



PH.D SCHOLAR - Current

Estimation of passenger and freight demand
Scholar: Aashly V S

Sustainable solution for last mile delivery in Delhi NCR
Scholar: Abhishek

Evaluation of micromobility and integration with public transport
Scholar: Abhishek Bansal

Role of Intermediate public transport in Indian cities
Scholar: Aishwarya S Jaiswal

Assessing the impact of extreme events on accessibility on public transportation and non-motorised transport users
Scholar: Akanksha Bhardwaj

Assessing the safety effectiveness of speed cameras on the highway in India
Scholar: Akhilesh Kumar Srivastava

Public utility coordination in Rights-of-Way (RoW) management
Scholar: Amit Kumar

Using big data for traffic emissions and road safety
Scholar: Asha S V

Surrogate safety in traffic engineering
Scholar: Debashis Ray Sarkar

Investigations into bio-mechanics of road traffic injuries
Scholar: Laureb Rao

Impact Testing of helmet
Scholar: Manish Kumar

Impact of enforcement strategy on road safety
Scholar: Manoj Kumar

Assessment of autonomous vehicle/connected vehicles on traffic safety using simulation
Scholar: Marsha Khan

Road network quantification and the associated health impacts
Scholar: Mehrab Nazir

Pedestrian safety challenges on multi-lane highways in low- and middle-income countries with settlements
Scholar: Mekuanint Getnet

Pedestrian safety perception in built environments
Scholar: Neba C Tony

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

New bearings on equity in urban mobility: A case study of North-West Delhi
Scholar: Nishant Singh

Integrated simulation analysis of driving behaviour: A comprehensive study on vehicle and pedestrian intersections using simulators
Scholar: Parth Parikh A

Accident prediction modeling of priority junctions at inter-city urban highways
Scholar: Parveen Kumar

Analyzing the impact of disruptions on road network resilience
Scholar: Piyush Purshottam Lalwani

Mobility as a service for case city of Delhi
Scholar: Pratik Jha

Pedestrian safety in highways
Scholar: Priyanshu Aman

Impact of transportation depend management strategies on pollution, congestion and mobility in gurugram
Scholar: Ranjana Soni

Study of Traffic risk to bicyclists in urban area
Scholar: Rashmeet K. Khanuja

Safety of Two-lane undivided highways in India
Scholar: Sanjay Kumar Nirmal

Service characteristics and infrastructure design for e-rickshaws in Delhi
Scholar: Sourav Das

Interventions to improve bicycling use in Indian cities
Scholar: Srishti Agarwal

Issues in addressing pony injuries in pedestrian crashes
Scholar: Sushil Kumar

Developing Statistical models to predict crash probabilities at different road typologies
Scholar: Syed Huzair Shafi

Crash safety of electric vehicles
Scholar: Thanigaivel Raja T

The epidemiology of road traffic injuries
Scholar: Vishnu Kumar V

Realtime Conflict modelling on highways
Scholar: Yawar Ali

PH.D. - Completed

Assessing the Impact of Intra-Household Interaction on Activity Travel Behavior
Scholar: Punyabeet Sarangi

MS (RESEARCH) - Current

Integration of autonomous public and freight transport.
Student: Aditya Kumar
Supervisor: Prof. Lokesh Kumar Kalahasthi

Calibration of VDF parameters for mixed traffic.
Student: Akash Shanbhog
Supervisor: Prof. Sai Chand

Analysis of electronic media for traffic incidents and crashes monitoring
Student: Ashutosh
Supervisor: Prof. Sai Chand

Heat stress and its impact on behavior of women
Student: Kanishka
Supervisor: Prof. Deepthy Jain

Assessing the impacts of last mile deliveries
Student: Prajwal Gudadoor
Supervisor: Lokesh Kumar Kalahasthi

Vehicle routing for hazardous freight in a multimodal network under changing weather conditions/ traffic restrictions
Student: Samridha K
Supervisor: Lokesh Kumar Kalahasthi

Pedestrian crashes on Rural Highways
Student: Santosh Prakash
Supervisor: Prof. Geetam Tiwari and Prof. Rahul Goel

Estimating adoption timing of autonomous vehicles
Student: Siddharth P
Supervisor: Prof. Sai Chand

Alternate Methods in Synthetic Population Estimation for Public Transport Demand Analysis
Student: Yash Jaiswal
Supervisor: Deepthy Jain

MS (RESEARCH) Completed

Traffic safety: Enhanced vehicle modelling for surrogate safety measures
Student: Pushkin Kachroo
Supervisor: Prof. Geetam Tiwari and Prof. Kalga Ramachandra Rao



Excerpts from: GLOBAL STATUS REPORT ON ROAD SAFETY 2023

World Health Organisation

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. More than half of all United Nations Member States reduced road traffic deaths between 2010 and 2021. The slight overall reduction in deaths occurred despite the global motor vehicle fleet more than doubling, road networks significantly expanding, and the global population rising by nearly a billion. This shows that efforts to improve road safety are working but 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.

