



PHD SCHOLARS

Role of Intermediate Public Transport in Indian cities

Scholar: Aishwarya Sanjay Jaiswal

Assessing the safety effectiveness of speed cameras on the highway in India

Scholar: Akhilesh Kumar Srivastav

Public Utility Coordination in Rights-of-Way (RoW) Management

Scholar: Amit Kumar

Surrogate Safety Measures For Traffic Safety Assessment

Scholar: Debashis Ray Sarkar

Pedestrian safety near crosswalks and bus-stops: A case study in Delhi

Scholar: Deotima Mukherjee

Material characterization for blast loading

Scholar: Kanhaiya Lal Mishra

Investigations into bio-mechanics of road traffic injuries

Scholar: Laureb Rao

Impact testing of helmet

Scholar: Manish Kumar

Pedestrian safety perception in Built environments

Scholar: Neba C Tony

Transportation equity

Scholar: Nishant Singh

Traffic safety risk in part urban area: A case study of NCT Delhi

Scholar: Neelabha Roy

Accident Prediction Modeling of priority junctions at inter-city urban highways

Scholar: Parveen Kumar

Optimization framework for transitioning to electric bus system for New Delhi

Scholar: Pranav Gairola

Impact of transportation demand management strategies on pollution, congestion and mobility in Gurugram

Scholar: Ranjana Soni

Study of traffic risk to bicyclists in urban area

Scholar: Rashmeet Kaur

Service characteristics and infrastructure design for e-rickshaws in Delhi

Scholar: Sourav Das

Issues in addressing pony injuries in pedestrian crashes

Scholar: Sushil Kumar

Safety of Two-lane Undivided Highways in India

Scholar: Sanjay Kumar Nirmal

Crash safety of electric vehicles

Scholar: Thainigaivel Raja T

Realtime conflict modelling on highways

Scholar: Yawar Ali

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Prediction of missing data in road accidents

Scholar: Alok Nikhil Jha

Urban landuse and transport modeling

Scholar: Amit Sharma

Residential self-selection and activity travel behaviour

Scholar: Chetan Nagesh Doddamani

Railway track pedestrian safety

Scholar: Darbamulla Saibaba

Formulation of energy absorption model to estimate the pre-impact speed of motorcycle involved in a crash on Indian roads

Scholar: Kuldeep Singh

Pedestrian and crowd modelling

Scholar: Lakshmi Devi Vanumu

Evaluating the effect of highway geometric on the safety of national highways of India

Scholar: Laxman Singh Bisht

Cellular Automata Modelling of Multilane Signalized Junctions with Heterogeneous Traffic

Scholar: Mohit Kumar Singh

Evaluating public private partnership in urban rail in India

Scholar: Mukund Kumar Sinha

Urban freight trip generation and estimation of factors influencing mode choice in emerging economies - Case study Delhi

Scholar: Nilanjana De Bakshi

Methodology for prediction of pedestrian injuries under different motorcycle-pedestrian impact scenarios

Scholar: P Devendra Kumar

Characterization of aorta and diaphragm at high strain rate loading

Scholar: Piyush Gaur

Human body finite element modelling

Scholar: Rajesh Kumar

Estimating post-crash accessibility to trauma care facility

Scholar: Richa Ahuja

An empirical study on sustainable procurement in the construction industry

Scholar: Santu Kar

Prediction of thoracic injuries of occupants in car crashes

Scholar: Sanyam Sharma

Ambulance location optimization for enhanced coverage and survivability in Delhi

Scholar: Shayesta Wajid

Development of a predictive model to assess the performance of a construction worker through skill development training

Scholar: Sparsh Johari

Assessing the future of E-rickshaw

Scholar: Shiv Priye

Understanding pedestrian motion at mass gathering and evacuation process

Scholar: Tarapada Mandal

Performance measurement in sustainable freight transportation

Scholar: Vijayta Tukaram Fulzele

Landuse transport integration

Scholar: Vishal Rai

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Traffic capacity implications of the autonomous vehicles and regular vehicles in a heterogeneous environment

