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CONTENTS

Contents	2
Editorial	4
Abstracts and Keywords	6
Evaluating cycling fatality risk with a focus on cycle helmet use <i>Colin Clarke</i>	7
Re-visiting passenger transport in mega cities of India: How far do people commute? <i>Dr. Nachiket Sharadchandra Gosavi, Ms. Mansee Barbhaiya</i>	26
There are no clean cars: In the debate on how we will transport ourselves in the future, there is more to discuss than just technology. Our mobility culture must change. A guest commentary. <i>Wolfgang Lohbeck, Helmut Holzapfel</i>	41
Bless this Road: A Unique Approach to Community Education and Healing Road Trauma <i>Wendy Sarkissian</i>	43

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In this issue we return to some key themes that we have discussed in previous issues. Returning to key themes is very important. The gap between what we know about sustainable transport and how we can improve the lives of billions and how we can solve climate change problems and what we actually do is wider than ever. Every day it gets wider. Local authorities, regional and national governments globally are still obsessed with building new roads that they know will add to carbon emissions. They still reject intelligent transport planning based on accessibility concepts, fiscal re-balancing, world-best walking, cycling and public transport offers and refuse to consider a future that has fewer cars, fewer aircraft and less consumption of kilometres but has a huge increase in accessibility and is socially progressive (it rewards the poor, those on low income, children, the elderly and those with disabilities). The current transport paradigm is socially regressive. It rewards the rich, car owners, has a clear gender balance in favour of men and discriminates against pedestrians, cyclists and public transport users.

Transport and mobility policies globally are a magnificent failure, reward failure and consume billions of dollars, pounds and Euros in a futile attempt to solve congestion problems or stimulate economic activity.

In this issue Colin Clarke draws attention to the illogicality and poor public decision making around cycle helmets. Why does the Netherlands with hardly any cycle helmet wearing have a fatality rate of 8 per billion kms cycled, the UK with 21 and the USA with 48? Helmet wearing and the promotion of helmet wearing is much higher in the UK and USA than the Netherlands. The emphasis on helmets is unscientific and more importantly damages cycling and blocks the kind of cycling policy and infrastructure in successful cycling cities e.g. Freiburg, Delft, Lund, Copenhagen or Muenster.

Nachiket Sharadchandra Gosavi and Mansee Barbhैया turn our attention to very large cities in India and the importance of

framing transport and mobility policies that can assist India to deal with enormous air pollution and road safety problems. The article focuses on the commuter trip and the potential for less car travel and choices that shift in the direction much more use of alternatives to the car.

Wolfgang Lohbeck and Helmut Holzapfel draw our attention to some important and fundamental concepts around mobility and sustainable transport e.g. "There are no clean cars". The cleverest and smartest technology changes are just as capable of delivering non-sustainability as the original Henry Ford concepts of mass car ownership and car use for as many journeys as possible. In this short article, originally published in the *Frankfurter Rundschau* in Germany, the authors explain why and how our mobility culture can and must change.

The article by Wendy Sarkissian is a hugely important contribution to a key component of our mobility culture. Currently we kill about 3,200 people every day on the world's roads and with the exception of Sweden and its Vision Zero policy (there will be no deaths in the road traffic environment) and similar policies in the Netherlands there is a startling lack of awareness of the scale of these tragedies. The tragedy is deeper and more hurtful than the death of a loved partner, child or friend. The deaths are regarded as collateral damage (just as in wars) and there is no attempt to deal with those deaths in a civilised intelligent manner. Deaths are not inspected with the vigour and thoroughness of an aircraft tragedy. Nothing is done to make changes so that things can be changed to avoid yet more deaths in that location or in that combination of vehicle, speed and behavioural circumstances. Wendy Sarkissian has had to deal with the death of her partner, Karl, and the "disdain" of the local authority responsible for the road where the death occurred. The article tells the real human story around a road death (there were several deaths) and the ways in which the deaths were not scrutinised leading to improvements to reduce the chances of yet more deaths. This is a human story but it is far

more important than dozens of academic articles about road safety and very important indeed for a total transformation of the ways police, engineers, coroners, politicians and professionals deal with road deaths. Will they all learn? Doubtful..but there is no excuse now for maintaining an inhuman and unethical and unintelligent approach to road deaths.

John Whitelegg
Editor

Evaluating cycling fatality risk with a focus on cycle helmet use

Colin Clarke

Abstract:

During the last 3 decades the use of cycle helmets has increased substantially in some countries, with laws requiring their use and many places promoting them. Reports have detailed the cycling fatality risk with rates varying per billion kilometres cycled, for example the Netherlands with a rate of 8, Germany 11, France 27, United Kingdom 21 and United States of America 49. Helmet wearing is much higher in the USA than in the Netherlands or Germany, yet they have a fatality risk 4 to 5 times higher, so how much effect does helmet wearing have? Claims are made of them saving lives and preventing head injuries. On the other hand, some findings suggest a higher accident/injury rate may result from helmet usage and other evidence suggests they may not have a significant effect in saving lives. Helmet requirements and legislation can lead to discouraging cycling, resulting in serious health implications. A clear understanding of the pros and cons of the issues are needed to guide individuals and public policy.

Keywords: Cyclists, Helmet, Fatality rate, Pedestrians

Re-visiting passenger transport in mega cities of India: How far do people commute?

Dr. Nachiket Sharadchandra Gosavi, Ms. Mansee Barbhaiya

Abstract:

Commute trips could be a cause of at least half of the incidences of urban congestion. In this backdrop, the present research attempts to understand commute linked mobility in mega cities of India. This analysis has considered two dimensions namely, commute distance and commute mode preference. The research reveals that each mega city has its own characteristic and devising an envelop transport policy for mega cities as a group is difficult. As commute trips have a known origin and destination, use of non-motorized/

non-personalized modes need to be insensitized. Such a policy has the potential to push mega cities on a sustainable course and help them realize their economic potential.

Key Words: Mega cities of India, passenger mobility, commute trips, commute distance, mode preference, Transport policy.

Evaluating cycling fatality risk with a focus on cycle helmet use

Colin Clarke

Introduction

The cycling fatality rate varies from country to country due to multiple factors, such as age, gender, cycling infrastructure, traffic speeds, traffic laws, separating cyclists from HGV type traffic, use of safety aids, time of day, general road safety, expectation of drivers encountering cyclists, cyclist and driver's behaviour and if drinking alcohol is involved. Cycle helmets are expected to improve safety and are designed to cushion and protect from impacts to the head. It has been claimed that helmets will prevent a proportion of deaths and the majority of cyclists who die incur head injuries. In practice, deaths will often result from injuries to other bodily parts than the head and sometimes the impacts will exceed the protection afforded. There is evidence to suggest that helmet use increases the accident rate¹. Data from several countries is evaluated and worldwide information to assess if helmets provide an overall safety benefit in saving lives and how significant or not they are.