Road traffic deaths and injuries remain a major global health and development challenge. As of 2019, road traffic crashes are the leading killer of children and youth aged 5 to 29 years and are the 12th leading cause of death when all ages are considered. Two-thirds of deaths occur among people of working age (18– 59 years), causing huge health, social and economic harm throughout society.

More than half of the fatalities are among pedestrians, motorcyclists and cyclists. Occupants of 4-wheel vehicles account for almost one-third of fatalities. Occupants of vehicles carrying more than 10 people, heavy goods vehicles and “other” users constitute one-fifth of all deaths. Micro-mobility modes such as e-scooters account for 3% of deaths.

Vulnerable road users such as pedestrians, cyclists and motorcyclists remain dangerously exposed. Nearly 80% of all roads assessed do not meet a minimum 3-star rating for pedestrian safety, and as cyclist fatalities increase, just 0.2% of all roads assessed have cycle lanes.

Nine in 10 deaths occur in low- and middle- income countries, while people in low-income countries continue to face the highest risk of death per population. Globally, 28% of all fatalities occur in the WHO South-East Asia Region, 25% in the Western Pacific Region, 19% in the African Region, 12% in the Region of the Americas, 11% in the Eastern Mediterranean Region, and 5% in the European Region.

The European Region reports the largest drop in deaths since 2010 – a 36% decline. The Western Pacific Region reports a 16% decline, the South-East Asia Region a 2% decline and the number of deaths has remained constant in the Region of the Americas. Reductions in the number of deaths were observed in 108 countries, including 10 where the 50% was achieved by 2021. However, in 66 countries there was a rise; 28 of these countries are in the African Region, which has seen a 17% rise in the number of deaths since 2010.

Measures to mitigate the risk of death and injury, including enacting laws that meet WHO best practices, have advanced modestly. Policy-makers have known of the key risk factors that contribute to road crashes for decades, yet only six countries have reached WHO best practice legislation on five risk factors – speeding, drink driving, motorcycle helmet use, and seat-belts and child restraint systems.

With a growing and increasingly urban global population, the rising demand for mobility is set to overwhelm transport systems, particularly those that rely heavily on private vehicles. Yet many countries continue to design and build their mobility systems for motor vehicles, not for people, and not with safety as the main concern. This slows efforts to save lives and to protect vulnerable road users.

Some of the greatest gains have been made where the safe system approach to road safety – which puts people and safety at the core of mobility systems – is most widely applied. The European Region has the greatest concentration of countries with policies and legislation that align with this approach and reports the largest drop in deaths. The Western Pacific Region is second, both in the number of countries adopting aspects of the safe system approach and in reducing fatalities.

These examples show that fatality reduction targets can be met, given a level of political will, investment and capacity that matches the scale of the road death and injury crisis.

In addition to being the leading killer for children and young adults, road traffic deaths impact people during their most productive years. Approximately 66% of fatalities are among people aged 18–59 years and

19% are aged 60 years or above. Road traffic deaths continue to disproportionately impact men, with an overall female-to-male fatality ratio of 1 to 3.

The importance of deaths among people of working ages and the disproportionate impact on males is also reflected in data on work-related driver deaths available from 21 countries. In these countries, approximately 23% of driver deaths relate to trips to or from work (e.g., commuters); 16% of deaths result from work-related driving (e.g., deliveries and appointments); and an additional 12% of deaths are among (disproportionately male) professional drivers “at work” (e.g., bus drivers).

Globally, occupants of 4-wheel vehicles represent 30% of fatalities; followed by pedestrians who represent 23% of fatalities; and powered two- and three-wheeler users make up 21% of fatalities. Cyclists account for 6% of fatalities. Occupants of vehicles carrying more than 10 people, heavy goods vehicles, “other” users and “unknown” user types comprise the remaining 20% of deaths. Given the rise in powered personal micro- mobility modes such as e-scooters, questions on these modes of transport were newly included in the survey for this report, and reveal that globally, 3% of deaths are among users of these modes (which are included in the “other” road user category).

