WINTER
2024

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INDIAN INSTITUTE OF TECHNOLOGY DELHI

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

RESEARCH AND CONSULTANCY PROJECTS

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.

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 analytics/dashboards for ND-FRCS

A – ROW – Advancing Research on Walk (MFIRP-UCL)
Sponsor: University College of London (UCL)
Project Team: Deepty Jain
Objectives:
Promotion of walking is key to addressing societal challenges, including call-highlighted Climate Crisis and Health and wellbeing as well as SDG 11, 13 and 3. Growing research from IITD and UCL has explored the physical environments, urban forms, and pedestrians perception, traffic condition on walkability. Building on a unique range of research expertise and teaching opportunities, this project will produce a range of multidisciplinary collaboration initiatives with the walking theme. objectives -
1. To develop actionable collaboration plans for research projects, student projects and masters and PhD programmes.2. To support data collection and advance knowledge on pedestrian risks, security and accessibility.

Retrospective Assessment of Road Injuries and Fatalities in Delhi Referral Trauma Hospitals, Post-Mortem Centres, City Wide Ambulance Services, and Police Control Room (PCR) Calls
Sponsor: Vital Strategies India Services Private Limited
Project Team: Rahul Goel and Geetam Tiwari
Objectives:
The study aims to collect road traffic fatality and serious injury data from designated trauma centers, post-mortem centers, city-wide ambulances run by Centralised Accident and Trauma Services (CATS) and PCR calls, to describe the epidemiological profile of those killed and injured, and to provide a basis for re-estimation of RTI mortality in the city through linkage to police crash records and application of a capture-recapture approach.

Highway Safety Status in India: current challenges and the way forward
Sponsor: The Infravision Foundation
Project Team: Girish Agrawal, Geetam Tiwari
Objective:
1. :Identified the interventions required to address the road safety on highways in India.
2. Identified road traffic crash patterns based on published reports and studies and identify the key areas needing intervention.
3. A brief summary of scientific principles accepted for road safety will be presented.
4. Global best practices for highway and expressways design will be summarised. . A road map for phased implementation of the recommended measures will be proposed

Delhi Mohalla Bus Route Rationalization & Monitoring in Delhi
Sponsor: Delhi Transport Infrastructure Development Corporation
Project Team: Rahul Goel, Girish Agrawal, Lokesh Kalahasthi and Geetam Tiwari
Objective:
The project aims to identify bus routes and develop scheduling for Mohalla Bus service for Delhi (excluding North-West Delhi). The following lists the scope of the project:
1.Data collection and analysis to identify demand points and catchment areas.
2.Development of an AI-based route planning algorithm & associated constraints.
3.Network design using the route planning algorithm for available bus counts.
4.Estimate number of buses needed and their headway/ frequency and identify respective bus depots.
5.Post-implementation monitoring to analyse the network operational data (e.g., ridership and bus movement parameters) and recom

Developing a Roadmap for Transition in the Commercial Transportation Sector in the Eastern Region: A Case Study of Bihar and Jharkhand
Sponsor: Asian Development Research Institute (ADRI)
Project Team: Lokesh Kumar Kalahasthi
Objectives:
As this study will be supplementing the ongoing strategic interventions in the public and private mobility segment, it is envisaged to further investigate the transition possibilities in the commercial transportation sector to achieve the following objectives:
•As a case study, investigating characteristics of commercial sector transportation in emerging economic hubs for the exchange of priority goods and services within inter and intra-cities of Bihar and Jharkhand;
•Scoping policy, technological, and infrastructural reforms required for transition in the commercial sector transportation that eventually aid overall ambient air quality at the city level or complement the research requirements of the low carbon transition pathway of the state.

Feasibility and user perception of autonomous robots for cleaner, safer, and energy-efficient last-mile deliveries in confined environments.
Sponsor: NMICPS, IIT Hyderabad
Project Team: Lokesh Kumar Kalahasthi
Objective:
The key objective of this project is to assess the potential of Automated Vehicles (AVs) in Last-Mile Deliveries (LMDs) in confined environments and prepare the software tool to plan efficient transition. Also, to figure out the perceptions of various stakeholders involved in the LMD regarding the use of Avs.