Method

General details regarding the fatality risk per billion kilometres cycled is considered from various countries, to provide a broad indication of the level of a risk when cycling. Data on cyclist deaths is examined from some countries where a legal requirement to wear helmets has been introduced and from where wearing rates have increased appreciably. To reflect road safety and other changes, cyclists are compared with pedestrians to see if a major change in the proportion of deaths has occurred. Changes to cyclist and pedestrian deaths, relative to car fatalities over time, are provided for 16 countries via European data. Worldwide trends of cyclist fatalities are examined to see if helmet use has resulted in relative reductions in fatalities, compared with countries without helmet requirements. Consideration is given to research that has compared helmeted to non-helmeted and differences reported in behaviour and other aspects. Relative changes in cycling levels that are associated with enforced helmet laws are noted. Details of cyclist deaths due to non-motor vehicles accidents are also consid-

ered. Evidence is sourced from both published and unpublished papers and from fatality databases and from enquires with government agencies. The Discussion section considers additional aspects and the cyclist to pedestrian fatality ratio for several countries where helmet use has increased. The Conclusions are based on the evidence and recommendations made that may help improve safety for cyclists.

Cycling fatality risk

The cycling fatality risk has been reported to vary by country from 8 per billion kilometres cycled for the Netherlands (one death per 125 million km cycled) to 49 for the United States of America². Assuming the average person cycles 20 km per week for 50 years in a lifetime, they would cover 0.052 million km. For the Netherlands³ this would equate to a risk of one in 2404 lifetimes, of being killed whilst cycling. For the USA the rate would be one in 392 lifetimes risk. In contrast, a person cycling would likely gain in health benefits. Recent estimates suggest that the health benefits from physical activity outweigh the risks by up to 77:1 (Rojas-Ruede et al, 2011)⁴. For Great Britain where about 34% of people cycle (approximately 20 million people) with about 100-110 deaths annually⁵, this equates to about one death in 180,000 people who cycle. In contrast, about 85,000 people die annually from conditions related to inactivity⁶, about 800 for each cyclist.

Comparing cyclists to pedestrians

European data shows how pedestrian and cyclist deaths reduced with changes over time. The graph below provides an indication of when road safety improves, and then fewer deaths occur to car users, pedestrians and cyclists⁷. From 1980 to 2004 pedestrians had more than a 60% reduction and cyclists approaching a 60% reduction in fatalities. In most fatality cases for pedestrians and cyclists, head injuries are involved. Test data from vehicles impacting dummies at lower speeds, from 40 km/hr to 30 km/hr, indicate a reduction in HIC (Head Injury Criterion) value of 78% for cyclists and 70% for pedestrians. This could result from a change in driving speed of 4.2km (2.6mph) from 70km/hr to 65.8km/hr, when reaction and braking times are included⁸.

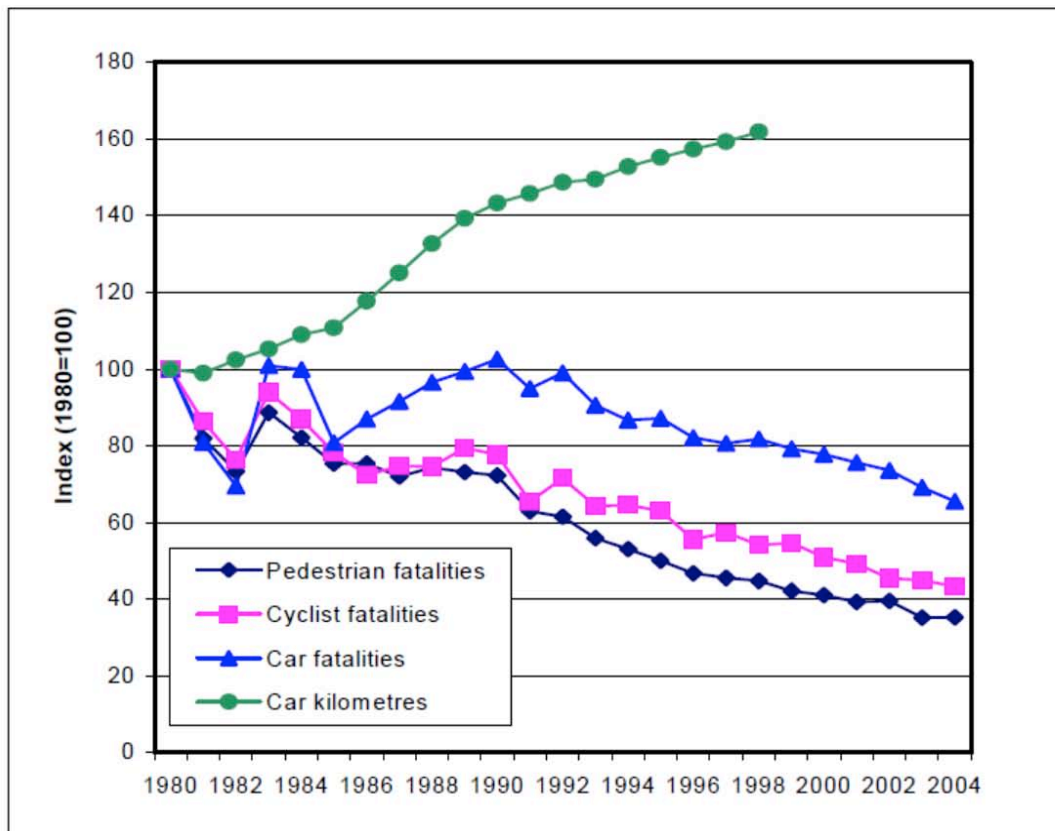


Figure 1: Index numbers of average number of pedestrian, cyclists and car fatalities in 16 European countries and index numbers for average number of car kilometres for 9 of those countries.

Source: *IRTAD*

Australia

Australia was the first country to introduce a mandatory requirement to wear cycle helmets for all ages in 1990 to 1992. The general road fatality rate per million population reduced from 174 in 1988 to 53 in 2016. By comparison, the UK had a rate of 26 in 2016. The Australian reduction stemmed from a combination of speed control measures, lower drink driving levels and other changes that affect both pedestrians and cyclists and all road users. Cycling levels were increasing during the 1980's but dropped due to the helmet laws⁹. As examples, a post law survey for Melbourne in 1991 showed an extra 10% wore helmets compared to 36% fewer people cycling. In Victoria enforcement was high with more than 19000 fines issues in the first 12 months. For New South

Wales surveys revealed the law resulted in 569 more children wearing helmets compared with 2658 fewer cycling.