The distribution of deaths among road users changes significantly, however, when data are disaggregated by region. Except for the European Region and Eastern Mediterranean Region (where occupants of 4-wheel vehicles comprise the largest share of the deaths at 49% and 33% respectively), in most regions, it is pedestrians and powered two- and three-wheelers users that make up the majority of deaths. In the Western Pacific Region, pedestrians comprise the largest share of fatalities while in the South-East Asia Region, cyclists account for 12% of all deaths. This is especially concerning given that pedestrians and cyclists tend to be the most vulnerable road users and, in most countries, represent the economically most disadvantaged.

The vast majority of road traffic deaths, 92%, occur in upper-middle, lower-middle, and low-income countries combined. Seventy- nine percent of road traffic deaths occur in lower-middle-income countries and upper- middle-income countries combined (44% and 35% respectively), with low-income countries accounting for 13%, and high-income countries accounting for the remaining 8%.

Relative to the size of countries’ motor vehicle fleets and road networks, there is a disproportionately high number of fatalities in low- and middle-income countries compared to high-income countries. For example, high-income countries have 16% of the world’s population, 28% of the world’s vehicle fleet, 88% of all paved inter-urban roads, and 8% of fatalities; by contrast, low-income countries have 9% of the world’s population, less than 1% of the world’s powered vehicle fleet and paved inter-urban roads, yet 13% of fatalities.

In terms of absolute numbers, the highest number of fatalities occur in the South-East Asia Region (330 222 deaths, or 28% of the global burden), followed by the Western Pacific Region (297 733 deaths, or 25% of the global burden); the African Region (225 482 deaths, or 19% of the global burden); the Region of the Americas (144 090 deaths, or 12% of the global burden); the Eastern Mediterranean Region (125 781 deaths, or 11% of the global burden); and the European Region (62 670 deaths, or 5% of the global burden). Fatality rates are highest among low-income countries, at 21 deaths per 100 000 population, and lowest in high-income countries, at eight deaths per 100 000 population. Upper- middle-income and lower-middle-income countries both have fatality rates of 16 per 100 000 population.

The African Region has the highest fatality rate at 19 deaths per 100 000 population, and the European Region has the lowest fatality rate at seven deaths per 100 000 population. For the other WHO regions, fatality rates per 100 000 population are 16 in both the Eastern Mediterranean Region and in the South-East Asia Region, 15 in the Western Pacific Region, and 14 in the Region of the Americas.

Within regions, the same correlation between income level and fatality rates can be observed, with fatality rates highest in low- income countries



and lowest in high-income countries in all regions. In some regions, such as in the Region of the Americas, the differences between the rates are not as significant, but in others, such as the Eastern Mediterranean Region, fatality rates in the region's low-income countries are nearly double those of its high-income countries.

Since the start of the Decade of Action for Road Safety 2011–2020 there have been significant rises in the global population, the number of powered vehicles, and the size of the world's road networks. Rapidly evolving technology, increasing population density and growth in urban areas, along with the emergence and growing presence of micro-mobility and use of mobility services, are some of the challenges affecting the burden of road traffic injuries in the past decade.

When compared to the estimated 1.25 million road traffic deaths in 2010, the current figure of 1.19 million for 2021 represents a reduction of 5%. After the start of the Decade of Action for Road Safety 2011–2020, the number of road traffic deaths peaked in 2012 (at 1.26 million). This was followed by a gradual decline that started in 2013 and continues until 2021. The predominantly steady downward trend since 2010 contrasts with the gradual upward trend during the 10-year period prior to the Decade of Action for Road Safety 2011–2020. The current estimates are now close to those in 2000, at the start of the upward trend.

The only notable exception to these gradual shifts can be seen in 2020, when the Coronavirus disease of 2019 (COVID-19)- related confinement policies restricted mobility, and fatalities significantly, if temporarily, declined.

As discussed, the period 2010–2021 saw a 5% reduction in absolute numbers of road traffic fatalities, and it also saw the global population grow by nearly 1 billion or roughly 13%. When this growth in population is considered, the road traffic fatality rate has also declined – from nearly 18 per 100 000 people in 2010 to the current estimate of 15 per 100 000 people in 2021. This represents a 16% fall in the death rate since 2010.

Similarly, the period 2011–2020 saw the global motor vehicle fleet burgeon, with countries reporting a 160% increase since 2010. Four wheel vehicles comprise 85% of the world's motor vehicle fleet, with powered two- and three-wheelers accounting for the next largest share at 12%. Powered two- and three-wheelers have nearly tripled in number, with a 175% increase since 2011. The global increase is driven by the South-East Asia Region with a 273% increase, the Region of the Americas with a 217% increase, the Western Pacific Region with a 155% increase and the European Region with a 142% increase. This growth corresponds to data from the International Road Federation which shows an increase in road density worldwide, but especially in the African and the Western Pacific Region.

