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Publications

RESEARCH PAPERS

Measurement of Abrasion Injuries in Crash-related Environments. WA Lakew, S Mukherjee, A Chawla, Biotribology Voulme 9, March 2017, Pages: 12-17. https://doi.org/10.1016/j.biotri.2016.12.001.

Contour Based Repositioning of Specific Joints of the GHBMC Human Body FE Model. A Chawla, S Singh, S Paruchuri, A Chhabra, SAE Technical Paper, Published January 10, 2017, 2017-26-0265, https://doi.org/10.4271/2017-26-0265.

A Pilot Study at National Highway-8 for On-Site Crash Data Collection and In-Depth Investigation in India. K Singh, A Chawla, S Mukherjee, P Agrawal, SAE Technical Paper, ISSN 0148-7191. DOI: https://doi.org/10.4271/2017-26-0001,Published January 10, 2017.

Spline Based Repositioning for the Vertebral Column of the GHBMC Human Body Finite Element Model. Aditya Chhabra, Sachiv Paruchuri, Kshitij Mishra, Dhruv Kaushik, Anoop Chawla, Sudipto Mukherjee, Rajesh Malhotra. IRCOBI Conference Proceedings 2017.

Contour Based Repositioning of Lower Limbs of the GHBMC Human Body FE Model. Aditya Chhabra, Sachiv Paruchuri, Kshitij Mishra, Dhruv Kaushik, Anoop Chawla, Sudipto Mukherjee, Rajesh Malhotra, IRCOBI Conference Proceedings 2017.

Finite Element Simulation Estimation of Wheel base Reduction and Deformation Energy of a Typical Indian Motorcycle Crash at Known Impact Speed against Sedan Car. K. Singh, A. Chawla, S. Mukherjee, IRCOBI Conference Proceedings 2017.

Evaluation of Load Path for Injury Prediction in Soft Tissues. D Kumar, S Mukherjee, A Chawla, IRCOBI Conference Proceedings 2017.

Modelling Vehicular Interactions for Heterogeneous Traffic Flow Using Cellular Automata With Position Preference. G Pandey, KR Rao, D Mohan Journal of Modern Transportation 25 (3), 163-177, 1/9/2017 , Springer Berlin Heidelberg.

Urban Street Structure and Traffic Safety. D Mohan, SI Bangdiwala, A Villaveces Journal of safety research 62, 63-71, 01/9/2017, Pergamon.

Evaluation of Odd–Even Day Traffic Restriction Experiments in Delhi, India. D Mohan, G Tiwari, R Goel, P Lahkar, Transportation Research Record: Journal of the Transportation Research Board, 2627, 9-16. 01/8/2017, Transportation Research Board of the National Academics.

Analysis of Pedestrian Movement on Delhi Roads by Using Naturalistic Observation Techniques. A Jha, G Tiwari, D Mohan, S Mukherjee, S Banerjee, Transportation Research Record: Journal of the Transportation Research Board, 2634, 95-100, 1/5/2017, Transportation Research Board of the National Academics.

Sustainable Mobility Indicators for Indian Cities: Selection Methodology and Application. Deepty Jain and Geetam Tiwari, Ecological Indicators, Volume 79, August 2017, Pages 310-322 (https://doi.org/10.1016/j.ecolind.2017.03.059).

Assessment of Interstate Freight Vehicle Characteristics and Impact of Future Emission and Fuel Economy Standards On Their Emissions in India. Leeza Malik and Geetam Tiwari. Energy Policy, Volume 108, September 2017, Pages 121-133, https://doi.org/10.1016/j.enpol.2017.05.053.

Population Disaggregation to Capture Short Trips – Vishakhapatnam, India. Deepty Jain, Geetam Tiwari, Computers, Environment and Urban Systems, Volume 62, March 2017, Pages 7-8. , https://doi.org/10.1016/j.compenvurbsys.2016.10.003.

Official Government Statistics of Road Traffic Deaths in India Under-Represent Pedestrians and Motorised Two Wheeler Riders. Kavi Bhalla, Nidhi Khurana, Dipan Bose, Kumari Vinodhani Navaratne, Geetam Tiwari, Dinesh Mohan Injury Prevention 2017; olume 23, Page1-7. Date of Publication 20 January 2017.

Comparing Public Bus Transport Service Attributes in Delhi and Mumbai: Policy Implications for Improving Bus Services in Delhi. Hemant K. Sumana Nomesh B. Boliaa Geetam Tiwari. Transport Policy, Volume 56, May 2017, Pages 63-74 (https://doi.org/10.1016/j.tranpol.2017.03.002).

Factors Contributing to Motorcycle Fatal Crashes on National Highways in India. Hasan Mehdi Naqvia Geetam Tiwari, Transportation Research Procedia, Volume 25, 2017, Pages 2084-2097 (https://doi.org/10.1016/j.trpro.2017.05.402).