Table 1 shows fatality data for pedestrians and cyclists in four-year periods from 1986 to 2017. Allowing for changes in the cycling levels the C/P values do not show a significant improvement for cyclists compared with pedestrians.

Table 2 below shows census data with percentage cycling to work, together with deaths to cyclist and pedestrian age 17 years and older and the ratio C/P for each census year from 1981 to 2016.

The proportion cycling to work from 1986 to 2001 changed from 1.68% to 1.21%, a relative decrease of 28%. In 1986 there were 86,201 cyclist commuters and in

	86-89	90-93	94-97	98-01	02-05	06-09	10-13	14-17
Cyclists	342	224	216	161	144	139	155	141
Pedestrians	2079	1444	1444	1194	927	815	684	618
C/P%	16.45	15.51	14.96	13.48	15.53	17.05	22.66	22.81

Table 1

	1981	1986	1991	1996	2001	2006	2011	2016
Cyclists – C	33	39	35	37	34	39	32	29
Pedestrians. - P	491	423	292	306	253	197	172	170
C/P%	6.7	9.2	11.9	10.2	13.4	16.2	18.6	17.0
% cycling to work	1.56*	1.68*	1.50*	1.24*	1.21*	1.24*	1.29*	1.24*
% walking to work	4.4**	3.9**	3.9**	3.5**	3.5**	4.0**	3.9*	4.2*

Table 2: Fatalities (17 years and older¹⁰)

* national data

** data from main cities

2001 a lower number of 78,210. The actual number cycling to work increased by 2016 to 107,756 but not to a sufficient extent to equate to a nearly doubling of the C/P value. From 1981 to 2016, the Australian population increased from approximately 15 million to 24 million.

The Australian Transport Safety Bureau (ATSB) examined data from 1996 to 2000¹¹ and information was available on 222 cyclists who died, 187 male and 35 female. Of 55 male cyclists in the 10-19 age group, 27 were not helmeted. For the period 2001-04, of known cases 62% were helmeted (30 cases). From 2008 to 2012 about 75% of known cases were helmeted¹². Survey data showed lower wearing rates for teenagers compared to other age groups.

For NSW in the period 1992-2011 there were 231 cyclist deaths, 154 helmeted, 66 not wearing and 11 unknowns. Of known cases, 70% were helmeted. The 1993 Smith survey reported wearing rates of 68% for children under 16 at road sites (56% for Sydney) and 83% for adults (77% for Sydney). The wearing rate for cyclists varied and the lowest use appears to be associated with night-time cyclists and teenagers¹³. The use of hi-vis vests is typically associated with adult cyclists and they reportedly result in a lower accident rate¹⁴. Some non-wearers may typically be at higher risk due to other factors¹⁵. Between 1996 and 2011, of 22 known cases who had drunk alcohol, 10 wore helmets and 12 did not¹⁶. Nine of the 12 non-helmeted cyclists had a Blood Alcohol Content (BAC) of 0.150 or above and only one of the 10 helmeted had this level. Six of the 10 helmeted had low levels of between 0.001-0.019. Of known cases, 10% of hel-

meted and 29% of non-helmeted had been drinking. For pedestrians, around 30% of fatalities had a BAC of 0.05 or more¹⁷.

For Queensland in the period 1993-2008 there were 146 cyclist deaths, 82 wore helmets, 44 not wearing and 20 unknowns¹⁸. Of known cases, 65% were wearing helmets. In critical accidents helmets can dislodge and on inspection it may not be known if the rider was wearing or carrying a helmet. Of the 44 not wearing, 13 (29.5%) had been drinking alcohol and from the 82 helmeted, five (6.1%) had been drinking. In comparison, for pedestrians about 25% had been drinking alcohol. Queensland data (1999 to 2004)¹⁹ shows 51 deaths in the six years, 35 wearing, 10 not wearing and 6 unknowns. Of known cases, 77.7% were wearing helmets, which was similar to the reported wearing rate of 77%²⁰. From the 10 not wearing, three had been drinking alcohol and none of the 35 wearing helmets.

Four tragic cases of young children being hanged by their helmet straps have been reported, two in Victoria, one in South Australia and one in Tasmania²¹. Suitable warnings about the danger of strangulation are not provided by states detailing the requirement to wear helmets.

A recent study regarding bicycling fatalities reported Australian police data between 1991 and 2013 and mentions, "The decrease in cycling deaths over the study period was only observed in fatalities following multivehicle crashes (at a rate 2.9% per annum), while those resulting from single vehicle crashes actually increased by 5.8% per annum." Several factors may be involved and considered in the Discussion section.

New Zealand

New Zealand introduced a cycle helmet law in 1994. In 2014 it was reported; 'About 10,000 cyclists a year are stopped and fined by police for biking without a helmet'²². Enforcement was at a high level and wearing rates more than 90%. Surveys reported a big drop in cycling levels, from 39.2 million hours per year in 1989/90 to 26 million hours in 1997/98 and to 22 million hours in the 2003 - 2006 period. The drop in average hours cycled per person was 53%²³. From 1989 to 2011, average time spent cycling (on roads and footpaths) fell by 79% for children aged 5-12 (from 28 to 6 minutes per person per week) and 81% for 13-17 year olds (52 to 10 mins/person/week)²⁴.

Deaths to cyclists and pedestrians²⁵ are shown in Table 3, also estimates on million hours cycled and walked annually.

For New Zealand the percentage cycling to work reduced from 5.39% in 1991 to 3.12% by 2001 and even lower by 2006 to 2.52%²⁶, a relative reduction of 53% and similar to the overall reduction in hours

cycled per person per year from pre-law to post law. Clarke 2012 evaluated the reduction in cycling and the health implications and concluded it had 'resulted in an overall increase in approximately 53 premature deaths per year.' The C/P values adjusted for the changes in proportion cycling increased from 21.7% to 47.1%. The fatality risk to cyclist reduced by about 9% per million hours cycled, whereas for pedestrians it reduced by about 58%. Sage et al detailed that out of 20 bicycle riders fatally injured in Auckland, New Zealand, between 1974 and 1984, 16 died (80%) of injuries were to multiple organ systems. Their report stated that "wearing of suitable safety helmets by cyclists is unlikely to lead to a great reduction in fatal injuries". It reported four cyclists dying from head injury alone and one was wearing a helmet and his death resulted from a fall at moderate speed without a motor vehicle being involved²⁷. The increase in number of deaths (9 to 29) from other than motor vehicle accidents, from 1989 to 2013, raises obvious concerns. If 1988 data was included, with 4 deaths, the increase would have been near to doubling and appears to be similar to that for Australia.