Quantifying and comparing road network resilience of Indian cities using crowdsourced data and simulation
Funding agency: Department of Science and Technology
Project Team: Sai Chand
Objectives:
1)To create scripts for automating the extraction of road network (from OpenStreetMap) and travel time data (from Google Maps and TomTom).
2)To develop metrics for quantifying road network resilience as a function of topological characteristics and traffic performance indicators.
3)To evaluate the impact of network structure, land-use patterns, demographic characteristics, and socio-economic characteristics on network resilience.
4)To compare and rank road network resilience among Indian cities.
5)To calibrate link performance functions for different road classes in Indian cities.
6)To develop macro simulation models and simulate the disaster scenarios on multiple Indian road networks.

Development and evaluation of pedestrian crowd simulation tools
Funding agency: Medulla Soft Technologies Pvt. Ltd.
Project Team: Sai Chand
Objectives:
Evaluation of various available crowd simulation tools.
Planning of crowd data collection exercise.
Develop, calibrate and validate a crowd simulation tool.
Review and assist in the deliverables, reports and presentation.

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Excerpts from: INDIA STATUS REPORT ON ROAD SAFETY 2024

Tiwari G., Goel R., Agrawal G., Singh N., and Bhalla K.

Road traffic injuries remain a significant public health challenge in India, with little progress in reducing fatalities, despite improvements in other health areas. Most states are unlikely to meet the United Nations Decade of Action for Road Safety's goal to halve traffic deaths by 2030. This report examines road safety in India, analysing data from six states' First Information Reports (FIRs) and audits of state compliance with Supreme Court directives on road safety governance. It highlights disparities in road traffic death rates across states and emphasizes the vulnerability of motorcyclists and the prevalence of fatal crashes involving trucks.

The report also highlights the achievements in other public health challenges in the last few decades. However, road safety and traffic injuries continue to be at the fringes of the public health domain, and hence it calls for affirmative policy-level interventions. Based on their experiences while gathering data, the authors of the report point out the unreliable nature of the compilation of available road accident injury data. In the absence of a 'crash surveillance system', which would have provided much more reliable data, the report had to base its study on FIRs collected from six states and, as noted, on the audit reports of states on road safety governance.

Road Safety governance is another important area that needs to be looked into. It comprises many players, from road designers to road builders, the automobile sector, the public health sector, and the urban governance structure. How to bring in convergence in all of the above is another area that needs to be looked into for better road governance. The report has pointed out poor infrastructure audit of roads, both National Highways, and State Highways. In some states, these audits have never been done. Thus, a policy level shift needs to be brought in as early as possible.

Another interesting fact that the report highlights is the comparison of data from India with some of the developed nations like Sweden and other Scandinavian countries that have done considerably well in road safety governance. This reveals that in 1990, a person in India was 40 percent more likely to die in road accidents compared to a person in the above-mentioned countries. This difference has shot up to 600 percent in 2021, because of India's failure to improve road safety. Does the solution to such an epidemic lie in better-equipped automobiles with more bursting balloons, though the largest number of deaths are of two-wheelers, cyclists, and motorcyclists?

The report finds that states have made varying progress in implementing institutional frameworks, infrastructure improvements, enforcement measures, education, and medical care. While some states have created lead agencies for road safety, infrastructure audits and enforcement remain inconsistent. Helmet use is particularly low in rural areas, and trauma care facilities are inadequate. The report calls for scaling up road safety interventions, establishing comprehensive governance frameworks, and developing reliable crash surveillance systems. Tailored safety strategies are needed, with a focus on research, data collection, and field evaluations to address unique road safety challenges across different states.

The report serves as a baseline for monitoring progress in road safety across Indian states and underlines the need for targeted interventions to meet global road safety goals by 2030.

Road traffic injuries present a significant public health challenge in India. In contrast to decades of progress in improving other aspects of health in the country, road traffic injuries remain a significant burden, with little improvement in their management or outcomes. With current trends, most states will fall far short of what is needed to meet the target of the United Nations Decade of Action for Road Safety 2021–2030 to halve deaths by 2030.

This report reviews the status of road safety in India, including the incidence of road traffic injuries and the efforts being undertaken by the state governments to address them. Although reliable crash data are a prerequisite for effective safety programs, India does not have a reliable crash surveillance system. Therefore, this report presents an analysis of data extracted from First Information Reports (FIRs) from six key states—Chhattisgarh, Chandigarh, Delhi, Haryana, Maharashtra, and Uttarakhand. Additionally, this report summarizes results from audits of the compliance of states with Supreme Court directives to establish robust road safety governance frameworks, including institutional arrangements, infrastructure enhancements, enforcement measures, educational initiatives, and medical care improvements.

