WINTER
2023

WHO COLLABORATING CENTRE

INDIAN INSTITUTE OF TECHNOLOGY DELHI

T R I P - CENTRE **BULLETIN**
TRANSPORTATION RESEARCH & INJURY PREVENTION CENTRE
VOL 2 NO. 3

RESEARCH AND CONSULTANCY PROJECTS

Centre of Excellence for Advance Data Management System for Highways (ADMS Highways)
Sponsor: National Highway Authority of India
Project Team: G.Tiwari, K.R.Rao, K.N. Jha, A.K. Swamy, Manoj M., Anoop Krishnan Naduvath Mana

The report presents an update of six ongoing research projects: Machine learning assisted incident analysis and prediction using structured and unstructured NHAI data, a system for organising and searching all digitised data at NHAI, an approach towards creating a safe traffic work zone environment on National Highways, Empirical Assessment of Schedule and Cost Performances of Various Contracts of NHAI and Development of a Decision Support Framework to Improve the Performances, Developing a comprehensive repository of national highway infrastructure, and the development of crash database for national highways.

Traffic Incident Management System (TIMS), an integrated multi-disciplinary procedure used to detect, respond, and clear highway incidents so that the traffic flow on the highway restored quickly and safely. TIM ensures the safety of road users, victims and reduces the duration and consequences of highway incidents.

This involved the use of advanced machine learning algorithms including both supervised and unsupervised learning. Specifically, various techniques such as clustering, classification, regression, decision tree analysis, along with surrogate model-based optimization techniques are implemented to learn from the available data. A system architecture for automated text extraction and data retrieval from large corpus of texts is developed. Development of integration mechanism of database, files, and CMS is underway which will be then used to prepare a searchable integrated database system.

The methodological framework is developed towards creating a safe traffic work zone environment on National Highways using available information from Data Lake. The information available is classified into type I and type II fields. The information is also matched to the requirements of Accident Recording Form by MoRTH and missing information is identified within current datasets, based on which additional information which needs to be collected is put forth.

This study focusses on delays and cost overrun particular to highway projects and highway projects in India. The empirical assessments are performed with actual project data of past projects. Research which includes both qualitative and quantitative assessment. Study showing the significance of contracting method and its influence on project schedule and cost. Out of the 79% projects whose execution commenced on site, 38% of the project are delayed due to various reasons. This project finds the reasons for delays, and categorizes it based on the choice of contract.
It is well accepted fact that pavements deteriorate under action of traffic and environmental loading over period of time. This project will look at developing deterioration models and prescriptive analytics to recommend appropriate maintenance activities.

Information available on DataLake is used to assess effectiveness of different designs on safety, address network level safety, asess impact of IT enabled measures-e-challan, red light cameras. To this extent, various data sources required for appropriate dashboards are assessed and a framework to integrate them into a unified database is developed. These dashboards would also serve as a real time traffic monitoring system, allowing the authorities to monitor the traffic throughout the country under various exigent scenarios, thereby aiding the decision making of other government bodies.

The aim here is to develop a systematic database using the diverse set of information that is reported at the project level across NHAI road network. Once these datasets are developed, they can be joined to conduct various road safety analyses.

Pedestrian Safety and Sustainable Mobility in NCT, Delhi (Sub-Project under MI02263 DRIIV)
Sponsor: Principal Scientific Adviser, Govt of India
Project Team: Geetam Tiwari
Objective: As per the Paris agreement (2016), as we are bound to reduce the emissions, this can be achieved by creating a smart city having the following facilities at large
1. Adaptation of large-scale electric vehicle (EV) in transport sector.
2. Creating the charging infrastructure (from renewables) for Evs.
Increasing the use of Electric Vehicles (EVs) to reduce the pollution in the city like Delhi, the prime bottleneck is the availability of charging infrastructure. The development and deployment of DC fast chargers across the city will encourage the adoption of EVs for private and public transport. A prime thematic problem which is to be solved to have a smart, sustainable and secure EV infrastructure in the city is
•Optimization of EV charger placement in the city
•Creation of Charging Infrastructure with utilization of renewables (solar power).

Road Safety Audit of Identified BlackSpots in the year 2021 and 2022 on UP PWD Roads
Sponsor: Uttar Pradesh Public Works Department
Project Team: G.Tiwari, D.Mohan, K.R. Rao, K.N. Jha and S. Mukherjee
Objective: Uttar Pradesh government has been working to reduce traffic crashes on all roads. In this context the UPPWD has identified 321 blackspots in selected districts. Methodology for safety inspection and audit of these spots for preparing site specific observations and recommendations will be finalised.
Field Safety Inspection: The travelling participants (at least 6 field engineers nominated by UP PWD and 4 academic experts) will travel on selected highway corridor. Field audit will be conducted on selected stretches of the highway corridor by this team.
Lecture cum Discussion Session: A three-hour discussion session will be organised. Discussion session will preceded by an expert lecture on an important topic of Road Safety.

