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Can new communication technology promote sustainable transport?

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Abstract

Under business-as-usual projections, global car ownership and travel will continue to rise. In future, oil might still be available at higher prices than today, but the climate change implications of oil use will remain. As evidenced by the continued rise in global transport GHG emissions, conventional proposed solutions for mitigation are not working. Accordingly, this paper examines whether the new information technologies can contribute in a major way to the environmental sustainability of global passenger transport. The main finding is that the two technologies considered here—travel substitution and smart cities—could potentially increase or decrease greenhouse gas emissions. Nevertheless, both travel substitution and smart transport, if given the right policy support, could be important means for enabling people and organisations to cope with the need for reduced travel in a climate-constrained future.

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Keywords: global climate change; ICTs; smart transport; sustainable transport; travel substitution.

1. Introduction

Conventional solutions for mitigating transport's impact on climate change, all already used to some extent, include a shift to low carbon transport fuels, major improvements in vehicular fuel efficiency, modal shift, and travel reductions. As evidenced by the continued rise in both transport and GHG emissions [1], these technical fixes are

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not producing the deep transport GHG cuts urgently needed [2]. Dray et al. [3], writing in a European Union context, have argued that meeting transport CO_2 reduction limits needed in that region for 2050 by technical means alone will not be possible, even under optimistic assumptions about adoption rates for vehicle efficiency improvements and low-carbon fuels. In the US, the Federal Highway Administration data show that fuel efficiency is now falling in the US for all light vehicles, and that overall road vehicle-km is again rising, surpassing the previous 2007 peak in 2014 [4].

Given the limited effectiveness or even feasibility of other options, this paper will discuss two alternative approaches to passenger transport GHG reductions, both based on the new communication technologies (CTs). Nowhere is technical progress occurring as rapidly as with the new CTs, as exemplified by Moore's 'Law' for computer technology: for over half a century, the number of transistors on each computer chip has roughly doubled every two years. It is not surprising that some have seen the application of CTs to transport as a key to the resource, pollution, congestion and even cost problems faced by passenger transport. Funk [5] has argued that such application will transform transport by enabling better system design and lower transport costs. Although the possible applications of CT are many, they are here grouped for convenience into two broad categories, treated in turn in the following sections: travel substitution by CT, and 'smart transport,' partly based on 'big data.' Each approach has a long history, preceded by decades the rise of the Internet, various data-gathering platforms, and smart phones. What is new in this paper is a discussion on the transport effects of both approaches being deployed together—as is likely in practice.

Nomenclature

CT	communication technology
GHG	greenhouse gas
OECD	Organization for Economic Cooperation and Development
PTA	Personal Travel Assistant
ST	smart transport

2. Travel substitution by Communication Technology

There has long been a debate as to whether telecommunications and travel substitute or complement each other [6]. The long-term historical record is clear: both have risen in step, with ownership and use of both cars and phones rapidly expanding over the entire 20th century. With the rise of the personal computer in the early 1970s, together with the two oil supply crises of that decade, interest increased in the possibility of 'tele-commuting' (then interpreted as working from home using a desktop computer) as a means of saving (imported) oil [7]. It was also promoted as a way of saving personal commuting time and money costs. The rise in public adoption of the Internet since the early 1990s, and more recently, smart phones and social media, has spurred further interest in this topic. Not only tele-commuting, but tele-shopping (especially for information goods and services), tele-medicine and tele-education (in the form of massive open online courses), are now well-established. The question is of course, whether they have had any discernible effect on travel.

The arrival of peak travel in a number of OECD countries has raised the possibility that CTs, particularly the widespread use of smart phones, are now being used as a substitute for travel [8]. However, they are a variety of other possible causes for this decline, and it is unlikely that a single cause will be responsible in any country. A list of the more important reasons could include:

- Rising overall travel costs over the relevant time period
- Falling average travel speeds over the relevant time period
- Changing demographics, with a higher proportion of age groups that travel less in the general population
- Changing urban land uses which promote less vehicular travel
- Changing population attitudes towards vehicle licence-holding, travel, and the environment
- Changing spatial inequality, with a higher share of high income households living in areas with lower transport needs, such as the inner suburbs of cities

- Rising income inequality and the Global Financial Crisis.