Student: Ankit Kumar

Identification of black spots on Highways (using NHAI datalake information)

Student: Avdesh Gupta

Estimating Travel demand and traffic risk in Periurban areas in Delhi

Student: Furqan Aijaz Qureshi

Machine learning-based activity sequencing model on Indian Time use data

Student: Manjinder Singh

Early opening of pavement for traffic under uncertainty

Student: Pradeep Singh

Pedestrian risk perception in different built environments

Student: Saujanya Nepal



Excerpts from: WALKING IN INDIAN CITIES

Geetam Tiwari

India is a land of walkers. An estimated 45 million walk to work daily, compared with a mere 54 lakhs who used motorised personal transport¹. However, the infrastructure that is in place for road users is skewed against Non-motorised Transport (NMT), either pushing pedestrians to the margins of the road networks, or even worse, compelling them to jostle for space with motor vehicles, thereby exposing them to injury or death.

More as a norm than as an exception, pedestrians have no option but to walk on the carriageways designed for fast-moving motorised traffic exposing them to a high risk of Road Traffic Crashes (RTCs). Yet, road and traffic regulatory agencies continue to invest in grade-separated, signal-free junctions, and elevated roads that are aimed at solving problems posed by vehicular congestion. These have the combined effect of only further excluding and invisibilising the millions of pedestrians who are in plain sight.

Encouraging children and the elderly to walk as much as possible also provides individual benefits in the form of better health outcomes. The social benefits of such an approach include a reduction in the number of vehicular trips, resulting in a lowering of local and global emissions. For this change to take place, a fundamental flaw in the approach to road design - to cater to smooth flow of motorised traffic - needs to be corrected. In addition, there is a need for a long-term vision of accepting zero deaths of pedestrians in cities. This should be supplemented with a road map for achieving this target in the next decade.

Moreover, current administrative structures in most Indian cities do not respond to long term goals and conflicting demands. Implementation of a walkable city requires changing the priority at various levels of governance. Although this is a long process that requires continuous efforts and pilot projects to reconfigure the road network, it is an urgent requirement to ensure that India's pedestrians do not continue to languish at the margins of the country's developmental process.

India's policy planners, traffic engineers, and urban designers are mostly concerned with ensuring smooth flow of motorised traffic in cities by constructing signal-free road junctions and elevated roads. However, data show that 31 per cent of Indian workers in urban areas walk to work². Table 1 shows the proportion of work trips by different travel modes reported in the Census of India, 2011. The

proportion of women walking to work is substantially higher than men - 55 per cent vs 28 per cent. Walking trips are higher in rural areas than in urban areas, where walking trips constitute 31 per cent for all workers and 46 per cent for women workers. All public transport trips include walking segments to access and egress from such trips, which mean that at least 50 per cent of urban commutes include a walking component. In addition, school and shopping trips are generally more dependent on walking. If these were to be taken into account, one can safely say that walking constitutes a major mode of mobility in urban India. A 2019-survey in selected cities reflected this, showing that 63 per cent of all trips were walking trips³, making pedestrians the single largest category of road users.

Moreover, a large proportion of people who walk to work are 'captive pedestrians' as they do not have access to any other mode of travel, primarily because of low income. Therefore, despite hostile road conditions because of motorised traffic and the poor quality of pedestrian paths, the proportion of walk trips remains high in all Indian cities. More women walk to work than men. It is possible that women chose work close to home to enable them to look after their own households. Moreover, men have better access to a vehicle at home — a bicycle, a motorcycle or a car. As shown in Table 2, the proportion of walking trips reduces as the distance to commute increases. The proportion of men travelling to work longer than 5 km is higher than women. Indian urban areas have evolved having mixed land-use patterns, enabling short commutes to work. Low income households whose members rely on walking as their main mode of transportation are located close to their places of work. These are often in the form of informal residential settlements requiring short commutes.

