1. Introduction: transport and ICT

Nikolas Thomopoulos, Moshe Givoni and Piet Rietveld

1 ICT EVOLUTION

Radical technological changes have occurred in the dawn of the twenty-first century, creating high expectations both for short-term and long-term evolutions in the use of information to improve trip accuracy and travel convenience within the transport sector. Information has become the global currency of this century and ICT (Information and Communication Technology) enables the distribution of information, facilitating both physical and digital accessibility. Coupled with increased mobility, the transport sector is constantly generating data through multiple devices, sensors and sources (Pelletier et al., 2011), an illustration of the unique feature of this era. Global mobile data traffic grew 81 per cent in 2013 and forecasts show that Africa and the Middle East are anticipated to grow – based on the compound annual growth rate – by 70 per cent whereas Central and Eastern Europe are anticipated to grow by 68 per cent (Cisco, 2014). So travellers and institutions have the ability to create value about themselves on their own, as members of organized communities or as part of the wider digital domain constantly producing or using data. It has been predicted that user-generated content and networking can act as democratizing forces in this context (Dutton, 2013).

Mobile phone penetration has reached peak levels in certain countries such as Italy, where almost every individual has two mobile phones, whilst smartphones are used by more than one out of three users in countries such as the UK, Sweden, Italy or Germany (OfCom, 2011). Smartphone penetration is over 70 per cent in both the United States and China (Phadke, 2013), with almost half of mobile phone users in developed countries including the United Kingdom, Germany, Italy and Australia using their phone to access the Internet. Over 1.2 million software applications (that is, apps) existed in June 2014 for each of the two major smartphone types, demonstrating an immense interest by users, businesses and governmental organizations for ICT through apps, social media and short
message services (SMS). On the other hand though, there are places in developing countries where five people share the same phone, highlighting the immense gap between societies and economies as well as the diverse rates of innovation adoption (Figure 1.1) in diverse contexts.

There are very few sectors other than transport where accurate and timely information is valued more. This is reflected also in the ever-growing number of transport-related smartphone apps as well as in the actual infrastructure installed in railway stations, airports, car parks or bus stops. More than 40 million travel information requests by smartphones are registered every month in Sydney (Berejiklian, 2014) and more than 70 per cent of Londoners use travel apps through their smartphone (Rode et al., 2014a) for instance.

This book is in line with the emerging interest in the intersection of ICT and transport, two related disciplines which have been brought closer recently due to increased infrastructure and technological developments. In conjunction with increased mobility worldwide and the widespread use

Notes: Solid line indicates market share of each of the 5 groupings. Broken line indicates cumulative adoption of an innovation as a proportion of the total market share. Graph courtesy of Marco Derksen.


Figure 1.1 Five stages of diffusion of innovation
of mobile technology and smartphones, this interest is expected to boom in the near future. The number of connected devices has been estimated to surpass 20 billion, with the potential to reach 50 billion by 2020, yielding net profits of more than US$1 trillion across a wide range of market sectors (Schindler et al., 2013).

However, technological advancements and the so-called Internet of Things are often accompanied by limitations, so identifying threats and mitigating risks is fundamental particularly at the early stages of development in order to fully exploit opportunities which may bring multiple benefits at various levels. Emerging hierarchies and practices have to be reviewed both locally and globally to counter rather than augment inequalities (Marwick, 2013). The budget constraints currently faced by certain developed countries pose more challenges since the design of efficient ICT for transport networks often comes at a high cost, but it is also an opportunity if it is able to replace, at least partly, investment in physical transport infrastructure, which is likely to be even more costly.

Consequently, it is crucial to draw attention and funds to the types of ICT for transport infrastructure needed the most at local, national or international levels in order to ensure that benefits reach a range of stakeholders. What types of ICT hardware, software or smartphone apps are able to engender interest from users while at the same time meeting environmental, social or economic targets? Are threats and opportunities common for all types of transport modes, for example motorway transport, public transport or non-motorized transport? Which are the key similarities and differences in the needs of developed and developing countries in the quest to establish effective ICT for transport applications? Since today’s ICT will not be the ICT of tomorrow, which theoretical framework should be applied to ensure continuity? Such issues about ICT for transport focusing on people, processes, infrastructure and transport are addressed in this book, aligned with contemporary interest by global institutions such as the European Commission (Schindler et al., 2013) to ensure that relevant policies abide by established values and regulations whilst promoting a positive societal impact through technological innovation.