	1989 - 93 (5yrs)	94 - 98 (5 yrs)	99 - 03 (5 yrs)	04 - 08 (5 yrs)	09 - 13 (5yrs)
Cyclists - C	117	81	65	67	71
Pedestrians - P	537	384	337	254	228
C/P %	21.7	21.1	19.3	26.4	31.1
Hrs 10 ⁶ cycled -A	39.2*	26	22	24	26
Hrs 10 ⁶ walked -W	191	200	190	200	193
Cycling level % 'B'	100	66.6	56.4	61.5	66.6
C/P % adjusted - C/B/P	21.7	31.7	34.1	41.2	47.1
Cyclists not involving a motor vehicle	9	10	12	16	29

Table 3

Note:

* 39.2 million hours based on 1989/90 survey

'A' is estimated average value of million hours cycled per annual

'B' is percentage estimate of annual hours cycled compared with the pre-law period 1988 to 1993.

Canada

Some parts of Canada have helmet requirements, as listed in table 4 and 5. Laws for minors refer to those less than 18 years of age. Five provinces have introduced all age helmet laws, and bicycle use based on 1994/95 and 2013/14 information, is shown below. For household population 12yo or older, the percentage that used a bicycled in the previous 3 months by province, is shown for 1994/1995. For the period 2013/14, details of cycling in the past 12 months are shown²⁸. Comparable data for Northwest Territories, Nunavut and Yukon (all no law) is not available.

Provinces without all age helmet laws show on average a higher use of bicycles and from 1994/95 to 2013/14 also show a better outcome with more people cycling 42.1% v 29.3%. A Health Report published by Statistics Canada in 2017 shows all age cycling in the country declined from 28.7% of the population in 1994/95 to 23.7% in 2013/14. British Columbia, Ontario, New Brunswick and Nova Scotia introduced all age or under 18yo helmet

laws from 1995 to 1997, with five other provinces progressively following suit up to 2015. Helmet law provinces have fallen back compared with no 'all age' law provinces except perhaps for PEI where the Confederation Trail was completed in August 2000, providing a network of 438 km off road routes for cycling. Helmet law enforcement fines data is limited. There are specific examples of reductions in cycling related to helmet laws, for example Alberta, law introduced in 2002 and applied to the under 18 yo. The pre and post law surveys for children and teenagers, shows a reduction of 45%²⁹. For Nova Scotia with an all age helmet law the pre to post law surveys shows reduced counts of cyclists per day, 88 to 52, down by 41%. Clarke 2009³⁰ provided details regarding the age group 5-19 years and reported provinces without helmet laws had a better overall safety outcome but information was not specific to fatalities. An analysis of cycling for people aged 12 or older shows that in the 2013/14 period, 42% reported always wore a helmet³¹. The self reporting v observed wearing rates can be different, as reported from India and the USA^{32,33}, with

Province with AAL	Bicycle use % in past 3 months 1994/95	Bicycle use % in past 12 months 2013/14
British Columbia	33.4	40.2
Newfoundland and Labrador	16.6	18.4
Prince Edward Island	18.4	29.1
Nova Scotia	18.4	26.8
New Brunswick	22.1	32.0
Average value	21.8	29.3
Ratio; 2013/14 to 1994/95	1.34	

Table 4: Provinces with all age helmet laws (AAL)

Province without AAL	Bicycle use % in past 3 months 1994/95	Bicycle use % in past 12 months 2013/14
Quebec	31.7	47.8
Ontario**	26.5	38.4
Manitoba**	30.3	46.1
Saskatchewan	27.9	38.1
Alberta**	31.7	40.3
Average values	29.6	42.1
Ratio; 2013/14 to 1994	1.42	

Table 5: Provinces without all age helmet laws

Note: ** helmet laws for cyclists younger than 18 years old

people saying a higher rate than observed. Table 6 below compares cyclist to pedestrian deaths from 1990 to 2015, based on Road Traffic Accident (RTA) data.

Years	90-93	94-97	98-01	02-05	06-09	10-13	14-15*
Cyclists - C	364	281	244	218	230	249	89
Pedestrians - P	2036	1727	1527	1456	1376	1261	584
C/P%	17.88	16.27	15.98	14.97	16.71	19.75	15.2

Table 6

Note: * only two years data used

Table 7 below compares cyclist to pedestrian deaths from 1990 to 2015, based on Statistics Canada (SC) data.

Years	90-93	94-97	98-01	02-05	06-09	10-13	14-15*
Cyclists - C	371	286	275	273	305	345	121
Pedestrians - P	2031	1800	1732	1612	1565	1504	676
C/P%	18.26	15.89	15.88	16.93	19.49	22.94	17.90

Table 7

The proportion cycling to work has increased appreciably to about 200,000 and walking to work has marginally increased³⁴. Canada’s population in 2013 was approximately 35.2 million and with approximately 23.7% cycling this equates to about 8.3 million, therefore the proportion cycling to work is only about 2.5% of people cycling.

For 1994/97 Statistics Canada (SC) reported cyclist deaths almost match the RTA figures, 286 v 281; however, they diverge in later years. The RTA data will include road deaths within 30 days and due to road traffic accidents. Whereas SC data covers all deaths, some may be later than the 30 days and others due to falls without a motor vehicle being involved. For the period 2010 to 2013 the SC data shows 96 extra deaths compared with RTA data.

Notes;

Data from Alberta, covering a 14-year period (1998-2011) and 101 cyclist deaths³⁵ reported 41% dying at the scene and a further 7% dying before reaching hospital, it reported 26 (26 %) of cases were wearing helmets. In relation to alcohol it stated;

‘Fatally-injured cyclists who had evidence of alcohol consumption were less frequently reported to be wearing a helmet than deceased cyclists without documented alcohol use (4 % vs. 33 %; p=0.003). More deceased cyclists who crashed in the dark had consumed alcohol compared with those who crashed in daylight (15/25 vs 8/67; p<0.001).’

Of the 25 cyclists with evidence of alcohol use, one cyclist was reported to have been wearing a helmet, 15 were reported to have not been wearing a helmet, and helmet status was unknown for nine cyclists. Of the 21 who crashed at night, one cyclist was wearing a helmet, 14 were not and helmet use was unreported in six cases. Deaths due to non-motor vehicle accidents were reported as 34, including eight wearing helmets, 13 drinking alcohol and 4 drugs related.

