MPC-631
August 25, 2020

Project Title

Enhancing Crash Data Reporting to Highway Safety Partners in Wyoming by Utilizing Big Data Analysis and Survey Techniques

University

University of Wyoming

Principal Investigators

Anas Alrejjal
Graduate Research Assistant
University of Wyoming
Phone: (307) 761-3899
Email: aalrejja@uwyo.edu
ORCID: 0000-0003-1661-6697

Milhan Moomen, Ph.D.
Postdoctoral Research Associate
University of Wyoming
Phone: (765) 237-8230
Email: mmoomen@uwyo.edu
ORCID: 0000-0001-8324-7540

Khaled Ksaibati, Ph.D., P.E.
Professor and Director of the Wyoming Technology Transfer Center
University of Wyoming
Phone: (307) 766-6230
Email: khaled@uwyo.edu
ORCID: 0000-0002-9241-1792

Research Needs

Road crashes extoll high costs on lives and property and has been a major concern for society. Traffic safety analysis is required to raise awareness about the effects of road crashes and traffic injuries, convince policy makers to take action, identify safety hot spots and recommend best measures to counter the occurrence of traffic crashes. To achieve this, reliable and accurate data are needed to formulate strategies, set targets and monitor safety performance. Police-recorded crash data forms the primary source of information about crashes and the relation of the environment, human behavior and vehicle characteristics to the crashes. Traffic safety stakeholders and partner agencies in Wyoming rely on WYDOT to provide reliable and accurate data to fulfill their strategic goals. However, a gap exists between the expectations of the agencies in terms of data type and quality required, and what is provided by WYDOT. Also, because human factors form a significant proportion of the factors impacting crash frequency

and severity, an analysis is required to identify these factors. The product of this study will be an identification of the safety data needs of partner agencies by identifying gaps in the type and quality of safety data provided by WYDOT through a survey questionnaire. This will result in an improvement in the reporting of safety data to partner agencies so that effective countermeasures and policies may be implemented to improve traffic safety in Wyoming.

Research Objectives

The first objective of this study is to assess the data needs of WYDOT's safety partners and agencies, identify gaps in crash reporting, and recommend appropriate guidelines to present traffic safety data. The study will also to identify human factors that impact crash severity and frequency in Wyoming using big data analysis and determine reporting intervals for such factors.

Research Methods

Big data analysis will be utilized to identify human factors impacting crash severity and frequency. Also, big data analysis will be utilized to analyze long and short-term trends of the factors identified. From the analysis, factors that change significantly within short intervals will indicate the need for short-term reporting, while factors that show little fluctuation over time will suggest long-term reporting. A survey questionnaire will be prepared and distributed to the safety agencies to identify the data gaps between data required by the agencies and what is currently being provided by WYDOT.

Expected Outcomes

Based on the results from the survey and data analysis, a matching of the data needs and human factors identified will be undertaken. The matching will help to identify gaps in variables being currently reported to the safety agencies and what the agency needs are. Recommendations will then be made on how to bridge the gaps identified, propose other important human factors that need to be reported and recommend reporting intervals of the variables identified.

Relevance to Strategic Goals

Overall, the research is expected to improve safety in Wyoming. Following the results of the survey and assessment of human factors, recommendations will be made on frequency of reporting on important safety variables affecting safety. This will help in the timely identification of safety issues and effective deployment of countermeasures. Also, the research will make recommendations on the generation of crash reports such that they fit into the wider goals and objectives of safety agencies in the state.

Educational Benefits

The research will require contributions from a transportation engineering faculty member, a postdoctoral researcher, and a student. The team will apply big data analysis techniques to analyze human factors which will provide a new perspective on the research of safety data using the new field of machine learning approaches. This will be an initial experience and the methodology will lay a good foundation from which future researchers can learn.

Technology Transfer

The results of the study will help WYDOT identify critical safety human factors that impact crash frequency and severity. This can assist safety agencies in the state to select and implement effective countermeasures to improve safety. The final report from the study will form a guideline for the WYDOT safety office to integrate their safety basis. Also, reporting templates will be provided as an output of the research to guide WYDOT in preparing crash reports that satisfy the data needs of safety agencies in the state.

Work Plan

- Literature review – The literature review will evaluate the current state of crash reporting systems in the United States and the use of big data in safety studies. This task will last five months.

- Identify and assess WYDOT safety reports/databases – This task is expected to commence in January 2020. Typical WYDOT reporting formats will be assessed and databases integrated to provide better data utilization.

- Comprehensive data needs assessment – By March 2020, a comprehensive data needs assessment of safety agencies will be undertaken to evaluate the reporting requirements of the safety partners. This will take about six months.

- Communication with safety partners about objectives of this study – Channels of communication will be opened with the safety partners to explain the objectives of the study. This task will be completed in four months.

- Identify human factors impacting crash severity and frequency – An evaluation will be conducted to identify human factors impacting crash severity and frequency using big data analysis. This task will be undertaken in eight months.

- Determining the reporting frequency of human factors – From the results of the previous task, trend analysis will be utilized to determine the reporting frequency of important human factors identified. The task will be completed in five months.

- Recommend best formats and intervals to report crash data – The data needs and the most effective reporting format for the safety agencies will be recommended. The task will be completed in four months.

- Integrate report generation with WYDOT format – This task will involve recommendations on the integration of generated crash reports with existing WYDOT formats to ensure compatibility with existing formats and software. The task will be completed in four months.

- Prepare final report and present study findings – The findings of the report will be presented in a final report to WYDOT. Sample formats for crash reporting will be included in the final report. This task is expected to last five months.