2 COMBINING ICT AND TRANSPORT: ICT FOR TRANSPORT

The link between ICT and transport started to evolve more than 30 years ago (Figure 1.2) and is anticipated to continue after 2020 with connectivity, digital demand and innovative solutions playing an instrumental role (Mohr et al., 2013). As presented in Chapter 11, the European Union
ICT for transport

established it further with Directive 2010/40/EU, which focuses on the deployment of Intelligent Transport Systems (ITS) for road transport and the interface with other transport modes (OJEU, 2010). Sustainable Urban Mobility Plans provide another platform to link ICT and transport in order to benefit users and meet urban policy objectives.

Global Interest

Global institutions have acknowledged during the past few years the importance of technology to meet economic, environmental and social objectives. Therefore the interest in ICT for transport and the role it is expected to play has become clear. This has been communicated via the terms *smart and green development*, used frequently after the Rio+20 summit (Ang and Marchal, 2013; Floater et al., 2014; OECD, 2010; UNEP, 2011; UN, 2012). These terms have been translated into World Bank policies varying from the freight and green trucks programme implemented in China (Mehndiratta et al., 2011) to the ICT in the context of green growth aiming at agriculture and climate change in Africa (Palmer, 2012). Similarly, the UN has stressed the potential of public transport to act as a smart and green solution, not only for developed but also for developing countries (UN, 2010) since it can reduce greenhouse gases (GHGs) emissions by 25 per cent and urban traffic


Figure 1.2 ITS timeline in Europe
fatalities by 15 per cent (Pourbaix, 2012). Technology transfer including ICT between developed and developing countries (EU, 2012) will enable the dispersion of benefits gained within the transport sector as well as in other sectors. In 2010 the European Union adopted a specific policy, Europe 2020: a strategy for smart, sustainable and inclusive growth (EU, 2010), which should meet relevant targets in the forthcoming years through EU headline targets, integrated guidelines, country-specific recommendations, devoted stability, convergence and national reform programmes (EC, 2010). In addition, 6.4 billion euros have been ring-fenced for smart, green and integrated transport through H2020, the respective EU programme for Research & Development (EC, 2014a) which aims to address uneven spatial dispersion of ICT innovation (EC, 2014b).

Smart Cities and the Use of Diverse Terminology

Nonetheless, certain barriers have not allowed a smooth integration of ICT and transport. To begin with, due to the use of diverse terms in the past decades to encompass the link between ICT and transport, a smooth integration of these sectors has not been permitted. Internet of Things, Web 3.0, Web 2.0, Cloud computing, ubiquitous computing, emerging technologies and Big Data\(^1\) are not new terms to those within the computing and IT (Information Technology) sectors. Along with terms such as telematics, Intelligent Transport Systems, Information Technology and Transport or resilient systems, urban planners and transport practitioners have started to merge terminology, mainly within the intelligent, digital, electric, sustainable, future or smart cities context (Burdett and Rode, 2012; Komninos, 2002; 2008; 2014; Moir et al., 2014), which seems a fertile terrain where ICT for transport can be applied and flourish. Nonetheless, the terminology used is only the tip of the iceberg since competing priorities, diverse viewpoints and work patterns or funding allocation have hindered collaboration among researchers and practitioners within related disciplines and halting progress. The International Telecommunication Union (ITU) has recently looked into this evolving domain and attempted to shed light by reviewing terminology used in relation to smart cities,

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\(^1\) Since no rigorous definition of Big Data exists, this term is defined based on Mayer-Schönberger and Cukier (2013): ‘Big Data refers to things one can do at a large scale that cannot be done at a smaller one, to extract new insights or create new forms of value, in ways that change markets, organizations, the relationship between citizens and governments, and more’. 

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suggesting the following definition which highlights the key role of transport within this field:

A smart sustainable city is a city that leverages the ICT infrastructure in an adaptable, reliable, scalable, accessible, secure, safe and resilient manner in order to: [...] Streamline physical infrastructure based services such as the transportation (mobility), water, utilities (energy), telecommunications, and manufacturing sectors (ITU, 2014)

Despite the different notions embraced by the contested concept of smart cities (Caragliu et al., 2011; Greenfield, 2013), it is widely accepted that certain cities have already managed to successfully integrate ICT and transport, enabling them to implement innovative solutions to address to some extent contemporary challenges such as congestion, traffic safety, emissions, cost of transport, and reliability.