Historically, Indian cities evolved as walking cities. From the 1960s onwards, major cities initiated the exercise of preparing Master Plans in India. The Master Plans were mostly influenced by the American vision of cities and some version of the Garden City movements. The Master Plan-making exercise focussed on allocation of land for different uses, gridiron street structures, and straight streets. The discussion on traffic problems continued to focus on traffic congestion and had no mention of conflicts and problems faced by pedestrians or bicyclists. Between the 1970s and the 1980s, the focus shifted to

preparing Comprehensive Traffic and Transport Studies (CTTS) commissioned by city administrations to find solutions to traffic congestion at specific roads and junctions in their cities.

At international meetings organised by the PIRAC (a World Road Association founded in 1909 which enjoys a consultative status at the UN's Economic and Social Council) in 1971, 1973, 1975, 1983, and 1985, Indian representatives spoke of a major thrust on the pedestrianisation of its cities. Complete Bicycle Master Plans for Delhi, Chennai, and Pune were also presented at these meetings. Disappointingly, nearly 40 years later, no Indian city has any meaningful semblance of a network of pedestrian or bicycle friendly infrastructure. It is clear that the official presentations to the international community were only statements of policy intent, not implementation.

Pedestrians on Indian urban roads are often exposed to high risks. This is because their basic needs are not recognised as a part of the urban transport infrastructure improvement projects. Rather, an ever increasing number of cars and motorised two-wheelers encourage the construction of large numbers of flyovers/grade separators to facilitate signal-free movement for motorised vehicles, exposing pedestrians to greater risk. A significant number of pedestrians are willing to take risks in both before and after situations.

The absence of signals makes pedestrians act independently, resulting in rash and erratic risk-taking behaviour. The variability in the speeds of all categories of vehicles has increased after the construction of grade separators, while the waiting time of pedestrians at the starting point of a crossing has also increased. The correlation between waiting times and gaps acceptable by pedestrians shows that after a certain time of waiting, pedestrians become impatient and seek out even small gaps in the vehicular flow to cross the road.

Khatoun et al studied pedestrian risk taking behaviour in Delhi after the construction of a grade separator and the removal of the traffic signal to provide an uninterrupted flow for motorised traffic. A signal-cycle provides green time for pedestrians to cross the road without exposing them to risk. But after the construction of a grade separator, all pedestrians who were crossing the road at the grade separator face the risk because of the continuous flow of traffic. The removal of the traffic signal



also resulted in increased variability in speeds of all categories of vehicles. At the starting point of the crossing, the pedestrians' waiting time increased after the construction of grade separator. It was also found that higher pedestrian delays result in a higher number of unsafe crossings.

Pedestrians give higher priority to convenience and saving time rather than to road safety, a behavioural trait that should be considered by policymakers, planners, and engineers while planning to promote urban traffic and transport infrastructure. A large number of Foot Over Bridges (FOBs) and subways continue to be created to ensure safe pedestrian crossings, despite research studies repeatedly showing that FOBs and subways are neither comfortable nor convenient for most pedestrians. The usage of such facilities remains low, and often the area near FOBs and flyovers become accident black spots because pedestrians crossing the road at such locations are exposed to high speed motorised traffic.

Safe pedestrian crossings can be easily ensured by controlling the speed of motorised traffic. This can be most effectively achieved by appropriate use of rumble strips and speed calming humps (World Health Organization, 2013)³⁶. These are low-cost measures and are found to be very effective in controlling speed. On non-arterial roads, small roundabouts have been found to be very effective in controlling vehicular speed and ensuring safety. However, cities continue to invest in high-cost projects which have very little benefits for pedestrians or public transport users.