Correlates of Fatality Risk of Vulnerable Road Users in Delhi, Rahul Goel, Parth Jain, Geetam Tiwari, Accident Analysis & Prevention, Volume 111, February 2018, Pages 86-93. (https://doi.org/10.1016/j.aap.2017.11.023) Research, 2149 -

Public Health Burden of Transport in Delhi, Rahul Goel, Sarath Guttikunda, Geetam Tiwari. Journal of Transport & Health Volume 5, Supplement, June 2017, Page S57, (https://doi.org/10.1016/j.jth.2017.05.350) Research, 2022 .

Towards an Integrated Global Transport and Health Assessment Tool (TIGTHAT), James Woodcock, Marko Tainio, Thiago Herick de Sa, Audreyde Nazelle, Rahul Goel, Nelson Gouveia, Geetam Tiwari, Asish Verma, Jaime Miranda, Soren Brage, Journal of Transport & Health Volume 5, Supplement, June 2017, Pages S99-S100 (https://doi.org/10.1016/j.jth.2017.05.258).

Pedestrian Route Choice Modelling at a Large Scale Mega Religious Gathering. Tarapada Mandal, K. Ramachandra Rao, Geetam Tiwari, In Proceedings of 5th International Choice Modelling Conference, Cape Town, 2017.

Fundamental Diagrams of Pedestrian Flow Characteristics. Lakshmi Devi Vanumu, K. Ramachandra Rao and G. Tiwari. European Transportation Research Review, 2017, 9 (49).

Optimization of Work Zone Segments on Urban Roads Using Cellular Automata Model in Mixed Traffic. Mohit K. Singh, G. Pandey. K. Ramachandra Rao. Periodica Polytechnica – Transportation Engineering, 2017 (Forthcoming).

Link Speed and Physical Parameter Relation Using GPS Probe Data. R. Basu and K. Ramachandra Rao, 4th conference of Transport Research Group of India (CTRG), Mumbai, Dec 2017 (forthcoming).

Numerical Investigation of Ventilation and Human Thermoregulation for Predicting Thermal Comfort of a Rider Wearing Ventilated Helmet. Bhagwat Singh Shishodia, Sanjeev Sanghi, Puneet Mahaja. Journal of Fluids Engineering, Vol 139, Issue 6, 061103, Published on 01/6/2017, doi: 10.1115/1.4036084.

Redesigning of Motorcycle Helmet for Improved Air Ventilation Using Numerical Simulations. BS Shishodia, S Sanghi, P Mahajan, Fluid Mechanics and Fluid Power–Contemporary Research, 625-635, Published in 2017, Publisher Springer, New Delhi.

The **Transportation Research and Injury Prevention Programme (TRIPP)** at the Indian Institute of Technology Delhi, is an interdisciplinary programme focussing on the reduction of adverse health effects of road transport. TRIPP attempts to integrate all issues concerned with transportation in order to promote safety, cleaner air, and energy conservation. Faculty members are involved in planning safer urban and inter-city transportation systems, and developing designs for vehicles, safety equipment and infrastructure for the future. Activities include applied research projects, special courses and workshops, and supervision of student projects at postgraduate and undergraduate levels. Projects are done in collaboration with associated departments and centres at IIT Delhi, government departments, industry and international agencies.

BIG DATA APPLICATIONS FOR MICRO AND MACROSCOPIC SAFETY ANALYSIS

Mohamed Abdel-Atey, Jaeyoung Lee, Qi Shi

The advent of the Big Data era has transformed the outlook of numerous fields in science and engineering. The transportation arena also has great expectations of taking advantage of Big Data enabled by the popularization of Intelligent Transportation Systems (ITS). The challenges in the transportation system are many, ranging from increase in travel demand, growth in congestion, need to improve safety to the reality of limited resources. Processing this large data requires different analytical and data mining techniques. This paper addresses several concepts and examples of using big data analytics. The presenter shows examples from many projects currently ongoing at the University of Central Florida (UCF). These projects deal with applications of big data analytics in safety. The lecture shows examples of UCF research using big data in safety analysis, adverse weather conditions and safety planning. Real-time safety, operation and adverse weather analysis are presented. For example, the viability of monitoring and improving traffic safety and operation on urban expressways in Central Florida using real-time Microwave Vehicle Detection System (MVDS) data is researched. From the perspectives of volume, velocity and variety, the MVDS should be regarded as one of the main sources of Big Data. Other big data applications involve combination of census, planning, safety, roadway and land use data to improve safety planning. This extensive research shows the promise and possibilities for the development of real time applications to primarily improve road safety in the context of Pro-active traffic management. It also demonstrates the transformation occurring in safety research and applications based on Big Data.

In an age of data explosion, almost every aspect of social activities is impacted by the abundance of information. The information, characterized by alarming volume, velocity and variety, is often referred to as “Big Data” (Beyer and Laney, 2012). As one fundamental elements of human life, transportation also confronts the promises and challenges brought about by the Big Data era. Big Data in transportation arena, enabled by the rapid popularization of Intelligent Transportation System (ITS) in the past few decades, is often collected continuously from different sources over vast geographic scale. Huge in size and rich in information, the seemingly disorganized data could considerably enhance experts’ understanding of their system. In addition, the creation of other transportation-related databases, such as roadway geometric characteristics, crash records, weather conditions, census and regional planning data, all contribute to the Big Data in transportation field.

