vehicles

Editorial

Emerging Transportation Safety and Operations: Practical Perspectives

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1. Introduction

Improving transportation traffic safety and operations is a global priority, with efforts focusing on both technological advancements and strategic planning [1]. Generally, researchers and practitioners in the transportation field are continuously seeking and utilizing modern approaches and technologies that can be implemented to improve the safety and efficiency of transportation systems. Modern concepts focus on the application of new strategies, data-driven methods, and innovative technologies to address contemporary challenges in transportation safety and operations [2,3]. There are several key focus areas that can be highlighted here due to their popularity and worldwide usage.

Advanced Traffic Management Systems (ATMSs) is an area that has become a major focus worldwide [4–6]. These systems include connected and automated vehicles (CAVs), which involve the integration of connected and autonomous vehicle technology into traffic systems to reduce human error and improve traffic flow [7,8], as well as smart traffic signals, which involve adaptive traffic signals that adjust in real time based on traffic conditions to reduce congestion and improve safety [9]. These systems also include Intelligent Transportation Systems (ITSs), which include the use of technologies like cameras, sensors, and data analytics to monitor and manage traffic conditions [10,11].

Another important aspect that transportation professionals are leveraging to their advantage is data-driven decision making. This involves big data and analytics [11], leveraging data from various sources, such as GPS, mobile devices, and traffic sensors, to make informed decisions regarding traffic patterns, safety measures, and infrastructure improvements. This decision making also includes predictive analytics, which uses historical data to predict future traffic conditions, identify high-risk areas, and proactively implement safety measures [11,12].

Vision zero and the safe system approach are two concepts that are currently being advocated for and explored worldwide. Vision zero is a strategy aimed at eliminating all traffic fatalities and severe injuries, while promoting safe and healthy mobility for all [13,14]. It focuses on the design of roads, vehicles, and systems that prioritize human life and on minimizing the consequences of human error. The safe system approach emphasizes a holistic view of the transportation system, accounting for human vulnerabilities by creating multiple layers of protection (such as safer road designs, vehicle safety features, and responsible road user behavior) [15,16].

The use of emerging technologies in transportation safety is another practice that is increasingly becoming common, and it is expected to be very influential in the future. This Special issue mentions just a few of these technologies. First, it discusses artificial intelligence (AI) and machine learning (ML): AI algorithms are used to detect unsafe driving behaviors, analyze crash data, and predict potential collision points in real time [17,18]. Next, it discusses drones and aerial surveillance: drones are used for traffic monitoring, accident investigation, and emergency response coordination [19]. It also focuses on vehicle-to-everything (V2X) communication, which enables vehicles to communicate with other

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vehicles, traffic signals, road infrastructure, and even pedestrians to enhance situational awareness and reduce crash risks [20,21].

Roadway infrastructure enhancement is another area being pursued to enhance safety and traffic operations. Some of the initiatives include dynamic road markings and signages that utilize LED technology for dynamic lane markings and road signs that change in response to traffic conditions or weather [22]; cable barriers and roadside safety features that involve improved designs for barriers, guardrails, and crash attenuators to enhance safety on highways and reduce the severity of collisions [23,24]; road diets [25] that involve the reconfiguration of roadways to reduce the number of lanes, lower traffic speeds, and create safer environments for pedestrians and cyclists.

Several sustainable and resilient transportation solutions are introduced. Examples include multimodal transportation systems [26] that encourage the integration of various modes of transportation (buses, bicycles, walking, etc.) to reduce reliance on single-occupancy vehicles, promote safety and reduce traffic congestion; complete street design [27], which involves designing roadways to accommodate all users, including pedestrians, cyclists, and public transit riders, not just motor vehicles; and resilient infra-structure planning [28] by ensuring transportation systems can withstand and recover quickly from extreme weather events and other disruptions.

This Special Issue aimed to share and provide a platform for sharing forward-thinking approach that combines technology, policy, data, and human behavior to create a safer, more efficient, and more inclusive transportation system.

2. Overview of Published Articles

The call for papers for this Special Issue received a good response: we received fifteen (15) submissions, and ten (10) of them were published. Table 1 summarizes an overview of the contributions to this Special Issue.