The WHO kicked off the Decade of Action for Road Safety 2021-2030 in October 2021, with the ambitious target of preventing at least 50 per cent of road traffic deaths and injuries by 2030. India can meet this target by focussing on pedestrian safety and improving the walkability of cities. Many countries have adopted the safe systems approach based on The Vision Zero policy propagated by Sweden in the late 1990s aims to ensure that none should be killed or injured due to traffic accidents and, therefore, the transport system should be designed in a way that fatal or serious injuries do not occur. This means that safety is more important than other issues in the road transport system (except for health related environmental issues). Mobility, therefore, should flow from safety and cannot be obtained at the expense of safety.

Current traffic safety science suggests that if road users do not take their share of the responsibility, for example, due to a lack of knowledge or competence, or if personal injuries occur for other reasons that lead to risk, the system designers (road designers) must take further measures to prevent people from being killed or seriously injured. This is consistent with the Vision Zero theory, which suggests that humans have limitations in

perception, diligence, and other driving-related performance that are predictable and inevitable. These natural limitations constitute the primary reason for increased responsibility by system designers.

The three important principles of Safe Systems Approach (SSA), derived from Vision Zero, provide the necessary guidance for ensuring pedestrian safety and meeting the mobility related SDG targets. The SSA has three key principles:

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

Understanding of pedestrian behaviour and acceptance of SSA principles together can lead to ensuring pedestrian safety and creating walkable, inclusive safe cities. Improving walkability and safety of pedestrians, therefore, is the key to meeting the UN's SDG related to mobility.

A large proportion of people walk in Indian cities; however, cities are not walkable. Making cities walkable requires a strong policy framework guiding investments and implementation of planning and design guidelines. For this to be effectively translated to reality, interventions are required at various levels.

As urban transport is a State subject, the NUTP has to be adopted at a State or city level or an urban transport policy framework has to be developed and mandated by the State or city level government. Chennai, Pune and Coimbatore have attempted this. However, the policy framework and the revised standards are not mandated by any law. Therefore, the impact of the NMT policy has not been achieved as desired. A mandatory State-level policy guiding all the cities in the State in preparing a road map for achieving pedestrian friendly (sustainable urban transport compliance) seems necessary.

In the last decade, many street design guidelines have become available to guide city engineers. The Indian Roads Congress has revised the Urban Street Design Guidelines. Global best practices have been introduced by NGOs working in a few cities in India. However, city-engineers and planners often need city-specific guidelines. Preparation and implementation of city-specific guidelines require a combination of civil engineering and design skills of architects. Public works department and municipalities should induct designers and planners to work closely with civil engineers to make pedestrian-friendly streets. Compliance with current street design guidelines should be made mandatory by law. Traffic enforcement agencies also have to be guided to ensure pedestrian safety and compliance to pedestrian requirements over motorised traffic.

Specific interventions can be implemented with immediate effect such as restricting free left turns at signalised intersections and speed compliance of motorised vehicles on arterial roads by better enforcement through red light camera and police monitoring. The installation of speed tables at all intersections on non-arterial roads to enforce the 30km/h speed limit is also an immediately possible intervention. In intersections of small towns, well designed small roundabouts can be constructed to ensure speed compliance and smooth flow of traffic. Similarly, rural road junctions can have a combination of rumble strips and speed humps.

City administration has to create a monitoring mechanism to evaluate the progress of implementing walkability guidelines. This can be on the lines of SDG monitoring mechanisms by the NITI Aayog. At the city level, administrative units should be set up whose responsibility is to evaluate various indicators of walkability and monitor the progress of pedestrian compliant infrastructure implementation.

There are many challenges and barriers to create walkable cities. Current administrative structures in most Indian cities do not respond to long-term goals and conflicting demands. The SDGs are not a priority for many city governments. Cities need encouragement and national support to adopt and implement the SDGs. Fresh thought has to be given to how the SDGs can be used to influence day-to-day decisions. The SDGs can also be a part of the outcome-based budget of municipalities in order to make them a priority.