The report identifies significant dramatic disparities in road safety performance across India. States like Tamil Nadu, Telangana, and Chhattisgarh reported among the highest road traffic death rates, more than twice the national average. States such as Bihar, Tripura, Chhattisgarh, Madhya Pradesh, and Assam have seen death rates rise by 20% or more in the last 5 years, while others, such as Punjab, Karnataka, Rajasthan, West Bengal, and Gujarat, observed reductions.

Motorcyclists face very high risks across the country. In contrast, occupants of 4-wheeled vehicles were much less likely to die, but these vehicles were involved as impacting vehicles at high rates. In particular, trucks were the leading type of impacting vehicle in deaths for most road users. While the most common crash configurations varied by state, fatal crashes were as likely to be due to rear impacts as head-on collisions. This is likely due to the large speed differentials that are common on Indian roads and reflects the need to address these issues through road design countermeasures.

State-level data showed large variations in the types of victims injured, impacting vehicles, and the most common crash configurations, highlighting the need for tailored safety interventions and programs grounded in detailed empirical data on local risk factors. Expansion of data from FIRs to a national scale can provide a starting point for such analysis. However, FIRs can only provide limited crash details. India needs to invest in establishing state-level units to systematically collect reliable data for fatal crashes by combining information from police reports, hospitals, and road-owning agencies.

States have made varying progress in complying with the directives issued by the Supreme Court Committee for Road Safety since 2015.

•Institutional arrangements: Most states have established lead agencies by executive order and most have assigned the transport commissioner as the head of the agency. Several, but not all, states have complied with the committee's directive to staff these agencies with technical expertise and created dedicated funds to coordinate road safety activities. All states have notified road safety policies.

•Infrastructure: Eight states have audited more than half of the national highway length, but very few states have audited more than half of their state highways. Many states have either not reported or not conducted road audits. Appropriate traffic safety measures, including traffic calming, markings, and signage, have not been implemented in most states.

•Enforcement: Most states record information in police reports and prepare tables, as suggested by the Transport Research Wing of MoRTH. Since 2021, most states have implemented an iRAD/eDAR system. However, helmet use remains low, with use much lower in rural areas. Helmet use was higher than 50% in only 7 states.

•Education: The education department of most states reported including a module on road safety in the school curricula.

•Medical Care: Most states have not yet established trauma care facilities adequate to the scale of the problem.

State and central governments need to prioritize the scale-up of road safety interventions. This report underscores the importance of establishing comprehensive governance frameworks yet also reveals significant gaps in understanding the specific and unique road safety challenges and solutions in diverse settings across the country. Each Indian state exhibits distinct traffic dynamics and risk factors, which will remain poorly understood without significant efforts to establish reliable crash surveillance systems. Furthermore, developing safety solutions will require generating new insights into effective strategies, designing tailored interventions, and conducting thorough field evaluations. Consequently, India must commit substantial resources to the research and development

necessary to drive improvements in road safety.

Road traffic injuries in India represent a significant public health crisis, particularly among young men. Despite making notable progress in combating a variety of diseases and health conditions over the past few decades, India has failed to reduce the burden road traffic injuries impose on society. This disparity underscores the urgent need for targeted interventions to address the high burden of road traffic injuries.

In 2021, road traffic injuries were the 13th leading cause of death in India and the 12th leading cause of health loss. They were a top 10 cause of health loss in 6 states (Haryana, Jammu & Kashmir & Ladakh, Punjab, Rajasthan, Uttarakhand, Uttar Pradesh; Figure 2). At the national level, the health loss from traffic crashes (11 million DALYs) is comparable to the health loss attributable to unsafe sanitation (8.2 million DALYs),1 which includes inadequate access to proper infrastructure for managing human excreta – an issue that the government made the target of the world's largest sanitation program (Swachh Bharat Mission) with a US$28 billion budget.

Traffic injuries are a particular concern for young men. Health loss (DALYs) for men is over four times that among women, which is likely due to women having much lower exposure to traffic due to low rates of participation in the workforce. Among men aged 15-49 years, traffic-related deaths were the second leading cause of health loss, surpassed only by the impact of COVID-19. Before the pandemic (in 2019), traffic injuries were the leading cause of health loss among men in this age group.

Over the last three decades, India has made substantial progress in addressing many diseases and health concerns, yet the progress in reducing traffic injuries has been small. A stark comparison can be made with maternal health. In the 1990s, maternal mortality was the leading cause of death among young women aged 15-49 years, but through concerted efforts, India achieved an 87% reduction in maternal death rates (per 100,000 women) by 2021. In contrast, the reduction in traffic injuries among young men (aged 15-49 years) has been less than 3% over the same period. Today, a young man is over three times more likely to die in a traffic crash than a young woman is to die during childbirth. This situation is a reversal from 1990 when a young woman was more than twice as likely to die in childbirth as a young man was to die in a traffic crash.