Gendered approach of addressing adaptation capacity to hot weather conditions
Sponsor: DT Global International Development, UK
Project Team: Deepty Jain, Rahul Goel and Geetam Tiwari
Objectives:
•Understanding the daily travel patterns of women belonging to varying income groups,
•Measuring the variation in thermal comfort conditions by the time of day and built environment factors,
•Measuring the exposure level to hot weather conditions for non-adaptable trips,
•Analysing the adaptation capacity of respondents for the recorded trips and
•Codesigning implementable solutions with the community using community engagement exercises.

A Framework for Selecting an Appropriate Urban Public Transport system in Indian Cities
Sponsor: The Infravision Foundation
Project Team: Geetam Tiwari and Deepty Jain
Objective:
•Current travel pannern (based on censuses data, city typology)
•Description of alternate PTs (Definitions and operational characteristics)
•Indicators users/operators/government (Broad framework. Method for scenario building)
•Estimated travel patterns for 2030, 2040, 2050
•Details of alternate Pts
•Indicators Users/Operators/Government

National Database – Fatal Road Crash System (ND-FRCS) Development
Sponsor: JP Research India Pvt Ltd., India
Project Team: Rahul Goel, Geetam Tiwari and Girish Agrawal
Objective:
i Develop methodology for capturing details of fatal crash data from police FIR Crash Data.
ii Develop a Nationally Representative Fatal Crash Database (ND-FRCS) by coding previous 3 years fatal crashes for selected States/UTs
iii Training workshop for all researchers involved in the coding(TRIPC and JPRI).
iv Form a joint working group/committee between TRIP Centre and JPRI for steering the progress, engaging with relevant users/stakeholders.
v To undertake coding for the following States in phase one (first year): Haryana, Delhi, Chatttisgarh and Rajasthan
vi JPRI Consortium to undertake coding for the following States in phase one (first year): Gujrat, West Bengal, Tamil Nadu and Telangana
vii Jointly work towards building a preliminary

Continued on page 4

T R I P - CENTRE BULLETIN
TRANSPORTATION RESEARCH & INJURY PREVENTION CENTRE
VOL 2 NO. 3
WINTER 2023

Excerpts from: WALK WITH ME: EMBRACING INTERSECTIONAL EQUITY TO SUPPORT A JUST WALKABILITY TRANSITION - 2nd Dinesh Mohan Memorial Lecture

Derlie Mateo-Bambiano

The Intergovernmental Panel on Climate Change (IPCC) released its sixth (and final) Assessment Report instalment. The report describes the grim reality that we are living in a carbon-intensive world. The transport sector is the second largest global emitter of carbon dioxide. As the climate crisis intensifies, our home planet, Gaia/Mother Earth, becomes more vulnerable to climate change impacts. As transport planners, engineers, and future professionals, we have the duty to explore alternative ways in which transport can contribute towards a more climate-adaptive world (Boehm and Schumer, 2023).

One decarbonisation pathway towards achieving low-carbon mobility is encouraging active transport. This refers to initiatives that encourage more walking and cycling in cities and communities. For instance, implementing walking behavioural change programs such as walking school buses, encourages a shift from the use of private vehicles to a more active mobility lifestyle (Cambra and Moura, 2020; Nikitas et al., 2019). However, while these types of initiatives are receiving increasing attention nowadays, decarbonisation as a transitionary route can also lead to a short-term increase in associated social costs (Emodi et al., 2022). This can be in the form of incurring higher prices of (goods and) services as transport service providers might pass on upfront costs to consumers if the scaling and adoption of solutions have not been carefully considered. Care must therefore be at the core of these processes to ensure that the transition does not lead to more inequities but must be prudently considered and undertaken in a just and inclusive manner (Tammaru et al., 2023).

Active transport refers to both walking and cycling. Walkable places are locations that promote active lifestyles. Promoting walkable places should be a strategy that governments, civil society and the private sectors must support to achieve more inclusive cities and equitable communities. While ample evidence shows the obvious benefits of walking at the individual, societal and global scales, various actors, and stakeholders, particularly those who can influence how transport environments are shaped, are reluctant to support the transition towards more pedestrian-friendly environments. This is because of the lack of a more holistic and comprehensive understanding of the multi-dimensional barriers to walking. At the individual, (resulting from a diverse pedestrian experience) (Arellana et al., 2021), neighbourhood (planning for diversity and inclusive design) (Wang et al., 2016) and institutional levels (policy frameworks that support more inclusive governance) (Curtis and Low, 2016).

By adopting Crenshaw's (1990) intersectionality theory as the framework to explore the concept of equity within walking environments, the aim of the presentation is to explore an important but neglected dimension of walkability, the diversity of pedestrian experience. I argue that the lived experience of pedestrians provides an essential dataset at the individual level (e.g., actors/stakeholders including policymakers, users, and operators) to guide walkability transitions at the street/neighbourhood levels (planning and design).

By drawing on the results of the systematic literature review, we then propose an intersectional equity framework to guide the development of a Pedestrian Experience Tool. The Tool serves as the platform to explore the diversity of pedestrians through Persona-development and the diversity of the pedestrian experience through the piloting of the Tool. The instrument is introduced as an awareness-raising tool to be able to walk in another pedestrian's shoes and to comprehend the diversity of pedestrian experience, including the 'barriers' and 'facilitators' to walking, and identify elements that encourage and discourage walkability at the street/neighbourhood level. The purpose is to articulate how the diversity of experiences of pedestrians can support walkability and the shaping of walkable environments that leave no one behind.