Rio de Janeiro, for instance, has established an operations centre aiming at reducing emergency response time offering real-time updates to officials and citizens, whereas Singapore has agreed to offer know-how and support to build 100 smart cities in India, starting from the Delhi–Mumbai Industrial Corridor (DMIC). Here the merging of ICT and transport has a prominent role through computerized traffic systems, centralized traffic light management, the provision of real-time traffic information and public transport services at stations or on board. Along the same lines, the Connected Boulevard partnership between ICT corporations, urban solution providers and the city of Nice in France aims at proving the concept of the Internet of Everything within smart cities. Through the use of multiple sensors and networked devices, the aim is to generate data about everyday life such as smart traffic circulation, smart lighting, smart parking or environmental monitoring. Similarly, iPavement, which utilizes Wi-Fi and Bluetooth technology and has been tested on Via Inteligente in Madrid,2 or solar roadways,3 which have been developed as a prototype in the US and provide an interconnected network of data-generating sensors within cities or along motorways. This data will be owned and managed by the city or regional authorities in an attempt to generate innovative business models which would be able to finance such initiatives globally (Cisco, 2013).

Based on similar principles, the Oyster card introduced in 2003 offers

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3 More information is available at: http://www.solarroadways.com, which also refers to the Department of Transportation SBIR grant (http://www.sbir.gov/sbirsearch/detail/355952).
improved reliability for travellers in London by allowing them to reach their destination through multimodal journeys using the underground, Docklands Light Rail, commuter trains, buses or river services while reducing transaction costs for operators and offering lower ticket costs for users. Such innovations have been feasible through the establishment of Transport for London (TfL), which benefits from the advantages of integrated transport authorities overseeing the provision of transport across administrative boundaries (Rode et al., 2014b). The next stage in London is anticipated to be the introduction of new ICT technologies via contactless payment for travel within Greater London as well as the integration of the public hire bicycle scheme for Oyster users.

Personalized travel schemes are also on the rise through technological advancements illustrated by GLIDE in Singapore, which offers more intersection crossing time for elderly or physically impaired pedestrians (Debnath et al., 2011) or by Smart Mobiliteit in Enschede, the Netherlands (Enschede Municipality, 2014), which supports self-motivated and rewarded travelling. Along with the first autonomous vehicle test in Europe to be realised in Ede-Wageningen, all these constitute best practice examples which can be assessed through existing measures such as the Readiness Guide (Berst et al., 2013). Such assessments contain the identification of a champion, the assembly of an appropriate team, the establishment of a larger vision for the wider area and the prioritization of objectives through predefined metrics.

Certain cities such as Amsterdam or Seoul have focused their smart evolution on sustainability, competitiveness and advanced ICT infrastructure (ITU, 2013) through specific ICT for transport initiatives (Figure 1.3). Yet even cities without a high quality ICT infrastructure can follow their own distinct path in yielding the benefits of ICT for transport by adopting initiatives gradually as part of a wider development plan (Figure 1.4). However, it is vital to circumvent locking in carbon-intensive and climate-vulnerable infrastructure in both developed and developing countries or to leapfrog by shifting investment towards sustainable transport that utilizes ICT according to its budget constraints and development stage (Ang and Marchal, 2013). The latter has been reflected in the policies adopted in the planned city of Masdar in Abu Dhabi, where technological optimism bias initially led the authorities to envisage a city with no private motor vehicles where transport would rely totally on Personal Rapid Transit. These plans have been revisited, though, to shift the focus more to electric and clean vehicles, mainly due to the high cost of introducing Personal Rapid Transit. The latter demonstrates an approach of adopting sustainable policies whilst avoiding carbon-intensive solutions in practice.
**ICT for Transport: a Contemporary Snapshot**

Innovative transport schemes have been implemented globally since the nineteenth century when the London underground was inaugurated, but concepts such as shared mobility or multimodal integration have proliferated in the twenty-first century (Table 1.1), stressing the indisputable role of ICT for transport, also in the context of advancing sustainable transport. As demonstrated by Hidalgo and Zeng (2013), there is a strong correlation between the number of cities introducing after the year 2000 car sharing, bike sharing, smart cards and Bus Rapid Transit (BRT), and the technological infrastructure available in those cities. Expanding the use of digital information, for example through smart ticketing, has hugely benefited from the concept of shared mobility, which in turn has been