More generally, between 1990 and 2021, India achieved significant reductions in death rates from major health concerns: diarrheal diseases, neonatal disorders, and tuberculosis, which saw declines of 76%, 72%, and 60%, respectively. In stark contrast, the death rate from road traffic injuries (across all ages and sexes) in India increased by 6.3%.

The slow improvement in road safety in India is in stark contrast to countries such as Sweden, the UK, and the Netherlands, which are widely acknowledged for their mature road safety management programs. In 1990, a person living in India was about 40% more likely to be killed in a traffic crash than residents of these countries. In 2021, this safety gap has grown to more than 600%.

The quality of road traffic injury data is an important concern in India because (1) the underreporting of traffic deaths in official statistics leads to the low prioritization of traffic safety in national and state-level safety policy agendas, and (2), India's crash surveillance is unreliable and inadequate for guiding road safety programs.

Official statistics in India are derived from police-reported crashes, which form the basis of MoRTH and NCRB reports. However, underreporting in police statistics has been an ongoing concern.2 ICMR and IHME's GBD project estimates that there were 218,406 deaths (95th CI: 196,576-242,486) in India in 2021, 42% higher than official statistics (1,53,972 deaths). GBD uses nationally representative health-sector data sources, notably including the Registrar General of India's National Sample Registration System (SRS). An alternate estimate by WHO published in the Global Status Report on Road Safety (GSRRS), estimated 216,618 deaths (95th CI: 193,271 – 239,965), similar to the GBD estimate. At the state level, estimates of underreporting are higher in the Northeastern, and the North and North-central states compared with the southern states (Figure 3). The current pattern of state-level underreporting is broadly consistent with the estimates produced using SRS data in 2013,3 suggesting that the situation has not improved.

The scale of underreporting is consequential for the prioritization of road safety in state policies. Consider, for instance, the state of Uttarakhand, where GBD estimates place traffic deaths in the top 10 causes of death (Rank 8), ahead of serious health concerns like diabetes, diarrheal diseases, and liver cirrhosis. However, official statistics of traffic deaths would not place them even in the top 20 causes of death.

Nevertheless, it is important to note that health-sector data in India are also unreliable and this is evident in the wide uncertainty ranges of GBD and GSRRS estimates, and the large difference between their mean estimates. Nevertheless, these studies strongly suggest the need for research on underreporting of official statistics of traffic deaths. This should include, for instance, studies that link police reports with traffic deaths identified in population-representative data sources (such as the SRS) to identify the proportion of deaths that are missed by police across the country.

Reliable crash data systems are a prerequisite for effective safety programs. High-income countries were only successful in reducing traffic injuries starting in the 1960s after country governments initiated a rational and systematic approach to risk management.4 This approach involves developing an intervention strategy based on assessing population-level risks, available interventions, and allocating resources to the most effectual approaches. Quantitative targets are set for final outcomes (deaths/injuries), intermediate outcomes (e.g., helmet-use prevalence), and the institutional outputs (e.g. enforcement levels) needed to achieve outcome targets. Furthermore, data are needed for monitoring performance and recalibrating safety activities on an ongoing basis.

Despite concerns of underreporting, police reporting is the only viable source for a national crash surveillance database. Other sources (e.g., hospital-based surveillance) do not have access to most of the information (e.g., location infrastructure details, vehicle characteristics, and use of protective equipment) that is needed for road safety management.

Nevertheless, India's national road safety data systems are inadequate for guiding public policy. At present, India does not have a national crash-level database. State and national level statistics are only available as tables that are generated at individual police stations, from where these tables flow to district, state, and national crime records bureaus, which publish the aggregated tables. These tables only allow the most rudimentary epidemiological analyses, ruling out most forms of intervention and program evaluations. Furthermore, comparisons with GBD, and SRS strongly suggest that the tables provide inaccurate information about variables, such as the victim's mode of transport, that are important for road safety management.

