



## SMART AND SUSTAINABLE TRANSPORT: SHORT REVIEW OF THE SPECIAL ISSUE

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Sustainable transport systems and infrastructure (roads, highways, bridges, airports, railways, waterways, etc.) strive to reduce the impact on the environment, the economy, and society in all aspects and throughout its life cycle from the conception to design, construction, maintenance, and operation. Sustainability is not a goal, but a process of continuous improvement according to the needs and the context, which can vary in time and space. A number of recent advances made in wireless smart sensor networks, nanotechnology, energy harvesting, high-performance computing, imaging and visualization, big data analytics, etc. has significant potential to accelerate the evolution of safe and smart Cyber Physical System (CPS) – enabled sustainable transport infrastructure and systems. This Editorial presents a short review of all 14 original papers and 1 review paper published in the current Special Issue on *Smart and Sustainable Transport* (SST), see Table.

Safe movement of visually impaired persons in the traffic network requires public services based on advanced Information and Communication Technologies (ICTs). Paper #1 by Perisa *et al.* (current special issue: 247–252) analyzes the currently available information system of users when moving traffic network, and the current services bases on new ICTs. The analysis was carried out on a representative sample involving all interest groups of visually impaired people in the City of Zagreb (Croatia). New services based on two new ICTs, namely Near Field Communication (NFC) and Real-Time Locating Systems (RTLS), were proposed to inform and facilitate communication with the visually impaired. The authors concluded that the proposed technologies successfully met their technical requirements and that

more efficient usage of them has the potential to enrich the quality of lives of the blind and the visually impaired.

Autonomous driving systems have greater precision than human drivers in controlling a vehicle and can help address the demands of rapidly growing traffic volumes for safer and efficient use of roads by reducing the spacing between vehicles and thereby increase the road capacity. In Paper #2, Godoy *et al.* (current special issue: 253–263) presents the results obtained during a driverless experiment (dubbed as the AUTOPIA program) conducted on a 100 km route around Madrid (Spain), including both urban and motorway environments. Very precise tracking results were obtained with the Cooperative Adaptive Cruise Control (CACC) with the distance error (between the leading and trailing vehicle) being kept to less than 1 m. As part of future work, the authors recommended improvements on the localization system to allow longer GPS signal outages (such as while passing through a long tunnel, etc.).

Provision of real-time traveler information services is crucial both for travelers as well as for traffic managers. While Bluetooth is considered as one of the most economical options for estimating travel times, the process of data filtration and correction can be quite tedious. Paper #3 by Mitsakis *et al.* (current special issue: 264–272) discusses a robust methodology for real-time estimation of travel times in dense urban networks using point-to-point Bluetooth detectors and applies it to a case study with 10 Bluetooth detectors installed at major intersections of Thessaloniki's Central Business District in Greece. The authors suggest that the proposed methodology can be extended to other similar technologies, such as automatic toll collection systems or Wi-Fi sensors.



