THE IMPACT OF ADVANCED TELECOMMUNICATION TECHNOLOGIES (ICTs) ON TRANSPORT AND THE BUILT ENVIRONMENT

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ABSTRACT

With information and telecommunications technologies (ICT) transforming the way we live and work, there is a clear need to investigate what impact these developments could have on transport and the nature of cities. Researchers must understand and explain the way in which ICTs are transforming the cities where people live and work. With every decade, the use of new telecommunications systems is progressing faster and becoming more widespread in society. Digital living will include less and less dependence on being in a specific place at a specific time, and even the transmission of place itself will start to become possible. The aim of this paper is provide an overview of the impact of advances in ICT and related technologies on cities, and specifically how they could impact on transport. The paper looks at a few ICT application areas and also relates them to South African realities and trends. The outcome of the research could be used to inform future policy-making and planning in the South African context. Possible further research needs are also identified in view of the lack of current and relevant local information on the topic.

1. BACKGROUND

The new information and communications technologies (ICT) are changing the way we undertake many activities – working, shopping, learning, entertainment and many kinds of social interaction. Historically, we have associated transport activities with the carrying out of these functions. Either we need to travel to do them, or we need to send and receive items physically. With ICT transforming urban regions, there is a clear need to investigate what impact these developments could have on transport and the nature of our cities. The accelerated development and merging of IT, telecommunications and broadcast technologies in the latter years of the 20th century have led to many new possibilities for carrying out activities 'virtually' and therefore in principle without the need to travel. Digital living will include less and less dependence on being in a specific place at a specific time, and even the transmission of place itself will start to become possible. Virtual accessibility could therefore become more relevant in future.

This paper is based on a report entitled *The impact of ICT on transport – An overview* (Maritz *et al.,* 2004) that aimed to create a greater understanding of the nature of ICT and the possible implications for travel and transport. The paper examines some ICT application areas where transport plays a part, including eCommerce, Telework, E-Education and E-Banking, and reviews the main trends and developments in South Africa (SA).

2. OBJECTIVES AND METHODOLOGY

The impact of technology development on transport is not always clear and, as a result, issues related to continued advances in technologies such as ICT are not purposely reviewed or taken into account. The aim of this project was to do a broad background study on the impact of advances in ICT and related technologies on transport, as well as on how this could impact on cities.

The outcome of the research could be used to inform future policy-making and planning on the relevance of ICT to transport. In this paper the assumption is made that the reader has a basic understanding of the terminology, technologies and related sub-sectors that make up the ICT field. Figure 1 illustrates the extent of the study.