More than anything else, citizens' engagement is a primary requirement and has been discussed in many policy documents. However, it is difficult to measure the outcome of such engagement in the short term. Citizens who are adversely affected by many infrastructure decisions (high speed roads through the city, poor facilities for pedestrians) do not have institutional mechanisms to express their demands. A "predict and provide" paradigm (i.e.) forecast increase in vehicles and increase capacity for motorised traffic movement, seems to dominate the approach of decision makers and city planners, rather than well-designed scientific approaches that are backed by empirical evidence.

Implementing programmes that elevate India's anarchic urban clusters to walkable cities requires a comprehensive re-look at the priorities given to this important role of the state at various levels of governance. Needless to emphasise, this is a long process and will require continuous efforts and demonstration projects. It is also an unavoidable investment in the future for a nation that aspires to join the comity of the developed world.

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Prevention of crashes at work zones a systematic review and a case study of work zones on National Highways in India

Student: Siva Esarapu

Supply and operational characteristics of e-rickshaws

Student: Sowmya Majumder

Estimating Traffic risk to bicyclists on different category of roads in Delhi

Student: Srishti Agrawal

Evaluating alternative criteria for the design of Delhi e-bus clusters

Student: Tanisha Pangtey

Analysis and Understanding of Impact of Road Surface Condition on Safety and Accidents

Student: Tousif Akhtar

Modelling phase-wise electrification for e-bus system

Student: Utsav Panta

NEWS

Road safety of elderly pedestrians in the urban context: an approach based on infrastructure and socioeconomic variables

In this study, a negative binomial regression model was constructed to evaluate the number of collisions between one vehicle and one elderly pedestrian at a district level in Madrid city, considering socio-economic and infrastructure variables to assess their importance. It can be considered a first approach on the subject by the authors. Because of that, mainly direct data has been used to study the phenomenon. A database containing features about Madrid districts was constructed to be the independent variables in this study. Crashes that were found to be suitable for this study were geolocated using self-designed algorithms to be placed in a GIS software in order to obtain the number of crash occurrences in each city district, that is the dependent variable in this research. Later, these two objects

were joined to form the final dataset to construct the regression model. An exhaustive model search was performed to find the model with the lowest AIC, that was the indicator to assess the goodness of fit. Variables from all groups have been found to be significant. The final regression model is composed by inhabitants, population density, ageing rate, road length and the number of Points of Interest (POIs), being population density the most significant in the model. The small sample size used in this study (21) is due to the lack of direct information about the proposed variables at a smaller spatial level, such as neighbourhoods. This issue can be solved as it is described in the next paragraph.

Further research is considered to be necessary in various respects due to some reasons. (i) There is a remarkable heterogeneity inside the districts in some variables. In consequence, the study of the neighbourhoods or using a homogeneous grid is thought to be the

next step to follow. Furthermore, some of the candidate variables have not been found to be significant, but in a further analysis at another scale they will be tested again. Also, sample size will be increased if another spatial unit is used. Finally, one of the most time-consuming tasks carried out was to geolocate the accidents.

The ultimate objective of this research is to develop a set of countermeasures to mitigate road safety issues in view of the present population ageing process. Developing criteria and strategies about how cities should be designed is an important subject to reduce elderly pedestrian road accidents. Further research will explore in more detail possible contributory factors that are not found in this paper.

Daniel Gálvez-Pérez, Begoña Guiraoa, Armando Ortuño (2021). Transportation Research Procedia 58, 254–261.

COURSE ANNOUNCEMENT

The Transportation Research and Injury Prevention Centre (TRIP Centre) at the Indian Institute of Technology Delhi, is organizing "International Course on Road Safety and Road Safety Audit, Biomechanics and Crashworthiness" from 05 - 19 December 2022. The course will be

organised in two parts. Module A would cover Transport Planning and Road Safety and Module B would cover Biomechanics and Crashworthiness. Participants in the Road Safety Audit module should have minimum B.Tech(Civil) or equivalent degree and will have to undergo an exam to get a

"Road Safety Auditors Certificate" after fulfilling the requirements as recommended by the Indian Road Congress (IRC).