Against this backdrop, a substantial decline can be seen in annual fatality rates per 100 000 vehicles, from 79 deaths per 100 000 vehicles in 2010 to 47 deaths per 100 000 vehicles in 2021 – a 41% reduction.

The impact of increased levels of motorization are reflected in changes in the relative shares of deaths among user types. Comparisons with the Global status report on road safety 2013 reveal modest overall changes in the total share of road traffic deaths by user type, with reductions of 1% for 4-wheel vehicle occupants and 2% for users of powered two- and three-wheelers. These overall changes hide more significant changes by WHO region. For example, fatalities among powered two- and three-wheeler users have reduced their share of total deaths by 5% in the Eastern Mediterranean Region and 20% in the Western Pacific Region but have increased their share by 4% in the European Region; 11% in the African Region; 13% in the Region of the Americas; and 15% in the South-East Asia Region.

And compared to the Global status report on road safety 2013, the number of cyclist deaths has risen from 5% of all fatalities in 2010 to a current estimate of 6%, representing a 20% rise. This increase is particularly prominent in the South-East Asia Region and the European Region where the proportion of cyclist road traffic deaths rose from a reported 4% in each region in the Global status report on road safety 2013, to current shares of 12% and 9% – an increase of 200% and 125% respectively.

Emerging evidence from some countries suggests this increase in cyclist fatalities is due in part to the electrification of bicycles which has resulted in increased ridership in cities that often lack adequate cycling infrastructure. In some countries, there has been an increase in e-bike use among older populations who are especially vulnerable to serious injury and death in the event of road crashes. These examples illustrate the importance of monitoring and conducting research on how new technological innovations

are adopted within the transport system and their impact on safety.

While the global target to halve road traffic deaths from the baseline set by the Decade of Action for Road safety 2011–2020 was not met globally, at the end of 2021, 310 countries from four different regions achieved the target reduction of at least 50% in their fatality numbers: Belarus, Brunei Darussalam, Denmark, Japan, Lithuania, Norway, Russian Federation, Trinidad and Tobago, United Arab Emirates, and Venezuela.

In addition to the 10 countries where the target of a 50% reduction in deaths was met, reductions of 40–49% were observed in 15 countries, of 30–39% in 20 countries, of 20–29% in 33 countries, and of 10–19% in 19 countries. An additional 11 countries achieved reductions of 2–9%.

Overall, during this period, reductions larger than 2% were observed in 108 countries – nearly half of which are high income. Reductions have been observed in eight low-income countries..

These reductions have been observed across four regions, ranging from a 36% decrease in the European Region to a 0.1% decrease in the Region of the Americas, a 2% reduction in the South-East Asia Region (even though the South-East Asia Region has the highest death rates and numbers overall); and a decrease of 16% in the Western Pacific Region. In contrast, the number of deaths rose in 66 countries, of which 28 are in the African Region (where there was an overall increase of 17% in the number of fatalities); 20 in the Region of the Americas; eight in the Eastern Mediterranean Region (where there was an overall increase of less than 1% in the number of fatalities); four in each of the European Region and the South-East Asia Region; and two in the Western Pacific Region. Some of the greatest gains were made where the safe system approach to road safety – which puts people and safety at the core of mobility systems – was most widely applied.

The results of this report demonstrate that the European Region saw the greatest concentration of countries with policies and legislation that align with this approach and reported the largest drop in deaths. The Western Pacific Region came second, both in the number of countries adopting aspects of the safe system approach and reducing fatalities. These examples show that fatality- reduction targets can be met, given a level of political will, investment and capacity that matches the scale of the road death and injury crisis.

About 60% of the global population is expected to live in urban settings by 2030, meaning that increased demand for mobility will exceed the capacity of most current systems in these areas. Mobility needs and the systems to fulfil them must continue to evolve in response to opportunities created by technological innovations as well as challenges such as the impact of transport on climate change as well as road traffic death and injury.

Information on transport mode use in a recent survey of 48 countries shows that most people in these countries see themselves, at one time or another, as pedestrians (with percentages close to 95% in all regions except the Region of the Americas, where 85% of the population recognized themselves as pedestrians). The next most common user category is public transport user (between 68% and 96%, depending on region). Around 93% of people across all regions see themselves, at one time or another, as a car passenger, while identifying as a car driver is reported by between 67% and 81% of individuals, depending on region. Identifying as a motorcycle rider or passenger is reported by between 41% and 72% of people. While these findings underscore the importance of active modes of transport, particularly considering the mental and physical health benefits associated with their use, the increasing proportion of deaths among pedestrians and cyclists observed over the past decade is cause for concern.