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### Implementation Plan for Category 1 & 2 Cities

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<tr>
<th>INITIATIVES</th>
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<tr>
<td>• Common Fare Integration - multi-modal smart cards with RFID technology and Cellphones • Traffic Scan with Mobile Density • Enterprises Resource Planning (ERP) • Vehicle Tracking System through mobiles and GPS technology • Smart Solutions–Interactive city dashboard &amp; social media • Modelling &amp; Simulation • Passenger information system with Data Integration &amp; Analytics • Surveillance &amp; Enforcement System • Advanced Parking Management Systems • 24×7 monitoring of traffic mobility</td>
<td>• Multi-modal contactless Smart Cards with ‘Aadhaar Card’ • Modelling &amp; Simulation (M&amp;S) • Intelligent Traffic Management System • Controlled Parking Zones (CPZ) • Future technology - Para-transit fleet management • NMT – Smart signals &amp; public bicycle system • Advanced level of decision making and analytics tools</td>
<td>• Congestion charging • Future technology • Advanced Simulation Models – ‘Urban Sim’</td>
<td>• Multimodal integration across different modes of transport • Future technology – ‘Connected Vehicles’</td>
</tr>
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*Source: GoI (2014, p. 36). Reproduced with permission.*

**Figure 1.3 Implementing ICT for transport in cities with high quality infrastructure available**
facilitated largely through the widespread use of integrated multimodal transport, ICT infrastructure, smartphones, social media and travel-related applications. As an illustration, the use of ICT has significantly altered public transport ticketing with contactless payment through smart cards. This is clearly reflected in Seoul, where 90 per cent of bus passengers and 75 per cent of underground passengers use smart cards to board buses and the underground respectively, offering travel benefits in the form of user convenience and reduced costs, as well as reduced transaction costs and time loss for operators (Pelletier et al., 2011). Notably, the more that cities implement such concepts, the more expertise and know-how will be exchanged between cities globally, reducing deployment costs whilst sharing best practice.

Equally, mobile Internet and smart phone applications have opened up major opportunities for shared mobility, which appears to be at the core of this revolution where new technologies are being developed to serve the needs of emerging urban economies. Those developments have been anticipated for more than half a century (Brotchie et al., 1991), but sharing a car, a bicycle or a taxi nowadays through apps such as Avego, BikeShare, Bixi, BlaBlaCar, car2go, Flywheel, Hailo, Lyft, Taxibeat, Uber, Zagster or Zipcar is not uncommon in several countries, from Brazil to India and from...
<table>
<thead>
<tr>
<th>Area</th>
<th>Concept</th>
<th>Initial year of implementation (City)</th>
<th>Number of cities to date</th>
<th>Stage</th>
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<tbody>
<tr>
<td>Car restrictions &amp; pricing approaches</td>
<td>Congestion pricing</td>
<td>1975 (Singapore)</td>
<td>6</td>
<td>Emerging</td>
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<td></td>
<td>Low emissions zones</td>
<td>2003 (Tokyo)</td>
<td>200+</td>
<td>Mainstream in Europe</td>
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<td></td>
<td>Vehicle quota systems</td>
<td>1990 (Singapore)</td>
<td>5</td>
<td>On the rise in China</td>
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<tr>
<td>Mass transit</td>
<td>Metro</td>
<td>1863 (London)</td>
<td>188</td>
<td>Mainstream in EU and North America, tipping in China</td>
</tr>
<tr>
<td></td>
<td>Bus Rapid Transit (BRT)</td>
<td>1974 (Curitiba)</td>
<td>153</td>
<td>Tipping in Latin America and China; emerging in India</td>
</tr>
<tr>
<td>Shared mobility</td>
<td>Car sharing (2-way)</td>
<td>1987 (Lucerne, Zurich)</td>
<td>1000+</td>
<td>Mainstream in EU and North America; emerging in developing countries</td>
</tr>
<tr>
<td></td>
<td>Bike sharing</td>
<td>1998 (Rennes)</td>
<td>≈500</td>
<td>Tipping in EU, the Americas and China</td>
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<tr>
<td>Urban design for access</td>
<td>Transit Oriented Development</td>
<td>Late 1800s and early 1900s (New York, London and others)</td>
<td>–</td>
<td>Mainstream in Europe, Japan, Hong Kong, Singapore; tipping in the US</td>
</tr>
<tr>
<td></td>
<td>Car-free zones</td>
<td>1953 (Rotterdam)</td>
<td>360+ (213 in Europe)</td>
<td>Mainstream in European cities; tipping in North and Latin American cities</td>
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<tr>
<td></td>
<td>Complete street</td>
<td>1971 (Portland) [455] (in the US)</td>
<td></td>
<td>Tipping in the US</td>
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</tbody>
</table>
Norway to Greece. Even large car manufacturers and car rental companies have realized the contemporary trends and have entered these evolving markets through Zipcar or car2go. Car-sharing schemes had grown to include 1.8 million registered users in 27 countries across all continents by the end of 2012 (Cohen, 2013) and new programmes have been launched in China, with electric vehicles also available for sharing in Hangzhou (Forbes, 2014). In this changing environment, Waze has revolutionized the way car drivers and commuters travel in countries such as Israel or the United States, and CityMapper has revolutionized the way public transport is used in Spain, the UK or the US. By contrast, bike-sharing programmes have proliferated across both developed and developing world cities, with 535 schemes operating in 49 countries in 2013, with Spain and Italy offering the most schemes in European cities while the Asia-Pacific region offers more than half of the global fleet (Larsen, 2013).

