TRIPP BULLETIN
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TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
INDIAN INSTITUTE OF TECHNOLOGY DELHI

Research & Consultancy Projects

Sustainable urban transport in less motorised countries: research and education

Sponsor: *Volvo Educational Research Foundations, Sweden*
Project team: *Dinesh Mohan, Geetam Tiwari, Anoop Chawla, Sudipto Mukherjee, S.R.Kale, Sanjeev Sanghi, Puneet Mahajan, Niladri Chatterjee*
Objective: To develop resources and expertise in the control of adverse health effects of road transport in as integrated a manner as possible and wide dissemination of this knowledge. This process involves: (a) prevention of pollution or crash from taking place; (b) controlling the effects of emissions and minimizing injuries once people use motorized modes and crashes occur; and (c) management of adverse health effects when they do occur.

Pedestrian safe public transport systems: infrastructure, operations, vehicles, policies and legislation

Sponsor*: Volvo Educational Research Foundations, Sweden*
Project team: *G. Tiwari, S.Mukherjee, N.Bolia, A.Chawla, K N Jha, D.Mohan, S Sanghi, P. Mahajan, N. Chatterjee, K.R.Rao*
Objective: (I)Develop pedestrian accessibility assessment tools and demonstration projects to assist city authorities and public transport companies to identify priority location for creating safe and comfortable pedestrian access to public transport stops. (II). Develop city, state and central level legislation to ensure implementation of pedestrian priority designs and traffic management strategies. (III) Develop road map for pedestrian compliant safety standards for vehicles in consultation with the automobile industry.

Driver behavior study in India

Sponsor: *Nissan Motor Co Ltd., Japan.*
Project team: *Dinesh Mohan, Geetam Tiwari, Sudipto Mukherjee and Subhashis Banerjee*
Objective: 1.To understand driver behaviour characteristics in India to help introduce advanced driver assistance systems. 2. Clarify acceptance and characteristics of the systems that are under development and would be introduced to India. 3. Extract features of peculiar driver behaviour and seek opportunities of unique support function for India.

Select study of urban freight in Delhi

Sponsor: *Volvo Research and Educational foundations (VREF), Sweden.*
Project Team: *Nomesh Bolia, Geetam Tiwari and Jose Holguin. Veras*
Objective: The project address two objectives: to characterise the demand for freight transport in Delhi by developing travel demand models to estimate the freight trips and secondly, to analyse the impact of delivery restrictions that are imposed and comprehend the effectiveness of such policy measures. The first objective entails developing freight trip generation and freight generation models based on establishment surveys for over 2000 establishments located in the NCT of Delhi. In addition, the interstate traffic that contributes to urban freight will be ascertained through cordon counts and driver surveys. The study on impact of delivery restrictions includes conducting interviews with different stakeholders and standard decision making tools such as ABC analysis suitably designed for this context. In addition to this analysis and these recommendations, there will be a heightened awareness among various stakeholders, particularly decision makers, surrounding sustainability and the effeciency of freight operations so that further studies and implementation of the desired measures are initiated.

Indicators of reliability and variability of BRTs/bus systems (INDIRA B)

Sponsor: *CEFIPRA (Indo French Centre for Advanced Scientific Research)*
Project team: *Geetam Tiwari and K.R. Rao*
Objective: This project includes major interventions at two levels - product and process. The product involves use of Intelligent Transportation Systems (ITS) technology, for developing performance indicators for Bus Rapid Transit (BRT)/ bus systems. At the process level, the aim is to improve the operation of BRT by means of branching modules, dealing with new indicators in an existing management system exploiting an existing real time data acquisition system (AVLS).

The three partners in this work are: COSYS of IFSTTAR (The French Institute of Science and Technology for Transport, Spatial Planning, Development and Network); DIMTS (Delhi Integrated Multimodal Transit System Ltd.) and TRIPP (Transportation Research and Injury Prevention Programme).

The objective is to assess some of the existing well known quality-of-service indicators, and to develop new ones. Performance indicators should be clear, easily understandable, and useful to the audience. The main outcome of this research is to develop a computer-based research tool consisting of different modules. This could be integrated into an operational platform for analysis and diagnosis of the quality of service of BRTS/bus systems lines in different operational use. The applications will be tested in Delhi, and generic modules will be developed for other cities.