Despite the potential benefits of multimodal transport and the need to ensure that vulnerable road users are equally protected as other road users (including those in passenger vehicles), few countries to date have systematically assessed multimodal transport planning as part of their road safety strategies. To assess the status of data collection on multimodal transport, countries were asked if they tracked the frequency and distribution of trips by mode of transport. About a quarter of all countries report collecting data on transport modes. Forty-two countries have data on the use of passenger (4-wheel) vehicles; 30 countries report collecting data on walking or cycling, and 10 collect data on the use of powered two- and three-wheelers and other personal mobility devices. Data on publicly operated transport is available in 54 countries.



NEWS

Systematic literature review of 10 years of cyclist safety research

Cyclist safety is a research field that is gaining increasing interest and attention, but still offers questions and challenges open to the scientific community. The aim of this study was to provide an exhaustive review of scientific publications in the cyclist safety field. For this purpose, Bibliometrix-R tool was used to analyse 1066 documents retrieved from Web of Science (WoS) between 2012 and 2021. The study examined published sources and productive scholars by exposing their most influential contributions, presented institutions and countries most contributing to cyclist safety and explored countries open towards international collaborations. A keywords analysis provided the most frequent author keywords in cyclist safety shown in a word cloud with E-bike, behaviour, and crash severity representing the primary keywords. Furthermore, a thematic map of cyclist safety field drafted from the author's keywords was identified. The strategic diagram is divided in four quadrants and, according to both density and centrality, the themes can be classified as follows: 1) motor themes, characterized by high value of both centrality and density; 2) niche themes, defined by high density and low centrality; 3) emerging or declining themes, featured by low value of both centrality and density; and 4) basic themes, distinguished by high centrality and low density. The motor themes (i.e., the main topics in cyclist safety field) crash severity and bike network were further explored.

The research findings will be useful to develop strategies for making bike a safer and more confident form of transport as well as to guide researchers towards the future scientific knowledge.

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Publication in cyclist safety field growth has been rapid since the last 10 years, and it is anticipated to continue to rise. One hundred seventy-one different sources released on cyclist safety. Notably, Accident Analysis & Prevention

led the production between 2012 and 2021, attaining the highest number of published documents. Moreover, as a result of a bibliometric and scientometric overview Zou et al. (2020) confirmed that in recent years Accident Analysis & Prevention

is increasing the publications on VRUs, especially on child bicyclists. Sources analysis results could address scholars in the choice of more suitable journal for their research papers.

An analysis of influential articles published in the field showed that the 70 % of the twenty most-cited papers have been published in Accident Analysis and Prevention. Cyclists still represent one of the road user categories with the highest injury and fatality risks (Prati et al., 2017). The EU remarked in the 2021–2030 EU road safety policy framework its long-term strategic goal to get close to zero deaths and zero serious injuries by 2050 (Vision Zero) (European Commission, 2021a), and its medium-term goal to halve deaths and serious injuries by 2030. Identifying the factors that affect crash injury severity is an important step towards accomplishing these goals. However, although there has been a quite large number of research studying safety of bicyclists, comparatively few studies have investigated the factors influencing bicyclists' injury severities. The study carried out by Behnood and Mannering (2017) represents a starting point for cyclist crash and severity analysis.

In addition to crash severity, highly cited papers have tackled issues such as factors contributing to crash frequency, e-bike, risk factors, overtaking, surrogate safety measures, helmet use, and bike network.

Antonella Scarano, Massimo Ariab, Filomena Mauriello, Maria Rella Riccardi, Alfonso Montella. Accident Analysis & Prevention, Volume 184, May 2023, 106996

COURSE ANNOUNCEMENT

The Transportation Research and Injury Prevention Centre (TRIP Centre), Indian Institute of Technology Delhi, is organizing its 34th International Course on Road Safety and Road Safety Audit at the IIT Delhi Campus in Hauz Khas, New Delhi, India, from the 25th of November to the 9th of December 2024. The first three days will include a common module (Module 1) for all participants, followed by parallel modules on Road Safety (Module 2A), Road Safety & Field Audits (Module 2B), and Governance of Road Safety Policy and Planning (Module 3). Details of the course can be accessed from <http://tripc.iitd.ac.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
Ford Motor Co., USA: Ford Chair for Biomechanics and Transportation Safety
Ministry of Urban Development India: MoUD Chair for Urban Transport & Traffic Planning
MoUD Chair for Urban Transport and Environment
MoUD Chair for Urban Traffic Safety
VREF: Volvo Chair for Transportation Planning for Control of Accident and Pollution

Establishment funds have been received from

Ministry of Industry, Government of India
Asian Institute of Transport Development, India
Tata Motors Limited, India
Volvo Research and Educational Foundations (VREF), Sweden

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Extract from Ph.D. Thesis

NEW BEARINGS ON EQUITY IN URBAN MOBILITY; (A CASE STUDY OF NORTH-WEST DELHI)- Nishant Singh

The public transport system in Delhi is built upon a bus-based transport system run by both the government and private contractors, and a large network of the Metro rail system. However, while the metro rail transit system has a dedicated right of way and enjoys large budgetary support from both the State and the Union governments, the bus transportation system has remained fiscally side-lined and the necessary up-gradations in the system have always been delayed. The metro has been projected as the symbol of the contemporary Delhi that aspires to become a "global city", while the public bus is viewed exclusively as the poor people's transport.

