Special issue “RSS2022 Conference Advanced Road Safety Analyses

Yannis, George; Papadimitriou, Eleonora

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Editorial

Special issue “RSS2022 Conference: Advanced Road Safety Analyses”

1. Introduction

This Special Issue of Safety Science titled “RSS2022 Conference: Advanced Road Safety Analyses” compiles groundbreaking research presented at the 8th Road Safety and Simulation International Conference 2022 (RSS2022) that took place on 08–10 June 2022 at Zappeion Megaron in Athens, organized by the National Technical University of Athens (NTUA) and the Hellenic Institute of Transportation Engineers (HITE). This collection reflects a concerted effort to advance scientific knowledge in road safety, aiming to mitigate crash fatalities and injuries in the digital era through innovative quantitative research methods.

2. Overview of selected papers

This Special Issue from the RSS2022 Conference provides a synthesis of ten (10) high-quality scientific papers which cover a broad spectrum of topics within road safety analysis. From Big Data and naturalistic driving, to automated vehicles and safety modelling, each paper contributes valuable insights into the current challenges and opportunities in road safety research. Notably, the studies employ a range of methodologies, including survival analysis, Bayesian modeling, and microscopic simulation, in order to explore the complex dynamics of road user behavior and road risk, and assess the effectiveness of various safety interventions.

2.1. Naturalistic driving

Naturalistic driving is the most comprehensive way of monitoring of driver behavior in real traffic conditions; however, it requires significant effort for the appropriate vehicle instrumentation, as well as thorough and tedious data cleaning before conducting any analyses. Researchers reveal that despite the extensive setup and preprocessing work, the depth and authenticity of the data collected make naturalistic driving studies invaluable for developing safety interventions and informing policy decisions aimed at reducing road crashes (Ziakopoulos et al., 2020; Singh and Kathuria, 2021).

Fafoutellis et al. (2023) utilized naturalistic driving data to explore the impact of the COVID-19 pandemic on driving behavior, specifically focusing on ecological driving. They employed a clustering approach to identify distinct driving profiles uncovering three unique profiles: aggressive, eco, and typical. Through statistical analysis across different periods—before the lockdowns, during the first and second lockdowns, and between the two lockdowns—they observed a trend towards smoother, safer, and more ecological driving behaviors.

On a similar note, Venthuruthiyil et al. (2023) conducted research that focuses on the safety of Powered Two-Wheelers (PTWs) in low- and middle-income countries, where PTWs are a popular mode of transport due to their agility and speed in congested urban environments. Vehicle trajectory data gathered from an urban midblock section were used to estimate traffic conditions and potential crash states. Particularly, utilizing the Anticipated Collision Time (ACT) as a surrogate measure of safety, the study proactively assesses PTW safety, utilizing revealing that PTW crash risk is significantly affected by traffic density and PTW maneuvering behaviors like filtering and weaving. The findings highlight the need for targeted safety interventions and the development of advanced rider information systems to mitigate PTW crash risk.

2.2. Big data

Big Data are increasingly omnipresent to support the authorities, the industry and the road users; however, governance, market and technical issues should be properly tackled, together with the need for pertinent analysis by road safety scientists. By harnessing vast datasets from sources such as GPS devices, vehicle / road sensors, and video surveillance, researchers can now analyze and predict high risk sites, understand the underlying factors contributing to crashes, and evaluate the effectiveness of safety treatments with greater accuracy and detail (Neilson et al., 2019). Big data analytics enable the identification of subtle patterns and trends that were previously indiscernible, allowing for the development of customized and targeted data-driven strategies to enhance road safety.

In that context, Yang et al. (2023) challenged the traditional approach of aggregating traffic crash data over long periods, such as a year, an approach which assumes temporal stability in treatment effects. Recognizing the fast-evolving changes in road safety brought by events like the COVID-19 pandemic, they utilized individual crash records to investigate the temporal characteristics of crashes and propose a Survival Analysis with Random Parameter (SARP) for before-after analysis to capture the potential temporal instability in the treatment effect. Through a simulation study on COVID-19′s impact in the case of Manhattan, the study demonstrates SARP’s ability to accurately estimate temporally unstable treatment effects, suggesting its utility in analyzing the safety impact of emerging transportation technologies.

Similarly, Schultz et al. (2023) examined the effectiveness of employing dual crash ‘hot spot’ analyses for intersections and roadway segments, enhancing the precision in identifying sites with higher-than-expected injury-causing crashes. By distinguishing crashes into intersection- or segment-specific analyses, the study highlights unique safety concerns, such as driveway-related incidents or excessive queuing, which might have been overlooked in a global network analysis. This

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dual approach enables transportation agencies to pinpoint high risk sites more accurately and deploy context-specific, targeted countermeasures for improving road safety.

In Xu et al. (2023) extensive Weigh-in-Motion (WIM) data were used in order to capture detailed vehicle weight information alongside road features, traffic volume, and crash data. Particularly, the authors analyzed data from 2011 to 2015 across 88 stations in New Jersey with the aim to investigate how truck traffic characteristics and other contributory factors influence the proportions of severe crashes on road segments. Through the development and application of one-part and two-part Fractional Regression Models (FRMs), their findings revealed that an increase in mean vehicle weight significantly increases the Fatality and Injury Proportion (FIP) of road segments with non-zero FIP, thereby establishing a critical link between actual vehicle weight in the traffic flow and road segment crash severity.

