2018 TRANSPORTATION RESEARCH BOARD PAPERS, POSTERS AND PRESIDERS

MOUNTAIN-PLAINS CONSORTIUM

CONTENTS

COLORADO STATE UNIVERSITY

Applying Large-Scale Optimization to Evaluate Pavement Maintenance Alternatives for Low-Volume Roads Using Genetic Algorithms

Marwan Hafez, University of Wyoming
Khaled Ksaibati, University of Wyoming
Rebecca Atadero, Colorado State University

Over the last decade, significant progress has been made to customize the maintenance policies of low-volume roads (LVRs) to the available local needs and resources. The application of low-cost treatments and surface repairs are extensively employed to reduce the annual maintenance costs. Colorado Department of Transportation (CDOT) applies chip seals and thin overlays as the only available treatment options applied to LVRs. However, the effectiveness of these treatments depends mainly on the existing condition of pavements. Some surface treatments and light rehabilitations provide only short-term effectiveness, and state DOTs make unnecessary expenditures when applying these strategies. The multi-year optimization techniques support decision makers with a set of optimal maintenance activities to achieve specific pavement performance targets within reasonable budgets. This study applies large-scale optimization to compare between the current CDOT maintenance policy and an alternative strategy recommended for low-volume paved roads in Colorado. Genetic algorithms were applied in the optimization models because they are capable to resolve computational complexity of optimization problems in a timely fashion. The optimized maintenance alternatives were comprehensively investigated for a LVRs network in Colorado over a specific planning horizon. The specific optimization constraints and limitations prevailing LVRs are addressed and introduced in the problem formulation of optimization process. The results of both performance and cost analysis emphasize the effectiveness of the proposed

maintenance strategy compared to the followed one. The alternative policy provides much more benefit-cost saving while preserving the overall pavement performance of the network. This approach is expected to be efficient to quantify the mid and long-term financial impact of different treatment policies applied to LVRs within modest resources.

A Decision Support Framework for Assessing the Contextual Factors for Complex Highway Projects

Akanksha Sinha, Colorado State University
Kelly C. Strong, Colorado State University
Mehmet E. Ozbek, Colorado State University
Jennifer Shane, PhD (Iowa State University)

Traditional strategies for highway projects during the 1950s and 1960s focused on three dimensions of project management i.e. cost, schedule and technical (scope). Recently, with the focus shifting towards reconstruction/rehabilitation projects, project management strategies have shifted to include other project management dimensions. The Second Strategic Highway Research Program (SHRP2), project R-10 examined the best practices for managing complex renewal projects. The primary outcome of the study was a recommendation to utilize a five-dimensional project management planning (5DPM) model that added context and financing as two new dimensions to the traditional dimensions of cost, schedule, and technical. The pilot testing of the 5DPM implementation suggested that the most complicated dimension to assess during the project management planning phase for a complex project is the context dimension. Currently there is no efficient, structured process for evaluating the context dimension on complex projects within the 5DPM framework. Given this, the objective of this study is to develop a decision support framework which can be used by different transportation agencies when assessing contextual factors and assigning complexity rating scores. The framework uses a structured analytical process as opposed to the more subjective scoring used during the 5DPM workshops. As a major part of its methodology, this research uses a multiple-criteria decision-making tool called Analytical Hierarchy Process in developing the framework. The paper presents two implementation examples which demonstrate the feasibility of the developed framework for a rebuild project and an expansion project.

Driving Behavior on the Long-Span Bridge Under the Wind-Vehicle-Bridge Coupling System: A Driving Simulator Study

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Feng Chen, Tongji University
Xiaodong Pan, Tongji University
Haorong Peng, Tongji University
Suren Chen, Colorado State University
Yufen Zhou, Colorado State University

Long-span bridges play an important role in the transportation system. Nonetheless, they are often located at wind -prone areas thus pose special challenges on driving safety. On the long span bridge, driving risk arises due to not only the sole influence of the crosswind, but also the complex dynamic interactions among the wind, vehicles, and the bridge. Therefore, a rigorous driving safety study on the long-span bridge should be carried out in the wind-vehicle-bridge coupling system. In most existing studies using the numerical simulation, the role of driver behavior was either not accounted for or

overly simplified. However, the vehicle's motion is a result of both the external excitation and the driver's behavior. The objective of this paper is to characterize the driving behavior of cars and trucks under the wind-vehicle-bridge coupling system in driving simulator. To achieve this objective, a driving simulation platform was first established which incorporated external forces including the crosswind and the bridge vibration. Then a series of driving simulation experiments were conducted, involving not only the passenger car but also the truck. It was found that drivers usually over-correct the steering wheel, and this problem is more serious for truck. Another important finding was that the touch of the steering wheel was also an important source of driver perception, in addition to the visual. And when the vehicle speed was 60 km/h and the wind speed did not exceed 20 m/s, the influence of vehicle-bridge interaction on the vehicle moving state and the driver behavior was not significant.

Strategic Transportation and Logistics Management for Importing Crude Oil to Produce Asphalt and Road Oil in the United States

Raj Bridgelall, North Dakota State University
EunSu Lee, New Jersey City University
Michael Bell, New Jersey City University

Asphalt and road oil demand heavily leverages local supply because the product is a hot binder of aggregates that forms the final mix needed to pave roads. This paper discusses the supply chain characteristics of the crude oil feedstock by considering the overall logistics of sourcing heavy crude oil, which is source of asphalt and road oil production, domestically or importing it from international trading partners. The study examines several factors such as customs, regulations, security, environmental compliance, and natural events that will affect the costs, schedules, and risks. This study provides a framework for the decision-making to source feedstock for the production of asphalt.

Performance of Hyperspectral Imaging with Drone Swarms

Raj Bridgelall, North Dakota State University
James Rafert, North Dakota State University
Denver Tolliver, North Dakota State University

The ongoing proliferation and diversification of remote sensing platforms offers greater flexibility to select from a range of hyperspectral imagers as payloads. The emergence of low-cost unmanned aircraft systems (drones) and their launch flexibility presents an opportunity to maximize spectral resolution while scaling both daily spatial coverage and spatial resolution simultaneously by operating synchronized swarms. This article presents a model to compare the performance of hyperspectral-imaging platforms in terms of their spatial coverage and spatial resolution envelope. The authors develop a data acquisition framework and use the model to compare the achievable performance among existing airborne and space-borne hyperspectral imaging vehicles, and drone swarms. The results show that subject to cost and operational limitations, a platform implemented with drone swarms has the potential to provide greater spatial resolution for the same daily ground coverage of existing airborne platforms.