Details of the course can be accessed from -<http://tripp.iitd.ernet.in>

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
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Establishment funds have been received from

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Abstracts: Ph.D. Thesis

CELLULAR AUTOMATA MODELLING OF MULTILANE SIGNALIZED JUNCTIONS WITH HETEROGENEOUS TRAFFIC - *Mohit Kumar Singh*

Intersections are an inevitable part of the road traffic system. If these are not designed properly, it can lead to several problems such as excessive delays, emissions and crashes (MoRTH 2016). There are several problems associated with the modelling of intersections using closed boundary CA models. Some of the problems such as: low simulation speeds and excessive warm-up times can be overcome with open boundary CA models. Hence, the open boundary models were further investigated in this study.

The model developed in this study considers the zone of influence to segregate the behaviour of drivers at mid-block to those near the stop line. A total of 100 data samples for each of the vehicle types were collected for generating trajectories. These trajectories were used to identify the vehicle driving behaviour such as speed and acceleration.

Many studies classified drivers into broad categories based on accelerations such as aggressive, timid or normal drivers. In this study it was found there were no such distinct groups based on field observations. Instead, there could be more categories which follow a distribution rather than the distinct categories.

EFFECT OF SOCIO- EMOTIONAL, COGNITIVE, AND TECHNICAL COMPETENCIES OF WORKERS ON CONSTRUCTION LABOR PRODUCTIVITY - *Sparsh Johari*

Workplace training aims to enhance the performance of trainees by improving their specific skills. Unfortunately, the outcome of such trainings in terms of the percentage of increase in trainees' performance is not generally measured. On the one hand, this lack of measurement results in contractors not recognizing the importance of training in enhancing workers' performance, and on the other hand, the training providers do not

receive constructive feedback on the efficacy of their sessions. In addition, in the construction industry the competency requirements for mid- and upper-level employees are very well-defined, such clear definitions at the workers' level are missing.

This study therefore attempts to bridge this gap by conducting a nationwide survey of 598 industrial professionals in India, to identify six, nine, and thirteen competencies, through descriptive statistics, for unskilled, semi-skilled, and skilled categories of workers, respectively. These competencies included attitude, motivation, and physical strength for unskilled workers; self-confidence and technical knowledge for semi-skilled workers; and writing, reading, mathematical, and problem-solving competencies for skilled workers. Further, the authors have measured the identified competencies of the workers at construction site using survey instruments, which were identified through literature. Along with the measurement of the competencies, the productivity of the same workers was also measured via direct observation at sites. By applying various regression models to the collected data (measured competencies and productivity), best-fit curves were developed between each of the competencies and observed productivity. Subsequently, a regression model was developed by considering all the measured competencies as explanatory variables and productivity as dependent variable. Thereafter, the authors visited four training centers in India and measured the competencies of 137 trainee workers periodically (in every 2 days of a 90-day training). This periodical data on competencies of the workers was fed into the developed regression model to compute their performance increment during their training. Subsequently, a learning curve was drawn between the performance increment of the workers and their training time. In addition, the competencies versus training time curves were also plotted to understand how competencies of the workers were enhancing during their training.

The results indicate that workers' performance after training was far below the desired level of employers; the reason for this emerges from competencies versus training time curves, where it was found that training does not focus on enhancing socioemotional and cognitive competencies. Therefore, the study recommends that training providers incorporate these competencies in training curriculum to achieve more desirable

outputs from training. This will help in designing an effective workers' training program.