The paper is structured as follows: First, I will discuss the concept of intersectional equity as a lens to explore the question: Who is the pedestrian? Second, I will present the pedestrian experience tool as a tool to further examine the question: How diverse is the pedestrian experience? the awareness-raising tool enables individuals to walk in another pedestrian's shoes, comprehend the diversity of pedestrian experience, including the 'barriers' and 'facilitators' to walking, and identify elements that encourage and discourage walkability at the street/neighbourhood level. Third, I will explore the question: How do we go about a walkability transition? Here are some of my personal reflections:

"Take for example a man who is able-bodied with no physical disability, single without caring responsibilities, and who lives in a community where there are several transport options; he is not significantly disadvantaged mobility- and accessibility-wise as compared to a mother living with a disability who must also care for their young child. Her experience of disadvantage will be compounded if they also live in a place that lacks adequate walking infrastructure or is distant from a public transport stop. Fundamentally, their needs as pedestrians would be very different."

In this section, I will critically explore and introduce the concept of intersectional equity as a framework to answer the question: Who is the pedestrian from an intersectional equity perspective? I will draw from the dimensions of participation and representation, and the aspects which has informed the development of a pedestrian experience tool.

Jane Jacobs published her book titled The Death and Life of Great American Cities in 1961. Her book was a strong reaction against the modernist movement at that time. While it was written more than 60 years ago, the book's message continues to resonate with professionals and the public even today. Renewing urban areas by clearing entire city blocks and rebuilding them with beautiful architecture is unacceptable. At that time, she was a lone voice who went up against powerful and influential people such as the then-mayor Robert Moses who symbolised the technocratic planner whose concern was building freeways and high-rise infrastructures. While Jacobs did not have a background in urban planning, she understood very well what makes a city, a place, or a neighbourhood tick. It is not the grandiose architecture but the mixture of shops, offices, and housing that brought people together to live their lives. A scale that can best be experienced by walking the city.

At this point, I would like to introduce the concept of walkability to create a shared understanding of the concept. Walkability refers to the (built) environment potential affecting a pedestrian's ability to walk to different destinations and for different purposes (Annunziata and Garau 2020). Walkability can be limited by environmental factors or individual limitations because of one's current personal circumstances.

There are different reasons why one walks. One way is to consider walking as a mode of transport. Walking for transport refers to carrying out walking for the purpose of going to/from places. Because it will elicit different expectations in terms of walkability, this is therefore to be distinguished from recreational walking.

As a mode of transport, it becomes a derived demand. This means that because I would like to study, meet with friends, go to work or for another reason, I would need to move from one point (my house) to another point (school, friend's home, workplace) either solely by walking if these destinations are within walking distance or I need to walk to a public transport stop to then transfer to another mode.

According to the Collins dictionary, a pedestrian is a person who travels on foot. This can be a person who is walking, jogging or running, someone using a human-powered vehicle or mobility devices such as a self-propelled wheelchair, roller skates, skateboards, or mobility scooters, someone pushing a pram or wheelchair, but not travelling at a speed greater than 10 kilometres per hour (Truong et al., 2018). Pedestrians may also refer to adults in a hurry, groups having a leisurely stroll, individuals carrying luggage, parents with children in tow or pets with their humans. Beyond movement, pedestrians may also undertake other activities such as people stopping to buy a doughnut from a street vendor, someone who pauses to enjoy the view, or when one meets a friend and making a temporary stop to have a chat. Pedestrians are highly diverse and may use street spaces for both mobility and non-movement, demonstrating the diversity of street space use.

Pedestrians possess unique characteristics that must be taken into consideration when planning public spaces such as streets, sidewalks, or dedicated pedestrian facilities. When designing and planning for these facilities, we should ensure that it meets the needs of all users. For instance, their space requirements may vary ranging from less than 1 square meter to several square meters for people on mobility aids, or in groups or those bringing their pets along with them. Objectively, pedestrian traffic averages about 4.5 kilometres per hour, with a range of 2.8 to 9.0 kilometres per hour (Truong et al., 2018).

However, the environment can also pose a unique challenge to pedestrians. Take for example topography, inclined steps and irregular surfaces which are substantial impediments to young children, older pedestrians, those with physical disabilities, and individuals who are pushing prams. Female or child pedestrians or those with health conditions can be highly sensitive to congested traffic, street detours, uneven road conditions, street aesthetics, or the perception of street safety.

The way we design the built environment can also impact the experience of pedestrians. Missing sidewalks may mean a little inconvenience for an able-bodied pedestrian but can be a major concern for those on mobility scooters or those with strollers. This means that they would need to find an alternative route to navigate the street or when they need to descend a curb.

Hence, when articulating the pedestrian experience, it is important to comprehend that pedestrians are not a homogeneous group, and therefore will not manifest similar pedestrian experiences. In fact, because pedestrians represent a diverse group of individuals (women, ethnic minorities, older pedestrians, those living with disabilities, youth, children) and because of these differences, they would have different needs, requirements and perceptions and preferences as well. From our earlier descriptions of pedestrians, we could glean that some may be more vulnerable and disadvantaged than others when using the same space. Their level of vulnerability may be brought about by different walking needs because of the environmental conditions; we argue that this could be due to the diversity and intersectionality of a person's social identity.