Partner Institutions:
The consortium comprises of three partners. The Transportation Research and Injury Prevention Programme (TRIPP) at the Indian Institute of Technology (IIT) Delhi, is an interdisciplinary programme, focusing on the reduction of adveerse health effects of road transport. Introduction of BRTS projects in India was initiated by TRIPP members as advisor to Delhi government. GRETTIA is a research laboratory on transport network and advanced software engineering in the department COSYS components and systems at IFSTTAR, the French institute of science and technology for transport, spatial planning, development and networks. The Delhi Integrated Multimodal Transit System Ltd. (DIMTS) is an equal joint venture between Government of Delhi and Infrastructure Development and Finance Company. DIMTS is responsible for managing the BRTS corridor in Delhi.

Research and advocacy on public transport and in-use vehicle management

Sponsor: *Shakti Sustainable Energy Foundation, India*
Project Team: *Geetam Tiwari and Kalaga R. Rao*
Objective: The focus is in creating an enabling environment for coordinating policies at the national level to achieve a sustainable urban transport system involving intercity, small and medium city road transport in such a way that it improves passenger and freight mobility with lower CO2 emissions.

Studies will be done on the type and quantum city buses needed in cities of various sizes; estimates will be done to find the change in modal shares and the bus fleet requirement. Consultations will be held with stakeholders like SIAM, MoUD, MoRTH, ASRTU, STU, etc. on the bus fleets for each separate city.

Guidelines will be provided to the bus operators on data maintenance methods, route planning and the management of bus systems. This will be in addition to the detailed program of research on in-use vehicles.

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

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Excerpts

AN EXEMPLUM AND ITS ROAD SAFETY MORALS

Ezra Hauer

An 'Exemplum' is a genre in classical, medieval and Renaissance literature, a short tale originally incorporated by a medieval preacher into his sermon to emphasize morals or to illustrate points of doctrine. The exemplum I will use is from near my home (in Toronto, Ontario, Canada) but its morals are general.

One can view this exemplum from two alternate points of view: one faces backward, looking at accidents that occurred; the other is forward-looking and anticipates what accidents might occur in the future. The views from these two vantage points are very different.

Starting with the backward-looking point of view, imagine that a car-bicycle collision has occurred and is investigated. Viewed from this 'after-the-crash' perspective the investigator tends to ask: Was alcohol involved? Did the driver open the door carelessly? Did the rider veer into the car's path? Was it raining? Did the rider wear a helmet? Did the bicycle have a light? The investigator is not likely to ask, for example, why the bike lane was not placed to the right of parked cars where doors are opened less frequently.

Switching now to the forward-looking perspective and thinking about future accidents, the mind anticipates the circumstances in which these will arise. Noticing in that there is no buffer on either side of the bike lane leads one to think about the risk to the rider of being struck by a fast moving vehicle on the left or being 'doored' by a parked car from the right. In the same vein, noticing that every right-turning car has to cross the bike lane, one thinks of blind spots and of the conflicts inherent in this design. Prominent in the forward-looking view of prospective accident causation is the physical arrangement which entails the circumstances in which accidents are likely to occur. These physical arrangements could be made one way or another. Less prominent from the forward-looking perspective are the human frailties of inattention, error, risk taking, etc. After all 'errare humanum est' and the fallibility of road users is the causal background which is present in all design alternatives. The forward-looking perspective goes hand-in-hand with the 'Risk Analysis', 'Risk Management' and the 'Safety Audits' frame of mind: the examination by professionals of what can go wrong with a specific design, how frequently so, how severe will be the consequences, what can be done to mitigate the risk and at what cost.

If drivers were more attentive in opening the car door, if riders were more inclined to wear a helmet, or had the bike lane been placed to the right of parked cars, the probability of 'dooring' accidents leading to head injury would be different. Of course, in addition to the three 'causes' mentioned in the preceding sentence, many others could be listed. Each accident has many causes. Several observations follow.