This description of unequal mobilities will seem familiar to anyone who has ever paid attention to mobilities in Delhi or in most cities in India. Nevertheless, this conception of urban mobility frequently relies on a self-contained individual navigating (or being compelled to navigate) a city to be physically present at specific times at distinct spatial locations, specifically at avenues constructed, operated, and maintained by a self-contained complex of governmental and commercial entities. There is a widespread feeling about the fundamental forces that move people, in which there are always winners and losers, who are sometimes readily identifiable and sometimes not. Planning a transport system becomes a management of compromises based on calculation of fair shares for different interest groups. This, or some modification of this, is the model that is usually invoked when mobility inequalities are framed (either by government or market) as a failure to provide for the needs or demands equitably on a few, many or all occasions.

What if mobility is seen in terms of people interacting to produce individual mobilities, rather than the other way round. For example, let us again consider the two examples described above. The gated communities, however isolated physically from the world around them, still have to connect with the city through the labour of those who maintain it. On the other hand, the narrow roads in and around the bastis are in one sense spaces of lack, but in another sense spaces of sharedness and solidarity, or commons.

Understanding mobility inequalities means more than just analysing differences in resources people have for moving from one place to another in this city-region, but it is also about understanding how these complex relations of mobility get formed, become unfair, and support the power imbalances in how people navigate in this city. Taking this relational approach to justice in urban mobility, I essentially became interested in knowing whether and how the mobilities of one group are related to the mobilities of another.

Though the acknowledgement of the notion that transportation should aim to 'move people, not vehicles' (for example, it was already recognized in the National Urban Transport Policy of the Government of India back in 2006 Government of India 2006), has steadily grown in many cities and their urban mobility plans, its implications for the methods and assumptions of transportation planning have rarely been realized. It is under these circumstances of sharpening demand for social and climate justice that the need to pay particular attention to injustices in transport has arisen.

The discussion also finds social and policy relevance amid the everyday frustrations and real political contestations over resources associated with being (or not being) mobile in a city. Loud manifestations of these sentiments have been registered recently in the form of major mobilisations that happened in diverse places, particularly in the urban global South, such as the nationwide protests that erupted after metro fare hike in Chile (Díaz Pabón and Palacio Ludeña 2021), series of protests in Argentina against mining of lithium used in manufacturing batteries of electric-powered automobiles (Anlauf 2016), and against violent infrastructural transformation of Rio de Janeiro in the aftermath of the Olympics (Kemmer 2020); this also finds resonance in struggles based in Northern contexts such as the Yellow Vests movement against the sharp rise in fuel prices in France (Mehleb, Kallis, and Zografos 2021).

The existing research on urban transport injustices has addressed the issue largely with methodological positivism. Positivist approaches are suitable for determining the actual distribution of accessibility and risk levels that the individual is exposed to. Alternative indicators of transit provision, such as connectivity measures, have also been proposed (Kaplan et al. 2014) but are limited by their focus on minimizing travel time rather than considering broader equity principles. Furthermore, social psychological aspects of transport disadvantage and inequalities have not received sufficient attention in both, the

global North and the Southern contexts (Delbosc and Currie 2011). The exploration of latent associations and identification of vulnerable groups in relation to transport justice is lacking in the wider body of research.

Theoretical frameworks for transport justice have been considered from political philosophy and economics, with the Capability Approach emerging as a preferred guiding framework. A more recent body of literature has emerged, placing greater emphasis on developing a robust theoretical understanding of justice within the realm of urban mobility and transport systems. This theoretical perspective had previously been either neglected or regarded as of minor importance. This new wave of research has placed emphasis on making transport policies theoretically informed and methodologically more robust in the choice of evaluative framework.