Possible changes in some or all of these factors in recent decades greatly complicate the task of determing reasons for any decline in personal surface travel in recent years for a given city or country. For example, congestion and rising travel times could explain why surface travel in Japan, particularly in Tokyo, has fallen. In Australian cities, it may be that rising spatial inequality can explain most of the travel declines there. In Melbourne, for example, personal travel by outer suburban residents has risen more slowly than that of the generally higher-income inner suburbs [9, 10]. However, although the Global Financial Crisis undoubtedly did cause some further decline in travel, in many cases the declines had started a few years earlier [e.g. 11, 12].

If travel substitution by CTs was an important reason for the decline in per capita travel by surface modes, it would also be expected to show up in air travel statistics. Trips by air are expensive and time-consuming, if only because of the long distances involved. Hence greater substitution, if anything, would be expected for air travel than for short distance surface modes such as intra-city travel. However, air travel (both absolute and per capita) continues to rise in all markets, with a predicted 4.5% annual growth over the next two decades [13]. Also, air transport statistics are far more accurate than those for global surface travel; the latter are subject to considerable error, casting some doubt on the extent of travel declines. Hence air passenger travel should give the first reliable indication that CT is substituting for travel, with business travel perhaps showing more decline than travel for vacation or visiting family and friends.

Recent research has shown that the impact of CTs on transport is complex, with CTs acting to reduce travel in some circumstances, but increase it in others [6, 14-16]. As an example, a shopping trip may often include visits to several shops. Even if some goods are bought online and the number of shops visited is fewer, it may not affect shopping passenger-km. Or it may be that online shopping even leads to ‘higher in-store shopping rates,’ as found by Lee et al. [17] for Davis, California. Further, any reductions in GHG emissions from vehicular shopping trips for material goods may be offset by a corresponding rise in emissions from light freight vehicles now needed to deliver the goods to residences.

It can be concluded that in a market-oriented business-as-usual future, with real transport costs similar to today’s, the introduction and broad ownership and use of smart phones and social media cannot be expected to reduce total travel levels any more than did the introduction of earlier communication technologies (telegraph and telephone). Nevertheless, before tele-working was first discussed in the 1970s, mobility was never questioned much—its continued growth was seen as a mark of progress. But with increasing interest in teleworking (and teleshopping and so on), vehicular travel has started to be seen by some as an old-fashioned response to the *access* problem. For this reason, also, its effect on travel is likely to be subtle and difficult to isolate.

3. ‘Smart transport’ and ‘big data’

Although the term ‘smart transport’ (ST) is relatively new, many cities have long practiced one critical component: that of coordinating traffic signals over a wide area or even city-wide. Other practices such as variable speed limits, reversing the direction of travel on some traffic lanes, and public transport priority at traffic lights have also been used for decades. ‘Big data’ in a transport context refers to the vast volumes of information on travel patterns potentially available from, for example, ‘smart cards’ such as the Oyster card in London, and from smart phones.

What is driving this growing need for ST, and the use of big data? CT companies with ready-to-use software systems to sell are one reason why cities are moving in this direction. Further, cities are inclined to adopt the label of ‘smart cities’ (with ST a component of this) because it projects a positive image: no city wants to be considered a non-smart city. But more important are the growing problems today’s transport systems, especially urban, face. With the growth in car numbers and road traffic has come increases in road congestion for both cars and trucks, noise and air pollution, and parking problems. Most cities also face budget constraints, limiting the additions to infrastructure they can make. In some cases, it is simply not possible to build new infrastructure, whether road or surface rail, either because the land is not available, or because of resident opposition. Cities are thus forced to extract more transport services from existing infrastructure, and this approach will be aided by both the real-time monitoring of actual use—of roads and parking spaces, and public transport use throughout the day—and the very large volumes of transport-related data that are becoming potentially available.

The growing volume of data available to transport planners enable ‘natural experiments’ to be carried out, both faster and at far lower cost than conventional methods. Planners can potentially rapidly quantify the effects of changes to parking time limits or prices, changes to public transport services or fares, and changes to vehicle speed limits or traffic signal times.

Earlier transport plans often omitted non-motorised transport entirely from consideration. In the projections of global travel by Schafer and Victor [18], public transport and non-motorised transport were regarded as vestigal forms of transport which would be almost entirely superceded by faster modes. But with ST, the importance of all modes is explicitly recognised, together with the need for their integration. It is recognised that not only are under-utilised public transport services an inefficient use of resources, but that congested cities cannot avoid gridlock without substantial use of both public and non-motorised transport. Journey planners, such as Seoul’s Personal Travel Assistant (PTA), now give travellers a choice of modes for a given trip, so that they can select either the fastest or the cheapest, or alternatively, the one with the lowest GHG emissions [19]. Other things being equal, travellers selecting the low GHG option will help cut emissions.