First, having defined cause as something that alters probabilities of outcomes makes 'causes' a necessary part of accident prevention and safety management; only by altering causes can one prevent future accidents or ameliorate their consequences.

Second, because our business is prevention, and because prevention requires the alteration of causes, only those causes that can be reasonably altered by a human action are of interest to us. To illustrate, it may have been raining and the raindrops on the car mirror and on the bicyclist's glasses may have been amongst the causes of a dooring accident. But if neither rainfall nor the need to wear glasses can be reasonably affected by some human intervention these are not causes of interest . In contrast it is commonly thought that risk-taking, helmet wearing, and bike-lane design can be affected by human action and are therefore causes of interest. It follows that what are causes of interest depends on what people think can or should be modified. This introduces an essential subjectivity into empirical studies of causation; what is thought to be a 'cause of interest' reflects the investigator's belief about what are reasonable, desirable or plausible interventions. In other words, what portion of the time axis is illuminated depends on where the investigator of causation elects to point the flashlight.

Third, while all causes are present just before the accident, the actions that bring the causes into existence occur at various times. Causes such as inattention or risk taking materialize just before the crash, helmet or seat-belt wearing are decided on at the beginning of the trip, alcohol consumption before that, and decisions about the bike-lane design or whether the car has a collision warning-system are made a long time before the crash. To prevent an accident one alters the causes when they come into existence. It follows that opportunities for intervention occur along the entire time axis.

Fourth, since causes of interest are only those that can be altered by human action, the actors behind the causes belong to one of two groups. One group is made up of people present at the scene of the crash: the driver, the rider, the pedestrian. The other group consists of the planners, engineers, vehicle manufacturers, politicians, etc., those who, while not at the scene of the crash, have contributed to the creation of the causes of interest there. The red flashlight usually shines on the 'at-the-scene' group; the blue flashlight usually directs attention towards the 'not-at-the-scene' group.

Fifth, there is nothing in the definition of a cause of interest that makes it age or become obsolete. We have no problem thinking of the design of the O-rings as a cause of the Challenger disaster even though they were designed many years before the explosion . Similarly, we accept without reservation the assertion that chickenpox in childhood is the cause of shingles in the elderly. Therefore, one should not balk at the thought that the decision to place the bike lane to the left of parked cars is a cause of a dooring accident even if the bike-lane design was approved several years before the crash. The careless door opening which occurs an instant before the crash is neither more nor less of a cause of interest than the much earlier choice of the bike-lane design.

Sixth, in the definition of cause there is no intrinsic gradation making one cause primary or critical and making others secondary or merely contributory. Any such differentiation between causes would require the introduction of some additional considerations: how large might be the impact of changing a cause? How costly is it to change it? Would the alteration of the cause be socially or politically acceptable? Is its alteration the responsibility of the organization for which I work? … . Such added considerations all pertain to prevention, not to causation.

If these observations are valid then there is a potential problem. The problem is that,the red flashlight illumines only a part of the time axis along which causes come into existence. Crash causes that came into existence in the more distant past tend to remain in the dark . The danger is that attention and resources go to a specific subset of safety management actions while another set of potentially effective safety management opportunities is systematically missed.

Accident causation and prevention are related but are not the same. One can argue that the identification of accident causes is a necessary first step for accident prevention. One can also plausibly claim that a better understanding of causation might occasionally lead to novel ways of preventing accidents. For both reasons accident causation has been and still is a subject of research.

The concept of cause is a slippery one. Some of the difficulty can be avoided by distinguishing between two different of questions:

Question A: What are the causes of certain events (e.g., the causes of large-truck crashes)? Here one asks about causes that are not known.

Question B: What is the effect of a cause (e.g., the effect of cell phone use on crash probability)? In this question the 'cause' is known and unknown is its effect.

In the context of prevention blame and culpability are not of little interest. The answer to the 'who causes the problem' question was already given: causes are many and they are brought into existence at various times by two groups of actors, those 'at-the-scene' and those 'not-at-the-scene'.
The at-the-scene group of actors - the driver, the pedestrian and the bicyclist - are responsible for their part in crash causation, they need to behave safely. By the same token, the not-at-the-scene group of actors - the planners, engineers, vehicle manufacturers, politicians, etc. – they are responsible for what they contribute to accident causation by their actions.

