

Penetration of ITS Concepts at the University Level and Willingness to their Introduction

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Abstract—It is a common belief among researchers of the Intelligent Transportation Systems (ITS) community that ITS applications are the key to make transportation systems safer, more comfortable, and more efficient, while reducing the environmental impact. However, there seems to be a gap between ITS community and final users. It cannot be assumed that the advantages of ITS are clear to the users, and we must bear in mind that their reluctance to use some applications and services may be a serious problem to gain the maximum benefit from the ITS research. Of special significance are those systems which reduce the role of the driver in favor of automated control systems. This paper focuses on that gap, and presents the results obtained from a survey made to find out the attitude of young Spanish undergraduate students towards ITS. Special attention is paid to Information and Communication Technologies (ICT) students, since they are expected to be a part of the ITS community in a short future. Age, gender and college degree are taken into account when analyzing the results. As an example of our study, it was found that polled Spanish undergraduates seem to be more concerned about the environment than about road safety. Furthermore, the difference of concern is even larger among students of ICT degrees. The paper concludes with some clues to understand the answers given by students.

I. INTRODUCTION

If not everyone, almost everyone in the world of Intelligent Transportation Systems (ITS) agrees that ITS advances are conceived to improve transport efficiency, enabling intermodality among different transport means, diminishing the environmental impact and enhancing the experience of travellers. In order to achieve these objectives, it has been proven that new information and communication technologies are key elements. Among the different transportation modes involved in ITS, it is probably the road sector the one that has focused most of the efforts during the past years. In concrete, applications dedicated to traffic safety and the provision of value-added information to travellers have been some of the most studied systems, with a partial inclusion in current commercial vehicles. Well-known Advanced Driver Assistance Systems (ADAS) comprise a set of ITS applications conceived to be included in vehicles and specially focused on increasing road safety. Adaptive Cruise Control (ACC), Lane Departure Warning (LDW) or Intelligent Speed Adaptation (ISA) are some examples of ADAS systems. Although the applications that were just mentioned only involve the vehicles where they are installed, there are a set of solutions which do not only involve vehicles, but also the infrastructure support. Electronic tolling in highways (or

more generally, road tolling) is a good example of it, and one of the main ITS applications for highways. Its introduction in different European countries is already a reality, while some others expect to deploy their own system in a short period.

A recent study carried out by the European Commission [1] reveals that a high rate of people is aware of some ITS safety applications, but their willingness to buy a vehicle with these systems is highly dependant on the final price. In this way, it is clear that the real benefit found by population in ADAS is low and its use is not found essential yet. Reasons why ITS popularity is not as high as expected can be found in the lack of effective advertising campaigns or the reluctance against these technological advances. The survey-based study carried out in this paper works in this line, searching for evidences which could help us to understand this situation.

As it is stated later, several similar studies have been carried out in this line, however what clearly distinguish the work carried out in this paper from the rest is the special interest on new generations. This is the reason why our study is directed to evaluate the penetration of ITS concepts in undergraduate students, since they are expected to be particularly aware of new information and communication technologies and they will be a part of future ITS society.

The structure of the paper is organized as follows. Section II describes interesting works related to the acceptance of ITS. Section III presents the methodology carried out to prepare the survey model and the way in which the study was performed. Section IV introduces the collected results, and Section V presents a discussion on the most relevant aspects. Finally, section VI concludes the paper with a brief summary of the work, main remarks and future works.

II. RELATED STUDIES

In the current literature there are different works dealing with the study of acceptability of ITS services by the general public. These apply different techniques in order to determine the degree of penetration and willingness to ITS concepts. Some of them only study the way in which these kind of studies should be carried out. Others perform a theoretical analysis of the impact of ITS solutions. A third group collects survey information about users' acceptability. Finally, some works use simulators or real prototypes in order to study the opinions of the users that employ a system.

The work carried out in [2] introduces the problem of measuring the impact of novel information provision systems in the concrete case of public transport, considering intermodality measures between different transportation systems. However, the proposed survey strategy has not been used to collect real opinions. Even more preliminary was the study carried out in [3], where the “public support” concept is presented as a good measurement of the real acceptability of ITS solutions. An example of a theoretical study of the impact of ITS in current society is given in [4]. A socioeconomic model is used to estimate the effectiveness jointly with the cost of a convoy driving system, where vehicles would be autonomously driven in special lanes of a highway.