Table. Contents of the Special Issue on Smart and Sustainable Transport

	Title of the paper	Authors of the paper	Country
Paper #1	Adaptive technologies for the blind and visual impaired persons in the traffic network	Marko Periša <sup>1</sup> , Dragan Peraković <sup>2</sup> , Juraj Vaculík <sup>3</sup>	<sup>1,2</sup> Croatia, <sup>3</sup> Slovakia
Paper #2	A driverless vehicle demonstration on motorways and in urban environments	Jorge Godoy <sup>1</sup> , Joshué Pérez <sup>2</sup> , Enrique Onieva <sup>3</sup> , Jorge Villagrà <sup>4</sup> , Vicente Milanés <sup>5</sup> , Rodolfo Haber <sup>6</sup>	<sup>1,3,4,6</sup> Spain, <sup>2, 5</sup> France
Paper #3	A robust method for real time estimation of travel times for dense urban road networks using point-to-point detectors	Evangelos Mitsakis, Josep Maria Salanova Grau, Evangelia Chrysohoou, Georgia Aifadopoulou	Greece
Paper #4	Route plan evaluation method for personalised passenger information service	Dávid Földes, Csaba Csiszár	Hungary
Paper #5	Fuzzy logic approach in mode choice modelling for education trips: a case study of Indian metropolitan city	Ashu Shivkumar Kedia, Krishna Bhuneshwar Saw, Bhimaji Krishnaji Katti	India
Paper #6	Piezoelectric force sensors for hexapod transportation platform	Mindaugas Luneckas, Tomas Luneckas, Vytenis Gavelis, Vytautas Valaitis, Dainius Udris	Lithuania
Paper #7	Setting the weights of sustainability criteria for the appraisal of transport projects	Paola Carolina Bueno Cadena, José Manuel Vassallo Magro	Spain
Paper #8	A co-operative methodology to estimate car fuel consumption by using smartphone sensors	Vittorio Astarita, Giuseppe Guido, Domenico Mongelli, Vincenzo Pasquale Giofrè	Italy
Paper #9	How should the sustainability of the location of dry ports be measured? A proposed methodology using Bayesian networks and multi-criteria decision analysis	Samir Awad-Núñez, Nicoletta González-Cancelas, Francisco Soler-Flores, Alberto Camarero-Orive	Spain
Paper #10	CloudThink: a scalable secure platform for mirroring transportation systems in the cloud	Erik Wilhelm <sup>1</sup> , Joshua Siegel <sup>2</sup> , Simon Mayer <sup>3</sup> , Leyna Sadamori <sup>4</sup> , Sohan Dsouza <sup>5</sup> , Chi-Kin Chau <sup>6</sup> , Sanjay Sarma <sup>7</sup>	<sup>1</sup> Singapore, <sup>2,7</sup> United States, <sup>3,4</sup> Switzerland, <sup>5,6</sup> United Arab Emirates
Paper #11	Applying sustainability theory to transport infrastructure assessment using a multiplicative AHP decision support model	Marie Ridley Pryn, Yannick Cornet, Kim Bang Salling	Denmark
Paper #12	Sustainability effects of next-generation intersection control for autonomous vehicles	Zhixia (Richard) Li, Madhav V. Chitturi, Lang Yu, Andrea R. Bill, David A. Noyce	United States
Paper #13	Integration of motion planning and model-predictive-control-based control system for autonomous electric vehicles	Guodong Yin, Jianghu Li Xianjian Jin, Chentong Bian, Nan Chen	China
Paper #14	Non-linear mini-max problem of multi-stop flight routes	Srećko Krile <sup>1</sup> , Marina Krile <sup>2</sup> , Petr Průša <sup>3</sup>	<sup>1,2</sup> Croatia, <sup>3</sup> Czech Republic
Paper #15	Applicability of ICT solutions in passenger transport – case studies from different European backgrounds	Monika Bąk, Przemysław Borkowski	Poland

Paper #4 by Földes and Csiszár (current special issue: 273–285) focusses on improving the customer satisfaction and perception of public transportation system quality by developing route plan evaluation method based on personalized user settings. By considering both the precise physical aspects of the infrastructure (such as detailed properties of walking paths, passenger facilities and vehicles) and the users' detailed personal preferences, the novel algorithm developed by the authors determines 'ideal routes' that are closer to reality than those of existing route planner applications. Areas of future research identified by the authors include multi-criteria survey of passenger demands and expectations for journey planner applications, analysis of stated and revealed personalized preferences, etc.

Rural-urban migration, especially in developing countries has been placing enormous pressure on urban infrastructure, especially the transportation system resulting in ever-increasing congestion and consequent emissions. Essential to developing sustainable transportation approaches for urban areas is having an understanding of mode choice and what prompts users to make a modal shift. The conventional logit modeling approach cannot accommodate uncertainty in the choice decisions. Kedia *et al.* (current special issue: 286–293) present a novel fuzzy logic approach to mode choice modeling for education trips and demonstrate its use in an Indian metropolitan city.

Wheeled or tracked robots are not suitable for payload transportation that require rough terrain traversability or very stable and careful movements. For this reason, walking robots, despite their slower speed, have been attracting recent attention as transportation platforms that can overcome the environment. However, stable motion of walking robots over the irregular surface requires accurate supervision of leg placement and the development of force sensing system on each foot of the robot for equal force distribution between legs. Different types of sensors could be used in the development of robot's force sensing system such as barometers, pressure sensors, etc. Paper #6 by Luneckas *et al.* (current special issue: 294–297) successfully investigates the improvement of a hexapod robot's feet by upgrading them with piezoelectric sensors. As part of future research, the authors intend to build unique barometer sensors for the hexapod robot and monitor the force distribution over a longer period.

Paper #7 by Bueno Cadena and Vassallo Magro (current special issue: 298–306) presents a novel methodology to set the weights of the sustainability criteria used in the Multi-Criteria Decision Analysis (MCDA) of transport projects in order to reduce the subjectivity and imprecision. Their proposed approach recommends eliciting weights based on both expert preferences as well as the importance that the sustainability criteria have in the geographical and social context where the transport project is developed. The authors successfully applied their methodology to a real case study to quantify sustainable practices associated with the design and construction of a new roadway in Spain.

Climate change is intimately related to Greenhouse Gas Emissions (GHG). Transportation sector is the second largest source of GHG and consequently the quest to use novel approaches to minimize emissions from vehicles. The advent of vehicle-to-vehicle and vehicle-to-infrastructure communications provides an opportunity to potentially modify driver behavior resulting in reduced fuel consumption and resultant emissions. Paper #8 by Astarita *et al.* (current special issue: 307–311) presents a co-operative methodology to estimate car fuel consumption by using smartphone sensors to detect vehicle kinematics. The preliminary results reported by the authors demonstrate that the proposed system provides reliable estimates of fuel consumption.