In the meanwhile, the challenges in the transportation nowadays, ranging from increase in travel demand, growth in congestion, need to improve safety could not always be coped with constructions of new facilities. Faced with the reality of limited resources and encouraged by the strength of Big Data, the research group at the University of Central Florida has made substantial efforts to explore Big Data applications for traffic safety improvement. These applications cover both microscopic safety evaluation aiming at reducing crash likelihood in real-time and macroscopic safety analysis targeting at more proactive safety planning. Different analytic tools are implemented to serve for the purposes of these studies. In this paper, examples based on projects in Florida at both levels are presented to show the potential of Big Data applications for a better and safer traffic system.

Florida is among the most populous states in the United States. Moreover, the state has several metropolitan areas with population more than two million. Consequently, traffic safety is major concern for both traffic planners and operators. In this paper, microscopic real-time traffic safety evaluation based on an urban expressway network in central Florida area and macroscopic safety analysis at the ZIP levels for the whole state were conducted. The following parts describe data preparation and methods used for two levels of study.

The microscopic safety analysis focuses on the expressway system located in Central Florida. The network consists of the segments of SR 408, SR 417 and SR 528 which are operated by Central Florida Expressway Authority (CFX) as shown in Figure 1. On the 75-mile system, a total of 275 Microwave Vehicle Detection System (MVDS) detectors have been installed, making the system well covered by traffic sensors with average spacing between detectors less than 1 mile

The MVDS system could monitor traffic flow conditions at the lane level on roadway segments, ramps, toll plaza cash lanes and express lanes. In total, the three expressways generate about 1.5 million number of traffic readings each day. Hence from a volume point of view, the amount of data archived is huge and still grows rapidly. Currently, the data are collected continuously at one-minute intervals. According to the need of traffic authority, they could be archived at even shorter time interval such as 20 or 30 seconds. Currently on the examined system, the authority has implemented real-time traffic data to provide drivers with travel time estimation. From a velocity point of view, the speed of data collection enables traffic operators to manage their system and react in real-time. The collected data are in structured numeric format and contain detailed traffic parameters. The MVDS system could detect spot speed, volume, occupancy and simple vehicle classification on each lane. In traffic safety analysis, these ITS data are typically merged or combined with roadway geometric characteristics, weather conditions and driver information depending on their availability. Thus from a variety point of view, rich information could be extracted from MVDS systems and the need of data merging and combination added the complexity in data processing. Each of the three standards (volume, velocity and variety) indicates that the MVDS traffic data should be treated and exploited as Big Data. The MVDS data have been collected from July 2013 to December 2014.

A macroscopic model was estimated for pedestrian safety using big data, in order to improve transportation safety planning. Data from 983 ZIP areas in Florida were collected and used for the analysis. ZIP code is the postal code system used in the United States and some researchers have used it as a base geographic unit for safety analysis (Abdel-Aty et al., 2013; Lee et al., 2013; Lee et al., 2014a; Lee et al., 2014b).

Pedestrian crashes occurring between 2009 and 2011 were collected from the Florida Department of Transportation (FDOT) Crash Analysis Reporting (CAR) system. Demographic, commute pattern, and socio-economic data were obtained from the U.S. Census Bureau and the roadway/traffic data were acquired from the Roadway Characteristics Inventory (RCI). Lastly, the facility/attraction data were obtained from the Unified Basemap Repository (UBR). Overall 40 candidate explanatory variables and 2 target variables (i.e., pedestrian crashes per location and number of pedestrian involving per residence) were processed.

The Poisson regression models have played a key role in analyzing crash frequency data. The Poisson regression model has been broadly used by many researchers since it can cope with non-negative integers. This study also adopted the Poisson regression based model because Poisson distribution approximates rare event frequency data such as the number of pedestrian crashes or the number of crash-involved pedestrians, which were used as the response variables in this study.

Synthesizing the results from random forest, correlation test and preliminary logistic regression, four variables were selected for the real-time crash prediction model: the peak hour indicator, logarithmic volume and average speed at U2 station and the CI at D1 station.

Three types of real-time logit models based on the training data were tested and compared. All the four variables involved in the final model stage appear to be significant at 95% confidence interval (Table 4). Peak hour is proved to significantly increase crash likelihood. Logarithmic volume at U2 station is positively related with crash occurrence while the average speed at the same location is negatively associated with rear-end crash. The congestion index at D1 station is also found to contribute to crashes. While Congestion Index is a direct measure of congestion intensity, higher traffic volume and lower speed are also regarded as indirect indicators of congestion. In this study, the effects of traffic parameters at both upstream and downstream locations all converged to the same statement: rear-end crashes are significantly affected by traffic congestion on urban expressways.