Who is the pedestrian from an intersectional equity perspective?
Individuals possess multiple, diverse social identities. This identity may include race, religion, ethnicity, indigeneity, disability, age, displacement, caste, gender, gender identity, sexuality, sexual orientation, poverty, class and socio-economic status. The intersections of these may create different levels of experience, including individual advantages or disadvantages as a pedestrian. In 1989, Kimberly Crenshaw introduced the concept of intersectionality. According to Crenshaw, intersectionality demonstrates the compounding effect of discrimination that a person may experience because of their intersecting social identities. For instance, in the short description of the epigraph:

Yet a gendered transport system persists due to the male/female division of labour. The planning and design of our transport infrastructure is still based on "the simple, uninterrupted, mono-journey to work and back again of the traditional male commuter" (Greed, 2019, p.29), placing a structural barrier to enabling women's mobility, which is often multi-purpose and complex.

The critical disability scholar Aimi Hamraie described the "normate template" (2017) as the basis for the default user, referring to Da Vinci's Vitruvian Man or Le Corbusier's Modulor Man, has set unrealistic expectations in the planning, design and management of our built environments, including the transport system. For instance, the basis for the design of space occupancy will be a man who is typically 180cm white, male, and able-bodied, person (Hamraie, 2017). In reality, the general population do not conform to this physical profile. As Stafford and Volz (2016) correctly critiqued, we are designing for mythical beings (Stafford and Volz 2016).

The difference in the lived experience of pedestrians must be captured authentically, to provide an essential dataset at the individual level (e.g., actors/stakeholders including policymakers, users, and operators) to guide walkability transitions at the street/neighbourhood level, planning and design; this would have important implications for planning and policymaking. The recognition of the diversity of pedestrian experience and the knowledge derived from these diverse experiences are vital to planning and transitioning to a more inclusive and just society.

Walkable places are locations that promote active lifestyles, are conducive to walking and create positive health outcomes. Encouraging a more sustainable and inclusive active mobility culture is an important goal in transitioning to more walkable places. But creating a shared understanding of what a just transition is in the context of attaining more walkable places is necessary to ensure that we can measure what matters but more importantly, we can measure the change that may occur.

If we are serious in our resolve to realise a transformation towards more walkable urban places, we need a theory of change that recognises that specific processes can sometimes lead to different distributions of benefits and drawbacks. A 'just transition' in walking for transport framework will consider current intersectional (in)equities. By bringing an intersectional equity perspective to walking for transport, we can shed light on an important but neglected dimension of walkability, the diversity of pedestrian experience.

Transitions theory is an analytical approach that combines both positivist-quantitative and constructivist-qualitative research design (Pel 2022). While both approaches appear divergent, both will situate the transition within the specificity and circumstances of the local conditions and context of place (place-based). Moreover, it engages the community of pedestrians who are local residents and regular workers/visitors as the local place experts (pedestrians as experts). The importance of the inputs of local communities as experts in the scoping and visioning for their place. Hence, the pedestrians, their experience, and how their intersecting social identities influence their experience as pedestrians are the most important datasets in walkability research.

There are two aspects in realising a just transition. First, it requires a pivot towards embedding intersectional thinking to identify and appropriately address disparities that are experienced by pedestrians with different social identities within the same transport environment. Second, placing equity at the core of any ongoing transition recognises that processes taken in shaping more walkable places may also lead to diverse distributions of benefits and drawbacks.

Hence, equity is not about providing equal access to walking for transport or mobility, it is ensuring that everyone is given an equal chance to participate in their choice of opportunities by taking into consideration their intersectional identities and how these identities compound advantages or disadvantages.

And so, building equity into transport planning means that the onus should not be on the pedestrians to make changes or adjustments so that they can participate. Structures and infrastructures need to shift so that the accountability of pedestrian participation and representation is on the planner and the provider of transport. Beyond considering current intersectional inequities, a just transition also acknowledges those who are more disadvantaged because of their intersectional identities which are most vulnerable to the negative impacts of transport service provision.

And so, a just transition will also call for stronger recognition of walking transition cultures, policies and frameworks that can directly support active transport, encouraging more walking and shaping a more sustainable and inclusive active mobility culture.

T R I P - CENTRE BULLETIN
TRANSPORTATION RESEARCH & INJURY PREVENTION CENTRE
VOL 2 NO. 3 WINTER 2023

Continued from page 1

Facilitate online learning on low carbon urban mobility and living labs: Online Course (Decarbonising transport in Indian cities) - an introduction to the decarbonisation of transport
Sponsor: Wuppertal Institut für Klima Umwelt, Energie gGmbH,
Project team: Deepty Jain and Geetam Tiwari
Objective: The Wuppertal Institute is engaged for the implementation of the project "Decarbonising Transport in Emerging Economies (DTEE)" through a Subgrant Agreement between the Organisation for Economic Co-operation and Development International Transport (OECD) and Wuppertal Institute signed on 30 September 2019.

