Intelligent Transport Systems: privacy, security and societal considerations within the Gauteng case study

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Abstract

Intelligent Transport System (ITS) is an umbrella term that describes the integration of Information Communication Technologies (ICTs) and applications used in effective road network management. These applications include CCTV surveillance and automated tolling through the use of radio communication infrastructure such as e-tags highway gantries. These technologies may assist in the improvement of road networks, ultimately resulting in the development of the economy and prosperity of the country. As the capture of personal information is essential in an ITS, information ethical concerns surrounding privacy and security of personal information belonging to motorists have been raised. Technologies utilised by ITS place motorists under constant surveillance and monitor transit behaviour in real time. However, the big question is whether or not such technological sophistication and economic gains are the primary success factor to any ITS. While these technologies may assist in the improvement of the physical infrastructure of a country, ignoring social impact issues, in the current economic climate, may be catastrophic to the success of a system. An investigation into international examples of such systems and the ITS currently in the implementation phase in Gauteng, South Africa, offers some insight into the ethical considerations and concerns around the management of Gauteng motorists' information as they begin to register for the new system.

In the Gauteng case study, the privacy concerns and the perceived tensions that the ITS can create will be debated. The information ethical issues specifically pertaining to privacy and security of personal information of the new ITS have not received sufficient attention in South Africa and herein lies the value of this article.

Introduction

The advancements in information and communication technologies (ICTs) together with the ability of ICTs to capture and store vast amounts of personal information has amplified the risk of this technology being used unethically (Reynolds 2011). These risks necessitated the application of a new set of ethical rules to an intangible world (Capurro 2006). This type of ethics is known as information ethics. To achieve a better understanding of information ethics, the origin and concept of ethics needs to be evaluated.

The word ethics stems from the Greek word *Ethos* implying the character and spirit with fixed moral attitude/culture that informs the beliefs and socially acceptable practices of a person or society (Britz 1996; Whitman & Mattord 2010). By extension, information ethics is concerned with the moral norms and justice, socially acceptable practices and beliefs concerning information use (Fallis 2007; Britz 2008). This field of ethics has received more attention with the increased development and capabilities of technology as well as enhanced access to information through the growing internet infrastructure (Molnar Kletke & Chongwatpol 2008).

In 2007 the South African National Roads Agency Limited (SANRAL), proposed the implementation of an ITS as part of the Gauteng Freeway Improvement Project (GFIP). This system contains technologies such as variable message sign boards (VMS), closed circuit television cameras (CCTV) and radio communication technologies such as e-tags (SANRAL 2012).

The proposed ITS, which incorporates a user-pays model for motorists, may have moral intentions, but what possible ethical challenges could such implementation have on the privacy, security and socio-economic status of motorists using the Gauteng freeways? This article aims to investigate some of these challenges caused by the ITS, as well as societal factors that lead to the failure or success of such a system, as seen in international examples.

Intelligent transport systems: advantages and limitations

The debate surrounding urban transport challenges including traffic congestion, deteriorating road conditions, the impact of vehicle carbon emissions on our environment and energy consumption have been the focus of governments and organisations around the world for decades (Heshner & Puckett 2007; Rodrigue 2013). To address these issues, many governments have turned to the implementation of ITSs that may include the application of advanced technologies and variable user charging, also referred to as user-pays models (Heshner & Puckett 2007; Jarašūniene 2007). The use of electronics such as variable message sign boards, communication technologies such as radio frequency identification tags, control and sending technology all assist in the improvement of road conditions and networks, safer and faster emergency response all through real-time transmission of information (Weiland & Purser 2000). For the purposes of this article the focus will be on the ITS that follows user pays models.

There are many documented advantages to using an ITS (Chattaraj, Bansal & Chandra 2009; Deaking, Frick & Skabardonis 2009). These include:

- smooth traffic flow from reduced traffic jams through assigning priority traffic during rush hour;
- more efficient accident response time;
- up-to-the-minute travel information via Variable Message Signs (VMS);
- reduction in the number of fraudulent license plates on the road;
- reduction in crime such as car and identity theft.

However, with every system comes limitations. According to Deaking, Frick & Skabardonis (2009) and Pfleeger & Pfleeger (2009), for the ITS system these include:

- extensive deployment costs and funding restrictions;
- political challenges that come with changes of political power;
- unauthorised access of control systems;
- interception of radio communication technologies used by the ITS such as RFID;
- liability concerns with regards to violation of constitutional rights, such as the right to privacy;
- the ability to track an individual's movements;
- the accessibility of potentially sensitive data about individuals such as license and registration information that includes identity numbers.

These documented benefits and limitations however do not alone determine the success or failure of these systems. Various factors that can contribute to their successes and failures will be discussed in the following section.