In the exemplum, but more generally in the design of roads, use is made of reference documents variably called 'guides', 'manuals', 'policies' etc . It may be assumed that these documents already take into account and embody the road safety considerations and therefore, by following them, the planners, the engineers and the elected officials automatically live up to their responsibility. To so assume is mostly incorrect.

In broad brush strokes the argument is this: There is a 'product' - roads. This product is known to be dangerous to health. The product is being put into public use without first ascertaining how large its danger is and it stays in public use unless someone notices that the danger is too large and brings it to the attention of the producer, the 'State' . Such a practice is not in keeping with what society usually expects. When compared to products such as food, drugs, toys, vehicles, stoves, etc. the contrast is evident . The main difference seems to be that when products are made by the private sector the 'State' provides for safety regulation and supervision, but when it is produced by the 'State', when the profit motive is not there, there is an assumption of 'essential beneficence', and the need for regulation and supervision may seem to be less obvious and urgent.

It is my opinion that the 'State' has interests of its own, and 'for the people by the people' may not work well when the 'State' has to protect its budget from lawsuits and its reputation from bad publicity. In such circumstances it may be best to circle the wagons around design standards and manuals rather than to be explicit what the safety consequences of decisions might be.

As Hakkert and Gitelman write: " … recognizing that human errors are unavoidable and, therefore, a road traffic system should be created with inherent safety features which would enable to mitigate the consequences of those errors, a new level of system thinking in road safety was introduced. Among the first countries to suggest this approach were the Netherlands where the notion of a sustainably-safe system was developed and Sweden which suggested the Vision Zero. Australia followed with the development of the Safe-system approach that is currently a general concept promoted in the developed countries…. the State is responsible for providing a basically safe roadway system, industry is responsible for providing safe vehicles and the road user is responsible for behaving in a basically safe manner."

It is the 'State' that builds and operates roads and professionals work for the 'State' directly as employees or indirectly as consultants. When the 'State' embraces its responsibility for the safety of the roads it builds and operates, the professionals' knowledge of how to predict the safety consequences of alternative courses of action comes into its own and is in full bloom. In this circumstance the professional is expected to possess the requisite knowledge and to make it available to the 'State'.

When the 'State' does not acknowledge its responsibility to transparently take into account the safety consequences of its actions, when it is inclined to shift the responsibility onto the road users, the professionals are between a rock and a hard place. They have a choice between personal and professional integrity on one hand and their livelihood on the other. The corrosive effect of this cognitive dissonance can be avoided by ignorance; it may be better not to know the safety consequences of their decisions. This can be achieved by not reading the literature and by not describing safety consequences in guidance documents.

The public is unaware of this problem. Beside the blame-the-driver drumbeat, there is also a more subtle reason for the public's misapprehension. In most engineered products failure is both rare and visible but when it comes to the design and operation of roads, failures of safety are not self-evident. Since on all roads some crashes are expected, their occurrence is not automatically construed to be a 'failure'. Whether there it is failure or not is a matter of degree. Moreover, in most cases it would take an inordinately long time for sufficient crashes to occur for 'failure' to become noticeable .

Because one cannot see the safety consequences of engineering action except by painstaking and long-term research, there is no practical professional accountability. This helps to excuse ignorance.

Using the exemplum I demonstrate that when one is looking at the events proximate to the time of the accident the mind tends to find causes in what the various road users did just then, whereas from the perspective of the more distant past one might perceive more clearly the actions of the not-at-the-scene actors as causes.

With the exemplum in mind it was easy to define what 'cause' is to mean and on this basis to make some important observations:

(a) That because our business is prevention and prevention requires the alteration of causes, only those causes that can be reasonably altered by a human action are of interest to us;

(b) That causes are many and actions that bring them into existence occur at various times, not only during the few seconds before the crash;

(c) That the human actors who bring causes into existence belong to two groups, those 'at-the-scene' and those 'not-at-the-scene';

(d)That a cause does not become obsolete just because it came into existence years ago;

(e) That there is nothing in the definition of cause that makes one critical and another secondary, only the consideration of accident prevention can do so;

(f) That myopic causations studies fail to examine causes brought about by the actions of the not-at-the-scene actors, do not see an important set of prevention actions, and thereby impair the efficacy of accident prevention programs.