In this context, interesting views have started to emerge, such as the one expressed at the 12th annual Transport Practitioners’ Meeting in London where the role and efficiency of TfL in developing and maintaining an online journey planner was questioned. Should public entities run such applications themselves in the future or should they merely collect and manage data offered to private entities who can then develop and maintain such ICT for transport applications more efficiently? The latter view

Table 1.1 (continued)

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<thead>
<tr>
<th>Area</th>
<th>Concept</th>
<th>Initial year of implementation (City)</th>
<th>Number of cities to date</th>
<th>Stage</th>
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</thead>
<tbody>
<tr>
<td>Multimodal integration</td>
<td>Smart tickets</td>
<td>1989 (Zurich) 1992 (Oulu) 1996 (Seoul) 1997 (Hong Kong)</td>
<td>250+</td>
<td>Tipping in developed country cities and some emerging economies like China</td>
</tr>
<tr>
<td>Information integration</td>
<td>2005 (Portland)</td>
<td>250+</td>
<td></td>
<td>Tipping in most developed country cities; on the rise in emerging economies</td>
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ICT for transport

raises several issues regarding data management, but it also brings up the potential role of cities and local authorities in acting as test beds for new ideas and technologies through living labs and public–private partnerships (PPPs). While existing applications like FixMyStreet, the first nationwide platform in the UK launched in 2007, which allows citizens to report problems such as potholes or broken streetlights directly in their local area, offer clear advantages in efficient management of resources and road space, others, like JustPark or ParkMe, offering private car parking space, raise questions about congestion, safety and tax revenue regulation.

Business Potential of Applications

Undoubtedly, there are high expectations for ICT advancements supporting business innovation to achieve improved efficiency in the transport sector, mainly to support management decisions (Kayikci and Zsifkovits, 2013) but also to entertain travellers through competitions or gamification of daily commuting aiming at community-wide environmental targets (Enschede Municipality, 2014; McCall et al., 2013). Nevertheless, mixed outcomes have been reported for logistics and taxi firms, partly also due to the limited amount of research devoted to the integration of diverse applications, the actual efficiency gains for hauliers, empirical findings on the adoption of new technologies by corporations, as well as the role of technology providers in the adoption and deployment of new technology (Perego et al., 2011; Sternberg et al., 2014). Although green logistics and green IT are areas of extensive focus for ICT developments within logistics, new areas are dominating the taxi sector (Frehe and Teuteberg, 2014; Murugesan and Gangadharan, 2012).

For instance, e-hailing apps on smart phones, which are used by travelers to call taxis, have gained significant popularity in China, reshaping the landscape of the taxi industry in large cities whilst attracting US$43 million in investment for this rapidly evolving sector in 2012–13. More than a third of the 68 000 taxis in Beijing have been using e-hailing apps since they became available in 2012. Analogous is the situation in other major cities such as Guangzhou, Hangzhou, Shanghai and Shenzen, where almost 90 per cent of the market based on daily apps orders has been led by two information technology firms, Tencent and Alibaba, which offer Didi Taxi and Kuaidi Taxi respectively (Jourdan, 2014). Interestingly though, Chinese authorities have stepped in, attempting to regulate this emerging market dominated by two leading players by imposing restrictions. Companies in Beijing are required to cooperate with the central telephone-based dispatch centre of the capital which forces them to pay them management fees. Likewise, Shanghai, which is a global
financial centre, in March 2014 banned the use of e-hailing apps by taxi drivers during the rush hour and has entirely forbidden their use by private vehicles registered for car sharing (WSJ, 2014).