As for the model selection, both model performance and prediction power were compared. The DIC values for the three models are comparable with random parameter model having slightly lower DIC. To evaluate the prediction power of the model, an appropriate cutoff point that classifies the membership (crash/non-crash) of each observation has to be determined first. Since the cutoff point is a probability value, theoretically it ranges from 0 to 1. The selection of a cutoff point that is too small would cause high sensitivity (crashes correctly identified) and low specificity (non-crashes correctly identified). On the other hand, a cutoff point that is too large would cause low sensitivity and high specificity. In these cases, the cutoff point is biased towards either sensitivity or specificity, and thus not optimized. As a response, a graphical method is to select the optimal point where sensitivity and specificity curves cross (Hosmer and Lemeshow, 2004). Only in this case, the cutoff point is neither biased towards sensitivity nor specificity. The optimal cutoff point in this study is 0.14 as illustrated in Figure 3. The prediction outcome, sensitivity, specificity, overall accuracy rate and area under the ROC (AUC) of both training and validation data sets are calculated for each model (Table 5). The performances of the three models based on training data are similar. In the validation data set, the random parameter outperforms others in specificity and overall accuracy rate. Based on the model fitting and prediction power of the training and validation data, we prefer the random parameter model as the input for reliability analysis. Another practical reason we choose the random parameter model is that FORM analysis could not deal with categorical variables.

In addition, 'Median household income (in $1,000)' was found to have a negative relationship with the second target variable. It is possible that people from lower socio-economic status households may prefer to walk or use public transportation even if they have vehicles. Also, the people from deprived areas might have difficulty in obtaining enough information regarding traffic safety (Martinez and Veloz, 1996). 'Proportion of high-speed roads (55 mph or higher)' is commonly significant for the first and second target variables. As in the first target model, it is also negatively associated with the second target variable. It infers that pedestrian crashes are less frequent in the area with more high-speed roads.

With regards to the random parameters (d_1, d_2, and d_3) that reflect the unobserved common components between 'Pedestrian crashes per crash location ZIP' and 'Crash-involved pedestrians per residence ZIP', d_1, d_2, and d_3 are significant at 5%. It implies the existence of common factors between the two targets although they are unobserved. Furthermore, the standard deviation of the shared spatial error term, 's.d. of f _i' is statistically significant at 5%. It suggests that both targets are spatially correlated among adjacent zones and the spatial autocorrelation is controlled by the spatial error term included in the model. In summary, 'Pedestrian crashes per crash location ZIP' has more physical variables (i.e. facility density) while 'Crash-involved pedestrians per residence ZIP' has more demographic and socioeconomic variables. Nevertheless, the two targets have three common significant variables, 'Proportion of high-speed roads (speed limit: 55 mph or higher)', 'Spatial autocorrelation', and 'Unobserved shared factors'.

Any variables that have potential correlation with other variables were not included simultaneously in the final model, and careful consideration of the correlated variables separately was attempted before reaching the final model. In the first target model, the strongest correlation was found between 'Proportion of high-speed roads (55 mph or higher)' and 'Number of K-12 schools per mi2' (r = 0.362). The strongest correlation in the second target model was observed between 'Proportion of households without available vehicle' and 'Median household income (in $1,000)' and its Pearson correlation coefficient is 0.302. None of the variables in the final model have evident correlations.

Subsequently, hotspot for the two targets were identified using PSI (Potential for Safety Improvements). The PSI is calculated as follows (Aguero-Valverde and Jovanis, 2009):

$$PSI = N\_expected - N\_predicted = \exp(\beta_0 + \beta X_i + \theta_i + \phi_i) - \exp(\beta_0 + \beta X_i)$$

All ZIP code areas in the study area were classified into three categories on the PSI: Hot (H), Warm (W), and Cold (C) zones. The hot zone refers to a zone with a top 10% PSI, The warm zone is defined as a zone with a PSI between 0 and top 10%, and cold zones are that with a PSI less than zero.

Summary and Conclusion

The rapid development of ITS systems in the past few decades has catalyzed the implementation of Big Data in the transportation arena. To harness the power of Big Data for better traffic system performance, it is vital to take full advantage of its real-time nature. In this study, both microscopic and macroscopic safety evaluations were carried out by taking advantage of Big Data. In microscopic real-time safety evaluation, the MVDS should be regarded as a main source of Big Data from volume, velocity and variety points of view. In macroscopic analysis, census and regional planning data for the whole Florida were utilized to shed lights into safety planning.

In the microscopic study, how congestion results in rear-end crashes was studied. It was found that the congestion was highly localized and time specific. As a result, to gain better understanding whether congestion leads to more crashes, it was deemed better to be evaluated under real-time modeling framework. Big Data enables the restoration of traffic for each crash case. Moreover, rear-end crashes were selected as the target since their connection with congestion could be more straightforward. Both data mining and Bayesian statistics techniques were adopted to identify the leading contributing factors to crashes in real-time. The results concluded that peak hour, higher volume and lower speed at upstream locations, and high congestion index (CI) at downstream detection point significantly increased crash likelihood. Thus, direct (CI) and indirect (volume, speed) congestion indicators all support the assumption that congestion has an impact on rear-end crashes. Currently, DMS have been widely applied on urban expressway systems for travel time estimation. However, they could also be used for congestion and safety warning. Information of congestion locations and queue-end warning would leave drivers enough time to adjust their speed and raise their awareness of surrounding traffic.