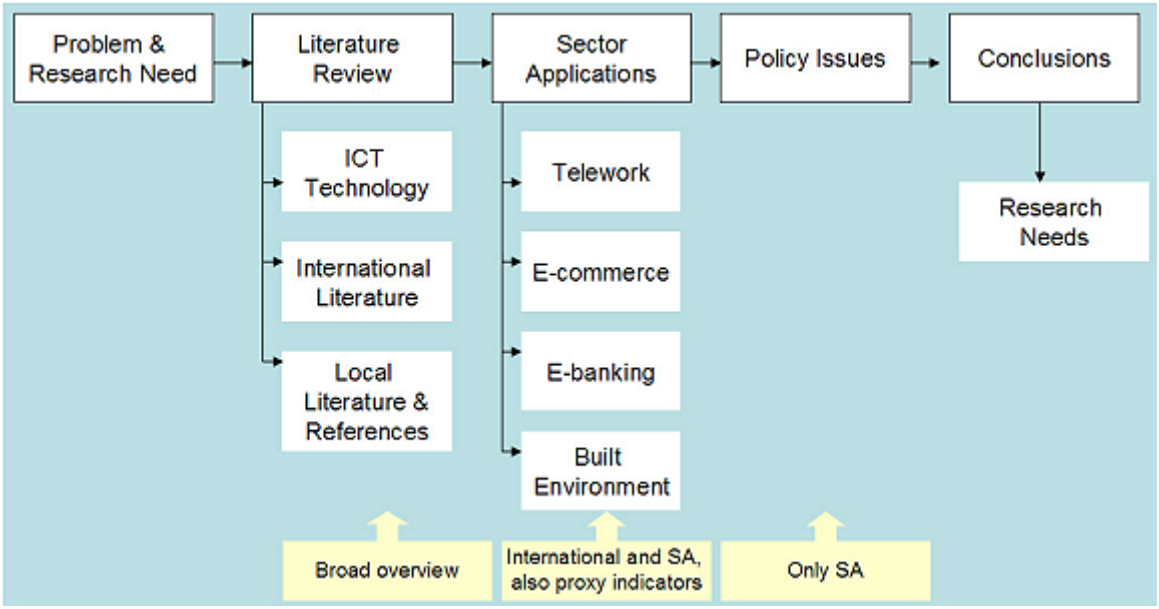

Figure 1. Extent of the study.

A broad literature review was undertaken as there is a substantial amount of relevant international literature on the topic. Once this literature had been reviewed, the realities of the South African context had to be addressed. As there is virtually no local information on this topic, additional information was obtained through a series of interviews/discussions with key organisations or individuals with experience in the ICT field. Some of the key organisations identified were Telkom, Vodacom, Standard Bank, MTN, Sentech, Siemens and various government departments. In addition, relevant individuals at the CSIR (in Transportek and Icomtek) were also interviewed in view of their expertise in the Intelligent Transportation Systems (ITS) field. It must be stressed that it was not the intention of this project to quantify the extent of the impact of ICT on transport given the general lack of appropriate information. It was clear from the literature review and the interviews that there were also other non-transport issues that should be discussed as they have indirect impacts on transport or the use and adoption of ICT. These would prove to be especially relevant given the local situation. Transport policy issues were also briefly addressed in the light of the possible long-term impact of ICT on transport. The paper ends by drawing some key conclusions from both the literature and local realities.

3. LITERATURE REVIEW

3.1 Review of Areas of Application

ICT technologies have influenced and will continue to influence the way we work, travel and entertain ourselves. Let us now look at current literature on the application of ICT in order to determine the likely extent of transport impacts. We will also examine the situation in the South

African context. Telework, e-Banking and e-Commerce are areas of application that are briefly described.

3.1.1 Telework

Telework describes a situation in which an employee is working anywhere but in his or her traditional office. Often telework (or telecommuting) refers to formal arrangements between employees and their employers regarding work conducted at home or at a remote centre that is more convenient to the employee than his or her main workplace. The very concept of telecommuting emphasises an impact on the home-to-work commuting trip. A report by HOP Associates (2002) lists several international studies that have shown that the impact of telework on reducing commuting distance per teleworker can be significant, as illustrated in Table 1.

Table 1. Examples of commuting distance savings.

Study	Reduction in commuting travel per teleworker
Mitchell & Trodd (1994)	181 kilometres per week
Lyons et al (1997)	93 kilometres per teleworking day
Mokhtarian (1998)	82 kilometres per teleworking occasion (centre-based) 55 kilometres per teleworking occasion (home-based)
British Telecom (2000)	149 kilometres per week for car users 230 kilometres per week for rail users

Source: (HOP, 2002)

Research has also found that teleworkers tend to work around 1,5 days per week away from the 'main office' – roughly equivalent to eliminating six round-trip commutes per month.

One of the key assumptions in the literature is that it appears that teleworking is appropriate for certain categories of workers only. As a result, the general conclusion is that teleworking is more suitable for 'knowledge workers' and/or managers and professionals or people who have occupations that do not require their full-time presence at specific locations. It is useful to distinguish between the direct and the indirect, or secondary, effects of teleworking. We might define the 'direct effects' of teleworking as being journeys eliminated by a person teleworking, and additional journeys made by that person or another person as a result of his/her teleworking. It is clear from reviewing the literature that the traffic-reduction effect of teleworking will be counterbalanced, to some extent, by teleworkers, or other household members, undertaking other journeys which previously would not have been made, or would have been made as part of a commuting trip.