Several studies can be found in the literature about users’ opinion regarding the usage of ITS services, although a great part of them are focused on ADAS solutions. In [5] different ADAS capabilities have been included in a simulator, which is used to obtain users’ opinion before, during and after a trial of the system. As it is stated, the perception of the system varies when the system is tested and in terms of the simulated scenarios. In [6], not only a simulator is used, but also a real prototype of a vehicle. In this case, the impact of an ISA service is analyzed, and it is concluded that people who drive more risky are the ones more reluctant to purchase these systems. A more complete study about the willingness to use a road pricing system is given in [7]. Here, a survey-based strategy is applied, together with opinions collected of the usage of the system and a model for extrapolating the acceptance of the system. As results show, users with medium-high incomes are willing to use the system if it assure safety and a time reduction in end-to-end travel.

In the specific case of only performing survey studies, the variety of ITS services considered is greater, due to that, it is possible to analyze the general opinion against the usage of services which are expected to be developed in the future. In [8] a large amount of ADAS services are evaluated to be included in future vehicles. Among them, those which imply privacy issues (such as electronic licence) and those which limit the control of the vehicle are less accepted. In [9], different ITS technologies are considered to improve the experience in the visit of national parks. The study reveals that safety preferences are higher than others when ITS solutions are evaluated to be included. Another ISA acceptance study is found in [10]. The results of the surveys again indicate that only-warning systems are preferred against solutions which limit the vehicle control. Moreover, the cost of these services are a key point and only cheap systems would be initially accepted. In the field of information provision to travellers in public transport, the study presented in [11] proves that there is as a good interest in these services and reveals that users find current approximations still insufficient.

The study carried out in this paper is performed following a survey-based method. It reaches several conclusions in the line of previous studies, but reveals perceptions of ITS concepts by new generations. Moreover, instead of narrowing the study to a unique ITS service or a set of them, it is oriented

to the ITS world in general, identifying knowledge gaps in ITS technologies, distrust patters against ITS advances and obtaining relevant data about environment preservation and the improvement of public transport services.

III. METHODOLOGY

The survey was designed to evaluate the acknowledge of ITS concepts and performed in undergraduates who are between 18 and 26 years old. In particular, we focus on students of Information and Communication Technologies (ICT) degrees, due to the fact that, a priori, they are more aware of new technologies. The survey was conceived to test the penetration of a wide range of ITS services and technologies, asking about a lot of different topics inside the ITS field.

The questionnaire is virtually divided into six sections, which focus on different aspects, although it is presented to students as a single test without sections. These six sections are the following:

- General acknowledgement on ITS (questions 1-4).
- Preferences about new advances in technology and vehicle alone vs cooperative (questions 5-11).
- Public transport vs particular vehicles (questions 12-14).
- ITS architectures and interoperability (questions 15-17).
- Relation among computer science, telecommunications and ITS (questions 18-21).
- Broadcasting in ITS policies in Europe and specially in Spain (question 22).

First section regards the most representative topics and technologies into the ITS field. The idea was to evaluate the degree of acknowledgement of young people in general, and with special attention to those who are aware of new technologies. Additionally, this section looks at attitude towards ITS of youngsters: whether they think about ITS in a negative way (pay for everything, enforcement, etc.) or more as something positive (useful services, live saving, etc.).

Second section treats to discover if the bet of undergraduates for the problem of vehicular collisions is an approach in which their own vehicles are equipped with the technology to support collision avoidance, or they prefer cooperative systems, in which the vehicles, people and infrastructure of the scene cooperates to achieve success, and every actor plays an important role. We also asked if they believe that research projects should focus on increasing the technology onboard the vehicles, or towards an integral framework vehicles-infrastructure. Finally, we asked if they would consider sacrificing some freedom while driving for the sake of a more efficient road management.

Third section is about preferences in investment of Spanish Government regarding improvements public transport and infrastructure for private vehicles (such as more or better roads). In addition to that, we asked their opinion of “pay for use of roads”.