The macroscopic safety analysis using big data focused on two targets: 'Pedestrian crashes per crash location ZIP' and 'Crash-involved pedestrians per residence ZIP' were comprehensively analyzed. Statewide crash data were collected the FDOT CAR system and explanatory variables were collected from multiple sources including U.S. Census Bureau, RCI, and UBR. Overall 40 candidate explanatory variables and 2 target variables (i.e. pedestrian crashes per location and number of pedestrian involving per residence) were prepared. Different exposure variables were applied for the two targets. 'Log of population', 'Log of VMT', and the product of 'Log of population' and 'Log of VMT' were attempted one by one, and all of these variables were found to be significant at the 5% level. Nevertheless, it was uncovered that 'the product of 'Log of population' and 'Log of VMT' was the best exposure variable for 'Pedestrian crashes per crash location ZIP', whereas 'Log of population' was the best exposure variable for 'Crash-involved pedestrians per residence ZIP. BPLSESEM (Bayesian Poisson Lognormal Simultaneous Equations Spatial Error Model) was adopted in this study to account for unobserved common factors between the two targets and spatial autocorrelation among adjacent zones. The BPLSESEM revealed that two targets have different contributing factors. The first target, 'Pedestrian crashes per crash location ZIP', has 7 significant factors whereas the second target, 'Crash-involved pedestrians per residence ZIP' has 6 significant factors. It was shown that the first target has more variables related to location factors such as facility related factors. In contrast, the second target is associated with more socio-demographic factors. It is probable that there are common factors between two target variables although the shared factors are unobserved. Moreover, both the spatial autocorrelations among adjacent zones are detected in the both targets but they are controlled by the spatial error term included in the model.

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Network redesign for efficient crowd flow and evacuation. Lakshay Taneja, Nomesh B.Bolia, Applied Mathematical Modelling, Volume 53, January 2018, Pages 251-266, https://doi.org/10.1016/j.apm.2017.08.030

Optimal loading of double-stack container trains. Amit Upadhyaya Weihua Gua Nomesh Bolia, Transportation Research Part E: Logistics and Transportation Review, Volume 107, November 2017, Pages 1-22 https://doi.org/10.1016/j.tre.2017.08.010

Proper Orthogonal Decomposition: A Tool To Study The Underlying Physics Of Turbulence, SM Yahya, SF Anwer, S Sanghi, JURNAL TEKNOLOGI 79 (7-3), 7-13, Publication date 01/01/1/2017

News

The effect of a yellow bicycle jacket on cyclist accidents

It is likely that risk adaptation compensates for the effect of the increased visibility, i.e. cyclists become less careful when they feel more protected. The test group might have adopted a more risky riding behaviour because they felt more safe wearing the jacket. Another aspect of risk adaptation is whether there are differences in car drivers' behaviour towards cyclists with and without visible safety equipment. A British study has shown that overtaking motorists pass closer to bicyclists wearing a helmet than bicyclists not wearing a helmet. If this was also the case in this study, it may have influenced the size of the safety effect. The effects mentioned point in different directions: the reporting bias, if any, would result in a lower number of reported PIAs, whereas the risk adaptation would result in a higher number of PIAs, causing the two effects to cancel each other out. Moreover, the effects on the number of PIAs in the test group are so large and robust that this is unlikely to compromise the main result from the study: the yellow bicycle jacket decreases the number of PIAs in the test group.
Most traffic safety evaluation studies are conducted as before-after studies, but this design does not allow for controlling for confounding factors that may bias the estimated effect. In this study, an RCT was conducted, since this design in itself corrects for confounding factors. Randomisation assigns each participant randomly to either the test group or the control group. This implies that all possible confounders are distributed equally between the two groups, and the design thus allows for the only difference between the two groups being the variable considered, in this case the participants' multiparty bicycle PIAs. In this study, however, a large number of participants (15.5%) did not confirm their participation after the randomisation, which may have resulted in a bias. One effect was that the study participants in the test group were one year older than the participants in the control group. Despite being statistically significant, it is unlikely that the small difference has played any major role for the conclusion of the study. Furthermore, drop-out numbers were similar in the two groups (test: 615, control: 634). Therefore, the safety effect found in this study can be assumed to result from the bicycle jacket use rather than from other factors that tend to influence the results in traditional before-after studies, such as demographic characteristics and changes in behaviour, infrastructure and general safety level over time.
Harry Lahrmanna, Tanja Kidholm Osmann, Madsena Anne, Vingaard Olesena, Jens Chr. Overgaard Madsen, Tove Helsc
https://doi.org/10.1016/j.ssci.2017.08.001

Evaluating the impact of connectivity, continuity, and topography of sidewalk network on pedestrian safety

With the increasing demand for sustainability, walking is being encouraged as one of the main active modes of transportation. However, pedestrians are vulnerable to severe injuries when involved in crashes which can discourage road users from walking. Therefore, studying factors that affect the safety of pedestrians is important. This paper investigates the relationship between pedestrian-motorist crashes and various sidewalk network indicators in the city of Vancouver. The goal is to assess the impact of network connectivity, directness, and topography on pedestrian safety using macro-level collision prediction models. The models were developed using generalized linear regression and full Bayesian techniques. Both walking trips and vehicle kilometers travelled were used as the main traffic exposure variables in the models. The safety models supported the safety in numbers hypothesis showing a non-linear positive association between pedestrian-motorist crashes and the increase in walking trips and vehicle traffic. The model results also suggested that higher continuity, linearity, coverage, and slope of sidewalk networks were associated with lower crash occurrence. However, network connectivity was associated with higher crash occurrence. The spatial effects were accounted for in the full Bayes models and were found significant. The models provide insights about the factors that influence pedestrian safety and the spatial variability of pedestrian crashes within a city, which can be useful for the planning of pedestrian networks.
Ahmed Osama and Tarek Sayed.
https://doi.org/10.1016/j.aap.2017.08.001

Cyclists as a minority group?