The purpose of an accident causation study is to help in the formulation of efficient prevention strategies. This study too points to the prevalence of driver-related actions. It does so once though the potentially misleading construct of 'critical reason' which says nothing about where the emphasis of prevention should go. It does so again by the fact that data collected in the narrow beam of the red flashlight are ill suited for the examination of those causes that are created by the not-on-the-scene actors.

Causation studies collect large amounts of field data, and real data cannot fail but be of use in some, often unexpected ways. But if the aim of these causation studies was to discover unknown causes, to lead to novel remedies, or to formulate an effective road safety management program, that aim was not met. By purposefully concentrating on the few seconds before the crash and on the actions of the on-the-scene road users, attention was diverted from causes created by the actions of the not-at-the-scene actors, the planners, engineers, and elected officials. By systematically not recognizing a group of causes one excludes from consideration a potentially effective set of remedial actions.

Excerpts from a chapter in a forthcoming TRIPP publication:* ***The Safe Way: State of the Art Papers on Road Safety* *(published with modifications in* ***Accident Analysis and Prevention****).*

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Simultaneous bus route network design and frequency setting in small and medium sized cities using evolutionary algorithm

Sponor: *Department of Science and Technology*

Project team: K. Rramachandra Rao and *Geetam Tiwari*

Objective: Bus Route Network Design (BRND) procedure is applicable for network of real size in which many parameters need to be determined to reach an optimal solution. As a result, the meta-heuristic approaches, which enable us to pursue reasonably global optimal solutions and deal with simultaneous design of the bus route network. The main objective of this research is to systematically study the procedure of bus route network design in small and medium sized cities, which have different travel behaviour and development characteristics. A multi-objective network design model would be formulated considering passengers (users), operators and the government perspectives.

Construction of bus que shelters at various places in NOIDA - cost estimate and technical advice

Sponor: *New Okhla Industrial Development Authority*

Project team: *Geetam Tiwari and K.N. Jha*

Objective: 1. To comment and advise on the specifications
2. To comment and advise on the cost estimate

News

Safety effects of exclusive and concurrent signal phasing for pedestrian crossing

Yaohua Zhang, Sha A. Mamun, John N. Ivan, Nalini Ravishankeer & Khandemul Haque. *Accident Analysis & Prevention, October 2015, Vol. 83, pages 26-36.*

This paper describes the estimation of pedestrian crash count and vehicle interaction severity prediction models for a sample of signalized intersections in Connecticut with either concurrent or exclusive pedestrian phasing. With concurrent phasing, pedestrians cross at the same time as motor vehicle traffic in the same direction receives a green phase, while with exclusive phasing, pedestrians cross during their own phase when all motor vehicle traffic on all approaches is stopped. Pedestrians crossing at each intersection were observed and classified according to the severity of interactions with motor vehicles. Observation intersections were selected to represent both types of signal phasing while controlling for other physical characteristics. In the nonlinear mixed models for interaction severity, pedestrians crossing on the walk signal at an exclusive signal experienced lower interaction severity compared to those crossing on the green light with concurrent phasing; however, pedestrians crossing on a green light where an exclusive phase was available experienced higher interaction severity. Intersections with concurrent phasing have fewer total pedestrian crashes than those with exclusive phasing but more crashes at higher severity levels. It is recommended that exclusive pedestrian phasing only be used at locations where pedestrians are more likely to comply.

In fact, pedestrian fatalities as a percentage of total roadway fatalities have increased from 11 to 15%. Overall gains in road safety over the past few years have apparently not translated into safety improvements for pedestrians, indicating the importance of focusing on improving pedestrian safety.