Project Cost

Total Project Costs:	$183,512
MPC Funds Requested:	$ 65,633
Matching Funds:	$117,879
Source of Matching Funds:	Wyoming Department of Transportation

References

Abdel-Aty, M., Abdelwahab, H. (2004) Predicting Injury Severity Levels in Traffic Crashes: A Modeling Comparison. *Journal of Transportation Engineering*. **130**(2), 204–210.

Abellan, J., Lopez, G., de Ona, J. (2015) Analysis of traffic accident severity using Decision Rules via Decision Trees. *Expert Systems with Applications*. **40**(15), 6047–6054.

Alcohol Alert (2019) Wyoming Driving Statistics. [online]. Available from: http://www.alcoholalert.com/drunk-driving-statistics-wyoming.html

Australian Bureau of Statistics (2019) Quality Declarations-Timeliness. *Quality Declarations*. [online]. Available from: https://www.abs.gov.au/websitedbs/d3310114.nsf/4a256353001af3ed4b2562bb00121564/429ef5357ff40788ca25734f001218c4!OpenDocument

Australian Transport Council (2008) *National Road Safety Action Plan 2009 and 2010*.

Chan, L.-Y., Chien, J.-T. (2013) Analysis of driver injury severity in truck-involved accidents using a non-parametric classification tree model. *Safety Science*. **51**(1), 17–22.

Chen, C., Zhang, G., Qian, Z., Tarefdar, R.A., Tian, Z. (2016) Investigating driver injury severity patterns in rollover crashes using support vector machine models. *Accident Analysis & Prevention*. **90**(May), 128–139.

Delen, D., Sharda, R., Bessonov, M. (2006) Identifying significant predictors of injury severity in traffic accidents using a series of artificial neural networks. *Accident Analysis & Prevention*. **38**(3), 434–444.

Dingus, T.A., Guo, F., Lee, S., Antin, J.F., Perez, M., Buchanan-King, M., Hankey, J. (2016) Driver crash risk factors and prevalence evaluation using naturalistic driving data. *Proceedings of the National Academy of Sciences of the United States of America*. **113**(10), 2636–2641.

Kashani, A.T., Mohaymany, A.S. (2011) Analysis of the traffic injury severity on two-lane, two-way rural roads basedon classification tree models. *Accident Analysis & Prevention*. **49**(2011), 1314–1320.

Khattak, A.J. (2016) *Safety Managment System Needs Assessment*. Lincoln, Nebraska.

Li, X., Lord, D., Zhang, Y., Xie, Y. (2008) Predicting motor vehicle crashes using Support Vector Machine models. *Accident Analysis & Prevention*. **40**(4), 1611–1618.

Logan, M., McShane, P. (2006) Emerging Crash Trend Analysis. In *Proceedings of the Australasian Road Safety Research, Policing and Education Conference*. Brisbane, Australia.

Mead, M.H., Carlson, M.D., Ledet, K. (2017) *Wyoming's Highway Safety Behavioral Grants Program Highway Safety Plan Report*. Cheyenne, Wyoming.

Mitchell, R.J., Williamson, A.M., O'Connor, R. (2009) The development of an evaluation framework for injury surveillance systems. *BMC Public Health*. **9**, 1–14.

Moghaddam, F.R., Afandizadeh, S., Ziyadi, M. (2011) Prediction of accident severity using artificial neural networks. *International Journal of Civil Engineering*. **9**(March).

Njord, J.R., Capka, R.J., Meyer, M.D., Horsley, J.C., Skinner Jr, R.E., Townes, M.S., Walton, M.C. (2005) *NCHRP Synthesis 350 Crash Records Systems-A Synthesis of Highway Practice*. Washington D.C.: Transportation Research Board of the National Academies.

Scopatz, R., Brown, R., Zhou, Y., Benac, J., Peach, K., Bryson, M., Lefler, N. (2017) *Crash Data Improvement Program Guide*. Washington D.C.

Singh, S. (2018) *Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey*. Washington D.C.

United States Department of Labor (2019) Wyoming State Plan. *Occupational Safety and Health Administration*. [online]. Available from: https://www.osha.gov/dcsp/osp/stateprogs/wyoming.html

United States Government Accountability Office (2004) *Highway Safety: Improved Monitoring and Oversight of Traffic Safety Data Program are Needed*. Washington, D.C.

Vandervalk, A.D., Snyder, D., Hajek, J.K. (2017) *Guide for State Department of Transportation Safety Data Business Planning FHWA Safety Program*. Washington D.C.

Vapnik, V. (1998) *Statistical Learning Theory*. Wiley, ed. New York, NY.

World Health Organization (2010) *Data systems: A Road Safety Manual for Decision-Makers and Practitionera*. Geneva, Switzerland.

Wyoming Department of Health (2019) Motor-Vehicle Traffic Injuries. *The Wyoming Injury and Violence Prevention Program*. [online]. Available from: https://health.wyo.gov/publichealth/prevention/wivpp/injurymvtui/.

Wyoming Highway Patrol (2019) Safety Eduction. *Safety Education*. [online]. Available from: http://www.whp.dot.state.wy.us/home/safety_education.html [Accessed August 27, 2019].

Wyoming Transportation Safety Coalition (2019) Welcome to the Wyoming TSC. [online]. Available from: https://wyotsc.com/.

Yu, R., Abdel-Aty, M. (2014) Analyzing crash injury severity for a mountainous freeway incorporating real-time traffic and weather data. *Safety Science*. **63**(March), 50–56.

Zeng, Q., Huang, H. (2014) A stable and optimized neural network model for crash injury severity prediction. *Accident Analysis & Prevention*. **73**(December), 351–358.