Fourth section concerns with ITS architecture. We asked our students about the interoperability among all the European ITS systems and connections among different transport modes (intermodal capability). Additionally, in this section

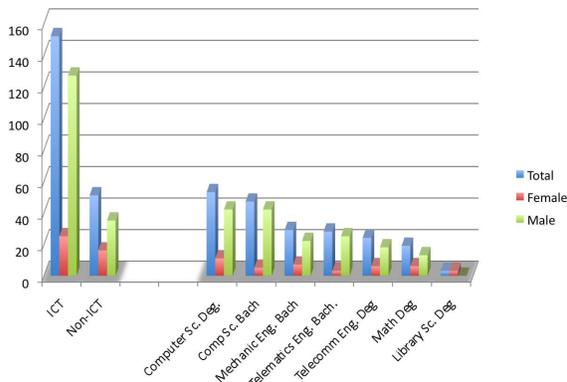


Fig. 1. Survey sample with the distribution ICT, non-ICT students, females and males.

we look at the nomadic systems (personal services associated to the individual, not the transport).

Section five analyzes how the students consider the relations among Computer Science, Communications and ITS. They were asked which subject of their studies is the most important for future ITS deployments. Finally, section six of the questionnaire goes deeply into the acknowledge of youngsters about the ITS European policies.

All questions are presented in a test format with five options: (1) totally disagree, (2) disagree, (3) no opinion, (4) agree and (5) totally agree. If a question is left in blank, it is considered as a *don't know* answer. Exceptionally, first and last sections contain multiple choice questions. The survey is anonymous, but students supply information about age, gender, course and college degree, useful for statistical analysis.

IV. COLLECTED RESULTS

The sample size is 203 students of the University of Murcia and the Technical University of Cartagena, both in Spain. As it can be seen in Fig. 1, most of the students are involved in ICT studies (around 75%), while the rest are registered in other scientific studies. Concretely, students from computer science and telecommunications engineering comprise the most relevant group. The rest of degrees under consideration are Mechanic Engineering, Telematics Engineering, Maths and Library Science. The age of the population ages varies between 18 and 26. This includes all possible academic years in Spain. One of our initial objectives was to evaluate the impact of age, gender and studies on the collected results. As it can be seen in Fig. 1, the amount of women is low, as compared to the rate of men. This highlights preference for science studies by Spanish males.

Next subsections present the most relevant collected results.

A. Perception of ITS

It is of special relevance that only a 25% of undergraduates is initially aware of the ITS concept (question 1), although a 35% of them later agree that electronic tolling, automatic

enforcement and GPS navigators identify technologies related to ITS (question 2), and even a 53% of those polled also identify in this group ADAS services such as collision avoidance and incident warning (question 3). For a future survey we have planned to change the order of questions to diminish this coherence problem.

The questionnaire results related to the popularity of several ITS (question 4) services are briefly summarized in Table I. As it can be seen, GPS navigators and speed enforcement systems are the most popular ones, mainly due to the recent massive implantation of speed radars in the Spanish road network. New advances in providing real time information in public transport and DSRC road tolling is also of recent deployment, what also causes an impact on collected results. Intermodality, which is, however, one of the most ambitious aims of public authorities achieves the lowest results.

TABLE I
POPULARITY RESULTS OF SEVERAL ITS SERVICES (QUESTION Q-4).

ITS service	Popularity
GPS navigators	97.04%
Speed enforcement, by Radar	89.16%
Public transport information systems	59.61%
DSRC automatic tolling	56.65%
Autonomous collision avoidance	43.84%
Unmanned navigation	35.96%
Vision technologies inside vehicles	28.57%
Fleet management	24.14%
e-Call	22.17%
Intermodality advances	13.79%

B. New technological advances in ITS

According to collected results in this part of the survey, Spanish students prefer to manage their vehicle at any time (44% of them highly agree), when they are asked about the possibility that vehicles could be autonomously driven (questions 5-7). Even a higher percentage of them (66%) assure that they would not take more risks if the vehicle would include novel active security systems (question 8). Related to this, a great part of the students (50% of them highly agree) do not think that solutions based on cooperation between vehicles and infrastructure should private them of managing their vehicles, even if this would decrease the number of accidents or ameliorate their consequences (question 9). Their opinion about the benefits in safety of cooperative services is however varied (question 10).

A significant result of this section is that around 57% of those polled highly agree that a greater effort should be paid on improving current road networks, instead of deploying novel ITS and technological advances (question 11).

C. Public transport vs. private vehicles

Surprisingly, many students (around 70%) would migrate from a private car to a urban public transport mean if the latter is supported by a more effective information system, providing realistic information about travel times and capabilities (question 12). They were also asked if they believe that public investment should focus more on public or private

transportation means (question 13). Only a slight preference toward public transport investment was detected.