Such examples indicate a strong business opportunity regarding ICT for transport for software developers and private corporations, but at the same time they blow the whistle for a certain level of regulation to avoid unintended consequences and manage public open spaces. Opportunities have been cited for both larger and smaller cities to act as test beds for innovation through the implementation of living labs to reap financial, technological and social benefits (Hjalmarsson et al., 2012) particularly through platforms deployed for smart cities by ICT corporations such as the Operations Centre in Rio de Janeiro. Likewise, numerous opportunities affecting travel behaviour and the use of travel time are emerging through the introduction of technologies such as 4G-LTE\(^4\) in trains, coaches and buses (Chang and Thomopoulos, 2014). The outstanding challenge is to test and establish viable business models that will benefit all stakeholders while offering wider societal benefits.

**Big Data, Open Data and Negative Impacts**

Consequently, it is evident that there is strong potential for positive impacts through ICT for transport applications by using resources more efficiently while meeting energy or environmental targets (Gavanas et al., 2014). The sensors currently used to support existing infrastructure and provide accurate data lead to the creation of large databases which will grow exponentially over time. Open Source code is a particular feature which can be turned into a prominent resource in the hands of local and national authorities. Combined with Big Data, there are good prospects for creating value through existing information and databases (Mayer-Schönberger and Cukier, 2013) which can then be converted into resources used to promote public and non-motorized transport along with sustainable development schemes or to aid in emergency situations, as a result of extreme weather events, for instance. The latter is a clear indication that ICT for transport can empower users, transcending existing geographical or social barriers as illustrated in Nairobi through the Digital Matatus project.\(^5\) Nevertheless, as stressed in Chapter 6, one has to be cautious when unveiling the socio-spatial benefits of Big Data (Shelton et al., 2014).

\(^4\) 4G-LTE refers to the 4th Generation of mobile telecommunication technology. It succeeds 2G and 3G and it precedes 5G. LTE (Long Term Evolution) refers to a technical standard of high-speed data transfer.

Since robust validation methods have yet to be developed, there is a risk of information asymmetry through the generation of large amounts of low-value information utilizing valuable resources through VGI (Voluntary Geographical Information) and crowdsourcing. Social media based on ICT may assist in reducing travel disruptions (Pender et al., 2014), but when employing Open Source software there is always a threat of data manipulation or misuse when internationally agreed data management procedures are not adhered to or are non-existent. Obviously, diverse approaches have to be adopted in developed and developing countries to minimize adverse consequences and the digital divide (Graham, 2013). Criticism of Big Data should not be ignored due to the ease and low cost of transport-related data collection using ICT. Despite it being a powerful tool, ICT does not constitute a magical elixir yet and entails risks due to common data biases, the universal need for theory supporting any analysis or the risk of spurious correlations (Economist, 2014). As a result, the use of Big Data or Open Data should not be discouraged, but at the same time decision makers should be made aware not only of the opportunities but also of the potential threats regarding issues such as surveillance, equity or wider social impacts of ICT for transport (Andrejevic, 2011; Castells et al., 2007; Greenfield, 2013; Kitchin, 2014; Pridmore, 2012; Thomopoulos and Karanasios, 2014; Wright and de Hert, 2012; Zurawski, 2011).

3 PREVIEW OF CHAPTERS

The first part of this book outlines the substantial changes which have occurred in the use of ICT for transport to influence travel behaviour, showcasing the societal impacts in urban areas. A review of theory and the use of incentives illustrates that altering travel behaviour is possible. However, to introduce a lasting impact and increase the use of public transport, a seamless ICT system is required. By reviewing the travel behaviour literature in Chapter 2, Ben-Elia and Avineri show how complex the behavioural response of travellers is to the provision of travel information. The provision of information is where most of the potential benefits from the use of ICT for transport probably lie, but securing such benefits may not be straightforward.