Consulting Services to audit the implementation by the States of the direction issued by the Supreme Court Committee on Road Safety (Group B, C & D)
Sponsor: Delhi Integrated Multi-Modal Transport Solution, Ministry of Road Transport and Highways
Project Team: Geetam Tiwari, Kalaga Ramchandra Rao, K Neeraj Jha
Objective:
•Evaluate the level of compliance (quantify)of the Supreme Court recommendations
•Identify problems in complying with the Supreme Court recommendations
•Evaluate impact of various recommendations on safety outcomes
•Identify the most effective recommendations in impacting traffic safety outcomes.
•Identify the most effective recommendations in impacting traffic safety outcomes.

Traffic Performance Evaluation and Optimisation of Highways in Delhi Using Simulation Analysis – for Delhi PWD Roads
Sponsor: Medulla Soft Technologies Pvt. Ltd.
Project Team: Sai Chand
Objective
•Check and quantify the travel demand data
•Data analysis of crowdsourced travel time data
•Check and review the simulation model for calibration validation

Development and Validation of an Electric Rickshaw Passenger Safety Scale
Sponsor: Science & Engineering Research Board (SERB)
Project Team: Manoj M., G. Tiwari and Nezamuddin
Objective: This project aims to develop and validate and electric rickshaw passenger safety scale. The study develops a methodology that combines machine learning algorithms and standard econometric approaches to develop and validate the proposed scale and prioritize safety improvement actions based on user perceptions. The project is the first attempt to present an electric rickshaw safety assessment scale from the passenger's viewpoint

Identification of key performance indicators for ITMS of Delhi using simulation
Sponsor: Gala Smart Cities Pvt. Ltd.
Project Team: Sai Chand
Objectives:
•Identify KPIs for Delhi ITMS using a simulation model
•Calibrate the travel demand data required for the simulation model
•Data analysis of crowdsourced travel time data from Tom Tom.
•Check and review the simulation model for calibration and validation

Improving gender equality and safety of cycling use in an Indian city
Sponsor: Urban Land Transport, Urban Development Department, Govt. Of Karnataka
Project Team: Rahul Goel, Avinash Chanchal, Ruchi Verma, Sandeep Gandhi
Objectives:
•To evaluate the mobility impact of the bicycle distribution among low-income women workers in Bengaluru.
•To measure a) livelihood of women to take up cycling to work and b) mobility among women (e.g. total daily distance, number of destinations).
•To identify various factors that mediate the impact of receiving a free bicycle.

Research to Support Large Scale Investments in Bicycling in the Cities of Low- and Middle-Income Countries
Sponsor: Susan and Richard Kiphart, Centre for Global Health and Social Development, USA
Project Team: Rahul Goel, Geetam Tiwari
Objectives:Large investments in bicycling can help LMCs make progress toward climate goals by decarbonizing transport. They can also help meet several Sustainable Development Goads (SDGs) due to reduced road traffic injuries, and the cardiovascular benefits of lower vehicular emissions and increased physical activity.
•To assess the current state of bicycling in the cities
•Describe the political economy of investments in bicycling infrastructure.

Technical Support for monitoring and Implementation of Transport Policies for improving traffic safety and Bus system in NCTD
Sponsor: Transport Department, Govt. of NCT Delhi
Project Team: Geetam Tiwari, Rahul Goel, Nezamuddin, K.R. Rao

Objective: To provide technical support for monitoring and implementing various ongoing activities related to traffic safety and route rationalisation and electrification of public transport system.

Road Safety Data: The road traffic crash data is already available on a GIS platform. TRIP Center will assist Bloomberg Philanthropies (BP) to use this data for identifying hazardous locations where infrastructure improvement can be implemented.

Safe School Zones: To enable a more evidence based approach, TRIP-Center- HumanQind has developed an innovative web based solution 'COMPASS' to create data driven safe school zones.

Vehicle Fleet Characteristics Using Pollution Under Control (PUC) Data Base: There are approximately 500 PUC centres in Delhi which are largely located at fuelling stations and some are located along the major corridors and highways.

Electrification of Urban Freight Fleet: Urban freight is dominated by small goods vehicles that include 3 wheelers and 4 wheelers. They are significant contributors in carbon emissions and local pollution. Such vehicles and their operations contribute 75% of all freight related emissions within the city.

Electrification Roadmap for Buses in Delhi: In public transportation, induction of e-buses into the existing fleet is on the rise. However, large-scale penetration of e-buses is hindered due to high upfront cost of e-buses and the charging infrastructure required for e-bus operation.

The Transportation Research and Injury Prevention Programme has been operational for two decades. On May 21st 2021 it was established as TRIP Centre. It is based at the Indian Institute of Technology (Delhi) and is an interdisciplinary academic unit focusing on the reduction of adverse health effects of road transportation. researchers at TRIP Centre seek to integrate all issues concerned with transportation to promote safety, active mobility, cleaner air, and energy conservation. They are involved in planning safer urban and inter-city transportation systems and developing designs for vehicles and safety equipment.