However, there is still a need to resolve divergent propositions and tensions between various conceptualizations to achieve a more mature theoretical synthesis of transport/mobility justice. The concept of mobility justice (Sheller 2018) underscores that every act of movement that carries inherent political implications, as it is intertwined with power dynamics. This perspective emphasizes that all forms of mobility and immobility are imbued with political significance, contributing to the formation of unequal patterns of movement and stasis in the flow of people, materials, and information. Additionally, it recognizes that cultural interpretations and personal experiences are deeply intertwined with these unequal mobilities. Mobility justice serves as a framework to analyse the complex interplay between power dynamics and social exclusion, as well as the disparities in access to movement and the agency to navigate it.

To address these gaps, it is necessary to go beyond studies explicitly using key phrases related to transport justice and engage with the broader questions of distribution, redistribution, and decision-making processes in mobility planning. Furthermore, a comprehensive understanding of transport justice in specific contexts, such as major urban centres in India, requires incorporating knowledge on environmentalist attempts, traffic congestion, unique road design needs, democratic governance, and the integration of social aspects into the planning process. A relational approach is needed that analyses the gap between actual and targeted levels of everyday mobility with the norms and values that shape those mobilities.

Social justice concerns should not just be incorporated in transportation planning, but transport planning should itself undergo a justice-oriented restructuring that explicitly addresses the value biases and provides an alternative to systematic domination by modelers and technocrats. A relational framework, such as the one presented in this thesis, that adopts key elements of critical theory overcomes the cliché dichotomy of efficiency and equity, and the narrow concerns of distribution of certain items or transport services. By shifting the focus from mere distribution of resources to understanding the intricate interplay of social relations, norms, and values in shaping mobility patterns, this framework offers a more comprehensive understanding of urban mobility injustices.

As highlighted in the introductory section, research contributions of this work revolve around two key dimensions:

- Shift away from methodological positivism and individualism to methodological and ontological relationalism for developing a theoretical and methodological framework that elucidates mobility relations within urban contexts, considering social composition and cultural interpretations.
- Empirical exploration focusing on the dynamics of mobility relations within a specific urban setting, aiming to uncover patterns of inequality, its latent associations with values and norms, and identification of groups vulnerable to urban mobility injustices

The findings underscore the importance of understanding mobility as a social action which people perform in relation with each other to satisfy the needs they value with means available to them and under the norms that operate in a particular social context. Thus, it has been argued that mobility should be seen as a relational good that is produced collectively by social and inter-personal relations, and everyday mobility decisions and capabilities should not be understood as intrinsic to individuals. Building on this framework, the study underlines the dominant role of cultural and social norms in shaping mobilities and mobility-related attitudes. Thus, there is need to create interventions which address deeper barriers such as the strong ideological presence of motorist supremacy.



AN ASSESSMENT OF THE IMPACTS OF INTRA-HOUSEHOLD INTERACTIONS ON HOUSEHOLD ACTIVITY-TRAVEL BEHAVIOR - Punyabeet Sarangi

Travel behaviour models have traditionally treated individuals as the decision-making unit, even though the behaviour of individuals is contingent on interactions among household members. Literature suggests that interactions at the household-level are observed not just in long-term decisions such as vehicle ownership and residential location choices but also in day-to-day activity-travel patterns. Therefore, the thesis aims to investigate the impact of intra-household interactions on household members' activity-travel behaviour within the framework of modelling short-term mobility decisions. Among the short-term decisions, this particular work focuses on decisions related to out-of-home activity participation, time allocation, travel parity composition, mode choice, and destination choice decisions.

The salient findings can be summed up as follows:

- A greater level of heterogeneity is observed in case of inter-person variation (between male and female head) than intra-person variation (within male and female head) in activity participation among spouses. The inter-person variation for activity participation and time allocation decisions of spouses was reported to be substitutive in nature. In contrast, the intra-person variation for these decisions is gender dependent.
- Regarding task allocation and touring parity composition, the error correlation matrix suggests significant inter-group substitution effects across the four accompaniment types (traveling alone, with immediate family members, extended family, or social members) for different non-work activities. The intra-group effects are complementary in the case of joint pursuits highlighting the likelihood of adult household members adhering to the same accompanying group while pursuing out-of-home non-work activities. The multivariate ordered probit model coefficients suggest that the effect of individual characteristics, household socio-demographics, and seasonal and temporal characteristics are more impactful than vehicle ownership and built environment features while determining the touring parity composition.
- The tour typologies concerning mode choice decisions reveal that the nature of intra-household interaction in a developing country is more pronounced (as 64% of total tours in the sample are joint) compared to a developed region (e.g., Sydney household travel survey data had 52% joint tours). The results from the structural model of the ICLV framework indicate that household socio-demographics and built environment variables significantly influence the attitudes and perceptions of adult household members while choosing a mode. By including the latent psychometric factors in the nested ICLV mode choice model estimation, a substantial part of the intrinsic taste (or distaste) variability associated with mode choice decision was captured that was previously ascribed to alternative specific constants. The thesis contributed to the literature by deriving distinct values of travel time savings for a car, MTW, and PT modes for different joint tour typologies, as there would be different trade-off preferences across activity types and touring parity composition.
- The heterogeneity in activity destination choice decisions is measured through the spatial repetition index (SRD) and temporal repetition index (TRI). The SRI index revealed that other maintenance activities have the highest median value indicating a certain level of spatial fixity associated with other maintenance destinations. On the contrary, shopping destinations have the lowest median SRI value, representing the variety-seeking behavior of household adults. Overall, the SRI values for maintenance shopping and recreation are lower than the TRI values for these two activities, which indicates the variation in visits to these activity destinations is higher than the variations in departure time. The variance-covariance matrix of the MMDCEV model suggested the need to incorporate inter- and intra-household variations while modeling the frequency of visits to activity locations. Among the explanatory variables, household socio-demographic and built environment variables are significant determinants of repeated trips to multiple activity destinations.