One important issue in pedestrian safety is safe accommodation for pedestrians crossing the road at traffic signals. There are two common types of pedestrian phasing used at signalized intersections, which for the purposes of this paper we call concurrent and exclusive phasing. A concurrent pedestrian phase allows the pedestrian to cross at the same time that the motor vehicle traffic on approaches parallel to the crosswalk receives a green indication. Pedestrians and vehicles share the same phase of the traffic signal, permitting longer uninterrupted phasing for vehicles and pedestrians. There are interactions between pedestrians and motor vehicles turning left or right across the crosswalk, but not between pedestrians and motor vehicles departing from approaches perpendicular to the crosswalk (other than right turns on red). Alternatively, an exclusive pedestrian phase stops vehicular traffic on all approaches to allow pedestrians to cross any leg of the intersection with no interaction with any vehicles (with the exception of vehicles turning right on red when permitted).

With concurrent pedestrian phasing, pedestrians must exercise more caution and judgment when crossing, obviously watching for possible conflicts with motor vehicles that are turning across the crosswalk. Exclusive pedestrian phasing is thus becoming popular for attempting to improve pedestrian safety, especially with senior and disabled advocacy groups. However, since traffic is stopped on all directions, exclusive pedestrian phasing results in longer delays for motor vehicles and pedestrians. Pedestrians often do not wait for the pedestrian phase, potentially resulting in unexpected interactions between pedestrians and motor vehicles. The requested pedestrian phase may then go unused, frustrating drivers who must then wait for the phase to run its course. This leads us to ask a basic question regarding the safety of pedestrians, “Is exclusive pedestrian phasing really safer for pedestrians?”

The primary objective of this study was to compare pedestrian crash counts and observed conflicts between pedestrians and motor vehicles between these two signal phasing types. To do this, interactions between motor vehicles and pedestrians and various physical characteristics of intersections were observed. Interactions between motor vehicles and pedestrians were classified by severity for 152 crossings at 42 signalized intersections in four cities in central Connecticut. Crash data were collected for each pedestrian crossing at these intersections over a six-year time span from January 2008 through December 2013. Finally, crash and conflict prediction models were estimated to determine the safety of pedestrians at intersections that have an exclusive pedestrian phase relative to those with concurrent pedestrian phasing. A secondary objective of this study was to investigate if pedestrian–vehicle conflicts can be a useful exposure measure for predicting pedestrian crashes, or a surrogate in place of observing pedestrian crashes.

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CONFER, India: TRIPP Chair for Transportation Planning
Ford Motor Co., USA: Ford Chair for Biomechanics and Transportation Safety
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MoUD Chair for Urban Transport and Environment
VREF: Volvo Chair for Transportation Planning for Control of Accident and Pollution

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A TRIPP Bulletin Insert

Excerpts from

Pedestrian Safe Public Transport Systems: Infrastructure, Operations, Vehicles, Policies And Legislation

Geetam Tiwari, Dinesh Mohan, Sudipto Mukherjee, Girish Agrawal, K. R. Rao, Sneha Lakhotia, Mark Zuidgeest, Marianne Vanderschuren and Banele Wasswa

This research developed and tested a 'walkability to public transport' survey instrument (based on crowd sourcing data collection) for various Delhi in India, and Cape Town in South Africa, and integrate this with existing auditing tools, such as the Indian "Urban Road Safety Audit (URSA)" and "Public Transport Audit" (PTA) toolkits. The project team obtained traffic crash data from Delhi traffic police for seven years(2006-2012) and identified high crash location involving pedestrian fatalities. Bus commuters perceptions regarding safety and security of bus tops, access to bus stops was documented for selected bus stops and the bus stops were audited for safety and security using the public transport audit tool. The results showed weak correlation between commuters' perception of safety and high crash locations identified using police data. The quality of bus stops in terms of comfort, security, safety varies across the city. The central city has high quality of bus stops, however has poor safety record. Speed of motorised vehicles near bus tops must be included in safety audits.

Government of India announced on April 2015 requiring all new models of cars to conform to the Indian pedestrian safety standard by 1 October 2017 and all models by 1 October 2018. The Indian standard is similar to that proposed by ECE WP29. These announcements obviated the need for discussions regarding the strategy for introducing these safety features in India. However, it is important that we assess and the benefits of these features in Indian conditions and the need for improvements. Pedestrian protection technologies of concern have largely been limited to cars. In the Indian context, it is necessary that we focus on future design specification for all motor vehicles.