In the social sciences, several definitions of minority group can be found. The definitions include different aspects such as power/status, number, distinctiveness, social category, group context, dispositions, and discrimination. Compared to motorized road users, cyclists are considered vulnerable road users because they lack physical protection. We argue that such definition does not capture the social and cultural aspects that characterize the membership within the group of cyclists. We offer arguments and reflections based on recent literature advocating that cyclists may share some features of the experience of minority groups. Although cyclists differ from other minorities in important respects, they manifest many of the characteristics by which minority groups are defined.
Gabriele Prati Víctor Marín Puchades Luca Pietrantoni
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A Pilot Study at National Highway-8 for On-site Crash Data Collection and In-depth Investigation in India.

The importance of on-site, in-depth accident research studies has been recognized internationally especially in developed countries. In order to address problems related to road safety, it is important to understand the epidemiology and causation of crashes. For this an in-depth investigation of the crash site, vehicles involved and injury details is required. Detailed crash information helps in analysing the events leading to crash and developing safety measures and/or intervention to reduce crashes. In order to pilot such an activity in India, an in-depth accident data collection activity had been carried out on national highway connecting Delhi to Jaipur (NH-8) for a duration of over a year by a joint team of IIT-Delhi and NATRiP.

A total of 1220 road traffic accidents (RTA) notifications were received by the team, of which 186 cases were attended and detailed data was collected in a pre-decided format. The crash data has been statistically analysed to determine the type of vehicles involved, contributory factors, collision type, type and level of injuries (injury categorized on the basis of severity).

Statistical analysis shows that heavy trucks (37.36 %) and passenger cars (21.5 %) account for majority of vehicles involved in RTAs followed by 2-wheelers (9.23%), trailer trucks (6%), bus (6%), and light trucks (5%). Other than that some tractors, 3-wheelers, road or construction work vehicles, bi-cycle, moped, rickshaw are involved in lesser numbers in RTAs. Most of the collision type reported were rear end/tail-gating (32.7 %), followed by 13.7% of "in a turn", angle collision and collision with object reported to be 7.5% each. It was also observed that 9 % of the crashes had fatalities and that most number of fatalities (77%), grievous injuries (41%) and minor injuries (46%) occurred where trucks are involved. RTAs occur as a result of a combination of factors which can be categorized as human error, vehicle factor, environmental conditions and road defect. Causes of the crashes were analysed and grouped into relatively independent and uncorrelated groups.

Transport system plays a very important role in the development of economic status in a country by promoting considerable distribution of goods and services. However, increase in transportation is also a leading cause of the increase in road traffic accidents (RTAs). Road traffic injuries are currently estimated to be the 9th leading cause of death globally and predicted to be ranked 7th leading cause of death by the year 2030.

The Global Status report on road safety, 2015 estimates that more than over 1.25 million people die each year in road traffic accidents around the world, with millions suffers from serious injuries and living with long-term adverse health consequences [2]. As per world health organisation (WHO) report, most of these road traffic deaths are in low and middle-income countries where rapid economic growth has been accompanied by increased motorization and road traffic injuries. The number of fatalities shared by India accounts for 16.7 % (207551 fatalities) of the total fatality as reported by WHO. The number of deaths reported by the data collected system (generally, police data) at national level in India accounts for 11% (137572 fatalities) which is different than that estimated by WHO. It is required to implement an effective national level accident database in order to accurately estimate road crashes in India and understand their epidemiology and causes.

A pilot in-depth crash data collection and investigation study was carried out for a duration of one year on NH-8 (Gurgaon to Jaipur). It was supported by Ministry of Heavy Industries and planned jointly by Accident data Analysis Centre (ADAC) of National Automotive Testing and R&D Infrastructure Project (NATRiP), Government of India and Indian Institute of Technology-Delhi (IIT-D). The pilot study covered a stretch of 194 km. Two centres were setup on the stretch to collect crash data through a traverse distance of less than 65 kms.

The pilot study carried out on NH-8 helped us to identify contribution of vehicles involved in crash, as well as road infrastructure, environmental factors and human factors related to road traffic crashes. It was observed from the data that trucks and passenger cars were involved in majority of the crashes collected by the team (186 cases attended). The data collection team received 1220 notification calls and almost 30 to 35% were related to vulnerable road users (VRU) such as pedestrians, bicyclists and powered two wheelers (PTW) many of which were not attended. It was reported by the team that the cases related to VRU were often too far off to reach in time, where either the team did not find the vehicle involved (PTW, cycle as well as opposing vehicle) and/or the crash victims were shifted to hospitals without being reported to local police or traffic police. It was also observed that vehicles involved were unknown in 24% of cases notified to the team.