Factors that contribute to the success and failure of ITS

Some documented success factors for the implementation of ITS include the presence of strong advocates and public support; weak opposition; a single agency overseeing the project; a good public transportation system in place; simple and affordable pricing systems using proven technology; environmental monitoring and protection; and comfort factors that create confidence amongst users (Carnevale & Crawford 2008; Jarašūniene 2010).

A major success story for such an ITS can be seen in the London Congestion Charge that was implemented in 2003. The aim of the system was to charge motorists for using the roads in certain 'congestion zones' around central London to alleviate traffic and encourage the use of public transport or car pools (Sainsbury 2006; Grose 2007; Carnevale & Crawford 2008). The London model is noteworthy for the way it was initially implemented and the way it is currently managed.

The charge itself is standard across all vehicle types, and discounts are given to residents of the area as well as citizens with specific characteristics or needs (eg: physically disabled). Motorists are only charged during heavy congestion times which are between 7am and 6:30 pm in the congestion zone (Transport for London 2013). Also noteworthy are the characteristics of London society. While the system was met with concern and apprehension in 2003, the citizens of London ultimately did not oppose the implementation. After years of extreme traffic and gridlock situations in London, the public were amenable to change (Sainsbury 2006; Grose 2007; Carnevale & Crawford 2008). The transition to the system was made easier as London has an excellent public transport system, including government subsidised buses, trains, subways and taxis (Sainsbury 2006). By law, the profits generated from the London Congestion Charge have to be reinvested into public transport development and improvements. Another very important characteristic was the political climate of London in 2003. The success of the implementation of the charge is widely accredited to the London Mayor at the time, Ken Livingstone, a very self-determined and persuasive political leader, who involved the public during the entire process and thus gained sufficient popular support to implement the system without much resistance (Sainsbury 2006; Attard & Ison 2010). Another noteworthy success story is Stockholm, which implemented a congestion charge similar to London, to assist in generating funds to finance a new bypass road to help alleviate congestion. Despite the initial resistance from the public, the charge has gained both public and political support. Following an approximately 6 month trial period, citizens and media were much more positive about the system after seeing a 30% to 50% drop in traffic congestion, and subsequently voted to keep the system in place (Grose 2007; Börjesson *et al.* 2012). This meant that the citizens had the final say on the system and by May 2011, 70% of the population supported the charges (Börjesson *et al*. 2012). Similar to the London charge, Stockholm has discounts and exemptions for residents, public transport and people with special needs (Swedish Transport Agency 2012).

Singapore is the oldest success story when it comes to a user-pays model of ITS. Since forming the road pricing scheme back in 1975, Singapore has successfully cut peak traffic demand and congestion, decreased carbon emissions and fuel use. One notable aspect of Singapore is that the system was never based on technical feasibility, but rather on cost-effectiveness and public acceptance (Goh 2002). Since 1998, Singapore switched to a pay-as-you-go system, where drivers are charged automatically through a short-range communication system that deducts fees from Cash Cards in the vehicle (Goh 2002; Pike 2010; DAC&CITIES 2012). Drivers pass under gantries on the road and are charged using real-time variable pricing. This is calculated according to traffic conditions, location, vehicle type and the time of day, together with historic traffic data to predict the amount of congestion expected. The funds generated from the fee collection are used for construction, road maintenance and the development of a better public transport infrastructure. The success of the system is considered the result of it being the cheapest and most cost-effective model, particularly with the real-time variable pricing (Replogle 2007; Pike 2010; DAC&CITIES 2012).

While there have been a number of success stories for ITS, there have also been some failures in their implementation. Examples of failures of International ITS will be discussed in the following section.

In many cases, charging for road usage through a user-pays model has not been successful. Motorists who have grown accustomed to using roads without restriction often view such monitoring systems as a threat to civil liberty and a way for the government to implement ‘stealth tax’ (Engin Çakici *et al.* 2009).

An example of such rejection of a system and the characteristics of the society that created a climate of non-compliance can be seen in both the Greater Manchester area and Edinburgh. Based on the example set out by the London Congestion Charge, the Greater Manchester system was proposed in 2008 and the Edinburgh system in 2005. The Edinburgh system was rejected by two thirds of voters during a referendum (Allen, Gaunt & Rye 2006). Some of the reasons cited for the rejection included a lack of adequate public transport, lack of trust in the Edinburgh government and confusion due to the complexity of the system (Allen, Gaunt & Rye 2006).