In 2020, MoRTH launched the Integrated Road Accident Database (iRAD) / e-Detailed Accident Report (eDAR) Project, which aspires to be a national, record-level crash database. The iRAD/eDAR Project is an initiative of the Ministry of Road Transport and Highways (MoRTH), Government of India, and is funded by the World Bank. Its objective is to strengthen data systems and improve road safety in the country. However, running a high-quality crash surveillance system requires much more than the provision of technological infrastructure. Notably, the underlying institutional purpose of police investigations is to adjudicate legal responsibility (i.e. assign fault for the crash). Therefore, substantial efforts are needed to ensure adequate human resources are available to collect relevant and standardized crash data. Furthermore, an ongoing data assurance program is needed to ensure that the information collected is accurate and reliable.

Unfortunately, despite having existed for over four years, iRAD/eDAR data are not shared with researchers, and there have been no independent assessments of the quality and reliability of the information captured. Therefore, this India Status Report was produced from a database developed from information extracted from First Information Reports (FIRs) in states. See the Appendix for details of data extraction. Briefly, FIRs are short written documents prepared by the police when they receive information about a cognizable crime. Despite logistical difficulties in accessing FIRs and the relatively limited information included in them, researchers in India have used them for evaluating road design,5 pedestrian risk factors,6 urban safety,7 truck safety,8 work zone crashes,9 urban public transport safety,10 trauma systems,11 and other applications.12 While these studies used FIRs for targeted investigations, for this India Status Report, data was systematically extracted data from all FIRs of traffic deaths in six states into a purpose-built hierarchical database. This Report presents descriptive statistics from this first record-level multi-state crash database in India.

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NEWS

The 15th World Conference on Injury Prevention and Safety Promotion (Safety 2024)

The 15th World Conference on Injury Prevention and Safety Promotion (Safety 2024) was held between 2nd-4th September 2024 at Taj Palace, New Delhi (India).

Safety 2024 global event focussed worldwide attention on safety and injury prevention. The conference gathered international experts in the field with a united goal of “Building a safer future for all: Equitable and sustainable strategies for injury and violence prevention”.
The conference was hosted by The George Institute for Global Health in collaboration with three other WHO Collaborating Centres in the region, viz., the Transportation Research and Injury Prevention Center (TRIP) at the Indian Institute of Technology (IIT) Delhi, Department of Emergency Medicine, All India Institute for Medical Sciences (AIIMS), and the Department of Epidemiology, National Institute of Mental Health and Neuro Sciences (NIMHANS). The conference was co-sponsored by the World Health Organization.

Geetam Tiwari, TRIP Centre, Indian Institute of Technology, Delhi gave a keynote lecture of her inspiring journey as a female researcher. She mentioned how critical observation from the field makes us better scientists and assists with solution designing in a remarkable way. Ted Miller bestowed the Lifetime Achievement Award of the American Public Health Association on Geetam Tiiwari for her extraordinary contributions to the field of road safety. She received the award with humility and dedicated this lifelong achievement to her students who question the status quo every day.

Ruchi Varma won the BEST ORAL PRESENTATION award (practice stream) for the paper 'Safer School Zones in Delhi. A new community-government model for road safety' at the 15th World Conference for Injury Prevention and Safety Promotion. Fuelled by an innovative methodology and an interdisciplinary team of designers, researchers, technologists, psychologists, the model has a high potential of replication in other Indian states and LMICs.

Selected under the equity pillar, the special case presented a mixed method & intersectional approach (based on the flagship CROSSWALK Initiative) for safe school zones with Delhi Government. The paper showcased: Co-creation of a context adaptive and evidence based model for safe school zones implemented across city in 11 schools.

Transportation Research and Injury Prevention Centre TRIP-C, the Indian Institute of Technology and the Independent Council for Road Safety International (ICORSI) organised a two-day workshop on traffic safety and sustainable cities: challenges for meeting SDG targets, leadership, road safety governance with lead agencies and global experts. The India Status Report on Road Safety 2024 was launched.

As a tribute to the pioneers in the field safety and injury prevention, a photo exhibition was organized. It gave a glimpse into the lives of safety & injury prevention leaders who devoted their lives for evidence-based research and practice to secure human rights and safe communities worldwide. The exhibition featured Barry Pless, Leif Svanstrom, Dinesh Mohan, Garry Liddle and Gayle Di Pietro.