Endowments for perpetual Chairs
CONFER, India: TRIPP Chair for Transportation Planning
Ford Motor Co., USA: Ford Chair for Biomechanics and Transportation Safety
Ministry of Urban Development India: MoUD Chair for Urban Transport & Traffic Planning
MoUD Chair for Urban Transport and Environment
MoUD Chair for Urban Traffic Safety
VREF: Volvo Chair for Transportation Planning for Control of Accident and Pollution

Establishment funds have been received from
Ministry of Industry, Government of India
Asian Institute of Transport Development, India
Tata Motors Limited, India
Volvo Research and Educational Foundations (VREF), Sweden

CONTACT
Phone: 91-11-26596361, 26596557
Fax: 91-11-26858703, 26851169
hodtripc@iitd.ac.in
http://tripc.iitd.ac.in
Transportation Research and Injury Prevention Centre
Room MS 815 (Main Building)
Indian Institute of Technology Delhi
Hauz Khas, New Delhi-110016
INDIA

T R I P - CENTRE BULLETIN
TRANSPORTATION RESEARCH & INJURY PREVENTION CENTRE
VOL 2 NO. 3
WINTER 2023

Excerpts from:

A NATIONAL INVESTIGATION ON THE IMPACTS ON LANE WIDTH ON TRAFFIC SAFETY: NARROWING TRAVEL LANES AS AN OPPORTUNITY TO PROMOTE BIKING AND PEDESTRIAN FACILITIES WITHIN THE EXISTING ROADWAY INFRASTRUCTURE

(Johns Hopkins Bloomberg School of Public Health)

Shima Hamidi; Reid Ewing; Ebrahim Azimi; Mohamad Tayarani; Bahar Azin; Justyna Kaniewska; Dong-ah Choi; Hassan Ameli; Duman Bahrami-Rad

This project is one of the first and the most comprehensive efforts to date to address a long overdue built environmental challenge to health: the lack of conclusive quantitative evidence on the effects of lane width on safety which has led to unnecessarily wide travel lanes that are designed to accommodate fast and convenient driving.

This national study investigates the feasibility of narrowing vehicle lanes as the easiest and most cost-effective way to accommodate better sidewalk and bike lane facilities within the existing roadway infrastructure. The study asks whether, and to what extent, we can narrow existing vehicle lanes (for different road classifications) without adversely impacting traffic safety.

This study employed a sample of 1,117 street sections (a series of homogeneous road segments) from seven different cities and conducted one of the most comprehensive data collections on geometric and street design characteristics of street sections including bike lane type and width, median type and width, sidewalk type and width, street's sense of visual motion, on-street parking type, width and occupancy rates, number of lanes and number of bus stops, street trees, and the degree of street curvature.

We conducted a series of four negative binomial regression analyses to investigate the relationship between lane width and the number of non-intersection crashes, after controlling for the aforementioned confounding factors. This study, to our knowledge, is the largest and most comprehensive study focusing on the impacts of travel lane width on traffic safety outcomes such as the number of vehicle accidents.

Overall, this study found no evidence that narrower lanes are associated with the higher number of crashes and that narrow lanes (9-foot and 10-foot) increase the risk of vehicle accidents, after controlling for cross-sectional street design characteristics and other confounding variables. Quite contrary, our models confirm that in some cases (in the speed class of 30–35 mph), narrowing travel lanes is associated with significantly lower numbers of non-intersection traffic crashes and could actually contribute to improvement in safety. These findings are novel with groundbreaking and immediate policy/practical implications for identifying streets in each road class as the best candidates for lane width reduction projects.

The traffic fatality rates in the U.S. are even more striking for pedestrian and cyclists as the most vulnerable street users. The year 2020 marked the deadliest year for pedestrians in 40 years. Pedestrian fatalities increased more than 40% from 2010 to 2018 while most other countries experienced a decline in pedestrian deaths during the same time. Biking fatalities are no exception and experienced an increase of more than 44%from 2010 to 2020.

One key reason for such striking statistics is that Americans drive more than their counterparts in other developed nations and so are increasingly exposed to car accidents. American cities are among the most sprawling and car-oriented cities where, in most cases, driving is the only travel mode available to households for commuting and other transportation needs. Higher numbers of car trips and longer distances significantly increase the likelihood of car crashes and fatalities.

Another key reason for such high rates of traffic fatalities in the U.S. has to do with its car-oriented street design. One of the most controversial street design characteristics is travel lane width. In most American cities, streets are designed to accommodate fast and convenient driving with the conventional traffic engineering theory that wider streets are often safer. High-speed designs are assumed to be more forgiving of driver error and, therefore, reduce the likelihood of traffic accidents and fatalities. As stated in the American Association of State Highway and Transportation Officials (AASHTO) Green Book (2004a, 67): "every effort should be made to use as high a design speed as practical to attain a desired degree of safety."

Yet, the evidence on the relationship between travel lane width and safety is mixed. The safety impacts of lane width have been the subject of empirical studies since 1950 and the majority of studies on rural highways found that increasing travel lane width up to 12 feet would reduce crashes (Milton & Mannering, 1998; Gross et al., 2009), but beyond 12 feet may be detrimental to safety (Miaou, 1996).