2.3. Safety modelling

Safety modelling investigates the extent to which various road safety factors may influence the occurrence of crashes and their severity; however, advanced skills of scientific quantitative analysis together with appropriate data are basic prerequisites for credible and useful results. The effective application of safety modelling demands continuous updates and validation against new data sets, to ensure the models' reliability and relevance in evolving traffic environments, thereby enhancing predictive capabilities and informing targeted interventions. For example, while the Road Safety Manual, issued by AASHTO in 2010 (AASHTO, 2010), offers detailed guidelines for assessing highway safety treatments on the basis of safety performance metrics, further research is essential to identify the section-specific crash causes that require targeted interventions.

Given the current limitations, Ali et al. (2023) conducted research to allow real-time crash risk evaluation and development of effective mitigation strategies. They proposed a novel traffic conflict-based crash estimation technique, utilizing a Bayesian modeling framework and a Block Maxima approach, to estimate real-time crash risks from traffic conflicts identified by modified time-to-collision (MTTC). Tested with 96 h of traffic movement video data from a Queensland intersection, the study demonstrated the model's effectiveness in estimating crash risk and highlighted significant variations in crash risk during different times of the day, confirming the framework's potential for proactive safety management.

Furthermore, Russo et al. (2023) aimed to explore the dynamics behind driver's fault status (at-fault / not at fault) and injury severity in rear-end crashes at intersections, using data from a southwestern US state. Through the estimation of a binary probit model for fault status, and a bivariate ordered probit model for injury severity, they identified significant factors influencing these outcomes, including vehicle type, driver age, and driver distraction or impairment.

Bartin et al. (2023) developed and calibrated a safety performance function for undivided two-lane urban and suburban arterial segments in New Jersey, exploring various statistical models, such as Negative binomial, Poisson, zero-inflated Poisson, and Hurdle model, in order to determine the best fit based on comprehensive evaluation criteria. They utilized a 'development' database for model generation and a 'test' database for calculating calibration factors. The findings suggest that the Negative binomial and Hurdle models showed superior prediction accuracy. Additionally, the study highlights the significant impact of crash location accuracy on analysis results, emphasizing the challenges and potential inaccuracies in crash frequency databases and resulting the identification of intersection-related crashes.

2.4. Connected and automated vehicles

Connected and automated vehicles are expected to boost road safety; however, multidisciplinary scientific research is needed to provide and evidence base for their responsible deployment and particular attention should be given to the long transition phase of mixed traffic of conventional and automated/connected vehicles. More precisely, the transition phase presents unique opportunities for innovation in traffic management, infrastructure design, and regulatory frameworks to accommodate the evolving traffic dynamics and ensure both safety and efficiency in an increasingly automated transportation landscape (Elliott et al., 2019).

One of the key advantages of incorporating automated vehicles (AVs) into daily transportation routines is their potential to enhance road safety, offering increased protection for the most vulnerable users, such as pedestrians and cyclists, as well as improving safety for other vehicle users. In that framework, Hula et al. (2023) aimed to establish a functional relationship between the proportion of automated vehicles (AVs) on the road and the expected number of accidents and fatalities involving vulnerable road users. They analyzed current accident causes to determine which ones could potentially be mitigated by AVs. Utilizing statistics on braking distances and reaction times, alongside a power model, they estimated potential reductions in crashes and fatalities, and presented a relationship between AV penetration rates and crash/fatality rates.

In this context, de Gelder and den Camp (2023) addressed the challenge of defining "reasonably foreseeable and preventable" collisions for Automated Driving Systems (ADS), a crucial aspect of the 2021 United Nations regulation for Automated Lane Keeping Systems (ALKS). They propose a quantitative method that considers the Operational Design Domain (ODD) of ADS, offering a clearer framework for developers, authorities, and users to understand and manage the residual risks associated with deploying these systems in real traffic. This method aims to facilitate the approval process for AVs by providing a concrete basis for evaluating system safety and justifying design decisions.

3. Conclusions

The Special Issue of Safety Science on "RSS2022 Conference: Advanced Road Safety Analyses" represents an essential contribution to the evolution of road safety research, providing a comprehensive overview of the latest methodologies, analysis techniques, and insights in the domain. Through a diverse collection of papers, the special issue addresses the multifaceted road safety challenges and offers innovative solutions leveraging naturalistic driving, big data, advanced safety modelling techniques and connected and automated vehicles applications. The fusion of these cutting-edge research themes underscores a pivotal shift towards more dynamic and case-specific data-driven strategies for mitigating crash fatalities and injuries. This highlights the importance of continuous adaptation of research goals and the adoption of novel technologies and analysis methods in the pursuit of safer roads. The emphasis on granular, real-time safety analysis one the one hand, and on the implications of automated vehicles on safety in mixed traffic on the other hand, are particularly noteworthy for assuming a much needed forward-thinking perspective on road safety.

The contributions within this special issue collectively underscore the critical need for interdisciplinary research and collaboration. By challenging traditional paradigms and integrating advanced technological and methodological approaches, the presented studies pave the way for a new era of road safety analysis that is more nuanced, predictive, and effective. The topics tackled in the special issue, together with their governance, technical, and market challenges, may serve as a roadmap for future research and implementation. Future road safety policies should adapt to and capitalize on the rapid advancements in transportation technologies, methods and data analytics, and the resulting enhanced understanding of road safety dynamics, ultimately leading to a real contribution in the reduction of road injuries and fatalities.

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George Yannis*
Department of Transportation Planning and Engineering, National Technical University of Athens, 5 Iroon Polytechniou St., GR-15773 Athens, Greece

Eleonora Papadimitriou
Faculty of Technology, Policy and Management Safety and Security Science Section, Delft University of Technology, Jaffalaan 5, Delft 2628 BX, the Netherlands

* Corresponding author.
E-mail address: geyannis@central.ntua.gr (G. Yannis).