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

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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

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Excerpts from:

IMPROVING GENDER EQUALITY AND SAFETY OF CYCLING USE IN AN INDIAN CITY

Rahul Goel. Avinash Chanchal, Ruchi Varma, Sandeep Gandhi

Mobility across the world is often gendered i.e., men and women make different types of trips or use different modes of transport. However, these differences are much greater in India where gender inequality is among the highest in the world. As an important indicator of this inequality, The labour force participation rate of women in India is among the lowest in the world with high gender gap— in urban areas, the rate is 20 % among women compared to 75 % among men in 2017 (Deshpande, 2021, Deshpande and Kabeer, 2019).This is a huge economic loss for India. India has one of the highest levels of gender inequality in the world. In 2021, World Economic Forum ranked India at 140 out of 156 countries for which they reported Gender Gap Index (WEF, 2021). The index included the following four components— economic participation and opportunity, educational attainment, health and survival, and political empowerment. The countries that ranked lower than India included those from South Asia (e.g. Pakistan), Middle East (e.g. Oman), and North Africa (e.g. Morocco). Among the four components of the index, India fares the worst in economic participation.

Women who work outside home depend greatly on walking and public transport. Men, on the other hand, have access to a wider range of transport modes including cycles, motorised two-wheelers, and cars. Ownership of private vehicles have grown rapidly in the last couple of decades. However, this has hardly improved independent mobility among women, as they comprise only 10% of all driving license holders in India. Cycling, being more affordable, has much greater potential for mass use across the country. According to data reported by Census of India in 2011, while cycling is prevalent across India, it is mostly men who use this mode. Among all the workers who reported using cycle, only 4% were women and the rest (96%) were men. Furthermore, of those women, many are likely to be pillion riders. According to a global study of cycling in 17 different countries (Goel et al., 2022), Indian cities had the most skewed gender representation among cyclists. International evidence indicates that danger from traffic tends to play an important role in discouraging women from cycling. Most Indian cities have high levels of road death rates compared to other international settings, and they are particularly unsafe for cyclists. In this project, we aim to evaluate the intervention to improve cycling uptake among women workers and identify interventions to improve safety of cyclists in an Indian city.

We will evaluate mobility impact of free bicycle distribution among low-income women workers in Bengaluru. The bicycles distribution has been conducted under Power the Pedal program of Greenpeace India—an advocacy group. We will measure the following outcomes resulting from this behavioural intervention—a) likelihood of women to take up cycling to work and b) mobility among women (e.g. total daily distance, number of destinations accessed). We will identify various factors (individual, social and infrastructure) that mediate the impact of receiving a free bicycle on these two outcomes. Next, we will identify impact of different road design features including cycle infrastructure on the safety of cyclists. We will use prospective and retrospective approaches to achieve these aims.

We interviewed a total of 151 women respondents who were provided with a bicycle under Power the Pedal program. We present the descriptive statistics of the survey responses in the order specified in the survey questionnaire (see Milestone 1 report). As all the questions were not answered by all the respondents, the respective sample size for each question is indicated along with its descriptive summary.

The average age of respondents was 33 years. About 65% of the respondents were in the middle-age group of 31-45 years while 32% respondents were below 30 years. Only 6% of the respondents lived alone, while 17% respondents lived in households with more than four members. The mean household size was 3.5 members. Nearly 71% of the respondents were married, 17% were either widowed or divorced and 12% were unmarried. Half of the respondents completed their secondary education and one-fourth studied beyond secondary. Around 1% of the respondents were illiterate.

Next, we present the descriptive statistics of current residence and migration history. On average, the respondents reported living at their current address for eight years and reported living in Bengaluru for 16 years.

Only 6% of the respondents lived in the house they owned. The maximum proportion of respondents (92%) lived in rented accommodation. The mean monthly income of the respondents was ₹9330 and that of the household was ₹16,600. Therefore, on average, the respondent contributed a share of more than half (56%) in the household income. The average per capita monthly income was about 5500 rupees.

Overall, 97% (N=149) of respondents reported being in paid employment. The remaining 3% included those who did not respond to the question. Almost all the respondents (N=146) were being paid monthly income, except one, who was paid on a per-day basis. Almost all the respondents were garment workers. About 87% (N=146) of respondents reported being employed before March 2020 i.e., before COVID started. The average weekly frequency of travel to work was six days.

We present the distribution of respondents by their mode of travel to work. Some respondents reported using more than one mode of travel (e.g., bicycle during some days, and walking otherwise). Therefore, the percentages in the figure do not sum to 100 percent. About 67% of the respondents reported traveling to work by bicycle. Please note that 34% of the women returned their bicycles. Conversely, 11% respondents retained their bicycles, however, did not report bicycle as a means of travel for any of the trip purposes including work. Around 33% of respondents reported using only bicycle for travel to work compared to 13% by walk only and 5% by bus only.