The article by Gkyrtis and Kokkalis [29] presents a brief overview of the contribution of roundabouts to road safety and the interactions between the safety and design elements of roundabouts. This article provides a discussion about current challenges in and the prospects of roundabouts. In addition, the article provides findings from the environmental assessment of roundabouts; these reveal insights into their expected use and performance with regard to the presence of autonomous vehicles which are anticipated to be the main vehicle types in the foreseeable future. It also provides an overview on the role and importance of simulation studies in the improvement of the design and operation of roundabouts in research on safer vehicle movements.

In the article by Skoglund et al. [30], the authors present an argument on the safety requirements of Automated Driving Systems (ADSs). The article's goal is to enhance the effectiveness of the assessment performed by a homologation service provider by using assessment templates based on refined requirement attributes that are linked to the operational design domain (ODD) and the use of Key Enabling Technologies (KETs). These include communication, positioning, and cybersecurity in the implementation of ADSs. This article contributes to the body of knowledge by (1) outlining a method for de-riving assessment templates for use in future ADS assessments; (2) demonstrating the method by analyzing three KETs with respect to such assessment templates; and (3) demonstrating the use of assessment templates on a use case, an unmanned (remotely assisted) truck in a limited ODD.

The article by Bridgelall [31] contributes to the urgent need for the efficient condition monitoring of road and rail infrastructure. The author argues that traditional methods are both costly and inadequate and thus advocates for the employment of vehicles with integrated sensors and cloud computing capabilities in order to provide a cost-effective, sustainable solution for comprehensive infrastructure monitoring. This article advocates for international standardization by providing compelling evidence that encompasses trends in transportation, economics, and patent landscapes by highlighting the advantages of such standards. It shows that by integrating data from diverse sources, agencies can optimize maintenance triggers and allocate funds more strategically, thus preserving vital transportation networks.

Table 1. Overview of the contributions to this Special Issue.

Authors	First Author Affiliation	Country	Focus
1. Gkyrtis, K.; Kokkalis, A.	Department of Civil Engineering, Democritus University of Thrace	Greece	Road design, safety and operation
2. Skoglund, M.; Warg, F.; Thorsén, A.; Bergman, M.	RISE—Research Institutes of Sweden	Sweden	Assess of automated driving systems
3. Bridgelall, R.	Transportation, Logistics, and Finance, College of Business, North Dakota State University	USA	Infrastructure monitoring and transportation economics
4. Vieira, M.; Vieira, M.A.; Galvão, G.; Louro, P.; Véstias, M.; Vieira, P.	DEETC-ISEL/IPL, R. Conselheiro Emídio Navarro	Portugal	Traffic management and intersection control
5. Granà,A.; Curto, S.; Petralia, A.; Giuffrè, T.	Department of Engineering, University of Palermo	Italy	Interchange design, surrogate safety measures, and traffic simulation
6. Sun, W.; Abdullah, L.N.; Sulaiman, P.S.; Khalid, F.	Computer Vision, Faculty of Computer Science and Information, Universiti Putra Malaysia	Malaysia	Traffic crash risk prediction and traffic safety management
7. Viadero-Monasterio, F.; Alonso-Rentería, L.; Pérez-Oria, J.; Viadero-Rueda, F.	Mechanical Engineering Department, Advanced Vehicle Dynamics and Mechatronic Systems, Universidad Carlos III de Madrid	Spain	Vehicle safety, intelligent vehicles
8. Zahedieh, F.; Lee, C.	Department of Civil and Environmental Engineering, University of Windsor	Canada	Surrogate safety measures and traffic simulation
9. Xu, V.; Xu, S.	Texas Academy of Mathematics and Science (TAMS), University of North Texas	USA	Radar detection, broadside collision avoidance
10. Tomasch, E.; Hoschopf, H.; Ausserer, K.; Rieß, J.	Vehicle Safety Institute, Graz University of Technology, Inffeldgasse 13/6, 8010 Graz,	Austria	Heavy vehicle–cyclist collision avoidance

An article by Vieira et al. [32] proposes an approach to enhance the efficiency of urban intersections by integrating Visible Light Communication (VLC) into a multi-intersection traffic control system. This article aims at introducing a procedure that can reduce waiting times for vehicles and pedestrians, that can improve overall traffic safety, and that can accommodate diverse traffic movements during multiple-signal phases. The proposed system utilizes VLC to facilitate communication among interconnected vehicles and infrastructure. The proposed system successfully reduces both waiting and travel times. Their study emphasizes the possibility of applying reinforcement learning in everyday traffic scenarios, showcasing the potential for the dynamic identification of control actions and improved traffic management.