Analysis of the crashes also helped identify the collision type and contributory factors related to the collected crash data. It was observed that mostly the vehicles were not maintaining enough gap (tail gating) or not obeying speed limits resulting in collision. Majority of road crashes were also reported while a vehicle taking either a right or left turn without using signal or the following vehicle was too close to react and prevent the collision during a turn. It was also observed that factors related to road infrastructure such as improper lane markings to guide vehicles properly, improper signboards, absence of street lights etc. and improper maintenance of road surface such as loose gravels, muddy surface, potholes also led to RTA for PTW as well as PV. Improper parking of vehicles at the side of the road without using retro-reflective devices to divert the oncoming traffic was also one of the reason for RTA. It seems, improvement in road infrastructure and enforcing road safety laws related to the movement of vehicles will prevent many of the road crashes. There can be various reasons or flaws for different stretches in the country and requires proper study to assess these flaws.

Off-site data such as FIR was also collected from the police stations and it was observed that cases which had fatalities only were recorded. This attributes to under-reporting of non-fatal or serious injury crashes in the national database. Crashes that resulted in no or minor injuries went unreported as pointed out in earlier studies. It was also observed that police reports the cases where insurance has to be claimed by the crash victims or to find out the faults. In police reported road crashes, human error is assigned as main cause, leaving behind other aspects involved such as road infrastructure, vehicle crashworthiness and safety and environmental conditions. Response time of the police officials in some cases as observed was high leading to which many crash victims were shifted to hospitals before police reaches the crash site. This had been primarily observed in cases where VRU were involved.

The case study presented in this paper also suggest that the data collected from the site such as damage details of vehicles, skid marks, final rest positions and orientation of the vehicles was sufficient to carry out a detailed crash reconstruction. It helps in understanding crash causation and analyzing factors which cause crashes on the road. It also shows how injuries can be correlated with the crash for further understanding of the events that happen during a crash. Analysis of the crash data collected by the team on NH-8 suggests that due to lack of scientific data collection process as well as analysis, the safety of road users is being compromised. It can be pointed out from the data analysis that there was contribution of road infrastructure, environment conditions, human factors and vehicle safety system which leads to a crash. The data collected and analyzed scientifically will help in finding links between the factors involved and will help in preventing crashes and related injuries. Needless to say, this needs to be done on a Pan-India basis.

The broad findings of this pilot study suggests that there is a requirement to set up a professionally managed accident data collection system that give a reasonably accurate estimate of RTA and investigation activity in India. The pilot study on NH-8 suggest that if the data collection activity is carried alongwith the assistance of state police, hospitals and insurance companies would provide in-depth national database reliable for analysis.

Kuldeep Singh, Anoop Chawla, Sudipto Mukherjee and Pradeep Agrawal, SAE Technical Paper 2017-26-0001, 2017, doi:10.4271/2017-26-0001.

Continued overleaf

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Excerpts from two publications: A TRIPP BULLETIN INSERT

Assessment of interstate freight vehicle characteristics and impact of future emission and fuel economy standards on their emissions in India

The transport sector is globally recognised as the backbone of economic growth. However, gradually concerns have been raised for its close association with the energy consumption and its related environmental impacts. Globally, transport sector accounts for 23% of CO2 emissions. Within transport sector, 75% of CO2 emissions are shared by automobiles and trucks travel. Sustainable and strategic planning for the transport sector has, therefore, been a growing thrust worldwide. Being a developing economy, in India, similar challenges have been realised and various policies have been implemented to combat the rising energy consumption and environmental emissions by the transport sector. India is facing an unfortunate recognition with 33 Indian cities among top 100 world's worst pollution affected citie. In fact, the health cost from air pollution constituted 23% of the total India's GDP value in 2010. Emissions and fuel consumption from the road transportation has always been focus of concern and is rather constantly monitored through the introduction of emission standards and through the promotion of fuel efficiency policies. Nevertheless, these worthy attempts have been marred by the increase in population, rapid urbanisation, rise in motorisation and limited investments in sustainable transport systems. According to Census of India (2011), the population of India increased to 1210 million registering a decadal growth of 17.64%. Meanwhile, the number of registered motor vehicles increased to 210 million with a compound annual growth rate of 9.8% between 2005 and 2015. Aggressive growth rate both in terms of population and vehicles have, therefore, continuously challenged the balance between India's energy demand, air quality and overall development.

The transport sector in India contributes to 6.4% share in India's GDP of which road transport accounts for 4.5–5% share. In 1950s road transport carried 15% of passenger and 14% of freight movements with the total network length of 0.4million km. However, over the past two decades, road sector has evolved as a predominant mode of transport both in terms of the number of vehicles and road network length. This is evident from the fact that road transport now accounts for 86% of the passenger movements and 66% of freight movements with the total network length of 4.7 million km in 2011. The rise in the share of road transport is attributed to its flexibility and adaptability in operation and is supported by massive investment in road infrastructure through government programmes like the National Highways Development Project (NHDP), Pradhan Mantri Gram Sadak Yojana (PMGSY) and Jawaharlal Nehru National Urban Renewal Mission (JnNURM).