Solving the Log-Truck Routing Problem Accounting for Forest Road Maintenance Policies: A Case Study of Oregon

Amin Keramati, North Dakota State University
Ahmad Sobhani, Oakland University
Seyed Ali Haji Esmaeili, North Dakota State University
Pan Lu, North Dakota State University

Reducing timber product costs has long been timber industry focus for centuries. Transportation cost accounts for more than 30 percent of the total log product costs and the most influential factor for transportation costs is log-truck travel distance, which is a function of various road characteristics and administration policies. Previous research shed a light on understanding those factors, however

understanding the impact of forest road maintenance policies on log-truck routing selection and on service coverage is still unclear. Forest roads with different maintenance levels will have different speed limitations and different operative status. Some roads with certain maintenance level will have to be decommissioned. In turn, it will affect log-truck route selection and service coverage. In this study, the researchers assess the travel-time between wood mills and timber production areas while considering the impact of forest road maintenance policies. Moreover, the effect on forest area coverage is also analyzed. The study tested on the effects of forest road maintenance policies and proposed improved log-truck rout selection considerations. The study indicates that there is statistical significant different in route selection under different maintenance policies, however, the current objective maintenance policy makes no significant difference on route selection than under operational maintenance policy, moreover, results indicated that 49% to 67% of the timber area can be under service if different forest maintenance policy is selected.

Managing the Safety of Older Drivers

Brenda Lantz, North Dakota State University

Lantz moderated this session which focused on managing the safety of older drivers operating commercial vehicles. Discussion focused on an examination of recent heavy vehicle crash data to identify risk factors most prominent among older drivers; challenges to safety program management; and evidence used to determine medical fitness to drive in the context of in the context of research needs and opportunities.

Truck and Bus Safety Committee

Brenda Lantz, North Dakota State University

Lantz presided over a meeting of the TRB's Truck and Bus Safety Committee. The committee identifies and articulates research needs related to commercial vehicle safety.

Truck and Bus Safety Research

Brenda Lantz, North Dakota State University

Lantz presided over this research session featuring poster on various topics focusing on commercial carrier safety research.

SOUTH DAKOTA STATE UNIVERSITY

Semicircular Bending (SCB) Test on Lab-Produced, Plant-Produced, and Field Warm-Mix Asphalts

Amir Arshadi, AECOM
Rouzbeh Ghabchi, South Dakota State University
Syed Ashik Ali, University of Oklahoma
Manik Barman, University of Minnesota, Twin Cities
Musharraf Zaman, University of Oklahoma
Sesh Commuri, University of Nevada, Reno

Fatigue cracking is a major distress in asphalt pavements. Occurrence of fatigue cracking depends on many factors such as pavement structure, traffic, environment, and most importantly fatigue performance of asphalt mixes used in the construction. Application of Warm Mix Asphalt (WMA) technology and incorporation of Reclaimed Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS) in asphalt mixes are effective and sustainable ways to preserve the environment while reducing the construction cost. Despite several advantages, concerns over the long-term performance of the green asphalt pavements have limited their use. In the present study, the cracking resistance of five different asphalt mixes including one hot mix asphalt (HMA) and four WMA mixes, were investigated using the Louisiana Semi-Circular Bend test, called SCB test in this paper. For all of the five mixes, the tests were conducted on laboratory-produced mixes, plant-produced mixes and, field cores. The results indicated that application of softer virgin binder and/or recycling agent improves the cracking resistance of a mix. Furthermore, the test results conducted on laboratory-produced and plant-produced mixes as well as the field cores were compared. Based on the outcomes of the laboratory tests, the SCB test was found to be an effective tool for screening of mixes for cracking resistance in the mix design process. The findings of this study are expected to add to the knowledge base in the area of the long-term performance of green asphalt pavements and facilitate their use, nationwide.

Reuse of Aqueous Waste Streams in Transportation Related Applications

Guanghui Hua, South Dakota State University
Gregory Hansen, South Dakota State University
Kyungnan Min, South Dakota State University
Christopher Schmit, South Dakota State University
David Huft, South Dakota Department of Transportation

Aqueous waste streams can be produced from many commercial, industrial, and municipal processes. Some aqueous waste streams such as salt brine may be used in transportation-related applications including pavement anti-icing and deicing, and dust control on unpaved roads. The objectives of this project were to identify potential transportation applications for aqueous waste streams available in South Dakota, develop guidance for evaluating the suitability of aqueous waste streams for transportation applications, and evaluate the reuse of ion exchange brine generated by the Watertown Municipal Water Treatment Plant. The results showed that many aqueous waste streams generated in South Dakota could be potentially reused for transportation applications, and the ion exchange brine could be reused for winter road maintenance to reduce the salt consumption for SDDOT.

Field Application of UAS-Based Bridge Inspection

Junwon Seo, South Dakota State University
Luis Duque, South Dakota State University
James P. Wacker, U.S. Forest Service

The use of Unmanned Aerial Systems (UASs), commonly known as drones, has significantly increased over recent years in the field of civil engineering. In detail, the need for a more efficient alternative for bridge inspection, has risen due to the increased interest from bridge owners. The primary goal of this paper was to evaluate the efficiency of a drone as a supplemental bridge inspection tool. To complete this study, a glulam girder with a composite concrete deck bridge was selected in the state of South Dakota (SD), and a drone, a DJI Phantom 4, was utilized to perform the bridge inspection. Based upon the literature review, an inspection procedure with a drone was developed, in order to efficiently identify damage on the bridge. A drone-enabled inspection was performed following the procedure, and resulting findings were compared to those available in the past inspection report provided by SD Department of Transportation (SDDOT). This study details drone-enabled inspection principles and relevant considerations to obtain optimum data acquisition. A key finding demonstrated throughout this project is that different types of structural damage on the bridge were identified using the drone.

Repairable Moment-Resisting Precast Bridge Columns

Mostafa Tazarv, South Dakota State University
Abdullah Boudaqa, South Dakota State University

Presented to a meeting of TRB AFF50, the standing Committee on the Seismic Design and Performance of Bridges.

UNIVERSITY OF COLORADO, DENVER

American Complete Streets and Australian Smart Roads: What Can We Learn from Each Other?

Alexa Delbosc, Monash University
James Reynolds, Monash University
Wesley Marshall, University of Colorado, Denver
Andrew Wall, VicRoads

No abstract provided.

Age-Specific Bicycling Safety Trends, 1985–2015

Nicholas Ferenchak, University of Colorado, Denver
Wesley Marshall, University of Colorado, Denver

Bicyclist fatalities have been in decline over the last thirty years, and closer analysis shows cycling safety rates improving. This research, however, notes age-specific differences in the direction and magnitude of this trend. Using fatality data from the Fatality Analysis Reporting System (FARS) and exposure data from the National Sporting Goods Association (NSGA), we disaggregate age-specific trends for children (aged 7-17 years) and adults (aged 18+ years). Results suggest that overall declines in bicyclist fatality rates have been primarily driven by a sharp decline in child bicyclist fatality rates, while adult bicyclist fatality rates have generally trended upwards. This work will hopefully add to the understanding of the dynamics of bicycling safety and define future research with regard to the importance of considering age-specific impacts.