Teleworking opportunities may also influence the choices of residential and employment location, which in turn affect travel demand (Niles, 1994). Telecommuting is appealing to planners and politicians because it implies a reduction in commuting travel at no cost in terms of infrastructure and transportation services. The potential role of new IT in facilitating teleworking also implies a technological solution to the congestion problem, which can generate overly optimistic forecasts of telecommuting.

In the South African context, there are no clear data that indicate the extent of telework. Various proxy indicators are often used when detailed direct statistics are not obtainable. These include items such as home Internet access, number of people self-employed, etc.

3.1.2 E-Banking

Banks have adopted and implemented new technologies with different degrees of success. The most widely used 'new' technology in the banking sector is the Internet. Internet banking allows customers to access their accounts 24 hours a day, no matter where they are. The number of online bank accounts in SA passed the one million mark at the end of 2003, and an increase in online

banking of 30% is expected during 2004 (World Wide Worx, 2004).

For the financially astute, doing monthly transactions on the internet has become the norm and has become part of daily life. Given the size of the 'banked' population, few people are using Internet banking. Many of the total banked population (about 11 million) who have registered for access via the Internet are best described as superficial users (HOP Associates, 2002). Many Internet users mainly check their account status, but remain hesitant about transacting online – this implies that the use of other services such as e-shopping will not progress rapidly.

The cellular network offers one of the most effective and efficient routes to the mass market in SA and for this reason it is a channel that is being rigorously explored by all the banks. As a result, mobile solutions are now being developed that perform useful functions, such as being able to validate a customer's cheque details and return the notification to a cell phone within seconds. This service is particularly useful to craftsmen and contractors on the road.

It is important to remember that large numbers of people in rural areas are still 'unbanked' or find access to banking facilities difficult as they often have to travel to towns and centres where bank(s) are located. This also creates an alternative risk, namely the high risk of being targeted because money is usually carried in the form of cash. Although mobile and ICT solutions (Internet banking) and debit cards would solve this problem, they are still not being utilised by the low-income and rural populations. In addition, the culture of cash is still strong in some local communities. Thus, for the moment, these people still rely on a vehicular trip, rather than ICT technologies, to satisfy their banking needs.

The 2003 World Wide Worx survey showed that *mobile* banking had not yet taken root in SA, with only 67 000 people using this technology, but most of the banks expected strong take-up during 2004. Mobile banking is, however, still not very convenient or cheap, but as mobile phone capabilities and interfaces improve, this will change perceptions and so could lead to it being bigger than Internet banking, as is the case overseas. The experience in other developing countries has been of a rapid adoption of mobile banking, especially using cellphones, which inevitably reduces the need to travel.

3.1.3 E-Commerce (Specifically Online Shopping)

As online shopping becomes more accessible and attractive due to imminent advances in IT, and as Internet users become comfortable with online shopping, travel behaviour will change as the number of online shoppers increases. The impact internationally could be huge – it is, however, unlikely that the same impact will be felt in SA, given the lack of access of a large part of our society. Few e-commerce observers seriously believe that online shopping will replace a large proportion of the time spent shopping at bricks-and-mortar businesses in the foreseeable future. Shopping is often linked with other activities, and there are many other reasons for shopping besides the ultimate purchase of a bundle of goods (Gould, 1998). The form of retail online shopping undertaken most frequently is grocery shopping. Gemini Consulting recently estimated that 70 000 South Africans go online more than once a month to buy goods and services. That is less than one in ten of those who bank online, one in 40 out of an estimated online population of just over three million, and a small drop in the ocean compared with South Africa's total population of about 45 million. The estimated online spend of well under R300 million represents less than 0,15 per cent of all retail sales (eBusiness, 2003). But the likes of Kalahari.net believe that online retail shopping is driven by online banking. Getting customers to do Internet banking is therefore the first step. Once they are confident about doing their banking transactions online, retail sales will follow. It may take some months for this conversion, but with nearly a million people already reported to be using Internet banking, they are hopeful of significant growth in online retail shopping in the medium term. It is important to remember that the online population represents the top-end, most sophisticated spenders of the total market.