Details from Ontario regarding 129 cyclist deaths were reported for the period 2006 to 2010^{36,37}. For the 34 helmet users a lower proportion of deaths due to head injuries was reported. In 30 of the cycling fatalities there was evidence of the cyclist being under the influence of alcohol

and/or drugs at the time of the collision. In 19 cases the cyclists were potentially distracted by using personal music player with headphones or in other ways. In 21 cases the cyclist was identified as carrying or transporting objects which may have encumbered his or her safe operation of the bicycle. Without knowing how many helmeted v non-helmeted were included in the 30-19-21 groups it is difficult to draw conclusions. Fifteen deaths resulted from falls. The three most common contributory cyclist actions identified were inattention (30 cases; 23%), failure to yield right of way (24 cases; 19%) and disregarding traffic signals (10 cases; 8%). These total nearly 50% of cases, 64/129. The coroner's report detailed;

'In 62% of cases involving a vehicle, a contributory action on the part of the driver was identified; this may be an under-representation.'

United States of America

In 1990 the USA population was approximately 250 million and by 2017 it had increased by 30% to 326 million. In comparison, the road fatality rate per 100,000 population reduced from 18.5 in 1990 to 11.4 in 2015, a reduction of 38%³⁸. Mandatory bicycle helmet laws for child/youth have been introduced in 21 US states and helmet wearing rates have increased in all jurisdictions³⁹. A number of reports contain indicators to changes in cycling levels over time. Child/youth cycling has declined⁴⁰. Cycling to work, 1980 to 2012, first declined then increased⁴¹. All age bicycling participation declined from 1993 to 2003 according to the Census data⁴². Estimates for 2015 of people using a bicycle vary from 35.5 million to 103.7 million⁴³ with an average of 3 trips per week at 30 minutes per trip (78 hr/yr). Rodgers pro-

vided estimates of bicycle use in 1998⁴⁴, with 85.3 million riders and averaging 204 hours cycling time per year. Younger cyclists to age 15 averaged 300 hrs per year. The 16 to 24 age group averaged about 200 hrs per year. Older cyclists had lower averages of about 100 - 150 hrs per year. Rodgers refers to helmet wearing rates varying substantially by sub groups and indicates an overall wearing rate of approximately 40% in 1998, with the under 16 age group having the highest wearing rates and the 16-24 group having the lowest. In 2015 a wearing rate of 40% is suggested as typical⁴⁵. Carpenter and Stehr⁴⁶ reported a reduction in cycling of 4% - 5% occurred due to legislation from 1991 to 2005. Chatterji and Markowitz⁴⁷ estimated a possible 9% reduction due to helmet laws. Information from the National Sporting Goods Administration suggests a reduction in cycling for the 6-17 age group from 1998 to 2016 of about 40%⁴⁸. Other information shows commuters increasing by 46% from 2005 to 2014⁴⁹ (total quoted as 904,463, equal to less than 1% of people using bicycles but they may cycle more often than the average).

Fatality data – all ages, source CDC⁵⁰

Average yearly fatality data in 5-year periods is shown in table 8 from 1986 to 2015. The USA data in tables 9 and 10 is also for road traffic accidents involving motor vehicles.

Estimates for age up to 15 years are shown below in table 9 and include average yearly data in 5-year periods from 1991 to 2015.

Table 10 shows data for ages 16 and above, including average yearly data in 5-year periods from 1991 to 2015.

Year	86-90	91-95	96-00	01-05	06-10	11-15
Cyclist	851	755	664	609	586	626
Pedestrian	7091	5956	5133	4914	4564	5147
C/P%	12.0	12.6	12.5	12.4	12.8	12.2

Table 8

Year	91-95	96-00	01-05	06-10	11-15
Cyclist	270	190	121	75	51
Pedestrian	900	656	495	366	303
C/P%	30.0	29.0	24.4	20.5	16.8

Table 9

Year	91-95	96-00	01-05	06-10	11-15
Cyclist	485	474	488	511	575
Pedestrian	5056	4477	4419	4198	4844
C/P%	9.6	10.6	11.0	12.2	11.9

Table 10

Cycling reportedly increased during the early 1991-95 /2008-2012 period and walking reduced⁵¹. Child/youth cycling reduced, in part due to legislation. The proportion of walking to cycling has been reported not to change very much from 2001 to 2009⁵². However, the proportion of adult/child /youth cycling has changed, adult increasing and child/youth reducing. Data from 1975 to 2016 shows the changes in age grouping. In 1975 for those aged 20 or older there were 212 deaths (21%) from a total of 1003. By 2016 there were 723 from 825⁵³ (87%).

Table 11 shows details of cyclist and pedestrian deaths, average per year, due to 'other' than from motor vehicle accidents⁵⁴. These would include deaths due to falls without a motor vehicle being involved and could relate to other reasons.

Year	86-90	91-95	96-00	01-05	06-10	11-15
Cyclist	105	114	150	209	258	296
Pedestrian	919	949	1107	1127	1110	1178
C/P%	11.4	12.0	13.5	18.5	23.2	25.1

Table 11: (not involving a motor vehicle)

Notes;

In 2015 for the whole of the USA, the average age of pedal cyclists killed in traffic crashes was 45. Over the previous 10 years, the average age of pedal cyclists killed in motor vehicle crashes has steadily increased. By comparison in 1989 about 17% were age 45 or older. In 2015, 27% of the pedal cyclists killed had BACs of .01 g/dL or higher, and 22% had BACs of .08 g/dL or higher⁵⁵ (2016 data estimated 33 percent of fatal pedestrian crashes involved a pedestrian with a BAC of .08 g/dL or higher). Light trucks were the most frequent motor vehicle involved in crashes in which a pedal cyclist was killed (similar for pedestrians 2016 data). In 86% of these crashes, the pedal cyclist came in contact with the front of the light truck. Overall

in 2015 an estimated 29% of the deaths occurred between the hours of 9:00 p.m. and 5:59 a.m. (2016 data for pedestrians shows 46% during these hours). Although daylight conditions vary during the year, most of these deaths probably occurred after dark. Another 24% occurred between 6:00 p.m. and 8:59 p.m., some of which probably occurred in dark conditions. For 1991 it was reported 'less than one-third of these night-time riders use headlights or taillights'. Florida provided 10 years of data from 2000 to 2009. In the 10-year period they had 1090 cyclist deaths and 49598 injured. For those wearing helmets there were 126 deaths compared to 6042 injured (2.08%). For non-helmeted, a little higher in proportion at 2.21% (964/43556)⁵⁶. Rodgers (1988⁵⁷) examined claims that the growth in the use of hard shell bicycle helmets had been successful in reducing bicycle-related

head injuries and deaths, Rodgers studied over 8 million cases of injury and death to cyclists over 15 years in the USA. He concluded as follows: "There is no evidence that hard shell helmets have reduced the head injury and fatality rates. The most surprising finding is that the bicycle-related fatality rate is positively and significantly correlated with increased helmet use."