Health, Transportation and Moving Forward

Carolyn McAndrews, University of Colorado Denver

McAndrews also presided over this poster session for practice-ready papers.

Let's Discuss Arterials, Public Health, and Metrics

Carolyn McAndrews, University of Colorado Denver

McAndrews presided this session which focused on ways to bring transportation and health metrics together in regard to arterial roadways.

Why Consider Transportation and Health in a Rural Context?

Carolyn McAndrews, University of Colorado, Denver
Keshia Pollack, Johns Hopkins University
Michael Widener, University of Toronto
Heidi Guenin, GridWorks
Robby Cantrell, North Central Alabama Regional Council of Governments

Transportation researchers and policy makers are growing increasingly concerned about the links between the health of residents living in rural areas and transportation. While much of the rural health discussion centers around access to health services based on social, economic, and demographic characteristics, there is a realization that the rural "health tent" is much larger. Active transportation, the jobs-housing-transportation balance, roadway and network design, and emissions regulation, are all of concern when considering population health in the rural context. Come join this session and help us frame a research agenda around the reasons for considering transportation and health in a rural context.

Bicyclist Safety Performance Functions for Road Segments in a U.S. City

Krista Nordback, UNC Highway Safety Research Center
Sirisha Kothuri, Portland State University
Bo Lan, UNC Highway Safety Research Center
Geoff Gibson, WSP
Nicholas Ferenchak, University of Colorado, Denver
Wesley Marshall, University of Colorado, Denver

Safety Performance Functions (SPFs) are able to estimate the relationship between collisions and exposure by accounting for the non-linear relationship between exposure and risk. While SPFs have been comprehensively developed for motor-vehicles, there is a need to further develop bicycle-specific SPFs. This paper uses data from eight years (2006-2013) in Boulder, Colorado to create the first bicycle-specific SPFs for roadway segments in a U.S. city that utilizes bicycle exposure. Such SPFs can help prioritize projects and inform the transportation decision-making process and future editions of the Highway Safety Manual. In this analysis, a negative-binomial model with log link was used to predict annual non-fatal motorist-bicyclist crashes on road segments per mile. The analysis shows that motor vehicle volume is a leading factor associated with more crashes between motor vehicles and bicyclists. Bicyclist exposure, population density, and percent retail land use are also predictive. The analysis also suggests that bicyclist exposure, at least in Boulder, Colorado, can be modeled as either bicycle volume or a combination of percent of road segment with a bike lane and pedestrian volume. While it is unlikely that pedestrian volume would be known and not bicycle volume, there may be cases where this surrogate for bicycle volume may be useful. However, results should not be interpreted to indicate that bicycle lanes cause crashes. The bike lane measure is likely a surrogate for bicyclist exposure.

UNIVERSITY OF UTAH

Number of Replicate Beams Required for a Valid Test of Asphalt Mixtures Using the Bending Beam Rheometer Based on AASHTO TP125

Abu Sufian Mohammad Asib, University of Utah
Pedro Romero, University of Utah
Faramarz Safazadeh, University of Utah

Developing any test, standard, or specification requires technical validity while keeping the costs as optimum as possible. AASHTO TP125 recommends Bending Beam Rheometer (BBR) as a simple, fast, relatively inexpensive, and repeatable method of testing low-temperature properties of asphalt concrete mixtures. However, a question on the number of replicate beams required to be a valid representation of population for asphalt mixture beam specimens remains unaddressed. This study used statistical methods to determine this number by analyzing the data of two variables- creep moduli and stress relaxation capacity (m-value); obtained from testing two different asphalt concrete mixtures. It was found that BBR data follow a normal distribution with minor skewness. Moreover, by randomizing the population and taking a different number of replicate beams to analyze coefficient of variation (CV) and sample means, it was found that eight beams represent the tests results of the BBR with a CV ranging between 0.05 and 0.11, and the maximum difference between sample and population mean is below 7%. Even though testing five beams as suggested in AASHTO TP125 showed more variability in the results, still the CV was well below 0.2, and the sample mean showed more than 10% difference from the population mean. In practice, core samples of Hot Mix Asphalt (HMA) provide a limited number of replicates; therefore, testing eight beams in both field and laboratory is feasible. Results obtained from this study suggests BBR as a dependable testing equipment to characterize the low-temperature performance of asphalt concrete mixtures.

The Challenge of ADAS Assessment: A Scale for the Assessment of the HMI of Advanced Driver Assistance Technology

Francesco Biondi, University of Utah
Douglas Getty, University of Utah
Madeleine McCarty, University of Utah
Rachel Goethe, AAA National
Joel Cooper, University of Utah
David Strayer, University of Utah

Assessing the usability and demand of assistance systems and their human-machine interfaces represents a challenge for Human Factors professionals. Despite assistance systems being engineered to enhance safety, recent driving simulator and on-road studies show the potential for these systems and their human-machine interfaces to cause unintended consequences on safety. Nonetheless, to these authors' knowledge, no one tool for assessing the usability and demand of assistance systems is currently available. NHTSA, the Alliance of Automotive Manufacturers and the European Commission have all released best practices and Human Factors guidelines for the assessment of function-aspecific interfaces. However, given their broad scope, none of them provides a rating and benchmarking tool for assessing a variety of design aspects pertinent to a wide spectrum of assistance systems, ranging from rearview cameras to lane keeping assist systems. This manuscript presents the development of a scale

for assessing the human-machine interface of ten different assistance systems. The scale contains 59 items, developed through multiple iterations in which a total of 94 distinct assistance systems available on vehicles of different make and model underwent evaluation. For each system, we provide a description of its characteristics, followed by a list of specific items for assessment, and relevant references. Two evaluators rate each system against specific assessment items, using a 4-point scale. This scale provides a comprehensive assessment tool for evaluating the demand and usability of a variety of assistance systems, to be used for benchmarking purposes, and in the early stage of development of assistance systems.