Grocery shopping over the Internet, although limited, is a reality in South Africa. Due to the level of disparities among the population, however, only a small number of the total population has access to such infrastructure. All the major supermarket stores are currently offering e-services. In South African cities there has been a rapid growth in the development of suburban supermarkets. This can be attributed largely to the low-density sprawl of residential areas. The location of these facilities and the need to transport goods home means that a substantial number of grocery trips are undertaken by car.

E-commerce in its present form is based on home delivery, which may lead to less-consolidated deliveries and more freight traffic. It may also result in increased transport demand, especially for road transport in urban areas, which may not be sustainable. If the frequency of orders increases, then this will put more pressure on the transport/distribution system. In addition, the greater the number of companies offering home delivery, the greater the number of vehicles operating within the city. The logistical requirement of extending the end of the supply chain to people's front doors is problematic and potentially extremely expensive, not least because of the paradox that "as customer demand for home shopping increases, the likelihood of their being at home to receive their purchases decreases" (Retail Logistics Task Force, 2001). Supermarkets are, however, prepared to charge delivery fees below the actual cost (involving order processing, storage, picking, packing and transport) in an attempt to increase their market share.

3.2 ICT Technology Market and Trends in SA

As previously mentioned, it is difficult to quantify the extent to which ICT is impacting on transport in SA. We can, however, look at the anticipated growth in the ICT sector to 'get a feel' for the possible transport implications.

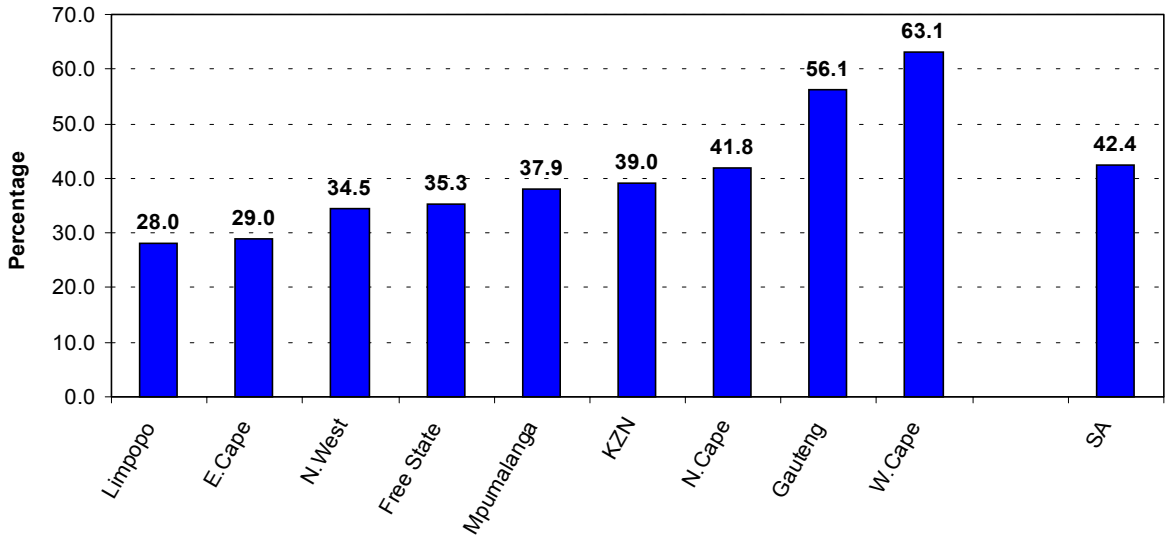

Figure 2. Percentage of households in each province with one or more telephones in the dwelling (Statistics SA, 2001).

The telecommunications sector is becoming increasingly important to the overall South African economy. In the ten-year period between 1992 and 2001, the revenue generated by the sector grew from R7 billion to R56 billion (Gillwald and Kane, 2003). In the process, it grew from representing 1,9% to 5,8% of South Africa's GDP. When one looks at the actual numbers and the level of access, it is clear that there is a large part of the population without basic access to telephones (fixed line or cellular). Only 42% of the population has access to a telephone in the dwelling (see Figure 2).

With over 30% of the total market share by 2001, and more than three times the number of subscribers than the fixed network, the mobile cellular market has grown beyond all expectations (see Figure 3). According to the market research firm BMI-Techknowledge, the pre-paid market in

South Africa makes up 75% of cellular subscribers, and more than 90% of new connections are pre-paid.