We present the percentage distribution of respondents by travel frequency and trip purpose in Table 10. Nearly half of the respondents (N=142) travel thrice a week to buy groceries. About 77% of the respondents (N=89) travel 2-3 times a week to bring water. About 73% of respondents (N=55) travel to places of worship every day. We present the percentage distribution of respondents by people accompanying for travel and trip purpose in Table 11. The proportion of respondents who go to buy grocery (N=142) by themselves is 88 percent while going to bring water (N=89) by themselves is 76 percent. About 46% respondents travel alone for worship compared to 30% going with family.

We present the percentage distribution of respondents by mode of travel and trip purpose in Table 12. Please note that the values for each trip purpose do not sum to 100 percent as the respondents reported more than one mode of transport for different trip purposes. About 47% of respondents (N=142) travel to buy groceries by bicycle as compared to 72% by walking. Similarly, 42% of respondents (N=88) travel to bring water by bicycle compared to 73% by walking. Around 25% of respondents travel to places of worship by bicycle compared to 84% by walking.

We compared the demographic and socioeconomic characteristics and travel characteristics of the respondents who returned their bicycles that were provided by Power the Pedal with those who retained their bicycles. We found that the respondents who returned their bicycles were slightly older, had higher household income, had a longer travel distance to work, were more likely to own a motorcycle in the household, and were more likely to care for an elderly or a disabled household member.

Overall, we recruited 32 participants across factories in Mysuru and Tumkur Road for obtaining their geotracking data. The participants carried these GPS devices for 48 hours. We downloaded the GPS data and monitored it for quality. We used Google Earth and Google Street View to understand micro manoeuvres. For example, in Figure 13, from point 2 to point 3, the respondent was found to be riding in a direction counterflow to the movement of motorised traffic. In Figure 14, bicyclist takes a U-Turn from point 2 to point 3. In Figure 16, there is an underpass under the railway line that is being used by the cyclist.

Our analysis includes both self-reported and police-reported crashes. For self-reported crashes, we asked respondents about their involvement in a cycle crash in the survey itself.

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SAFE HIGHWAYS IN INDIA: CHALLENGES AND SOLUTIONS

Geetam Tiwari and Girish Agrawal.

Indian Roads Congress (IRC) has issued various guidelines and codes of practice for guiding the field engineers. The application of IRC codes should be based on the principles of the Safe Systems approach:

- Principle 1: Recognition of human frailty
- Principle 2: Acceptance of human error
- Principle 3: Creation of a forgiving environment and appropriate crash energy management

Current highway standards for geometric design of highways can be reviewed in the context of these three basic principles. Principle 1 and 2 must recognize that highways in India will have presence of non-motorized vehicles and pedestrians along with motorized traffic. Principle 3 becomes the operational principle for setting appropriate speed limits for ensuring a forgiving environment for all road users. Pedestrians can make mistakes in judging the possible risk in the system and drivers can make mistakes in adopting an appropriate speed.

The design speed governs the design of the horizontal curve, the vertical curve and the safe stopping distance. The conventional practice of keeping design speed higher than operational speed has been questioned by several researchers. The design speed must be in line with the requirement of Principle 3, i.e. “Creation of a forgiving environment and appropriate crash energy management”. This implies that for setting appropriate design speed, presence of NMVs, presence of activities along the highway, density of built-up area along the highway, and frequency of towns and villages through which the highway passes, must be taken into consideration. Design speed may vary from 30 km/h to 90km/h with a broad cross-section designed for appropriate crash energy management depending on the surrounding land use along the highway. Design speed of a highway should be based on the understanding of the risk faced by various road users and the function of the road. The current guidance in IRC code mentions only the terrain conditions (plain, rolling, mountainous) for recommending different speeds.

Taking lessons from several studies conducted in the HICs, the most effective measure for speed compliance in India will be through design of active speed control measures. In the context of weak institutional capacity and weak enforcement of legislation, the design of speed control measures – texture change, audible markers, rumble strips, change in geometric standards, median designs, lowering speeds at intersections by introducing roundabouts, raised stop lines and speed humps on minor roads – is likely to be more successful in ensuring speed compliance by all road users: good drivers, bad drivers, young drivers, knowledgeable drivers, drivers with poor driving education etc. This would ensure compliance with Principle 2.

Many of the current standards for designing the highway cross-section need to be revised (H. Chen & L. Meuleners, 2011; Mohan et al., 2017) in order to comply with Principle 3. Appropriate design of service roads, width of shoulders, and design of medians have to be reviewed to ensure safe designs for NMVs and different kinds of vehicles on the road.