Agent-Based Approach to Analyzing the Effects of Dynamic Ridesharing in a Multimodal Network

Zhuo Chen, University of Utah
Xiaoyue Cathy Liu, University of Utah

An agent-based modeling study for dynamic ridesharing in a multimodal network is proposed in this paper. The study aims to evaluate the performance of dynamic ridesharing system within a multimodal network and explore the competing mechanism between dynamic ridesharing and public transit, with the presence of managed lane facility. The modeling process simulates the interaction between travelers and network and applies a heuristic algorithm to model travelers' decision making process under uncertainty. The model is applicable to networks with varying demographics. Multiple scenarios based on the classic Sioux Falls network have been examined. The modeling results demonstrate that the effects of dynamic ridesharing on a network differ with traffic demand and market penetrations of various travel modes. In networks with high travel demand and low market penetration of public transit, the benefits of dynamic ridesharing system on reducing congestion and providing reliable travel time are quite limited. To enhance the effectiveness of dynamic ridesharing, traffic operators may consider project investments on managed lane facilities. In networks with high market penetration of public transit, dynamic ridesharing may attract large amounts of short distance trips and bring extra congestion to the network, especially at the initial launching phase. Policy makers would want to ensure that the existing infrastructure is sufficient to accommodate the extra traffic induced by ridesharing. Ridesharing service providers might also consider proper strategies to avoid "abuse" of the system by short trips and accelerate the market penetration.

Select Papers on Basic Research and Emerging Technologies Related to Concrete

Amanda Bordelon, University of Utah

Bordelon presided over this session which featured a series of practice-ready papers.

The Effects of Voice System Design Components on Driver Workload

Douglas Getty, University of Utah
Francesco Biondi, University of Utah
Shae Morgan, University of Utah
Joel Cooper, University of Utah
David Strayer, University of Utah

In-vehicle voice control systems are standard in most vehicles, but their use while driving has been shown to be associated with high levels of workload and lengthy task times. The present study investigates design components of in-vehicle voice control and their relationship with driver workload. We measured system delay, system accuracy, and menu depth. Voice system accuracy was measured with via playback of a prerecorded corpus of voice commands through a monitor mounted in 8 vehicles. These measures were validated through correlation analyses with subjective workload measures gathered from a separate study. We found that system delay and system accuracy are significant predictors of time on task. These results extend past research by generalizing findings to multiple production level vehicle VCS.

An Empirical Assessment and Investigation of the Driver Injury Severities in Rain-Related Rural Single-Vehicle Crashes Using Mixed and Latent-Class Logit Models

Zhenning Li, University of Hawaii, Manoa
Cong Chen, USF Center for Urban Transportation Research
Yusheng Ci, Harbin Institute of Technology
Guohui Zhang, University of Hawaii
Qiong Wu, University of Hawaii, Manoa
Xiaoyue Cathy Liu, University of Utah
Zhen Qian, Carnegie Mellon University

Due to slippery road surface together with the limited visibility, single-vehicle crash during rain, especially the one occurred in the rural area, is more likely to result in driver incapacitating injury or even fatality. A two-year crash dataset including all rain-related rural single-vehicle crashes in four South Central states, i.e., Texas, Arkansas, Oklahoma, and Louisiana, from 2011 to 2012 were selected in this paper to analyze the impacts of the risk factors on driver injury severity. Mixed multinomial logit model and latent class multinomial logit model were both developed using the same dataset. Several parsimony indices including AIC and BIC, as well as McFadden pseudo r-squared, are calculated for each model to evaluate their performances. Results showed that choosing normal distribution as the prior for random parameters could best increase goodness-of-fit of the mixed logit model. In addition, the two-class latent class model also showed superiority when compared to the three- and four-class models. Finally, a careful comparison between these two models was conducted, and the results indicated that the latent class logit model behaves better in analyzing the aforementioned dataset in this study. Model estimation results showed that curve, on grade, signal control, multiple lanes, pickup, straight, drug/alcohol impaired, and seat belt not used have adverse impacts on driver injury severity in the two models. On the other hand, wet, male, semi, and young have favorable effects on injury outcomes. This study provides insightful understandings of the effects of these attributes on rain-related single-vehicle crashes and beneficial references for developing effective countermeasures for severe crash prevention.

A Finite-Mixture Random Parameters Model for Exploring the Risk Factors on Driver Injury Severity of Low Visibility–Related Crashes

Zhenning Li, University of Hawaii, Manoa
Cong Chen, USF Center for Urban Transportation Research
Guohui Zhang, University of Hawaii
Qiong Wu, University of Hawaii, Manoa
Xiaoyue Cathy Liu, University of Utah
Panos Prevedouros, University of Hawaii
David Ma, University of Hawaii, Manoa

Low visibility condition is found to be the most dangerous inclement weather event due to its highest fatality rate. A three-year crash dataset from 2010 to 2012 focusing on low visibility related crashes in four South Central states including Arkansas, Louisiana, Texas, and Oklahoma was adopted in this article to study the impacts of different variables on driver injury severity. In order to account for the unobserved heterogeneity within-class and varying across classes, a finite mixture random parameters model is developed in this study for analyzing the aforementioned dataset. After a careful balance, choosing normal distributions as priors for random parameters and classifying the dataset into two subtypes showed significant superiority than other models, and therefore were selected as the final model. Three parameters including rural (I), rural (F), and single vehicle (F) are found to be normally distributed across the observations. Other fixed parameters include the number of vehicles, light conditions, road surface, traffic controls, and driver characteristics. In addition, this paper also provides meaningful countermeasures and strategies on low visibility crashes for severe injury prevention.

Uninterrupted Flow

Xiaoyue Cathy Liu, University of Utah

Liu presided over a poster session focused on uninterrupted flow of traffic sponsored by the TRB Highway Capacity and Quality of Service Committee. The committee is concerned with investigating the factors which affect capacity, traffic flow, comfort, convenience, and safety and the development of techniques for quantifying the effect of these factors.

Innovations in Public Transit Service Availability and Accessibility Measurement

Matt Miller, University of Utah,

Miller presided over a session that used examples from the U.S. and abroad to explore innovative ways to measure public transportation service availability and accessibility.

Transit Vehicle Performance Analysis for Service Continuity or Termination: A Data Envelopment Analysis (DEA) Approach

Seyed Kiavash Fayyaz Shahandashti, University of Utah
Xiaoyue Cathy Liu, University of Utah
Ran Wei, University of Utah

Public transit agencies aim to improve services while reducing operating costs. Transit performance analysis, as the main approach to assess operating cost and revenue, has received a lot of attention in recent decades. Most of such studies focus on macro-level performance analysis by comparing across transit agencies or within a transit agency across different parts of its operation. The macro-level analysis assumes that bus drivers and vehicles have identical performance in terms of production and resource consumption. Yet they can vary significantly and directly influence service reliability and operational efficiency. As a result, micro-level vehicle performance analysis is needed for operation optimization. In this paper, we introduce an innovative and effective use of Data Envelopment Analysis (DEA) approach to estimate, project, and compare the operational efficiency of each transit vehicle. Using Utah Transit Authority (UTA)'s paratransit fleet as a case study, our study demonstrates the varying cost structures and operational efficiencies over time associated with different vehicle types. We show that such variations and time series analysis can be used to guide vehicle procurement and service continuity/termination prioritization, which further leads to significant cost savings and service reliability improvement. The proposed approach is replicable to any transit fleet with available maintenance and operation data. The proposed method provides transit agencies with data-driven analytics to facilitate decision making process.