India has a variety of statutes and policies related to regulation of roads and means of transport. However, in spite of the quantum of legislation, the rights of the pedestrian remain hazy because the motorized road user remains the central object of statutory concern and attention. Pedestrians are a plurality of road users in India, and also constitute a high percentage of traffic fatalities on Indian roads, pedestrians must be pivotal to the formulation of any transport policy in India. The statutory framework must also prioritize pedestrian safety and access. Acknowledging the ambiguity with respect to the rights and duties of the pedestrian in the current statutory and policy framework, a draft Charter of Rights and Duties for Pedestrians has been proposed in this study.

Background

Cities remain hostile for pedestrians and public transport users in India. Even after adopting policies at the national level (NUTP,2006), and the availability of funds through JnNURM(Jawaharlal Nehru Urban Renewal Mission), there seems to be a lack of will to improve infrastructure for pedestrians and bicyclists. The current government' SMART city mission has mentioned improvement of pedestrian facilities as an important milestone for smart city, however the implementation of these projects have not yet started. Also the lack of understanding of the need of pedestrian and bicycle infrastructure has resulted in discontinuity and removal of this infrastructure even at the locations where they have been approved and constructed. In South Africa availability of NMT infrastructure on desirable routes is very localized and often interrupted by higher order roads and even expressways leading to many captive pedestrians walking along highways or even crossing them.

This research aims to answer some of the following key questions:

- How to upscale pedestrian accessibility data collection using community based (or crowd sourcing) data collection techniques?
- How to augment the URSA and PTA audit tool data with the crowd source data
- How to generate street improvement recommendations using these data
- Why do city authorities find it difficult to follow the street designs and guidelines which give priority to pedestrians?
- Do cities and states have adequate comprehensive legislation and policies in place to implement pedestrian friendly designs and transport strategies?
- Can city authorities and public transport companies be assisted to identify specific areas for interventions and setup demonstration projects?
- Can automobile industry be engaged to prepare a road map for pedestrian safety standards?

The development and testing of the crowd sourcing survey tool has been a joint activity between TRIPP and ACET. The valorization into an actual road map of the process to improve pedestrian safety, and the development of vehicle standards for pedestrian safety has been limited to Delhi.

Objectives/goals

The main objective of the project is to enable public transport (PT) companies to create a safe pedestrian system around public transport. Since the majority of entry and exit trips to public transport are by walking, it is important to ensure safe pedestrian access around PT stops (bus and MRTS). Often public transport companies are not responsible for road infrastructure, therefore PT stop location, environment around PT stop is not mandated to be designed to satisfy pedestrian needs. Laws mandating pedestrian compliant guidelines are either weak or nonexistent. Public transport companies are acquiring new vehicles and include specifications for the type of vehicle required fulfilling safety and fuel efficiency requirements. At present pedestrian safety has not been included in the specifications and the Indian automobile industry is also not prepared to manufacture vehicles satisfying pedestrian safety requirements. Safe vehicles is an important element of a safe public transport system, and a road map for pedestrian safe vehicles would enable a safe public transport system. Therefore the main objectives of this project are:

I. Develop pedestrian accessibility assessment tools and demonstration projects to assist city authorities and public transport companies to identify priority location for creating safe and comfortable pedestrian access to public transport stops.
II. Develop road map for pedestrian compliant safety standards for vehicles in consultation with the automobile industry.

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Continued from overleaf:

III. Develop city, state and central level legislation to ensure implementation of pedestrian priority designs and traffic management strategies.

Summary Of Findings

Pedestrian Accessibility Tool Development

1. Walkability indicators can be classified into categories based on whether they are relevant to road/street network, sidewalk/footpath design and amenities, pedestrian crossings and land use characteristics.

2. Very few studies have included the indicators pertaining to footpath characteristics. This is especially relevant in the Indian context, where despite having dense road networks, and land use mix and intensity, the cities are not walkable due to lack of provision of pedestrian infrastructure, and the poor quality of it where it has been provided.

3. Audit of 360 selected bus stops in Delhi shows that bus stops received a higher score for safety and security as compared to comfort and convenience score. However, speed of motorised vehicles near bus stops was not recorded as a possible safety hazard as recommended in the audit tool kit.