However, for global GHG reductions, *system-wide* effects have to be considered. It is possible for ST to reduce emissions for a given trip but still increase city-wide emissions. Congested cities like Tokyo can have higher GHG emissions per car pass-km than a less-congested city, but still, have lower total passenger transport GHGs per capita. This can occur because congestion (and the resulting increase in travel times) in Tokyo has feedbacks to the relative use made of various travel modes, and overall vehicular passenger travel [20]. ST could raise overall city GHGs and transport energy use, rather than decreasing them.

4. Discussion

The CTs needed for travel substitution have already been developed: they are merely not being used for this purpose. The ST technologies that could potentially reduce transport GHGs are now being introduced in some cities. In Sections 2 and 3, the two approaches were discussed in isolation but will occur together in practice. Neither was found to unequivocally reduce greenhouse gas emissions: in each case, plausible scenarios existed which could greatly increase emissions. It was further assumed that both their introduction and direction they take would be market-driven. This section, in contrast, looks at the combined impact of both technologies in the context of the need for deep reductions in passenger transport CO_2 emissions. Such reductions, which will have to occur at unprecedented haste, will most likely require much more government involvement in transport than is presently the case.

Any major travel reductions, whether CT-induced or for other reasons, will interact with ST technologies. For technologies such as system-wide traffic signal coordination or parking availability information, CT travel reductions (or even car traffic reductions from other ST initiatives which shift car travel to other modes) will render these less relevant, as pressures on the road or parking space would then decrease. In other cases, particularly for newer ST technologies, ST and travel substitution approaches should work synergistically to enhance transport sustainability. It is possible to imagine that Seoul’s PTA (see Section 3) and similar smart phone applications could be further developed to advise travellers not just on individual trips, but on trips for a whole day or even a week. The PTA could now work out how some trips could be time-shifted so that they could be combined with other trips, subject to various time and place constraints entered by the traveller. These future PTA systems could even have a monthly personal travel CO_2 emissions budget, and advise travellers as to the state of their CO_2 ‘balance’ [21].

There is also promise in some recent big data transport research [22]. We mention two examples here. Song et al. [23] used mobile phone records to show the high degree of predictability in human surface travel patterns. In London, Manley et al. [24] have used public transport smart card data (some 640 million transactions) to explore in far greater detail than is possible with conventional surveys the regularities in urban travel.

As mentioned, both approaches discussed in this paper could potentially increase or decrease transport GHGs in a business-as-usual world. Over the past century, CTs have substituted for some trips but also given new reasons for travel. Some components of ST, such as maximising traffic throughput, will potentially increase road travel and with it GHG emissions; on the other hand, PTAs could help reduce car travel, or shift it to less carbon-intensive modes. Strong policies, therefore, need to be in place if the new technologies are to have a significant positive impact on passenger transport GHG emissions.

The policies needed to support GHG reductions enabled by travel substitution or ST will have to increase significantly either the time or costs (or both) of vehicular travel [10, 25]. Two related and necessary policy changes to alter money costs are the removals of the very large subsidies to oil use and vehicular transport generally, and the imposition of carbon pricing. The year 2015 global subsidies to oil alone were estimated by the World Bank to be $US 1500 billion [26]. Part of this figure is direct subsidies to oil consumers, mainly in oil-exporting countries, but most of the total is the externalities generated by oil use, including air pollution, and transport's role in climate change. If these heavy subsidies to global vehicular travel were removed and carbon pricing implemented globally, levels of travel would fall greatly. In this scenario, both travel substitution and smart transport could be important means for enabling people and organisations to cope with the need for reduced travel in a climate-constrained future.

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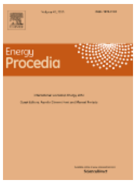

Biography

Stephen Jia Wang (research: Innovation Design Engineering, Tangible Interaction Design, behavioral changes for sustainability) is Joint Head of Programme, IDE & GID, School of Design, and Director of ITIDLab, Royal College of Art, London UK; Patrick Moriarty (research: energy, transport, global futures) is Adjunct Associate Professor, Department of Design, Monash University, Australia.