The Greater Manchester congestion charging system proposed the use of pre-paid e-tags where motorists would be charged automatically as the driver passed a cordon. The revenue generated from the system was to partly pay back a loan taken out by government for public transport improvements and to reduce road congestion, as well as develop a more extensive public transport system. The system itself however was proposed to be implemented only after 80% of the proposed public transport improvements had been completed. However, despite these proposed improvements, it was rejected by both local councils and the public by 2008 following a referendum similar to that held in Edinburgh (Swanson 2009; Wetzel 2012). Apart from distrust in the local authorities and an unclear purpose, record high fuel prices and a weakened economy were major factors in the rejection of the system (Swanson 2009). Stephen Glaister (in Swanson 2009) of the RAC Foundation (main transport research body for the UK) indicated that the Manchester project most likely failed due to negative public perception. He stated "the issue with the system is not a technical one but a political one.”

Further opposition to such user pays models can be seen in Hong Kong. Despite the implementation of an initial pilot project to demonstrate the effectiveness of such a system (using e-tags and CCTV cameras), and a massive government campaign emphasising the fairness of the system, it was initially met with opposition over high costs, privacy issues and uncertainty (Pike 2010). The system has since been reconsidered.

Thus, as can be seen in these international examples, information ethical issues can cause the failure of such systems. These issues will be addressed in the following section.

Information ethical considerations of an ITS

Floridi (2006) and Bynum (2008) describe information ethics in a broad sense as a branch of applied ethics that investigates the ethical implications of Information and Communication Technologies (ICT). It can therefore be considered as a critical framework for considering moral issues surrounding new environmental matters as technology advances and access to intelligent systems increases. Information ethics is of particular relevance to this article as it relates to the recording and use of motorists' personal information by the ITS. ITS is a rich area for applied research as, according to Weiland and Purser (2000: 3), it is important to understand "how to gather, organise, and present information to drivers, passengers, and pedestrians in a way that informs without causing confusion or distraction… and how to optimise the overall throughput of the transportation system within practical cost and social constraints". Based on the review of international cases discussed previously, the information ethical issues related to the privacy, security and societal challenges has been identified as most relevant to the implementation of the user pays model of the ITS.

Privacy, security and societal issues

Privacy has often been described as the "right to be let alone" (Shank 1986: 12; Stair 1992: 635; Rauhofer 2008:187). The right to privacy includes controlling external influences and control of personal information, such as exclusion from publicity and public identity (Neethling *et al*. 1996; Kizza 2010). Britz (1996) also raises an important aspect of privacy, stating that "the legal right to privacy is constitutionally protected in most democratic societies. In South Africa this right is protected by the Constitution of the Republic of South Africa Act 61 of 1996 as amended.

Information privacy, according to Gupta (2006: 424) is described as "the individual's ability to control the circulation of information relating to him/her". Gupta further describes information privacy as the "claim of individuals, groups or institutions to determine for themselves when, how and to what extent information about them is communicated to others." Information communication technology is often used in the storage and protection of personal data. However the protection of this data can be compromised when information security measures and controls are inadequate.

Information security consists of a set of measures aimed at protecting the confidentiality, integrity and availability of data from unauthorised access (Canal 2005). This protection, according to the Committee on National Security System (CNSS), should include not just the information but also the critical elements thereof such as computer hardware, software and information systems (Whitman & Mattord 2009). The protection of privacy through security measures may prevent the abusive use of technologies employed by the ITS, however, privacy and security are not the only concerns with the implementation of ITS.

Following the previous discussion on some successes and failures of ITS around the world, some of the basic societal issues have been identified as important considerations in the successful planning and implementation of a user pays model ITS. These include the political and economic climate of the area; affordability and equality of the model; existence of an adequate public transport network; and public involvement and acceptance.

These issues will be applied to the ITS in Gauteng that is currently in the implementation phase. The ITS in Gauteng includes the GFIP, as well as an e-tolling (user pays) system similar to those congestion charge systems seen in Singapore and Stockholm.

Application of ethical issues on the SA ITS: the Gauteng case study

In 2007, a road network improvement project for Gauteng was proposed by the South African National Roads Agency Limited (SANRAL) (SANRAL 2012). As part of GFIP, a user pays model was proposed consisting of the implementation of e-tolling gantries over a 185km network. Users of the road would have tolling fees either automatically deducted from an ‘e-tag’ attached to their windscreen or automatic license plate recognition using CCTV cameras attached to the gantries they pass under. The implication of the ITS is that these motorists will be communicating some aspect of their personal information with a SANRAL database on a daily basis. This includes information regarding aspects such as location, type of vehicle, daily travelling habits and possible banking details should the tolling system (associated with the ITS) be linked to the motorists’ credit cards (SANRAL 2011).