Comparing differences between helmeted v non-helmeted cyclists

Some of the general differences between helmeted cyclists and non-helmeted have been reported for the USA and are listed in Table 12 below.

USA differences	Helmeted	No helmet	Reference	Risk factor
Riding against flow of traffic	2.8%	12.3%	Webman et al 2013 ⁵⁸	3.6 to 6.6 ⁵⁹
Crossing against signals	5.5%	12.3%	Webman et al 2013	n.a.
Alcohol involvement	6.3%	11.1%	Webman et al 2013	n.a.
Alcohol or drug use	1.5%	33.4%	Crocker et al 2012 ⁶⁰	n.a.
Intoxicated	4.7%	22.2%	Harada et al 2015 ⁶¹	n.a.
Alcohol use, average 3 above	4.16%	22.2%	Ratio 1:5.34	Up to 20 ⁶²
Time of accident 8:01pm to 5:00am	7.9%	37.1%	Crocker et al 2012	2-5 range for NL ⁶³
Time of accident 9:00pm to 5:59am	14.4%	23.6%	Sethi et al 2015 ⁶⁴	2-5 range for NL
Use of electronic devices	7.9%	13.7%	Sethi et al 2015	n.a.
Skill level - beginner	3.2%	12.5%	Crocker et al 2012	n.a.

Table 12

Note: Sethi et al 2015 provides data on 'Riding against flow of traffic' claiming similar for helmeted v no helmet but percent quoted, and data do not tally. Details from Norway reported non-wearers cycle more often without light in the dark⁶⁵.

Table 13 below estimates bicyclist deaths for daytime hours, omitting most of the hours riding in the dark, based on average data from Crocker et al and Sethi et al above (11.15% helmeted v 30.3% no helmet) and related to known status of helmet use.

(2.8% v 12.3%), crossing against signals (5.5% v 12.3%), use of electronic devices (7.9% v 13.7%), totals 20.4% for helmeted v 60.5% for non-wearers. Some of these may overlap and other differences will likely be involved. Wearing rates reported in Boston were 36% for male and

Year	Actual				Estimating for 5.01/6.00am to 8.00/8.59pm		
	No helmet	Helmeted	Unknown	Total	No helmet	Helmeted	% helmeted
2010	429	94	98	621	299	87	22.5
2011	450	100	130	680	314	89	22.0
2012	469	123	138	730	327	109	25.0
2013	464	127	156	747	323	113	25.9
2014	429	118	176	723	299	105	26.0
2015	442	142	244	828	308	126	29.0
2016	424	137	274	835	296	128	30.1

Table 13

Note: based on road traffic accidents⁶⁶.

The above table indicates that during mainly daylight hours the percentage of deaths for helmet wearers is probably near to 30% but a large number of 'unknown' cases are listed. A number of other factors for helmeted v no helmet could also have a bearing - alcohol use (4.2% v 22.2%), riding against flow of traffic

50% for female⁶⁷ and this also has implications, with females generally having a lower fatality rate per billion km⁶⁸ (details from Australia for 1984/85 reported fatality rates of 58 for male and 30 for female per billion km). Also reported for Boston was wearing rates of 8.9%, 6.1%, 8.4% and 9.8% for the years 2009 to 2012⁶⁹.

Great Britain

Great Britain has promoted cycle helmets via the Highway Code since 1993. The table below compares cyclist to pedestrian deaths. The last national survey of helmet wearing was in 2008 and a wearing rate of 34.3% was quoted for major built up roads. The rate had increased by 18% in a 14-year period. Accident data suggests wearing rates are now higher⁷⁰. From 1995/07 to 2016 cycling levels increased by 15% (miles per person per year from 46 to 53)⁷¹ but cycling trips decreased and walking varied, tending to fall between 2005-15 and then return (miles walked per person per year, 199 in 95/97 to 198 in 2016).

Table 14 below shows average annual fatality data from 1985 to 2016 groups in 5-year periods, except for 2015 and 2016.

Years	85- 89	90-94	95-99	00-04	05-09	10-14	15-16
Cyclists - C	272	212	186	129	130	112	101
Pedestrians - P	1758	1382	957	801	613	428	428
C/P%	15.4	15.3	19.4	16.1	21.1	26.1	23.6

Table 14

Notes: Between 2003 and 2016 cycle traffic increased by 25 per cent⁷². However, the number of serious injuries rose by 48 per cent. From 2011 to 2016 there were 649 cycling fatalities, 123 helmeted, 111 no helmet and 415 helmet use not known. Included in the 649 deaths were 89 not involving a motor vehicle, 22 helmeted, 15 no helmet and 52 cases of helmet use not known⁷³.

Multi country information

Details in Table 15 below are for cyclist deaths from 28 countries, from 1990 to 2014, for selected years as shown in table 15. For Canada the data is similar to the Road Traffic data without including the extra deaths shown in Statistics Canada data. Similarly, for New Zealand and the USA with lower counts than occurred. Countries with no helmet laws had an overall reduction of 54.5% and countries with helmet laws had a 32.1% reduction (less if accurate figures had been used). The USA comprised more than half of the deaths for 'Law countries' and without the USA data, the overall reductions would be 54.5% v 53.2%. For Sweden from 1995 to 2014 it was reported 'the number of bicycle trips per capita has decreased by 38 percent'⁷⁴.

Discussion

The relatively low fatality rate of 8 per billion km for the Netherlands is probably due to a combination of factors. Their generally flat terrain may result in few occasions for cyclists to attain high speeds and their use of low to moderate speed limits plus and low alcohol limits for driving will assist in reducing dangers. In addition, their widespread use of separate cycling tracks to minimise cyclists encountering dangerous road conditions is a safety advantage and encourages more people to cycle. Children often learn to ride safely from a young age and motorists take extra care when near to cyclists. In most other countries the above combination of factors does not exist, so the fatality rate is higher. The ECF 'Safety in Numbers' explains where more people cycle then generally the fatality rate per billion km is lower⁷⁶. As more people cycle the planning and in-

frastructure provided for cycling improves. Some data, e.g Canada and the USA relates to road traffic accidents involving a motor vehicle and may not include cyclists who have fallen without a motor vehicle being involved. For the UK, New Zealand and Australia they appear to include all deaths.