The experience of the HICs shows that standards alone cannot ensure safe roads for all unless the safety performance is evaluated. Vision Zero accepts that it is possible to design a transport system that will not have any deaths and serious injuries. Therefore, to ensure safe highways in LMICs like India, the realization of Vision Zero also requires generation of new knowledge and establishing a process which enables generation of new knowledge. Given the complexity of traffic safety science and its implementation in the field, continuous experimentation is required in LMICs to develop safe highways based on the principles of the Safe Systems approach.

The road network of the country is 63.31 lakh km as on 31 March 2019, as reported by MoRTH in Basic Road Statistics 2018-19. Fatalities per 100 km of road length is the highest on NH with 45 deaths annually. NHs carry 40% of the total vehicular traffic, but this only partly explains the high crash rate. Geometric design, speed compliance and traffic operations play a major role in contributing to high crash rates.

Nearly 18% of the crashes involve hitting a fixed object on expressways clearly highlighting the poor design details. An errant vehicle hitting a fixed object should not lead to fatalities if the design details have been followed correctly. Fixed objects may be a crash barrier, high median, or pole installed for signage.

The highest share of crashes based on the type of collision on expressway are rear-end crashes, with 49% of those being fatal. The rear-end crashes are reported due to the collision with break down vehicle standing on the hard shoulder, and also due to driver “sleepiness”. In the case of fatal crashes, “hit pedestrian” crashes are second highest with 11%, followed by “hit median” with 9%, and “hit a guardrail” with 6% share in the total crashes. “Hit pedestrian” crash incidences are being reported in spite of the expressway being access- controlled. Vehicular underpass, cattle underpass, and pedestrian underpass are provided at regular intervals. However, people wait at the entry ramps to board the buses which stop on the expressway near entry and exit ramps as well as near the underpass on the highway.

“Hit median” crashes suggest that the design of the median is not appropriate for a high-speed road. An expressway has a 6m wide raised median throughout. The height of the curb is 200 mm. Research has established that raised medians are conducive to crashes, hence raised medians must not be permitted on expressways. “Median crossed” crashes indicate the shortcoming or inadequacy of the design. The current standards recommend that the road developer must refrain from using the combination of curb and guardrail; however, in case there is no option other than the combination of curb and guardrail, the height of the curb should not exceed 100mm.

An accident black spot is a site that has an abnormally high number of accidents. Most commonly, a black spot is identified based on a higher number of crashes compared to the expected number of crashes on a given stretch of road. This helps in prioritizing interventions. MoRTH notified in October 2015 that States should identify black spots on highways as any stretch of NH/SH/other roads of about 500 m in length in which (a) either five RTCs occurred during the last three calendar years or (b) 10 fatalities occurred during the last three calendar years. All states have sent a list of black spots to MoRTH. States are required to audit the black spots and suggest long-term and short-term remedial measures. Many states have reportedly initiated the process but information about the number of black spots audited and where the remedial measures have been implemented is not available in the public domain.

In order to reduce fatalities and serious injuries on the roads the design of roads can be guided by an understanding of road users who face the highest risk in traffic crashes on different categories of roads, of locations where a large number of crashes occur, and crash patterns observed in different category of roads. These aspects are further detailed below:

A large number of countries have successfully reduced road traffic fatalities since the 1970s. Global Status of Road Safety reported by the World Health Organisation has reported that there were an estimated 1.19 million road traffic deaths in 2021 – a 5% drop when compared to the 1.25 million deaths in 2010. However, RTIs have continued to increase in India, with 168,491 deaths reported in 2022, an increase of 9% from 2021 (MoRTH, 2023). Low- and middle-income countries in African and Southeast Asian regions have reported an increase in road traffic fatalities. Most European countries, plus Australia, Japan and a few Latin American countries, have reported reductions in RTFs.

In the early periods, the emphasis on road user behaviour and corrective measures focussed on improving behaviour through education, training, and strict penalties. As the RTF trend in figure 10 shows, the RTF rates continue to increase in this period. By the 1960s, the focus shifts from blaming individuals to accepting RTIs as a public health problem. It was understood that injuries are produced by energy interchange, and in principle, etiologically similar to any other disease (Gibson, 1961, Haddon 1968). The understanding that traffic injuries result from a complex interaction of sociological, psychological, physical, and technological phenomena resulted in the design of safer products, environments, roads, and traffic management systems. Once it was accepted that RTI (road traffic injuries) is a public health problem, it helped in initiating a regulatory process and scientific policy for injury control.