UNIVERSITY OF WYOMING

Using the SHRP 2 NDS Data to Advance Variable Speed Limit Systems in a Connected Vehicle Environment

Mohamed Ahmed, University of Wyoming

Presented during a session on findings from selected implementation application projects sponsored by the FHWA to use the SHRP 2 Naturalistic Driving Safety Data Base to improve highway safety.

Estimation of Gravel Roads Ride Quality Through Android-Based Smartphone

Waleed Aleadelat, University of Wyoming
Cameron Wright, University of Wyoming
Khaled Ksaibati, University of Wyoming

This study demonstrated the ability of smartphone sensors in evaluating gravel roads conditions. Seventy gravel roads with various conditions, surface materials, and geometric features were included in this study. The carried analysis was based on signals demodulation and wavelet transformation to reduce the effect of many external factors (i.e., speed dependency, engine vibrations, and suspension system) that may affect the obtained measurements. It was found that the acquired signals from a smartphone accelerometer can reflect the actual conditions of a gravel road. In addition, the location and the severity of surface deteriorations like potholes could be identified. A regression model (R^2=0.78) based on the acquired signals from smartphones was developed to predict the overall rating of gravel roads condition according to the Riding Quality Rating Guide (RQRG) system. An initial validation analysis, conducted on new 35 gravel roads, showed that this model was able to return reasonable ratings. Also, the statistical analysis showed that any difference between the predicted and the actual ratings of less than 1.3 was not significant. The proposed methodology can be considered a baseline for building a low cost crowdsourcing platform that helps local agencies in managing their inventory of gravel roads.

A Comprehensive Analysis of Driver Lane-Keeping Performance in Fog Weather Conditions Using the SHRP 2 Naturalistic Driving Study Data

Anik Das, University of Wyoming
Ali Ghasemzadeh, University of Wyoming
Mohamed Ahmed, University of Wyoming

Driving in foggy weather conditions has been recognized as a major safety concern for many years. Driver behavior and performance can be negatively affected by foggy weather conditions due to the low visibility in fog. A number of previous studies focused on driver performance and behavior in simulated environments. However, very few studies have paid attention to examine the impact of foggy weather conditions on specific driver behavior in naturalistic settings. This study utilized the SHRP2 NDS dataset to evaluate driver lane-keeping behavior in clear and foggy weather conditions. Preliminary descriptive analysis was conducted and a lane-keeping model was developed using the ordered logistic regression approach to achieve the study goals. Individual variables such as visibility, traffic conditions, lane change, driver marital status, geometric characteristics, etc., as well as some interaction terms;

especially weather and gender, speed limit, and driving experience have been found to significantly affect lane-keeping ability. An important finding of this study illustrated that affected visibility caused by foggy weather conditions decreases lane-keeping ability significantly. More specifically, drivers in affected visibility conditions showed 1.37 times higher Standard Deviation of Lane Position (SDLP) in comparison with drivers who were driving in unaffected visibility conditions. The outcome of this research may provide a better understanding of driver lane-keeping behavior and their perception of foggy weather conditions. Moreover, the results might be used to improve Lane Departure Warning (LDW) systems algorithm considering affected visibility by fog.

Evaluating the Safety Effectiveness of Variable Speed Limit: Before–After Study Utilizing Multivariate Adaptive Regression Splines

Sherif Gaweesh, University of Wyoming
Irfan Ahmed, University of Wyoming
Mohamed Ahmed, University of Wyoming
Ali Ghasemzadeh, University of Wyoming

Interstate 80 (I-80) is a vital freight corridor running in the southern part of Wyoming. As the corridor being selected as one of the three sites for Connected Vehicle Pilot Deployment Program, a baseline assessment of existing countermeasures is vital. The 402-mile freeway has four weather-based Variable Speed Limit (VSL) corridors totaling 147-mile. VSL systems are countermeasures that aim to improve road safety by providing different operating speeds based on existing weather and road conditions. A before-after study with Empirical Bayes (EB) was utilized to develop Crash Modification Factors (CMF) for the VSL. Crash prediction models are essential to estimate the safety effectiveness of the implemented countermeasures. Parametric Negative Binomial (NB) and non-parametric Multivariate Adaptive Regression Splines (MARS) were used to develop crash models in the before period. Crash models were developed for total crashes, fatal and Injury crashes (FI), and Property Damage Only (PDO) crashes. Comparisons between CMFs obtained from NB model and MARS model were conducted. Analyses were performed using crashes occurred on the 402-miles of I-80 corridor, in Wyoming. Six years of crashes in the before period from 2003 to 2008 were utilized in the analysis, in addition to five years in the after period from 2012 to 2016. Results showed that the VSL reduced all the investigated crash types by different percentages ranging between 26% to 67%. Developed CMFs using NB and MARS showed comparable results. CMFs developed using the NB model might provide a quick and easy method for practitioners. Yet, it provides reliable results.

Parametric and Nonparametric Approaches in Developing Crash Prediction Models for Rural Mountainous Freeways: A Case Study in Wyoming

Sherif Gaweesh, University of Wyoming
Irfan Ahmed, University of Wyoming
Mohamed Ahmed, University of Wyoming
Annalisa Piccorelli, University of Wyoming

Researchers have extensively used crash prediction models to quantify safety performance of various roadway facilities. This study compares between Multivariate Adaptive Regression Splines (MARS), which is a recently adopted nonparametric data-mining technique, with Negative Binomial (NB) model in predicting crashes on a unique 402-mile rural mountainous freeway corridor in Wyoming. I-80 is a

vital corridor running in the southern part of Wyoming that was selected as one of the three sites for the regional connected vehicle pilots. This study serves as a baseline investigation of safety performance of a connected vehicle pilot deployment corridor. Crash prediction models for different severity levels (total crashes, Fatal and Injury, and PDO crashes) were developed. Seven years of crashes from 2010 to 2016 were utilized in the analysis. Homogeneous segmentation method was used to segment the study corridor. Results showed that the MARS model out-performed the NB model. The developed MARS models were considered as better crash prediction models, given the lower AIC values. MARS model has the capability to handle nonlinear relationships between the predictors and the response variable. Furthermore, it automatically identifies the significant variables and interactions term. The relationship between crash counts and variables used in prediction are usually nonlinear. Therefore, using MARS model is recommended as a good technique to develop crash prediction models.