Some specific questions about environment preservation were included. Many students (57%) highly agree with the idea that people who pollute more should pay more taxes (question 14). This global result reaches a value around 70% when we focus exclusively on students involved in ICT studies. This difference can be seen in Fig. 2. This graph plots mean values gathered for most of the questions from students involved in ICT and non-ICT degrees¹.

D. ITS architectures and interoperability

One of the most important questions in this section of the survey points the importance of interoperability. A high rate of students (82%) thinks that ITS technologies should be object of standardization processes, in order to avoid protectionism and speed up inter-operativity between novel systems (questions 15-16).

Related to novel architectures, nomadic systems received a great attention in the collected results (question 17). A rate of 77% of students think that integration of mobile devices (such as mobile phones, PDAs or laptops) in the vehicle is a very good approximation. This way, a global ITS architecture could be improved with new communications means, independently on the transport system used.

The high agreement of interoperability/intermodality and nomadic device concepts can be clearly seen in Fig. 2. This section of the survey comprises questions 15-17. It is noticeable in the graph how this rate is even greater for ICT students, probably due to their higher knowledge on these concepts.

E. Computer Science and Telecommunications in ITS

When students were asked about the link between ICT and ITS we expected to see a unanimous agreement. However, the results show a more moderate response. Around 55% of those polled highly considered this association, and the rest of results are uniformly distributed from one to three. As we expected, this rate increases in the cases of youngsters from ICT studies, gathering values around 70%. This effect is clear in Fig. 2, questions 18-20. Similar distribution is found when students were asked about what ICT areas could be considered as the most relevant for ITS. Telematics and Communications (question 21-2) obtain the highest results, followed by Electronics and Computer Architecture (question 21-3). Artificial Intelligence and Programming Languages obtain the lowest results (questions 21-1 and 21-4, respectively).

F. ITS policies in Spain and Europe

The degree of knowledge of transport policies is also object of our study, with the aim of assessing the efficacy of advertising campaigns carried out by the Spanish Government and the European Union. This way, the questionnaire asks about some of the most important initiatives (question 22). These results are included in Table II. As it can be seen,

¹Multiple choice questions are not considered in this graph.

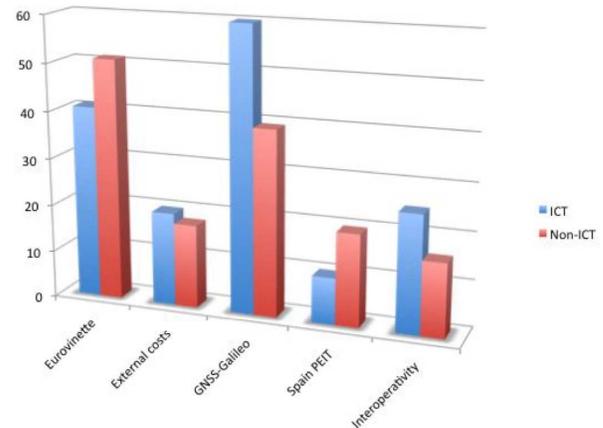


Fig. 3. Impact of ITS initiatives in ICT and non-ICT students (question Q-22).

the European GNSS project is the most popular one, with a 54% of students which highly agree that they know the system. The second most popular initiative is the road pricing directive, that maybe known due to the controversy of the initial purpose of charging trucks for the road usage.

TABLE II
POPULARITY OF ITS INITIATIVES IN EUROPE AND SPAIN (QUESTION Q-22).

Initiative	Popularity
European GNSS: GALILEO	54.68%
Roadpricing directive (Eurovinette)	43.35%
European emphasis on interoperability and intermodality	22.66%
Extra taxes due to external costs (pollution, etc.)	19.21%
Spanish PEIT Plan	12.32%

Interoperability and intermodality campaigns carried out by the European Union appears to be not very effective among Spanish undergraduates: only a 22% of those polled highly agree on its knowledge. In the special case of Spanish diffusion plans, the results are not any better: only a 12% of high agreement on the knowledge of the most important plan for advances in transportation in Spain (so called, the PEIT plan).