Over the past 30 years, many hospital-based case control studies of injured cyclists have compared the outcome for helmet wearers to non-wearers. They usually compare groups having different behavioural patterns as indicated in Table 12. It appears that people who generally choose to wear helmets are safety minded and take extra care in several ways⁷⁷. One study based on 26 countries and young adolescents reported higher risk taking levels for non-wearers, 1.17 v 0.89 from

Country	1990	2000	2010	2011	2013	2014	% change 1990-2014	Helmet law
Australia	80	31	38	34	50	44	-45.0%	Yes all ages
Austria	106	62	32	42	51	45	-57.5%	No
Belgium	196	134	70	68	73	76	-61.2%	No
Canada	106	40	61	50	63	60	-43.4%	Yes some provinces
Czech Republic	135	151	80	63	74	68	-49.6%	Yes children to 18
Denmark	110	58	26	30	33	30	-72.7%	No
Finland	101	53	26	19	20	27	-73.3%	Yes 2011 97%
France	429	273	147	141	147	159	-63.6%	No
Germany	925	659	381	399	354	396	-57.2%	No
Greece	26	22	23	13	15	19	-26.9%	No
Hungary	313	182	92	85	68	98	-68.7%	No
Iceland	0	0	0	0	0	0	0%	Yes children to 14
Ireland	46	10	5	9	5	13	-71.7%	No
Italy	477	401	265	282	251	273	-42.8%	No
Jamaica	56		26	33	17	26	-53.6%	No
Japan	1,509	1,278	938	864	813	738	-51.1%	No
Korea	644	317	294	272	281	272	-57.8%	No
Luxembourg	1	1	1	2	0	0	100.0%	No
Netherlands	304	233	162	200	184	185	-21.0%	No
New Zealand	27	19	10	9	8	10	-63.0%	Yes all ages
Norway	17	13	5	11	10	12	-29.4%	No
Poland	574	692	280	314	306	286	-50.2%	No
Portugal	120	62	31	44	29	35	-70.8%	No
Spain	160	84	67	49	69	75	-53.1%	Yes except built up
Sweden	68	47	21	21	14	33	-51.5%	Yes children to 15
Switzerland	58	48	34	39	21	34	-41.4%	No
UK	267	131	111	109	113	116	-56.6%	No
USA	859	693	623	677	749	726	-15.5%	21 states children
All	7,714	5,694	3,849	3,879	3,818	3,856	-50.0%	28 countries
No law countries	6,178	4,576	2,923	2,956	2,771	2,813	-54.5%	19 no law
Law countries	1,536	1,118	926	922	1,047	1,043	-32.1%	9 with some law
1990-2000 change								
All	-26.2%							
No law countries	-25.9%							
Law countries	-27.2%							

Table 15

Data source: OECD Road Safety Annual Report 2016⁷⁵.

a range of 0-5⁷⁸. The accident rate per million km cycled can vary by a factor of approximately 10 depending on the type of cyclist, e.g. long distance tourist 46, sports cyclist 71, untrained adult 317, children 447 (information adapted from Allan 1984)⁷⁹.

Case control studies need for groups being compared to be quite similar in general but in the case of cycle helmets they tend to include several differences apart from helmet use. A meta-analysis in 2018 reported the use of bicycle helmets was estimated to reduce the total number of killed or seriously injured cyclists by 34%⁸⁰. This

should if valid, reduce the proportion of cyclist to pedestrian deaths but in practice this does not seem to have occurred. Some of the weaknesses in a meta analysis approach regarding fatalities were discussed previously⁸¹. The findings from case control studies should therefore be treated with caution. The method used of comparing cyclist to pedestrian's hopes to reflect general changes in population, changes in the levels of road safety generally, changes in social aspects and time spent outdoors and changes in local trips.

The results for Australia where the C/P ratio changed from 16.45% to 22.81% suggest

no widespread benefit from their helmet law. The results for New Zealand adjusted for the changes in total hours cycled shows the C/P ratio changed from 21.7% to 47.1%, representing less of an improvement for cyclists compared with pedestrians. The C/P ratio for Canada shows a reduction of 2% based on SC data. In 1994 more than half of cyclists killed in Canada were in the 5-19 age group and some surveys have shown major reductions in child/youth cycling. All age cycling in the country declined from 28.7% of the population in 1994/95 to 23.7% in 2013/14, a relative reduction of 17.4%.

For the USA the C/P values seem to reflect changes in the proportion cycling and walking except for Table 11. The increase in the number of cyclist deaths not involving a motor vehicle, from an average of 105 per year in the 1986-1990 period, to 296 in the 2010-2015 period, needs further investigation. Grant and Rutner⁸² assessment of helmet legislation mentions fatalities may reduce by 15% in the long term, less in the short term but they commented "there must be other time-varying factors that influence juvenile bicycling fatalities more than helmet laws do." It referenced a 21% reduction in bicycle use associated with a 12% reduction in fatalities. Some changes are needed in the USA, perhaps by asking cyclists to have two rear lights at night, one flashing and on steady. Cyclists should be made aware that alcohol can increase the fatality risk by up to 20 times and riding against traffic is a higher risk factor. Trucks should be required to install cameras which should help in assessing why accidents occur and what needs to change.

For Great Britain the C/P ratio increased suggesting no significant benefit and perhaps reflecting changes in the proportions cycling and walking. A UK specialist biomechanical assessment of over 100 police forensic cyclist fatality case files predicted that between 10% and 16% could have been prevented if they had worn an appropriate cycle helmet⁸³. Examining deceased cyclists and predicting if they could have survived if wearing a helmet is only considering the potential benefit aspect. If people take more risks in any form, where they ride, how the ride, this may override

the expected benefits. About 80% of cycle accidents are probably due to falls⁸⁴ and helmets potentially have some disadvantages in terms of control, with some examples listed below.

Research from 1986⁸⁵ concerning bicycle helmet vibrations and relation to helmet dislodgement during normal road use detailed accelerations up to 100m/s² occurred (10g approximately) from riding speeds of 15-25km/hr and hitting deep potholes. Up to 30m/s² occurred (3g approximately) for other situations, such as hitting kerbs. A force of 65N was referenced due to the 10g acceleration and this is equivalent to 6.6kg under normal gravity. Most helmets today are lighter than used in the 1986 tests and on average lower forces would probably occur. When hitting an unseen pothole, for example 300mm wide and travelling at 25 km/hr (6.9m/s), the wheel would cover the distance in 0.043 seconds. The wheel would be dropping and impacting in most cases the far edge/side of the pothole. A rider's reaction time may be about 0.1 seconds, more than twice the time to cover the pothole width in the example. A helmeted rider will have extra forces that may be in random directions and occur before they have time to react.