Examining Driver Preference for Regulatory Headlight Use Signs Design in Different Weather Conditions: A Driving Simulator Study

Sherif Gaweesh, University of Wyoming
Mohamed Ahmed, University of Wyoming

Headlight use signs are regulatory traffic control devices that require road users to turn on their vehicles' headlights manually during the daytime. It is mainly used when a certain roadway section encounters an increase in crashes related to vehicles conspicuity. According to a field study conducted in Wyoming, headlight use signs have low compliance rates. This low compliance might be due to the sign design itself. In addition to the basic headlight sign design, two upgraded designs were proposed and tested in different weather conditions in a driving simulator environment. Survey responses were collected to obtain public preference for the upgraded designs. Factor Analysis (FA) and analysis of variance (ANOVA) were adopted to validate and analyze the collected responses of the surveys. Vehicle dynamics of the simulator were analyzed to examine the difference in driving performance at headlight sections. Most of the participants reported that the basic headlight use sign (the original design) is considered as a poor design and the third modified design is a better design. ANVOA results showed that there was no significant difference between the two newly proposed designs. Vehicle velocity was used as a surrogate measure in the performance analysis. The results showed that comprehending information from the third headlight use sign design was significantly easier, as no reduction in speed was encountered. This study would provide insights for transportation agencies, in Wyoming, to enhance highway safety and help in decreasing crashes related to visibility and noticeability of the headlight use sign.

Using Parametric Ordinal Logistic Regression and Nonparametric Decision-Tree Approaches for Assessing the Impact of Weather Conditions on Driver Speed Selection Using Naturalistic Driving Data

Ali Ghasemzadeh, University of Wyoming
Britton Hammit, University of Wyoming
Mohamed Ahmed, University of Wyoming
Rhonda Young, Gonzaga University

The impact of adverse weather conditions on transportation operation and safety is the focus of many studies; however, comprehensive research detailing the differences in driving behavior and performance during adverse conditions is limited. Many previous studies utilized aggregate traffic and weather data (e.g., average speed, headway, and global weather information) to formulate conclusions about the weather impact on network operation and safety; therefore, research into specific factors associated with driver performance and behavior are notably absent. A novel approach, presented in this paper, can fill the gap in previous studies by considering disaggregate trajectory-level data available through the SHRP2 Naturalistic Driving Study and Roadway Information Database. Parametric ordinal logistic regression and non-parametric classification tree modeling were utilized to better understand speed selection behavior in adverse weather conditions. The results indicate that the most important factors impacting driver speed selection are weather conditions, traffic conditions, and the posted speed limit. Moreover, it was found that drivers are more likely to significantly reduce their speed in snowy weather conditions, as compared with other adverse weather conditions (such as rain and fog). The purpose of this study was to gather insights into driver speed preferences in different weather conditions, such that efficient logic can be implemented to introduce a realistic Variable Speed Limit system, aimed at maximizing speed compliance and reducing speed variations. This study provides valuable information related to drivers' interaction with real-time changes in roadway and weather conditions, leading to a better understanding of the effectiveness of operational countermeasures.

Multivariate Adaptive Regression Splines and Logistic Regression Models to Identify the Impact of Rainy Weather on Driver Lane-Keeping Performance Considering Driver Demographics and Roadway Multivariate Adaptive Regression Splines and Logistic Regression Models to Identify the Impact of Rainy Weather on Driver Lane-Keeping Performance Considering Driver Demographics and Roadway Characteristics Using SHRP 2 Naturalistic Driving Data

Ali Ghasemzadeh, University of Wyoming
Mohamed Ahmed, University of Wyoming
Sherif Gaweesh, University of Wyoming

It is known that adverse weather conditions can affect driver performance due to reduction in visibility and slippery surface conditions. Lane keeping is one of the main factors that might be affected by weather conditions. Most of the previous studies on lane keeping have investigated driver lane-keeping performance from driver inattention perspective. In addition, the majority of previous lane-keeping studies have been conducted in controlled environments such as driving simulators. Therefore, there is a lack of studies that investigate driver lane-keeping ability considering adverse weather conditions in naturalistic settings. In this study, the relationship between weather conditions and driver lane-keeping

performance was investigated using the SHRP2 naturalistic driving data for 141 drivers between 19 and 89 years of age. Moreover, a threshold was introduced to differentiate lane keeping and lane changing in naturalistic driving data. Two lane-keeping models were developed using the logistic regression and multivariate adaptive regression splines (MARS) to better understand factors affecting driver lane-keeping ability considering adverse weather conditions. The results revealed that heavy rain can significantly increase the standard deviation of lane position (SDLP), which is a very widely used method for analyzing lane-keeping ability. It was also found that traffic conditions, driver age and experience, and posted speed limits have significant effects on driver lane-keeping ability. An interesting finding of this study is that drivers have a better lane-keeping ability in roadways with higher posted speed limits. The results from this study might provide better insights into understanding the complex effect of adverse weather conditions on driver behavior.

Characteristics Using SHRP 2 Naturalistic Driving Data

Ali Ghasemzadeh, University of Wyoming
Mohamed Ahmed, University of Wyoming
Sherif Gaweesh, University of Wyoming

It is known that adverse weather conditions can affect driver performance due to reduction in visibility and slippery surface conditions. Lane keeping is one of the main factors that might be affected by weather conditions. Most of the previous studies on lane keeping have investigated driver lane-keeping performance from driver inattention perspective. In addition, the majority of previous lane-keeping studies have been conducted in controlled environments such as driving simulators. Therefore, there is a lack of studies that investigate driver lane-keeping ability considering adverse weather conditions in naturalistic settings. In this study, the relationship between weather conditions and driver lane-keeping performance was investigated using the SHRP2 naturalistic driving data for 141 drivers between 19 and 89 years of age. Moreover, a threshold was introduced to differentiate lane keeping and lane changing in naturalistic driving data. Two lane-keeping models were developed using the logistic regression and multivariate adaptive regression splines (MARS) to better understand factors affecting driver lane-keeping ability considering adverse weather conditions. The results revealed that heavy rain can significantly increase the standard deviation of lane position (SDLP), which is a very widely used method for analyzing lane-keeping ability. It was also found that traffic conditions, driver age and experience, and posted speed limits have significant effects on driver lane-keeping ability. An interesting finding of this study is that drivers have a better lane-keeping ability in roadways with higher posted speed limits. The results from this study might provide better insights into understanding the complex effect of adverse weather conditions on driver behavior.