METHODOLOGY FOR PREDICTION OF PEDESTRIAN INJURIES UNDER DIFFERENT MOTORCYCLE-PEDESTRIAN IMPACT SCENARIOS" - *P Devendra Kumar*

Variation in pedestrian kinematics in motorcycle pedestrian crashes leads to a difference in kinds of injuries. The speeds of the pedestrian and motorcycle have been estimated from street cams of motorcycle-pedestrian crashes. The kinematics of the pedestrian head, chest, pelvis and knees has been extracted from the crash videos and compared with finite element simulations using THUMS HBM and model of Hero Splendor, 100cc, build up at IIT Delhi.

Evaluation of the THUMS model for injury-prediction capabilities in real-life motorcycle pedestrian cases has been assessed. This has been done in two steps; estimating pre-impact parameters and evaluating the model for injuries using these parameters. For pre-impact parameters estimation, five orientations (0, 15° CW, 15° CCW, 30° CW, 30° CCW), five positions (0, 20, 40, 60, 80 mm), and five speed variations have been simulated in MADYMO to assess the best match for the known throw distance for cases selected from a hospital database. For evaluation of THUMS-based injury estimates five real-life crashes have been selected. Fracture incidence has been estimated from simulation and compared with the clinical case report. An all-round evaluation of injuries from motorcycle-pedestrian crashes has been done by simulating injuries for five offset positions (-100mm, -50mm, 0mm, +50mm and +100 mm), five angular orientations (0-deg, 45-deg, 90-deg, 135-deg and 180-deg) and three impact speeds (30 kmph, 35 kmph and 40 kmph), resulting in a total of 75 different crash configurations. For angular variations, the maximum and the minimum number of injuries have been observed in 45-deg and 90-deg configurations, respectively. While in offset variation, the maximum and the minimum number of injuries have been observed in 0mm and +100mm configurations. For skeletal injuries corresponding to the sagittal plane,



Continued from overleaf

symmetric pedestrian injuries for 225-deg, 270-deg and 315-deg crash configurations have been estimated, which then predicts injuries for 120 configurations. Assuming the 120 crash configurations to be equiprobable indicates that the probability of fracture of bones is highest for the head, followed by Humerus, Ribs, Clavicle, and Tibia.

URBAN FREIGHT TRIP GENERATION AND ESTIMATION OF FACTORS INFLUENCING MODE CHOICE IN EMERGING ECONOMIES - CASE STUDY DELHI. *Nilanjana De Bakshi*

There are three objectives of the thesis, the first objective is, to determine the variables that can predict the Freight Trip Generation (FTG) and factors affecting the mode choice model given the socio-demographic variables, urban form, macroeconomic, trip characteristics using logistics, and spatial variables in an urban area. The second objective is to estimate the impact of the trip characteristics i.e logistics and spatial variables in addition to socio-demographic variables, urban form, macro-economic variables on urban freight trips and choice of mode. The sub-objectives, include analyzing if the trips generating from Distribution centers/warehouses in the zone contributing to trips by a particular mode. evaluating what variables increase the number of NMT and MTW trips? And what are the number of trips mode-wise? The third objective is to estimate the climate impact of the various scenarios resulting from mode shift and changes in land use and to propose a model for implementation for local authorities to enable decision-making for sustainable urban freight.

A comprehensive review of the literature highlights area and employment are the most commonly used measures of the business size used in trip generation models. Earlier studies have shown economic variables to have a significant relation with freight generation. A review of the literature on freight trip generation describes it as a function of trip characteristics, land use, network characteristics, socio-economic, economic development, and spatial variables. Also, the statistical method used for such analysis has largely been trip rates, Ordinary least squares regression, and Multiple classification Analysis. The model proposed in this thesis, considers urban form, trip characteristics in the form of logistics and spatial variables, socio-demographic characteristics, and macro-economic variables capturing the economic prosperity of the ward in terms of density and diversity, as these variables have not been used in a categorical count data Freight Trip

Generation (FTG) model or in mode choice models. The dependent variable, in this case, is a continuous variable hence, the count data model is used. The models are able to explain categorical and ratio variables thus explaining the behavioral aspects related to freight movement.