The control of this personal information relates to Durlak’s (cited in Kizza, 2010: 90) two classifications of privacy rights. The first classification details

issues concerning anonymity (the right to have no public personal identity), intimacy (the right to not be monitored) and solitude (the right to be let alone). The employment of an ITS would influence the motorist's anonymity, intimacy and solitude. Motorists would not have privacy during their daily journeys on the applicable road network and would have their personal information stored in information systems. Part of this personal information would include real time tracking of motorists' movements (Hommes, Holmner & Schutte 2013).
The second classification relates to "the right to control one's personal information including methods of dissemination of that information". This highlights the relationship between privacy and information. As information privacy is the right to determine how information relating to a person is communicated, one of the biggest challenges of an ITS is the breach of confidentiality of this information, should the control system of the ITS be compromised in any way. As the control agency (in this case SANRAL) will now have access to the motorist's personal information, motorists may thus lose the ability to choose to disclose their personal information in exchange for the use of the road. According to SANRAL (2011), the "Electronic Best Practice security [that] ensures the security of your personal and financial details" has been employed. Further research will need to be conducted into what security measures have been taken, as well as all the security risks involved in the use of ITS technologies.

While privacy and security are important information ethical concerns, a number of societal issues will also influence the success of such an ITS.

In a report by Standish, Boting and Marsay (2010), an economic case was also argued for the feasibility and appropriateness of the user pays ITS as a part of the GFIP. In this report, it was emphasised that inadequate transport networks may result in economic growth constraints for Gauteng. Thus the improved road network together with the user pays model may result in long term economic growth and a more 'fair' system to road users. However, contrary to the report by Standish, Boting and Marsay (2010), a study conducted around ITS in transitional and developing countries by Shah and Dal (2007) outlined how an efficient road network also leads to induced demand. Extended road networks can therefore lead to rapid motorisation, further congestion and safety issues and finally further extension projects. This approach may then lead to further environmental and social costs. Small *et al.* (2007) point out that the practical demands on urban road usage are more complex and require broader analysis.

Shah and Dal (2007) further detail how uncertainties influence the success of ITS, specifically in developing countries, due to of lack of knowledge, technological skill and public acceptance. Since 2010 the proposed user pays ITS including e-tolling, has come under serious public scrutiny. For South Africa, the lack of public acceptance is evident through the calls for civil disobedience from trade unions, lobby groups and non-profit institutions as well as the court hearings against SANRAL's implementation of the user pays model for ITS (Mokonyama 2012; OUTA 2013). In the light of high costs, increased public objections as well as court reviews into the fairness of this system, there have been major delays in the implementation of the system. This, in addition to growing public dissatisfaction in government service delivery and the history of corruption in technology based road systems in South Africa (Rajapakse, van der Vyver & Hommes 2012), has resulted in further lack of public acceptance of the system.

While economic cases and feasibility studies such as that conducted by Standish, Boting and Marsay (2010) in South Africa are important as a theoretical foundation for planning these systems, Small and Verhoef (2007) as well as Button (1993) point out that the practical demands on urban road usage are more complex and require broader analysis. The issue of inequality, for instance, looks at how the utilisation of a tolled road will be dependent on a person's income and their trade. Those who require a vehicle to work (such as a handy man, needing a vehicle to drive to sites and to house his tools) will be impacted upon more than someone travelling to an office job. Those in the lower income bracket with little or no disposable income to cover the costs of road charges will need to switch to public transportation, hence the importance of an adequate public transport network (Button 1993, Small & Verhoef 2007).

In South Africa, the government subsidised public transport network still needs development between the areas affected by e-tolling. The inadequate public transport system in Gauteng was recently highlighted by President Jacob Zuma during a press statement after using public transport between Pretoria and Johannesburg for a day in June 2012 (Joburg 2012; The Presidency 2012). Whilst the Gautrain has been a beneficial addition to the public transport system, it only reaches a minimal area of Gauteng. Having spoken to commuters using the Metrorail train system, one of the primary forms of public transport, complaints were heard of overcrowding in trains, lack of security and heavy delays (of sometimes more than an hour) because operators did not arrive for work on time (Joburg 2012; The Presidency 2012). The inadequate public transport system may have a significant impact on the acceptance of a user pays model ITS in Gauteng, as seen in Edinburgh and Manchester.

Conclusion

The international examples of ITS, particularly with reference to user-pays models, have begun to show similarities in factors that are crucial to the successes and failures of such systems. These factors are often of an ethical nature, in terms of privacy and security of personal information, as well as societal factors that need to be considered for the development of a country. While the research confirms the undeniable benefits of ITS and the user pays model, the perceptions, economic, political and social status of citizens are important components to consider when discussing the implementation of ITS. Evidence suggests that despite all the benefits, under certain conditions such as economic constraints, distrust in political administration or confusion about purpose and use of technology, these systems run a very high risk of failure. It is the opinion of the authors that, in the Gauteng case study, more consideration needs to be given to these conditions to prevent the risk of failure.

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