According to *The Goldstuck Report: Internet Access in South Africa, 2004*, 3,1 million South Africans had access to the Internet at the end of 2002. Growth in 2002 was around 7%, the slowest since the Internet became available to the public in 1993, and the first time it had been below 20% (World Wide Worx, 2004).

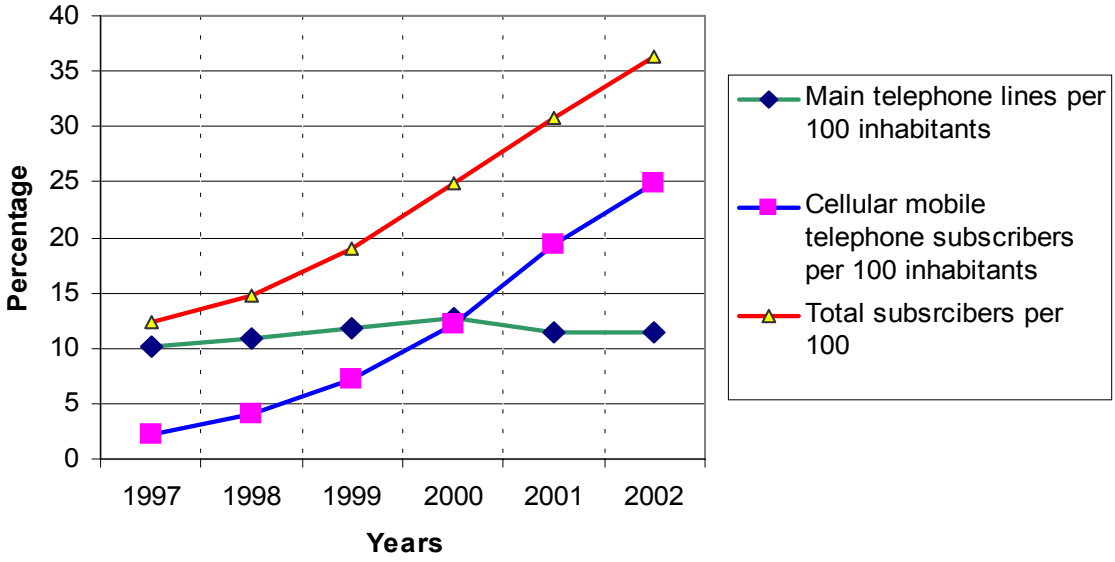

Figure 3. Growth of fixed line vs. cellular phones, 1997 – 2002.

Growth in 2003 was set to be only 6%, with 3,28 million South Africans expected to have access to the Internet by the end of 2003. This is a mere 1 in every 13 South Africans, marginally up from 1 in 15 at the end of 2001. Many South Africans still do not have access to telephones and more do not have access to the Internet. There is potential for growth in the Internet market in 2004 given the roll-out of competitive access services to businesses by the Second Network Operator, and the roll-out of high-speed or broadband wireless access by Sentech. The providers of these services hope to make further inroads into the South African market, especially in those areas not served by traditional infrastructure. This could be of benefit to the rural communities currently not served with fixed-line communication.

4. THE BUILT ENVIRONMENT

The century of motorised transport has played a prominent role in reshaping the horse-drawn city into the metropolis of the present. ICT, on the other hand, has been introduced into an entrenched automobile-dependent city. ICT is far from being a perfect substitute for the car, and consequently, its effects on cities cannot be expected to mirror the change brought by the automobile. Urban areas have evolved historically as activity centres which were initially based on their physical locational advantages, such as proximity to natural resources or transportation nodes. Distance played a major role in the formation of cities and their internal structures. Consequently, geographers and planners have paid much attention to technologies that affect the costs of traversing distance. The costs of distance include energy, time and money, as well as externalities, such as air pollution and noise. Transportation and telecommunications are the prominent 'friction-reducing technologies' as both can reduce the costs of distance. There is not much in the literature to demonstrate the link between ICT and urban sprawl or between people making longer trips as a result. Various assumptions are made that have not been substantiated with empirical data. These include "people are living further away or in rural areas because of technologies linking them with offices or employers".