Evaluation of Weather-Related Freeway Car-Following Behavior Using the SHRP 2 Naturalistic Driving Study

Britton Hammit, University of Wyoming
Ali Ghasemzadeh, University of Wyoming
Mohamed Ahmed, University of Wyoming
Rhonda Young, Gonzaga University

Previous research has shown that adverse weather conditions negatively impact the safety, mobility, and efficiency of freeways. Weather adjustment factors and other metrics indicate decreases in vehicle speed, freeway capacity, and vehicular throughput, which consider the impact of weather from a

network or macroscopic level. Another method to consider the impact of adverse weather is from a user/driver-level, which uses the fundamental behaviors of drivers (such as speed selection, car-following behavior, acceleration patterns, lane-changing, etc.) to model traffic flow measures at the microscopic or individual vehicle level. This paper uses a set of SHRP2 Naturalistic Driving Study trips in rain, snow, and clear weather conditions to investigate the impact of adverse weather on car-following behavior using this user-level approach. The intent of this study is to quantify explicit deviations in car-following behavior that are common during adverse conditions, to inform driving behavior models that are incorporated into microsimulation software. While the investigation of driving behavior is a complex task – generally limited to research – the incorporation of realistic driving behavior in adverse weather conditions into commonly-used microsimulation environments is imperative to advancing the state of the practice. The addition of accurate car-following behavior into practitioner microsimulation models will enable transportation agencies to make better informed operations and safety decisions related to forecast planning, alternative selection, traveler information, and real-time operational strategies (such as Variable Speed Limits).

Investigating the Impact of Fog on Freeway Speed Selection Using the SHRP 2 Naturalistic Driving Study Data

Md Nasim Khan, University of Wyoming
Ali Ghasemzadeh, University of Wyoming
Mohamed Ahmed, University of Wyoming

The negative effect of reduced visibility on driver performance has been recognized as one of the main causes of motor vehicle crashes in fog. Although many studies have concentrated on driver behavior during foggy weather in simulated environment, there is a lack of studies that have addressed the impact of fog on driver behavior and performance in naturalistic settings. This paper utilized the data from the SHRP2 Naturalistic Driving Study (NDS) database to understand driver behavior in general and speed selection in particular during clear and foggy weather conditions. In this study, following a unique procedure for identifying inclement weather trips in the SHRP2 NDS data, a comparative preliminary analysis, and an ordered logit model were developed to evaluate driver speed behavior in fog and clear weather conditions. Results from the preliminary analysis showed 5% and 2% reduction in speed due to heavy fog and distant fog respectively. In addition, results from speed selection model showed that the odds of reducing speed were 1.5 and 1.3 times higher for drivers traveling in heavy fog and distant fog, respectively compared to drivers who were driving in clear weather conditions. The results from this study could provide a better insight into driver speed selection during foggy weather conditions, which can be utilized to improve various safety strategies including Variable Speed Limits (VSL).

Converting Distressed Paved Roads to Engineered Unpaved Roads

Khaled Ksaibati, University of Wyoming.

Ksaibati presided over this session which featured an overview of practices from across the country. The session was sponsored by the Standing Committee on Low Volume Roads.

Developing a Toolkit to Improve Transportation Safety on Indian Reservations

Khaled Ksaibati, University of Wyoming

Presented during a session on Tribal Transportation Data: Needs, Applications, and Resources.

Factors Causing Truck Crashes on Two-Lane Downgrades in Wyoming: A Logistic Regression Approach

Milhan Moomen, University of Wyoming
Mohammad Mahdi Rezapour Mashhadi, University of Wyoming
Khaled Ksaibati, University of Wyoming

Truck crash occurrence causes extensive damage to lives and property. Truck crashes on downgrades exacerbates these costs due to the likelihood of a runaway being involved. Highway agencies have continuously sought engineering measures to reduce the incidence of such crashes. However, most past studies on truck crashes have focused on level roadway sections of highways without considering the effects of downgrades. The difference in geometric characteristics of downgrades and the mechanics of truck operations on such sections mean different factors may be at play in contrast to straight, level roadway sections. This paper investigates the factors influencing truck crashes on downgrades; an attempt to fill in some of the research gaps. An empirical analysis of factors affecting truck crashes on two-lane downgrade roadways in Wyoming was carried out using a binary logistic regression technique. After calibrating the model, the effect of each significant variable was determined using theoretical concepts established in previous studies and engineering intuition. Crash factors including driver gender and age, speed compliance, weather, lighting and road condition, shoulder width, lane width, number of sag and crest curves, roadway grade and length were found to be significant. The results of the study offer new understandings into how the identified factors influence truck crashes on downgrades.

Developing a Toolkit to Improve Transportation Safety on Indian Reservations

Sahima Nazneen, University of Wyoming
Trenna Terrill, University of Wyoming
Khaled Ksaibati, University of Wyoming

Indian Reservations hold the highest number of crashes that lead to fatal and incapacitating injuries across the United States. Limited resources, absence of coordination across jurisdictions, and limited crash data make it difficult for tribes to reduce the number of these fatal and serious crashes. A safety toolkit was developed in this work to identify the high risk crash locations and determine the low cost safety improvement countermeasures. It serves as a guideline and provides information, field examples, and resources in key topic areas to lead the effort to improve safety via the use of a five step methodology. These five steps are, namely, Compile data and Crash data analysis, Level I field evaluation, Combined ranking, Level II field evaluation to identify countermeasures, Benefit-cost analysis. The objective of the toolkit is to assist tribes to reduce the number of fatal and serious crashes and it provides flexibility for the tribes to utilize the methodology compatible with the on-site data, preference by the tribes, and other factors to meet the demands. The methodology described was successfully implemented on the Wind River Indian Reservation (WRIR), Standing Rock Sioux Tribe

(SRST), the Sisseton Wahpeton Oyate Tribe, and the Yankton Sioux Tribe and showed great success in identifying high crash locations.

Characterization of Crushed Base for Mechanistic–Empirical Pavement Design Guide

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Dawit Mebrahtom, University of Wyoming
Khaled Ksaibati, University of Wyoming
Shaun Wulff, University of Wyoming

A full implementation of mechanistic-empirical pavement design guide (MEPDG) requires the characterization of the moduli of pavement materials. The local MEPDG calibration to represent the characteristics and behaviors of local materials will improve the efficiency and economy of pavement designs. In a previous research study, subgrade materials were extensively characterized while the resilient modulus of base materials was only back-calculated using deflection data obtained from the falling weight deflectometer (FWD) test. This led to extreme differences in resilient moduli between subgrade and base materials. This paper describes a recently completed laboratory test program to determine the standard properties of crushed base aggregates collected from 14 road projects throughout the state of Wyoming. Eleven of 14 base aggregates were selected for resilient modulus testing performed in accordance with the WYDOT modified AASHTO T 307 procedure. Effects of moisture content, percent fines, stresses, and gradation on base resilient modulus were assessed. Models were developed using statistical methods to estimate the resilient modulus of base materials. The coefficients of NCHRP and Hicks and Monismith constitutive models were locally calibrated. A design chart of resilient modulus in terms of asphalt thickness was established to facilitate the iterative process involved in a pavement design. Finally, a design table of base properties for MEPDG Level-3 inputs was developed to facilitate the full implementation of the MEPDG. It is important to note that the proposed methods could be adopted nationally to increase the efficiency of MEPDG for all states in the United States.

