# Preface

The primary purpose of this textbook is to provide the state-of-the-art knowledge about how to better analyze safety data given their unique characteristics. This textbook provides the latest tools and methods documented in the highway safety literature, some of which have been developed or introduced by the authors. The textbook covers all aspects of the decision-making process, from collecting and assembling data to making decisions based on the analysis results, and is supplemented by real-world examples and case studies to help understand the state of practice on the application of models and methods in highway safety. Where warranted, helpful hints and suggestions are provided by the authors in the text to support the analysis and interpretation of safety data.

The textbook is suitable for college students, safety practitioners (e.g., traffic engineers, highway designers, data analysts), scientists, and researchers who work in highway safety. This textbook specifically complements the Highway Safety Manual (HSM) published by AAHSTO and the Road Safety Manual (RSM) by the World Road Association. The publication of the HSM, RSM, and other safety-oriented guidelines has substantially increased the demand for training engineers and scientists about understanding the concepts and methods outlined within. Hence, the content of this textbook helps fill in this gap by describing the methods in greater depth and allows the readers to broaden their knowledge about the fundamental principles and theories of highway safety.

All three authors of this textbook have taught graduate-level courses in highway safety at different institutions. The material covered had to be used from various sources, including chapters (or part of them) of various textbooks in areas within and peripheral to highway safety, published peer-reviewed papers, class notes from the world leaders in highway safety (e.g., Dr. Ezra Hauer), research reports, and manuals published by national public agencies. Most of these materials did not contain exercises and problems that students could use to apply the knowledge acquired from these documents. Throughout the years, it became clear that a textbook was needed that could combine all these important topics into a single document. The one from which students could read and learn about theoretical principles and apply them using observed (or simulated) data. In this regard, the textbook includes more than nine

datasets for more than 40 exercises. Most of these datasets have been used in peer-reviewed publications. All the datasets can be found at the lead author's website: https://ceprofs.civil.tamu.edu/dlord/Highway_Safety_Analytics_and_Modeling.htm.

The content of the textbook is based on an accumulation of more than 40 years of research and applications related to methods and tools utilized for analyzing safety data. The textbook is divided into three general areas. The first area includes chapters that describe fundamental and theoretical principles associated with safety data analyses. This area covers the nature of the crash process from the human and statistical/mathematical perspectives, as well as key crash-frequency and crash-severity models that have been developed in the highway safety literature. The second area groups chapters that describe how the various models described in the first area are applied. The chapters include methods for exploring safety data, conducting cross-sectional and before-after studies, identifying hazardous sites or sites with promise as well as tools for incorporating spatial correlation and identifying crash risk on a near real-time basis. The third area assembles alternative safety analysis tools. The methods include how to use surrogate measures of safety and data mining techniques for extracting relevant information from datasets, including those categorized as big data (e.g., naturalistic data).

It is hoped that the content will help readers to better understand the analytical tools that have been used to analyze safety data to make informed decisions for reducing the negative effects associated with crashes across the globe. This is even more important given the Vision Zero programs that have been increasingly implemented by various agencies in Europe, North America, and Eurasia among others. The content should also help improve or develop new tools aimed at estimating the safety performance of connected and automated vehicles, especially when they will be deployed in mixed-driving environments (within the next decade).

For implementing methods and techniques proposed in this textbook, the authors have provided computer codes for three advanced software languages. Of course, the methods are not restricted to just three, but many other software languages can be easily implemented to be utilized given the parameterization described in the textbook. Along the same line, Microsoft Excel provides simple, flexible, and adequate tools that can be used to implement various simpler methods, such as the graphical methods presented in Chapter 5 or before-after studies described in Chapter 7.

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