The thesis contributes to the literature on the broad topic of group-decision making and activity-travel behaviour. The study has also offered an analytical approach to explicitly incorporate joint household travel patterns and shared ride arrangements into various short-term activity-travel decisions within the random utility maximization framework. This research has made the following broad contributions:

- This thesis is one of the few studies that has investigated the inter- and intra-personal linkages and the nature of the interaction (substitution or complementary effect) associated with the non-work activity participation and time allocation decisions of spouses on weekdays in a developing country.

- This study investigates household task allocation decisions for non-work activity episodes by activity purpose and accompanying person arrangements by utilizing the activity-travel behavior information of all adult members (above 18 years) from a family to model the activity episodes aggregated at the household level. Such an approach gives a better perspective on the latent propensity of household members to engage in out-of-home activities. The accompanying person arrangements include traveling alone, with immediate family members, extended family members, and with social members. Thus, this study is the first of a kind that considers the influence of extended family members on household decision-making.

- While examining mode choice decisions at the household level, the thesis expands the systematic tour typology existing in literature by adding the with-whom travel arrangement dimension to the tour typology. The study has also attempted to integrate latent psychometric factors into this state-of-the-art framework that consists of tour types at the upper level and mode choices at the lower level. This would enable the modeler to account for the taste heterogeneity arising from variations in the perceptions and attitudes of decision-makers. In addition, the study has computed variations in the value of travel time savings (VTTS) for different accompanying person arrangements, as the authors could rarely find any evidence of studies that have computed VTTS based on touring parity composition.

- The thesis explores the influence of intra- and inter-household variations in activity destination choice and participation duration within the random utility maximization framework. The framework is estimated by adding a flexible total time budget constraint faced by a household during different time intervals in a day which is a major contribution of the study. In addition, the study has made a novel attempt to discretize the temporal repetition index values (based on percentile distribution) that are generally treated as continuous in the literature.

Overall, the thesis augments the existing literature on the influence of household interactions on the short-term activity-travel behaviour decisions of adult household members on weekdays. The short-term decisions considered in this thesis include activity participation, time allocation, touring parity composition, mode choice, and activity destination choice. The results obtained have significant policy implications.

Overall, the thesis shows significant commonalities and differences in the activity participation and time allocation decisions of household heads. For instance, a significant interpersonal substitution effect is associated with spouses' activity participation and time-use decisions concerning shopping and other household maintenance activities. In an Indian context, these correlations could be due to restricted mobility, limited accessibility to personal vehicles for women, and work constraints faced by female spouses. On the contrary, significant inter-person differences are observed in the activity participation and time use decisions of spouses for recreational activity. Examining the intra-person variations across activities, a significant complementary effect was seen in activity participation related to shopping and other maintenance activities. This indicates the possibility of linking both these activities together by the male and female head of a household. However, they are less likely to combine other maintenance activities with recreational activities. The intra-person variations concerning time allocation decisions for these activities also follow a similar trend. A mixed effect is observed regarding the intra-personal correlation between shopping and recreation activity participation between spouses. For instance, if a male head decides to participate in a shopping activity, he is less likely to undertake out-of-home recreational trips, whereas female heads have a higher probability of combining shopping with recreation activities, resulting in females having complex trip chains. However, the intra-person correlation for time use matrix indicates that both the male head and female head of a household have a negative correlation of allocating time simultaneously to shopping and recreational activities. The negative correlation might suggest the time constraints associated with child-rearing activities and in-home chores for female heads and paid work constraints for male heads of a household. Finally, examining the off-diagonal elements in the off-diagonal matrices, a negative correlation is seen between female heads' time allocation to other maintenance and male heads' recreational time use or vice versa.