Subsequently, Pronello and Camusso explore in Chapter 3 the specific user requirements that may enhance public transport use and attract more urban travellers by altering their travel behaviour while meeting local or international transport and environmental policy targets. Their comparative approach allows a valuable insight into Italian and German public transport users, whereas their findings about travellers with reduced...
mobility are of particular interest for both policy makers and practitioners. Gyergyay showcases in Chapter 4 that it is possible to change travel behaviour through tangible rewards when promoting non-motorized transport. By focusing on school trips in an area on the outskirts of London, he demonstrates that ICT is not only able to facilitate the management and monitoring of incentives distribution, but also that it is able to foster walking, thus introducing a lasting effect even after such schemes end due to limited funding.

Part II constitutes the core of this book, demonstrating through surveys and empirical evidence that innovation is not an easy task and that ICT for transport is not a panacea. Yet a wide variety of perspectives are offered via diverse case studies aiming at pointing out best practice and lessons to be learnt. In Chapter 5 Zegras et al. present findings of a recent survey in a developing economy, namely an area of a global mega-city such as Mexico City. By researching personal security perceptions of public transport users they provide important insight in the ways in which ICT can enhance sustainable transport, particularly for vulnerable travellers. The findings are useful for those interested in public transport in developing economies as well as those interested in enhancing transport surveys through the use of ICT. On a different topic of high significance, Chapter 6 presents World Bank findings regarding geolocation data and crowdsourcing, both of which are intertwined with the emerging field of Voluntary Geographic Information (VGI). VGI offers the opportunity to interested individuals to contribute their knowledge and expertise in collaborative projects such as keeping maps up to date, and it benefits particularly from the use of ICT. Such efficient practices increase both bottom-up and top-down participation in decision making whilst contributing to the decline of the digital divide between societal groups and countries. Examples of such a divide become evident in Chapter 7, which touches upon the potential benefits of vehicle-to-vehicle (V2V) communication in a developed country setting. There is a threat that V2V or similar technologies will be accessible only to a few users, allowing them to use improved travel services whereas the majority of users will not have access to such technologies and the derived benefits. Through a simulation, Lu and Han underline the potential advantages of wider use of V2V communication for fuel efficiency and reduced travel time, but warn that these benefits in real life situations should be expected to be much lower than those obtained in ‘clean’, ideal conditions tested in simulations, especially those of uniform traffic flow. Implicitly, they raise the issue of equity by analysing the impacts of only a minority of road users being able to benefit from V2V systems. They also show that ICT can shorten travel time and fuel consumption, but usually not simultaneously. Along the same lines, Envall stresses the potential
benefits of ICT for transport planning in Chapter 8 through the use of GPS data for cyclists in urban areas. Empirical evidence from Sweden and Slovenia indicates that cycle planning can be a high value activity for local transport authorities since ICT provides them with cost-efficient and accurate information about cycle routes and travel speeds.

It is the implementation of such innovative solutions that is needed to inform strategies, frameworks and policies globally. This is the theme of Part III, which ascertains the most relevant policy implications and makes relevant recommendations. Chapter 9 tries to expose some of the less explored aspects of the otherwise beneficial use of ICT for transport. Herzogenrath-Amelung et al. even refer to it as a ‘mission creep’ type of development, especially if ethical, social and legal considerations are not properly thought through. These are largely due to the marketing discourses within the development of ICT for transport applications that highlight benefits offered whilst downplaying or sometimes ignoring the risks involved. Privacy and surveillance issues raised by ICT applications in the transport domain are exemplified. Employing philosophical theories and applying them in London through the Oyster card case, they outline key challenges that need to be considered by decision makers when implementing ‘smart’ travel card applications. The prism under which ICT developments need to be discussed is not a single entity, namely a developer or a company, nor are these the responsibility of a single government agency. There is a network of actors, Communities of Interest (CoI), where these considerations must be accounted for. In Chapter 10 Angelidou et al. show the role of CoI in increasing the success of ICT development, and call for policy makers to provide the support for such CoI to function better. Along the same line of argument, Tyrinopoulos et al. present in Chapter 11 a long list of successful implementations of ICT for transport applications across the EU (European Union). Evidence is critically analysed and categorized and this chapter also maps the reference to ICT over time in EU transport policy reports.

As an epilogue, the concluding chapter summarizes findings and views reported within this book to build on potential synergies, minimizing contradictions. Thus, it provides a framework approach which may be used by policy makers, researchers or practitioners worldwide to guide decision making at a local or global level.

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