkWhiz, Justpark), opportunities to rent parking space privately (e.g. Park2Gether), payment by smartphone by QR (e.g. Parku) or number code (e.g. Easypark), park time reminders (e.g. Parker, ParkenApp2), or park location reminders (Find My Car). Illegal parking can be reported using Wegeheld, an app designed for pedestrians and cyclists encountering wrongly parked cars on cycle tracks/lanes or pedestrian walks. Public transport has seen the introduction of apps providing ‘crowdedness indicators’ (Moovit). Dutch Railways uses an indicator that considers observed passenger numbers in comparison to planned train length, and presents passenger reports on crowdedness in real time (Xtra). This allows travellers to choose less crowded alternatives. A different example related to travel for shopping is Bringbee, a home delivery service, intended to make shopping trips redundant. The app matches a customer at home with someone shopping, who will then also deliver the purchases. The service explicitly mentions reduced travel as an environmental benefit.

**7. Health**

A growing number of apps address health issues, measuring in particular physical activity. ‘Move app’ calculates distances, and can be used for walking, running, skiing or bicycling. The app measures the distances covered, while also visualizing routes on maps, and estimating calories burnt. Runkeeper provides weather services and offers functions including “lose weight, challenge myself, get fit, learn to run, run a race”. Values can be saved, and performance compared over time. Some apps (Map my walk) can also be synchronized with heart rate monitors, while others serve as incentives to be active: Pedometer measures the daily step count in comparison to a set target, while Jawbone Up or Moov are bracelets connected to apps: intended to work as ‘smart coaches’, these systems are designed to control activity levels, and to encourage increasing activity based on training programs. They link sleep and diets, as well as one’s own activities with those of friends, with the goal to “move at least 10 extra miles a month” (Jawbone Up). Audio coach encouragement, based on tracked progress/behavior is an alternative (“You are better than this. Push off the ground more”; Moov). Similar solutions also exist for bicyclists, with for example Wahoo monitoring heart rates, linked to the Strava app. Many apps cover different sports, with for instance Moov including walking and running, swimming, boxing, cycling and training programs. Competitive apps include Austrian RadeltZurArbeit, an app recording the distances cycled to work. Participants are ranked, and everyone cycling at least every second day has a chance to win various prizes.

**8. Motilities**

Interrelationships of IT with transport are of specific relevance in the context of physical (corporeal), virtual, and imaginative mobility. Many Internet-based innovations, including websites and social media, have fundamentally (re) shaped the understanding of the world. As an example, photographic evidence provided by Google Street View or Google Earth, sites such as Trip Advisor or Holiday Check, or social media including Facebook or Instagram provide visual ‘knowledge’ about the world, creating or correcting imaginative geographies (Crouch, Jackson, & Thompson 2005; Holdup & Larsen 2006). The Internet also makes it possible to travel virtually.

Sites also make the visitation of specific places more interesting or desirable, an aspect of particular importance in the context of social media. Facebook offers opportunities to dereference the places visited. Functions such as these allow for ‘interactive travel’ (Germann Molz 2006), i.e. to use smart phones with cameras and online Internet access to upload travel stories and pictures, in a process of co-presence through the communication of travel patterns (Germann Molz & Paris 2013). Importantly, social media generate competition to visit places (Gössling & Stavrinidi 2015), a trend that is currently taken up by a growing number of websites and apps, including Amcharts, Maploco, Travel Score, or Country-counter. These sites offer ‘personal’ world maps indicating the places visited, travel diaries or wish lists, and juxtapose travelness (Urry 2011) with one’s yet ‘unchartered’ territories. Instagram and sites such as Lonely Planet, GoPro, National Geographic and Arc’teryx also provide ‘travel inspiration’, with the most popular travel photographers attracting millions of followers.

**CONCLUSION**

This paper has reviewed The Role of ICT in Transportation System, with a focus on innovations that have become relevant for transport demand over the past decade, including Internet sites, social media, and smartphone apps. ICT now covers a wide range of areas, influencing transport behavior with complex, and often contradictory outcomes for the sustainability of the transport system (Banister & Stead 2004).

**RECOMMENDATIONS**

Information Communication Technology (ICT) is playing vital roles in the field of Transportation.

I therefore recommend that:

1. All transport companies should embrace ICT in their operations for effective passengers services
2. Proper maintenance should be always be done in ICT tools for effective performance
3. Retraining workshops should be organize to staff in order to ensure proper used of the ICT tools in the event of new innovations.
4. Passengers information should be uphold confidentially.

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