In this case, differences between ICT and non-ICT students are clear, as it can be seen in Fig. 3. It is appreciable how ICT students, with a higher knowledge on technologies, score higher values. By contrast, the knowledge of non-ICT students about policy measures is higher, presenting a better vision on social initiatives.

V. DISCUSSION

A number of conclusions can be reached from the results collected in previous phase (mostly showed in Fig. 2).

- The age of the students does not seem to be a noticeable factor regarding neither their knowledge of ITS, nor the relation between ICT and ITS. This is of special

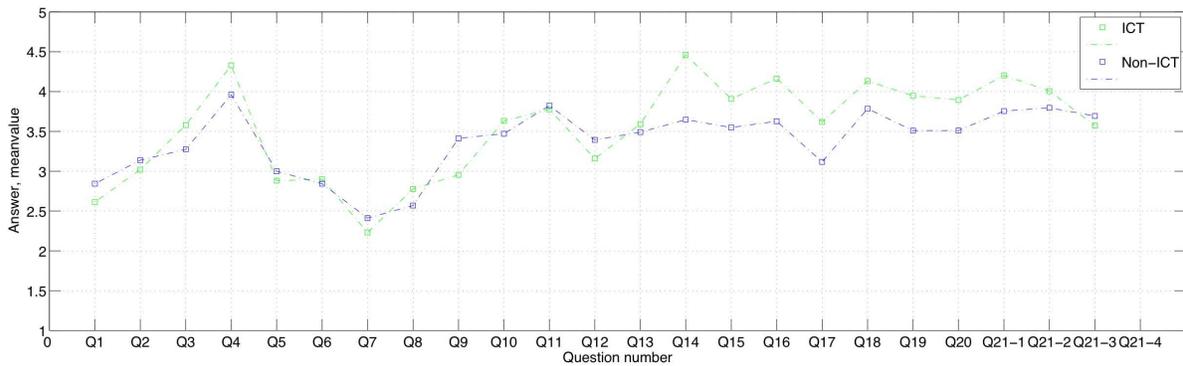


Fig. 2. Global results for ICT and non-ICT students.

interest when we consider that most of those polled are studying ICT related degrees. This could mean that current programs of both the Faculty of Computer of Science and the School of Telecommunication Engineers do not change the knowledge and point of view of their students regarding some applications of the ICTs.

- Students of the faculties related to ITS (such as Computer Science, Telecommunication, and Telematics) show in general more knowledge of ITS topics (questions 1-4) than students coming from some other backgrounds, such as the degrees of Maths or Library Sc. Since, as it was aforementioned, their academic year or age does not affect significantly their knowledge, we could claim that students interested in the ICT field, are simply more concerned with ITS-related issues.
- Contrary to a very popular thought, our results show that female students are the same aware and concerned of the ITS than male students.
- There is stronger anxiety toward automated vehicles among students of non ITS-related faculties (question 5). This could mean that the less our students are connected to the ICT world, the less they rely on technological deployments to ease the driving by means of automating some tasks. Nevertheless, it was that half of all students (including the ones of ICT degrees) do not rely on technology to control vehicles, and they prefer to keep the control on human hands, even if automated control would prevent from accidents and increase the overall safety and comfort (questions 6-7). Two reasons can be found to this: whether our students (even ICT ones) do not think that ITS helps to reduce accidents, or they believe it so, but still they do not want to stop driving for the sake of safety. One way or another, it is the authors' opinion that there is still a lot to be done regarding ITS education. Let us remember here that this study focuses on a population that is between 18 and 26 years old.
- Among students somewhat familiar with ITS, preventive safety application are more commonly identified with this term (question 9), rather than punishing and enforcement. It can be claimed that students who are familiar with ITS, find it positive.

- Regarding cooperative systems against ultra-sensorized vehicles (question 10), answers are uniformly distributed among “no answer”, “preferred cooperative”, and “preferred sensorized”. The authors' impression is that students are not familiar with the possibilities of cooperative systems. This is also based on the high number of “don't know” answers.
- The fact that the majority of our students would support more investments in infrastructure than in ITS (question 11) encourages us to think that they do not rely on advances in telematics to cope with problems of transportation. This agrees with a conclusion previously presented.
- Youngsters seem to be concern about the environment. The clear majority suggests that those who produce more pollution should pay more for driving (question 14). Of special interest is that two thirds of ICT students think so.
- Finally, it can be assessed that the inclusion of ICT to the different transportation modes is not well known, even among youngsters who are studying one degree connected to it.