In the urban area, the interaction between the built environment and the location of the economic activity give rise to freight trips and also generates additional trips. A regression analysis is carried out to understand the influence of using built indicators and economic indicators on generation of trips based on the mode. The results indicated the economic variable employment as a significant variable in the sectors, especially in Retail for both attractions and productions and the employment in Transport and storage sector is significant for FTP. The urban form indicators are significant for the modes Non-motorised Freight Transport (NMFT) and motorised two-wheeler based freight Transport (MTWFT).

In this study, in addition to motorised transport, the component of non-motorised transport is also evaluated as it is contextual to an emerging economy such as India. A key contribution of this doctoral research is to estimate the climate impact of the various scenarios resulting from mode shift and changes in land use.

RAILWAY TRACK PEDESTRIAN SAFETY. *Darbamulla Sai Baba*

As per the National Crime Bureau Report (NCRB 2019) of the government of India, in 2018, out of 474,638 traffic accident cases reported, 445,514 (93.86%) are road accidents and 27,643 (5.8%) are railway accidents accounting for 152,780 and 24,545 deaths respectively. Over 70% of total deaths on Indian Railways and an average of 10 deaths per day on Mumbai suburban are railway track pedestrian accidents. These accidents are classified as "untoward incidents" by Indian Railways and are not considered Railway accidents, as per the extant provisions of the Indian Railway Act. "The maximum incidents occur on Mumbai suburban system, which is a vast network of 116 stations, spread over 465 km on Western Railway (W Rly) and Central Railway (C Rly) zones of Indian Railways, operating above 2300 trains/day with an average footfall of 7.5 million passengers/day. The main cause for the untoward incidents listed in the government records are (i) collision of persons with the train while crossing tracks, (ii) falling from the train, (iii) knockdown by pole/traction mast, (iv) falling between the gap of platform and footboard of the coach.

On average 45 fatalities per day happen due to railway accidents involving falls from trains or collisions with people on track.

Sample data was collected from 19 suburban railway stations through a set of questionnaires to measure the observed and latent factors which influence the commuters for unsafe behaviour of crossing railway tracks or walking along the railway track. Based on risk propensity (number of incidents per 10 million footfalls) of unusual incidents, Mumbai suburban stations were classified as high risk, medium risk or low-risk stations. Accordingly, the entire Mumbai suburban network was divided into 4 spatial distribution zones viz., A, B, C and D, based on the average footfalls and number of stations in each zone. These 19 suburban stations were selected to represent a certain number of stations from these 4 zones, also classified on risk propensity.

The thesis is the application of 'Theory of Planned Behaviour' on the observed and latent variables (0 analyse the behaviour of pedestrians over railway track for two different scenarios; Scenario I: crossing the railway track & Scenario J: walking along the track. For the said analysis, sample data was collected from 19 suburban railway stations on Mumbai suburban network representing the city population. Using Confirmatory Factor Analysis (CFA) derived the latent variables from 18 observed variables and accordingly using Structural Equation Modeling (SEM) developed a behaviour model for the two scenarios. Factor Analysis through SPSS, generated CFA and SEM model in AMOS. The behaviour of pedestrians over railway tracks for (i) crossing railway track is highly influenced by conformity tendency and subjective norms. (ii) walking along the track is highly influenced by subjective norms, conformity tendency and perceived risk. Twelve observed variables were highly loaded and derived latent variables had good correlation coefficients. The model developed for each scenario is checked for validity and reliability and was found to be well within the stipulated parameters.

The study focuses on the risk-taking behaviour of commuters crossing or walking along the Railway track and used the extended Theory of Planned Behaviour. Based on the analysis, some ideas are proposed to ensure safer movement of commuters in Mumbai suburban. The analysis thereof may also help Railways to plan and prioritise the efforts towards infrastructure planning for capacity augmentation and safety of suburban commuters.