4. Land use mix and pavement type received highest scores whereas most bus stops had poor scores for disabled friendly infrastructure, cleanliness and signage.

5. Overall rating of bus stop audit showed a clear clustering of high scores in NDMC area (central Delhi), and lower scores of bus stops as the distance from the central city increases.

6. Bus user survey showed that almost 75% of the bus users use the bus for daily commute and in the absence of the bus the most common alternate mode is three wheelers followed by RTV (small buses run by private operators).

7. Most bus users have about 10 mins of access and egress trips to and from bus stops, and journey time is less than 30 mins for 50% bus users.

8. Bus users consider reliability of bus services-on time arrival followed by in vehicle time to be the most important attributes for using bus services.

9. Bus users have given lowest score to the current bus reliability and walkability of bus stops.

10. Fifty percent of the users considered presence of pedestrian signals as poor and 40% users considered lighting at bus stops as inadequate.

Traffic crash data from 2006-2012 was obtained from Delhi traffic police. Only fatal crash data was used for the analysis because injury data tends to be underreported (Mohan et al., 2009). The data obtained from police was recoded to get details of type of victim and impacting vehicle. From the description of the crash given in the police report the address was located on Google map and the location was geocoded in GIS map. About 30% crashes could not be located. This data base has been used for spatial analysis of fatal traffic crashes

Grand Trunk road which is National Highway 1 has the highest rate of pedestrian fatalities per km per year. This is followed by two major arterial roads with 1.49 pedestrian fatalities per year per km. Ring road is mostly signal free with all grade separated junctions. Meharauli Badarpur road is not signal free, both have similar rate of fatal pedestrian crashes.

2. All major arterials show a high density of pedestrian crashes. This is not restricted to junctions, but the high densities are observed along mid blocks of major arterials. Lower densities are observed near the periphery of the city, except a few junctions of highways entering the city which have a high density of fatal pedestrian crashes.

3. A buffer of 30 m and 200 m was created around all the bus stops in Delhi. The proportions of victims and striking vehicles remain similar at each level of aggregation. Forty six percent of the fatalities involve pedestrians near bus stops as compared to total fatal crashes in Delhi where pedestrians are involved in 48% of the cases.

4. The proportions of impacting vehicle shows slight variation for the sample bus stops where PTA audit was conducted as compared to total fatal crashes in Delhi. The proportion of buses hitting pedestrians within 30 m of a bus stop is 16% whereas for overall Delhi it is 12%.

5. The correlation of PTA score of 362 bus stops and the number of fatalities around bus stops is weak (.05). This shows that the current audit tool kit needs further improvement to capture the existing unsafe/high risk conditions to pedestrians.

Road Map For Pedestrian Compliant Safety Standards For Indian Vehicles

International work

1. The vehicle front shape design has changed from flat front vehicles of early 1970s to the shape which is seen on roads today, possessing smooth profiles. The role of vehicle shape on pedestrian safety was discussed as far back as late 1970s and are now influenced by the specifications used by New Car Assessment Programmes (NCAP).

2. Vehicle crash tests were developed to protect vehicle occupants and mandated in many OECD countries in the 1970s but pedestrians were not included. The EEVC working group -WG 17 Pedestrian Safety submitted their final regulations in 2006. These form the basis for the proposed current pedestrian safety standards and variations of the same are used by the New Car Assessment Programme (NCAP) around the world. However, most countries have not made these mandatory yet.

Car front optimisation for a compact car in India

1. One of the critical parts of pedestrian crash simulation computations was to develop a front end model of vehicle to capture the significant interactions of relevance in pedestrian. Vehicle dimensions were physically measured from existing vehicles in Indian roads. In addition, web downloads of blue prints as well as reconstruction from sketches or photographs were used.

2. The vehicle front model was developed using a generic shape with ellipsoid representation to model significant points of interaction with pedestrian during vehicle-pedestrian crash simulations.

3. Pedestrian impact models were run to evaluate different vehicle shapes and a generic shape giving front body dimensions indicating that it is possible to move towards a unified front shape.