In terms of the built environment, planners and policy-makers need to be aware of the potential effects of e-commerce on the vitality of commercial areas (Batty, 1997). The vitality of neighbourhood shops may well depend in part on whether such centres can compete with large chains in terms of online access and delivery services. Companies may also in future encourage employees to work at home by providing the necessary infrastructure and by restricting parking at the workplace (Stead and Banister, 2001). As technology increases the flexibility and range of choices offered to users, the impact may be to increase interaction and travel rather than reduce it.

ICT is a young concept, and ICT policy-making is still in its infancy. It is suggested that there is a knowledge gap in our current understanding of what impacts ICT and transportation have on urban areas.

5. POLICY

5.1 General Issues

It is unlikely that local metropolitan government (and provincial governments) will address the rising traffic and congestion problems faced in the major cities through large-scale investments in road infrastructure. There are debates about sustainable transport and reducing the use of private vehicles, and even discussions about promoting higher-density urban development, which will make the provision of public transport more viable. According to *Moving South Africa* (1999), "More and more people are switching to private cars for their daily transport needs". The trend is one of increasing congestion in urban areas as the car fleet is forecast to increase by 64% by 2020. The size of the stubborn[1] customer segment is set to increase by 88% over the same period.

Telecommuting is appealing to planners and politicians because it implies a reduction in commuting travel at no cost in terms of infrastructure and transportation services. The potential role of new ICT in facilitating telecommuting also implies a technological solution to the congestion problem, the appeal of which is undoubtedly responsible for generating overly optimistic early forecasts about the telecommuting adoption. Currently, transport policies involving ICT technologies seem vague and unclear. These issues are not specifically addressed: there are no clearly formulated transport policies to address issues such as telework, the use of ICT, etc., nor has the potential impact been researched. The following are extracts from various policy, strategy and framework documents that can be related to the issue of ICT.

The 2000 National Land Transport Transition Act (NLTTA) indicates broad principles that incorporate measures of ICT. These include the following:

Public transport plans must be developed to "give higher priority to public transport than private transport by ensuring the provision of adequate public transport services and applying travel demand management measures to discourage private transport" [Article 18.3.(b)].

During 2002 the National Department of Transport (NDoT) drew up a document entitled *Road Infrastructure Strategic Framework for South Africa* that provides a strategic-level plan of action for improved infrastructure delivery. This document again highlights the issue of information systems and decision support. Of specific interest to the subject of this paper is that it mentions ITS (Intelligent Transportation Systems) under the heading Future Developments.

Here it proposes that the role of national government is to support ITS through measures including the following:

- Showcasing the benefits of ITS
- Creating funding incentives

[1] 'Stubborn' meaning those who will only use their private cars – Moving South Africa ,1999.

- Establishing local technical ITS standards
- Building professional knowledge on ITS issues
- Promoting research into ITS.

One of the major transport trends identified by *Moving SA* was the following: "The rise of information technology: – with increasingly sophisticated IT, global high-value-added manufacturers have increasingly been able to move towards just-in-time manufacturing processes, reducing inventory costs but increasing the demand for high-precision transport and logistics. Similarly, within transport, IT allows operators to offer more precise information to shippers and customers, raising service levels". Here the emphasis has been placed only on addressing the issue of freight logistics.

The *Rural Transport Framework for South Africa* states that within the rural transport arena, much emphasis has been placed on connecting isolated communities to services and infrastructure to encourage development. ICT-based services linked closely with Multi-purpose Community Centres (MPCC) are seen to improve rural logistics. The document also sets out to highlight how "greater alignment and development synergies can be achieved, especially with those sectors that must serve a dispersed population from centrally located nodes, facilities and markets and those sectors involved in the provision of linkages, infrastructure and services (especially telecommunications and other ICT-based services)" (Mashiri *et al.*, 2002).

It is also important to note that ICT technologies have more recently been partly explored in areas of transport application such as the smartcard initiatives, the taxi recapitalisation programme and vehicle identification.