In [33] of the Special Issue, Granà et al. investigate connected automated vehicle (CAV)–human driver interactions and estimate the potential conflicts by using traffic microsimulation and surrogate safety assessment measures. The article highlights how CAV presence can diminish conflicts, employing surrogate safety measures and real-world mixed traffic data, and assesses the safety and performance of freeway interchange configurations in Italy and the US across diverse urban contexts. The authors propose tools for optimizing urban layouts to minimize conflicts in mixed traffic environments, and their results show that adding auxiliary lanes enhances safety, particularly for CAVs and rear-end collisions. They conclude that when CAVs follow human-driven vehicles in near-identical conditions, more conflicts arise, emphasizing the complexity of CAV integration and the need for careful safety measures and roadway design considerations.

In their article, Sun et al. [34] developed an innovative traffic crash risk prediction model called StackTrafficRiskPrediction, which intends to improve the accuracy of predicting the severity of traffic crashes. The model combines multidimensional data analysis including environmental factors, human factors, roadway characteristics, and accident-related meta-features. In the model comparison, the StackTrafficRiskPrediction model achieved an accuracy of 0.9613, 0.9069, and 0.7508 in predicting fatal, serious, and minor crashes, respectively, showing that it significantly outperforms the traditional logistic regression model. The authors conducted an experiment that analyzed the severity of traffic crashes under different road, light and weather conditions involving drivers of different age groups and with different levels of driving experience. The results show that drivers between 31 and 50 years of age with 2 to 5 years of driving experience are more likely to be involved in serious crashes.

In their article, Viadero-Monasterio et al. [35] argue that although the advanced driver assistance systems that were introduced significantly reduced motor vehicle crashes by providing crucial support for high-speed driving and alerting drivers to imminent dangers, these systems still depend on the driver's ability to respond to warnings effectively. In this article, the authors developed a neural network model for the automatic detection and classification of objects in front of a vehicle, including pedestrians and other vehicles, using radar technology, in order to overcome this limitation. The proposed neural network model achieved a high accuracy rate, correctly identifying approximately 91% of objects in the test scenarios. The results demonstrate that this model can be used to inform drivers of potential hazards or to initiate autonomous braking and steering maneuvers to prevent collisions.

Zahedieh and Lee [36] evaluate the impacts of a toll information sign with different toll lane configurations on the queue length and collision risk at a toll plaza with an estimated high percentage of heavy vehicles (HVs). The toll information sign displays information about different toll payment methods for cars and HVs upstream of the toll booth. The authors used a traffic simulation model to assess the impacts of the toll plaza utilizing the Gordie Howe International Bridge under construction at the Windsor–Detroit international border crossing as a case study. The results show that the toll information sign upstream of the toll plaza and converting the toll lanes with multiple toll payment methods to electronic toll collection (ETC)-only lanes reduces queue length and collision risk but at the same time increases the number of HV-only lanes, because a higher percentage of HVs increases the lane change collision risk.

In order to reduce broadside collisions, Xu and Xu [37] tested CornerGuard, a prototype system they developed that senses objects around a corner to alert a car driver of an impending collision with a pedestrian or automobile that is not in the line of sight (LOS). CornerGuard leverages a microwave-transceiving radar sensor mounted on the car and a curved radio wave reflector installed at the corner to sense objects around the corner and detect a broadside collision threat. Field testing demonstrated that CornerGuard can effectively and consistently detect threats within a consistent range without blind spots under broad weather conditions.

In an article by Tomasch et al. [38], the authors use crash simulations to assess a warning and autonomously intervening assistance system that could prevent heavy vehicle trucks from crashes with cyclists that is capable of blind spot detection (BSD). BSD is supposed to overcome challenges caused by local sight obstructions such as fences, hedges, or inattentive cyclists. The assessment results showed that the BSD system could prevent 26.3–65.8% of crashes involving heavy vehicles, such as trucks, and cyclists.

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