However, there is little consensus about the safety impacts of reducing lane width in urban areas. While some studies of urban arterials found no significant difference in safety with respect to lanes narrower than 12 feet (Strathman et al., 2001; Potts et al., 2007), others have shown that wide lanes adversely impact traffic safety in urban areas likely because drivers tend to adapt to their environment and may feel less safe and drive more cautiously on narrow streets (Manuel et al., 2014; Noland, 2003; Noland and Oh, 2004; Lee and Mannering, 1999).

The mixed evidence may be due to the fact that these empirical studies and the conventional engineering wisdom fail to account for confounding built environmental and design characteristics that would affect safety performance indicators. There are several design characteristics that have been largely missed in previous studies and could affect the safety of roads with the same lane width. Design elements such as the presence of trees, building setbacks, sidewalks, bike lanes, on-street parking, and other cross-sectional characteristics could play a key role in slowing driving speed and making the street safer and, therefore, should be factored in the analysis of the link between travel lane width and traffic safety.

In addition to the safety concerns, travel lane width is a critical indicator of the right- of- way for motorist and non-motorist users. There has been a constant competition for space in roadways' right-of-way. In most American cities, the automobile is the winner of this competition, making it a challenge to find space for bike lanes and sidewalks.

This study is one of the first and the most comprehensive efforts to date to address a long overdue built environmental challenge to health: unnecessarily wide travel lanes that are designed to accommodate fast and convenient driving. Previous studies on the relationship between lane width and road safety are inconclusive and report mixed findings, likely because the street design characteristics are largely missed from previous efforts due to the lack of data availability and difficulty of on-site data collection for these variables at a large scale.

This is one of the first studies that includes urban design characteristics in addition to the geometric variables (see Table 6) at a large scale. Previous studies show that urban design features can reduce vehicle operating speeds and, in turn, will minimize unsafe confrontations between motorists and pedestrians. Yet, these features are largely missed in safety studies particularly on travel lane width. This study employed several innovative data sources and data collection methods to measure and include variables related to sidewalks, bike lanes, visual sense of motion, street trees, and other urban design-related variables.

To our knowledge, this is the first multi-city study representing a large sample of 1,117 street sections from a diverse range of cities in the U.S. Almost all previous studies we reviewed are local (only part of a city or county) in their scope and, therefore, may have limited generalizability. This study is the first to make a national comparison of travel lane width and the potential for lane width reduction across states in the sample.

This study is also unique in its scope of sample selection, focusing on principal arterials (with intersections) and major collectors as dominant road classes in downtowns, urban subcenters, and residential areas, mostly likely to be used by cyclists and pedestrians.

The majority of existing studies on this topic have focused on either interstate highways, freeways, or arterials which are considered high-speed classes of roads and are less likely to be used be pedestrians and bicyclists.

T R I P - CENTRE BULLETIN
TRANSPORTATION RESEARCH & INJURY PREVENTION CENTRE
VOL 2 NO. 3 WINTER 2023

ESTIMATING FLEET CHARACTERISTICS FOR VEHICULAR EMISSIONS IN DELHI

Viswanathan, A.S. Tiwari, G. and Goel, R.

During the past few years, multiple policies have been implemented in Delhi that have the potential to miti-gate traffic emissions. These include implementation of Bharat Stage (BS) VI for cars and motorized two-wheelers (MTW), retirement of diesel and petrol cars that are 10 and 15 years old, respectively, and construc-tion of a peripheral expressway to provide a route for long-distance freight vehicles to bypass Delhi. To estimate the reduction in traffic emis-sions resulting from these policies, we first need to assess the characteristics of the in-use vehicular fleet.

We estimate the characteristics of the vehicular fleet in use in Delhi through analyses of three sources of infor-mation—VAHAN online portal, Pollu-tion Under Control (PUC) certification database, and a pilot observational survey of on-road vehicles. Data from 2007 to 2022 are used for these analyses.

The details of all registered vehicles in India are stored the VAHAN data-base, maintained under the aegis of the Ministry of Road Transport and High-ways (MORTH).

As of February 2023, VAHAN has details of 5.4 million currently regis-tered vehicles, and 0.3 million de-registered vehicles, including cars, MTWs, three-wheelers, trucks and other private and commercial vehi-cles. As the age of vehicles is limited to 10 years for diesel and 15 years for petrol vehicles, the oldest still-registered vehicles in 2022 are those that came on the road in 2007, for petrol vehicles, and 2012, for diesel vehicles. We compare this data to the number of registered vehicles given on the VAHAN dashboard, the public-ly available online counterpart of the vehicle database, providing aggregate numbers of vehicle registrations. When looking at number of vehicles specific to vehicle class and registration date, the number of vehi-cles listed in the VAHAN database for Delhi is lower than the aggregate numbers shown on the public-facing VAHAN dashboard. The discrepancy is largest for the two post-Covid years—12% of cars and 28% of MTWs missing for 2020, and 47% of cars and 61% of MTWs missing for 2021—, so we use absolute numbers for analysis only till 2019. Assuming that the data is missing across all ve-hicle classes with equal likelihood, we do include data from 2020 and 2021 while reporting proportions.