As far as energy consumptions are concerned, the transport sector of India accounts for 14% of the final energy consumption and has been associated with the highest growth rate in terms of energy consumption (annually 6.8% since 2000) among other end user sectors. A significant component of the transport sector energy consumption is dominated by the oil-fuelled road travel by freight vehicles. PCRA also highlights that “Of the total diesel consumed by road transport, trucks and buses accounted for about 77% with buses consuming around 7.08 million tonnes per annum and trucks consuming 24.25 million tonnes per annum.”

Given the nationwide concern towards the growing energy consumption and emissions from the freight vehicles, the present work aims at analysing the potential impacts of proposed fuel emission and economy standards in India for interstate freight fleet. The study contributes to the literature majorly in three ways:

- Previous studies use different assumptions for survival rates, annual mileage or fuel economy to calculate the total contribution of freight vehicles to overall pollution. This study attempts to narrow this gap by developing an emission inventory for freight vehicles used for interstate mobility.
- The characteristics in terms of age distribution, the variation of annual mileage and fuel economy with age are examined.
- Implication of various assumptions on the total amount of emissions is tested with respect to the base scenario developed using survey based results.

The objectives of the study are achieved by conducting O & D surveys and traffic volume counts at ten locations on national highways to capture the fleet characteristics. The results indicate the presence of newer fleet for long distance transport as compared with the urban area of Delhi. 46% and 71% of the fleet lies in the age group of 0–4 years for heavy and light-duty vehicles respectively. Only, 3.64% and 0.77% of heavy-duty vehicle and light-duty vehicle are greater than 10 years old, respectively.

The average annual mileage of 51,000 km and 30,000 km are observed for heavy and light duty vehicles, respectively. Uncertainties associated with the use of annual mileage of freight vehicles for emission calculations are also discussed. For heavy-duty vehicles, the decreasing relationship of annual mileage with age is captured. Annual mileage for heavy-duty vehicles decreases by 30%, 55% and 80% after the age of 5, 10 and 15 years, respectively. However, in the case of light-duty vehicles, a similar relationship between annual mileage and age is not found to be predominant. The fuel economy for diesel-run light-duty vehicles ranges in between 11 km/l and 13 km/l, whereas, for heavy-duty vehicles, it is in the range of 3–4 km/l. The results for the urban setting show the fuel economy to range from 4 to 6.6 km/l for light duty vehicles and 2 km/l to 3.85 km/l for heavy-duty vehicles, thus, representing the operating conditions in the two cases.

A significant overestimation in emissions is observed if a particular proportion is applied to the cumulative registered vehicles to calculate on-road vehicles. Indeed, this approach is also associated with significant overestimation of the emissions by old vehicles.

The analysis for three emission scenarios indicates a clear gain in early transitioning to the stringent emission standards. The emission reduction varies with the different type of pollutants. For NOx, 89% reduction is expected if BSIV standards are followed by BSVI standards in 2020 for heavy-duty vehicles. However, in the case of PM, a major gain is achieved by the implementation of BSIV standards in 2017 (80% reduction) for heavy-duty vehicles. In the case of light-duty vehicles, 84% reduction in NOx emissions will be observed by the implementation of BSVI standards in 2020. A total reduction of 91% will be achieved in PM emissions if BSVI standards are further implemented for light-duty vehicles. Finally, accelerated phasing of fuel economy standards is expected to reduce CO2 emissions and fuel consumption by 31% and 26% for heavy-duty and light-duty vehicle in 2026, respectively.

Although the scope of the current study is restricted to the national highways, the work is to be further extended to the different type of urban areas and different type of roads. For instance, the characteristics related to a metropolitan city may be quite different from a small medium sized city. Averaging the results for different areas will thus help to predict a representative survival curve for the national fleet of heavy and light-duty vehicles. This may also help us to predict the potential impacts of the proposed scrap page policy in India. Given the available data set, it may be too early to comment on this area. Further, the emission factors (g/km) based on which emission calculations for heavy-duty and light-duty vehicles are performed, do not correspond to the real world driving and payload conditions. Comprehensive documentation of on-road variation of emissions will help to reduce the uncertainties in the results. Thirdly, the proportion of super-emitters among the freight vehicles is required t be investigated to further improve emission estimates. Fourthly, future projections for the fuel economy standards need to be further improved. Long-term projections will require a complete understanding of presently available fuel efficiency technology, the time frame of their proliferation, market and societal response to fuel efficiency standards. Establishing disaggregate baseline scenarios for the different class of freight vehicles should be taken into account seriously.

However, from the aggregate analysis performed in the study, it is clear that much of the benefits in emission reduction can be achieved if emission standards are nationwide and timely implemented. The higher turnover rate of freight fleet offers a great scope of penetration of new fuel efficient technologies in the system. This is the need of the hour that we appropriately utilise the potential lying ahead, and push for planned freight policies for the betterment of environment and society as a whole.

Leeza Malik, Geetam Tiwari. Energy Policy, 108 (2017), 121-133.