VI. CONCLUSIONS AND FUTURE WORKS

The paper presents a survey-based opinion study about the knowledge and acceptance of ITS concepts of youngsters. Questions pointed different fields of ITS (technologies, legislation, strategies, current deployments, etc) and were addressed to undergraduate students of different universities, degrees, and levels, embracing several fields of science. This way, we believe that some meaningful results about the opinion of Spanish students were achieved.

To the authors' opinion, some of the conclusions gathered from collected results, are useful for administrations, researchers and educational staff of the ITS community. Firstly, a slightly better willingness has been identified from undergraduates involved in ICT studies. This highlights the need of improving ITS advertising campaigns to reach a more general audience. This could also affect the acceptance of novel ADAS systems. Let us remember here that most of those polled expressed their reluctance to install ITS services that automate driving tasks even if this would highly improve

safety. On the contrary, when students are asked about pollution, they highly agree that a policy of “the more one person pollutes the more this person pay taxes” should be applied. This highlights the good results achieved so far by campaigns of environment preservation. Finally, it is noticeable that the results achieved do not depend significantly on gender and age factors.

Since undergraduate students need to mature their knowledge about real-life projects, social necessities and political initiatives, a bias could appear if the survey results were compared with other population groups. However, our work has been focused on higher education, because one of our aims is to use these data to make the university community aware of the penetration of ITS concepts.

Our future plans in this line are focused on studying the impact of an specific ITS course at the third level of Computer Science Engineering studies. The results collected before and after the subject will be used as feedback in order to gradually improve the teaching. In addition to this, we also plan to extend the population under consideration to other groups and to use real ITS systems to collect the opinion of people before and after using concrete services and applications.

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REFERENCES

- [1] M. Kievit, K. Malone, H. Zwijnenberg and B. Van Arem, “Benchmarking promotion and deployment activities regarding intelligent vehicle safety systems in the EU.” Transportation Research Board Annual Meeting, Washington, USA, January 2008.
- [2] W. Guo and P. Blythe, “Intelligent personalised traveller information: impacts on the choice of travel mode,” 13th World Congress on Intelligent Transport Systems and Services, London, United Kingdom, October 2006.
- [3] S. Vlassenroot, J. De Mol, T. Brijs and G. Wets, “Defining the public support: what can determine acceptability of road safety measures by a general public?,” European Transport Conference, Strasbourg, France, September 2006.
- [4] J. Zhicai, W. Jianping and M. McDonald, “Socio-Economic Impact Assessment of Intelligent Transport Systems,” Tsinghua Science and Technology, vol. 11. no. 3, pp. 339–350, June 2006.
- [5] S. Joshi, A. Amditis, T. Bellet and V. Bodard, “Perceptions of risk and control understanding acceptance of advanced driver assistance systems,” European Conference on Human Centred Design for Intelligent Transport Systems, Lyon, France, April 2008.
- [6] S. L. Jamson, “Would those who need ISA, use it? Investigating the relationship between drivers’ speed choice and their use of a voluntary ISA system,” Transportation Research Part F: Traffic Psychology and Behaviour, vol. 9, no. 3, pp. 195–206, May 2006.
- [7] D. Brownsone, A. Ghosh, T. F. Golob, C. Kazimi and D. Van Amelsfort, “Drivers’ willingness-to-pay to reduce travel time: evidence from the San Diego I-15 congestion pricing project,” Transportation Research Part A, vol. 37, no. 4, pp. 373–387, May 2003.
- [8] E. Mitsopoulos, M. A. Regan and N. Haworth, “Acceptability of in-vehicle intelligent transport systems to victorian car drivers,” Royal Automobile Club of Victoria (RACV), Report No. 02/02, 2002.
- [9] G. Dilworth, “The relationship between conditions and attitudes: an examination of intelligent transportation systems,” Canadian Congress on Leisure Research, Nanaimo, Canada.
- [10] J. Piao, M. McDonald, A. Henry, T. Vaa and O. Tveit, “An assessment of user acceptance of intelligent speed adaptation systems,” International IEEE Conference on Intelligent Transportation Systems, Vienna, Austria, September 2005.
- [11] B. Caulfield and M. O’Mahony, “Factors which influence the preferences for rea-time public transport information,” European Transport Conference, Leeuwenhorst, The Netherlands, October 2007.