Using the data available on the VA-HAN Dashboard, we first study the changes in the population of new vehicles getting registered each year from 2013. The graphs below show the change in the proportions of cars meeting different emission standard and for cars by fuel types registered over the years. Similar data graphs are also developed for MTWs and Goods Carriers.

The PUC data was received from the Delhi Transport Department as two sets—one from October 2015 to Oc-tober 2021, and the other from No-vember 2021 to June 2022. Both contain the details of Pollution Under Control (PUC) tests performed across 913 PUC centres in Delhi. The two data sets were in different formats, as the records were initially kept by the Delhi e-Governance Society (DEGS) until late 2021, and then kept in for-mats specified by the National Infor-matics Centre (NIC).

The data was cleaned to bring it to a consistent format and then classified by vehicle type into seven categories: MTW, cars, buses, auto rickshaws, light-duty freight vehicles, tempos, and trucks.

We found that PUC compliance rate is almost the same among cars (~55%) and MTWs (~60%). However, com-pliance rates for MTWs are age de-pendent, with older MTWs less likely to be tested than the younger ones. This bias is less prominent among cars. As a result, the PUC database of cars is considered more representa-tive of the on-road fleet than that of MTWs. Due to the age restriction, the car fleet in Delhi across all fuel types is gradually becoming younger. There are no diesel cars older than 10 years and only a few petrol cars older than 15 years being tested at PUC stations. However, an on-road survey indicates that there may be some diesel cars still in use that are 10 years or older, though this needs further investiga-tion.

What happens to the cars that are de-registered in Delhi but may be fully functional? One possibility is that they are now in use in other states, where this age limit does not apply.

To test this, we compared age of cars being tested within Delhi with the age of Delhi-registered cars being tested outside Delhi. We found that 10.4% of Delhi-registered diesel cars outside Delhi were above 10 years of age compared to none in Delhi, and 1.8% of the petrol or CNG cars tested out-side were above 15 years, compared to 0.01% within Delhi. Delhi-registered cars getting tested outside Delhi are on average older than the cars getting tested in Delhi. However, it should be noted that our analysis does not account for the cars that have changed their reg-istration to another state after their de-registration from Delhi. Possible explanations of older "DL"-vehicles outside Delhi would be a) well-functioning vehicles are sold in the second-hand market, and bought by those outside Delhi, and b) de-registered vehicles from Delhi contin-ue to be operated outside Delhi. The longer permitted lifespan of vehicles outside Delhi might be leading to a migration of the older polluting vehi-cles from the capital

The shares of petrol, diesel and CNG among in-use passenger cars are 50%, 20%, and 30%, respectively. Electric cars are approximately one percent of the fleet. The share of CNG cars among in-use taxis is gradually increasing and now accounts for about 80% of the total fleet. The share of diesel cars among new regis-trations has reduced from 40% in 2014 to 10% in 2021, and share of diesel-fueled commercial vehicles among new registrations is almost zero in 2021. The number of diesel trucks and buses being tested at the PUC centres has been gradually re-ducing since 2019, possibly a result of the peripheral expressway di-verting this traffic.

Almost all the vehicles in the data pass the emissions test, indicating that PUC database may not be useful to detect non-compliance with emis-sion norms. We found that when new emission standards are implemented, their effect is reflected as lower emis-sions in PUC. For petrol cars older than 10 years, emissions are much higher than that of the younger fleet, and the increase in emission rates with age is much steeper for vehicles older than 10 years. This is likely a result of stringent BSIV emission norms that were implemented in 2010. Interestingly, CNG vehicles have significantly greater emissions of measured pollutants than petrol cars.

Motorised two wheelers are the larg-est segment of the vehicle population in Delhi, making up almost 63% of the vehicle population that comes for pollution testing. Most of the MTWs use petrol as their fuel. The emissions standards are applied as per the date of manufacture and the stroke of the vehicle.

Most three-wheelers in Delhi run on CNG. Most of the three-wheelers manufactured before 2010 are 2 stroke (18% of the population), while all those manufactured after 2010 and before the BS VI norms were applicable are 4-stroke engines (58.55 %). Almost a quarter of the MTW population coming for testing is classified as BS VI. The data show that three wheelers produce lesser emis-sions than MTWs.

Emissions analysis for commercial vehicles follows the same emission limits as for cars. Out of the 8455 buses in the database, about 53.4% of the buses get tested under BS IV norms for CNG, 37.7% under BS II/III norms for petrol/CNG, and the rest 8.9% are diesel (equally divided be-tween pre-BS IV, and BS IV catego-ries).

We conducted an on-road observa-tional survey of the current fleet of cars and MTWs, in which we record-ed license plate numbers of randomly selected vehicles (640 cars and 641 MTWs) at the junctions and mid-blocks at various locations in Delhi. The details of the study location and time are as follows:

Using the license plate number, the make, model, fuel type, and registra-tion date were then extracted for the observed vehicles from the VAHAN website.

The above results show that the mul-tiple policies that have been imple-mented in Delhi over the past decade have resulted in significant changes in Delhi's registered transport fleet. The next steps include better understand-ing of in-use emission factors and development of a transport emissions inventory for Delhi.