An Optimization Model to Select Unpaved Roads for Chemical Treatments as Dust Suppressants

Promothes Saha, University of Wyoming
Nikolai Greer, University of Wyoming
Khaled Ksaibati, University of Wyoming

This study developed a model to select the optimum sections of unpaved roads for chemical treatments as dust suppressants within limited budget. In the state of Wyoming, more than 12,000 miles of roads are unpaved. Wyoming being a leading producer of coal, and oil and gas, means its unpaved roads have more traffic that result in significant dust emissions. To reduce this dust emission, Wyoming currently uses $CaCl_2$ and $MgCl_2$as dust suppressants. Because the budget is limited, all these 12,000 miles of unpaved roads cannot be treated every year. A Previous study concluded that traffic volumes, percent passing through #200 sieve and annual rainfall have significant impact on generating dust. Considering these factors, this study developed a model that identifies which unpaved roads should be traeted within a limited budget using a linear integer optimization technique. As a case study, this model was successfully implemented on a small network of 27 unpaved roadway segments.

Charging Station Allocation for Electric Vehicle Network Using Stochastic Modeling and Grey Wolf Optimization

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Anemone Kasasbeh, State University of New York (SUNY)
Mohamed Ahmed, University of Wyoming

Charging stations (CSs) infrastructure design is one of the most critical challenges that faces Electric Vehicles (EVs) industry nowadays. A variety of approaches have been proposed to address the so-called chicken-egg problem. In this paper, a Markov-chain network model is designed to study the estimated demand on a CS by using the birth and death process model. An investigation on the desired number of electric sockets in each CS and the average number of electric vehicles in both the queue and the waiting times is presented. Furthermore, a CS allocation algorithm based on the Markov chain model is proposed. Grey Wolf Optimization (GWO) algorithm is used to select the best CS locations with the objective of maximizing the net profit under both budget and routing constraints. Experimental results have shown that to achieve the highest net profit, Level 2 chargers need to be installed in the early stages of infrastructure implementation. While Level 3 chargers attain higher net profit when the number of EVs increases in the transportation network.

Crash Frequency Modeling Incorporating Time Trend with Panel Data

Sadia Sharmin, University of Wyoming
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Standard crash models using longer time frames and aggregated data do not consider time effects on crash frequency which can result in biased regression parameter estimates due to unobserved heterogeneities, serial correlations, or time trends. An effective safety evaluation strategy is to develop predictive models that are capable of accounting for these different variations and properties which exist in crash data. In this study, the Negative Binomial distribution was used to model crash frequency where the temporal correlation was accounted for using a Generalized Estimating Equation (GEE) approach. Time was also included as an explanatory variable with linear and quadratic polynomials to investigate the crash trends across time. This analysis was based on 10 years of data for 174 four-legged signalized intersections in Wyoming. The study revealed that the Negative Binomial GEE (NB GEE) models outperformed traditional Negative Binomial (NB) and Random Effect Negative Binomial (RENB) models in terms of prediction capability. Quasilikelihood Information Criterion (QIC) statistics were used for assessing the choice of the working correlation structure in NB GEE models. This method also showed that NB GEE models incorporating “time” variables performed better than the models without time variables. Intersections with high traffic volume and large number of lanes in major and minor approaches, involvement of young drivers, and weather components came out to be significant contributing factors for high crash frequencies. Adding left-turn lanes at major approaches and presence of on-street parking contributed to reductions of all types of crashes. Intersection crashes also had an overall quadratic trend in time.

Modeling Street Connectivity: Case Studies from Three Cities in Utah

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Tim Sullivan, Parametrix
Julie Bjornstad, Fehr & Peers
Seyed Kiavash Fayyaz Shahandashti, University of Utah

Street connectivity measures the density of network connections and directness of path, and it includes both the quantity and quality of connections. Enhancing street connectivity is one of the best ways to increase network capacities, achieve a better distribution of traffic flows, improve accessibility and increase options for non-motorized traffic modes. Numerous studies have proven the benefits of street connectivity. This paper analyzes the benefits of street connectivity through transportation modeling of three community-scale (mesoscopic) and three neighborhood-scale (microscopic) networks in Utah, which was performed as a part of the Utah Street Connectivity Study. In general, a significant reduction in network travel times and delays was observed in the case-study networks. The distribution of traffic flows was more balanced in the networks with higher connectivity, with a reduction in Vehicle Miles Traveled, and in most cases reduction in delays. Better street connectivity in neighborhood-scale networks generally reduced travel speeds and increased delays due to more intersections, but at the same time provided for a better accessibility and a safer environment for non-motorized modes. This study confirms the numerous benefits of better street connectivity.

UTAH STATE UNIVERSITY

Fast-Charging Station Deployment for Electric Bus Systems Considering Electricity Demand Charges

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Electric buses (EBs) are considered a promising solution for urban transit, increasing energy efficiency and alleviating growing environmental problems. As a result of fast-charging technology, electric buses are able to provide uninterrupted service without a large battery, which makes them even more attractive. However, fast charging may result in high electricity demand charges, which may significantly increase bus operating costs. An energy storage system (ESS) provides the possibility of connecting the fast-charging station to a low-voltage grid, thus decreasing demand charges. In this study, a mixed-integer linear programming model that minimizes total expenditures, including the fast-charging facility cost and the bus operating cost, is proposed to locate the fast-charging stations and to determine whether to install an ESS, as well as design the optimal battery size for the electric buses, simultaneously. The model is tested on a bus line with 64 stations that serves Salt Lake City. The results demonstrate that the optimal design is able to smooth out peak demand at fast-charging stations through the installation of an ESS, hence reducing EB operating costs.

Density Differences: Exploring Built Environment Relationships with Walking Between and Within Metropolitan Areas

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Patrick Singleton, Utah State University
Joseph Totten, Portland State University
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To explore the relationships between measures of density and walking within and between urban areas, we present an analysis of the travel survey data from six different cities from the US and Santiago, Chile. The analysis of aggregate and disaggregate pedestrian trips presented here examine the potential consistency of relationships between walking and density within and across different regions, with a specific focus on population density. Our findings illustrate a relationship between population density and walk mode shares that is roughly linear and of nearly equal magnitude across US regions in densities below 20 persons/acre. Above that, the relationships are less clear. These findings raise concerns about assuming that results from one city are applicable to another. The relationship between density and walking activity may be transferable across lower density areas in US cities; however, this does not offer much guidance to planners since these are not the locations from which to model new walkability standards. Although support for transferability is discouraging, the consistency of 20 person/acre offers as a breakpoint in the regimes offers some promise. In addition, the distribution of densities in comparison to the total area appears to be important and raises the issue of the role of the larger urban spatial structure in walkability. As work in this area matures, fine-grained built environment measures should be complemented with constructs that describe the metropolitan structure, including density distributions and gradients, poly-centricity, and spatial extent of the urban area.