6. CONCLUSIONS AND RESEARCH NEEDS

6.1 Conclusions

Transport is a unique sector in that it links together activities carried out by individuals and companies. This means that it should not be dealt with in isolation but as part of any composite evaluation. Decisions made in each sector have transport implications – these include the housing sector, the location of businesses, recreational facilities, shops, schools, health services and a multitude of other factors (Stead and Banister, 2001). Telecommunications are just beginning to permeate almost every aspect of our lives. As we become busier, we will increasingly rely on IT to avoid unnecessary travel. As populations increase, particularly populations within metropolitan areas, we will also increasingly rely on IT to avoid congestion on transportation networks and at activity sites (for example – using cell phones to see the level of congestion on routes prior to departing). Small effects by a very large number of people can aggregate up to large effects on a system-wide basis.

The virtual accessibility supplied by the Internet could be most appreciated by people with low levels of conventional accessibility. At present, the highest Internet use per capita is in countries either with long, dark winters (e.g. Iceland, Finland, Norway, Sweden and Canada), or with isolated rural communities. New demand for connectivity is likely to come from isolated areas of developing nations. In South Africa, this is of particular importance as a large number of South Africans live in remote rural areas that are not easily accessed. This in turn makes the provision of services extremely difficult and costly. By implication, many people will remain in this situation unless the problems can be leapfrogged through the use of technology. ICT has just started to make inroads into rural areas, providing virtual access to communities that would normally have difficulty (and great expense) in accessing such services. The use of mobile cellular phones has grown enormously and has overcome the long process of providing land-based lines. Satellite television broadcast to remote centres now provides access to education services that were not available before. The extent of implementation of these technologies is still just at the beginning of the

process. Ongoing commitment is essential for more communities to gain access to such 'virtual' services. However, the adoption of new technologies is dependent on educating the (potential) users. This has to go hand-in-hand with the provision or expansion of virtual accessibility. The interaction between physical travel, virtual mobility and social participation will be increasingly significant. Such interactions are continually evolving and yet are under-researched and poorly understood. Past expectations of the positive impacts that ICT might have on travel and transport have often led to disappointment.

People are likely to use telecommunications to eliminate certain types of distasteful travel, or to reschedule and reroute trips to less congested times and places. The incidence of contingent, part-time and self-employment, to some extent increased by IT developments, must be reducing peak commuting travel, but again we have very little quantifiable evidence of this impact. Only telecommuting has been looked upon as a means of reducing travel, often with unrealistic expectations. In terms of the built environment, planners and policy-makers need to be aware of the potential effects of e-commerce on the vitality of commercial areas (Batty, 1996, 1997). The vitality of neighbourhood centres may well depend in part on whether such shopping centres can compete with large chains in terms of online access and delivery services.

People are being more exposed to and becoming more familiar with the information age and are adjusting their habitual behaviours accordingly. We should, too, remember that the Web and other developments concerning the Internet are still in their infancy. In South Africa, we are faced with an additional problem, that of the 'digital divide', which emphasises that a large portion of the population does not have even basic services, let alone ICT infrastructure. This group also does not have the financial means to 'get connected' easily.

6.2 Research Needs

Very little relevant research has been conducted in SA on the topic of ICT and transport. In addition, the research team involved in this project found a data-poor environment. Current surveys conducted by government do not include questions that can capture ICT – transport issues sufficiently. There is a need to look into and perhaps revise standard data-capturing processes to include the use and nature of ICT in the home/home office/mobile environment.

The behavioural response to all types of tele-activities is not completely researched or understood (locally). It is likely that the responses will be extremely variable, with subtle adaptations of behaviour rather than large changes.

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Johan is a town and regional planner working in the transport policy and decision support programme at Transportek, CSIR where he has worked since 1992. He has been involved in the geo-spatial environment for many years and has managed numerous GIS related projects over the years. He has completed various research projects and has focused on spatial accessibility related research since 1996. He also supports the development of decision support systems such as Bridge Management Systems, and Regional Development atlases. More recently, he has developed GIS functionality to perform raster based accessibility modelling.

He is a member of the South African Branch of the World Futures Society and has an interest in the impact of new technologies on the development of cities, regions and transport.