Implementation of dry ports can potentially mitigate the adverse impacts of increase in activity at seaports as well as act as a link between road and railroad networks and thus strengthen intermodal solutions. However, location of dry ports requires thorough analysis of the whole logistics supply chain with aim of transferring largest volume of goods from road to more energy-efficient transportation mode with minimal environmental impact. Paper #9 by Awad-Núñez *et al.* (current special issue: 312–319) investigates the variables influencing the sustainability of a dry port location and presents a methodology for assessing the sustainability of dry port locations through the use of MCDA and Bayesian Networks (BNs).

Vehicle data can be leveraged to improve vehicle performance, reliability, efficiency, safety, operational costs and user experience. Paper #10 by Wilhelm *et al.* (current special issue: 320–329) presents CloudThink, a scalable secure platform for mirroring transportation systems in the Cloud. The hallmark of CloudThink is the balance between flexibility to host many applications and the ability to securely store user data. The platform consists of low-cost, open-source hardware for capturing vehicle data and moving securely to a server, a web-based Application Programming Interface (API) for provision of 3rd party services and dashboard for access control and service distribution. CloudThink can enable a whole host of applications in the transportation domain including energy, environmental and policy. Three third-party applications using CloudThink data are discussed: remote vehicle actuation, vehicle state of health monitoring, and fleet eco-driving use.

In Paper #11, Pryn *et al.* (current special issue: 330–341) propose the SUSTAIN Decision Support System (DSS), a conceptualized approach to sustainability based on the nested model, as an alternative approach to traditional sustainable transportation assessment based on the three dimensions of economy, society and the environment. Based on the basic notions of sustainability presented by the historic Brundtland Commission report and the use of MCDA and a multiplicative version of the Analytical Hierarchy Process (AHP), the proposed approach provides a sound rationale for prioritizing longer-term ecological integrity over shorter-term economic concerns. As a case study, the authors successfully applied and demonstrated their proposed

approach in the planning and decision-making process related to a new construction across the Roskilde Fjord in Frederikssund, Denmark.

Paper #12 by Li *et al.* (current special issue: 342–352) presents ACUTA, a next-generation, enhanced reservation-based algorithm for control of autonomous vehicles at intersections. VISSIM, a microscopic traffic simulation platform was used to model ACUTA. The objective was to evaluate the sustainability impacts of ACUTA and compare it with traditional intersection control such as all way stop and signal control. MOVES, a state-of-the-art tool developed by the United States Environmental Protection Agency (EPA) was used for estimating emissions and energy consumption of vehicles. Results show that ACUTA has great potential in reducing pollutant emissions and energy consumption at intersections. Authors conjecture that the sustainability benefits could be maximized by extending ACUTA to a corridor as opposed to a single intersection.

Paper #13 by Yin *et al.* (current special issue: 353–360) integrated motion planning and model-predictive-control (MPC) based control system for autonomous electric vehicles. The proposed system is evaluated under two scenarios with a high-fidelity full vehicle model from CarSim using a seven degrees-of-freedom vehicle model. The two scenarios are lane changing maneuver and right angle turn maneuver. The simulation results demonstrate that the integrated planner and controller can meet the requirements of autonomous driving.

Every industry is in the quest for increased operational efficiency, productivity, safety, customer service and ultimately profitability. In air transport industry, multi-stop routes could result in significant fuel savings and better capacity utilization. Paper #14 by Krile *et al.* (current special issue: 361–371) developed an efficient heuristic algorithm for optimal transportation on multi-stop routes. The goal is to minimize idle capacity, expenses and maximize revenue by formulating the problem as a minimum cost multi-commodity flow problem rather than a non-linear convex optimization problem. The authors demonstrate the viability and computational efficiency of this approach through several test examples.

In Paper #15 Bąk and Borkowski (current special issue: 372–381) studied the acceptability of ICT solutions and barriers to their implementation through focus groups and interviews. Five case studies were conducted across the European Union covering a wide range of geographic, social and economic factors. The five studies are: smartphone applications (apps) for improving accessibility for disabled people in London (United Kingdom), ITS solutions for Barcelona's (Spain) local bus network, bike-sharing in Vienna and surrounding region (Austria), a grass-root cooperative smartphone-based car-sharing in Austria, and interurban public transport in Warmian–Masurian Voivodeship (Warmia–Masuria Province) of Poland. The main findings are that users have similar positive attitudes towards ICT regardless of social, economic and cultural backgrounds. Users expect ICTs to be delivered for free or economically. Most useful ICTs appear to be those aimed at pricing and ticket integration.