Some research has investigated wind effects on cyclists, bicycles and helmets, and the resulting forces^{86,87,88}. Birmingham University research into the side wind forces on cyclists reported that "The actual aerodynamic loads arising from such winds can be up to about 2.5 times the aerodynamic drag". Brownlie et al reported drag forces of about 15N when testing time trial helmets under wind speed conditions of about 15m/s (approximately 33 mph). The difference in stability between a bare head and a helmeted head when cycling in windy conditions would need targeted research to determine the level of forces and potential to contribute to loss of control. With the wide variety of helmets available it is likely that in some conditions they would apply extra forces compared to not wearing a helmet.

Cyclists may believe they are safer with a helmet and take increased risks, for example in mountain biking events or in

travelling at higher speeds. Parents may allow children to cycle at a younger age with the added protection of a helmet. Children may think they are safer and engage in higher risk cycling. Some schools allow children to cycle to school if wearing a helmet, so schools are deciding to allow a risk level based on their perceptions of a potential benefit. Fyhri and Phillips⁸⁹ reported on research that found riders who usually wore helmets cycle slower when not wearing helmets, suggesting a degree of change in behaviour. Gamble and Walker⁹⁰ reported wearing a helmet was associated with higher risk-taking scores compared with wearing a cap.

In addition to the above, when helmeted cyclists fall they have a higher risk of impacting the helmets compared to a bare head⁹¹. A bare head may avoid contact compared to a helmeted head (Clarke 2007⁹²). The rate reported for concussions is higher for helmet wearers 11% v 8.8%⁹³, therefore this may reflect a higher proportion of impacts to helmets v non-wearers impacting their heads. Helmeted reportedly suffered 18.1% minor head injuries AIS 1 (versus 27.7% without helmet), other more serious head injuries reported 1.6% for non-wearers v 0.6% for wearers.

One article on impact tests reported, 'The HIC values with and without the helmet were 3881 and 4923, respectively. The helmet could thus reduce the head acceleration by 6% and the HIC by 21%. However, even with the helmet, the acceleration and the HIC values were still very high and exceeded the HIC injury threshold (1000).' HIC values of 1000 represent a 15% risk of life – threatening brain injury. The duration of the impacts was longer for helmeted at about 11ms v 9 ms for non-helmeted. The maximum acceleration (m/s²) for the helmet was 2751m/s² and without 2937m/s²⁹⁴. The approximate product of acceleration and duration for helmeted equates to 30.26 v 26.43 without helmet, about 14% higher with the helmet. Helmeted impacts usually result in a longer period of acceleration but at a lower level. Wayne State University tests reported the same levels of rotational accelerations for helmeted v no helmet⁹⁵ and that rotational is more damaging than linear accelera-

tions⁹⁶. In linear acceleration tests, 7 from 32 helmet impacts gave results indicating HIC values of 1000 or more. For oblique impact testing it was reported that 3 from 16 tests resulted in high rotational values, 10,737 rad/s², 16,224 rad/s² and 20,642 rad/s² and at 10,000 rad/s² this indicated a 35% risk of a brain injury AIS 3-6⁹⁷.

Cyclist fatality data from Australia, New Zealand, Canada and the USA shows an increase in deaths not involving motor vehicles and data from the Netherlands also shows this trend. The deaths may be age related with older cyclists and perhaps a higher accident rate or of impacting the head for helmet wearers.

Even countries without helmet laws may be at risk from cycling being promoted as a desirable high risk activity, encouraging young cyclists to take more risks. The Olympics Games now include crash-prone BMX cycling events, taking undue risks when helmeted. Two deaths occurred at one track in New Zealand⁹⁸. Compared to normal cycling the risk reported is nearly twice as high⁹⁹.

Australia with the first all age law should have taken more care in evaluating and providing accurate surveys data in all states. Melbourne had initially 80 survey sites, reduced to 64 sites, based on 10 hours each to compare changes and in NSW had 122 survey sites. Other states should have provided widespread surveys. An evaluation of their law (Clarke 2015) reported 'The helmet laws have not delivered a net societal health benefit, with a calculated cost benefit ratio of 109 to 1 against'. In 2015 the Australia Senate, to their credit, did investigate the issue and received many submissions¹⁰⁰.

Conclusions

The risk for the average person of being killed whilst cycling is quite small, for the Netherlands about one in 2400 lifetimes and for most other countries somewhat higher. Some of the available evidence based on comparing injured helmeted to non-helmeted cyclists gives the impression of a major safety benefit from helmet use. Fewer reports provide information on fatalities. Information shows non-helmeted appear to behave similar to pedestrians in

aspects of drinking alcohol, helmet wearers seem to be more safety conscious in several respects. When the differences in the two groups are included in assessing, the expected benefits for helmets appear to be lower. Available data comparing the ratio of cyclist to pedestrian deaths from most countries considered does not show a benefit from helmet laws and increased helmet wearing rates. The number of cyclist's deaths due to situations not involving motor vehicles appears to increase with helmet use and needs further investigation. It is therefore not clear that helmets save lives in general terms, as sometimes suggested.

Enforced helmet laws cause massive social and health damage in terms of discouraging cycling and police action of fining cyclists. Evidence from Australia, New Zealand, Canada and the USA shows helmet laws discourage cycling. Advice to wear a helmet for general cycling is not warranted because there is evidence connecting helmet use with an increase in the accident rate. Alternative approaches to promoting helmet use to improving safety would probably be more effective and in some cases increase cycling levels, e.g. improving legal requirements on passing clearance/speed so that cyclists feel safer, driver education in how and when to overtake safely, people taking more care when opening vehicle doors, cyclists advised about the accident risk from drinking alcohol, providing suitable infrastructure to separate cyclists from high speed traffic and suitable speed limits.

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Re-visiting passenger transport in mega cities of India: How far do people commute?

Dr. Nachiket Sharadchandra Gosavi, Ms. Mansee Barbhaiya

1. Introduction

It is observed that cities in India are following their respective long-run growth trajectory, and the individual city growth is mean reverting. This indicates that urban agglomerations (UAs) and cities follow the law of proportional growth or Gibrith's law (Sharma, 2003). It may be inferred that this phenomenon leads to protection of class characteristics, i.e., cities in the largest quartile would remain in the same quartile. As a consequence, Mumbai, Delhi, Kolkata and Chennai remained the most populous cities and that this trend is likely to continue in the near future. The propensity to attract new jobs has led to the growth of urban centres (Brar et al., 2014; Su, 2014). The growth has occurred through two processes namely migration, and natural growth of cities. As a consequence, it is anticipated that by 2050, 497 million individuals would be added to its urban population (National Urban Transport Policy, 2006).

Due to assimilation of skills and economic activities, urban India contributes more than sixty percent to the GDP (Gross Domestic Product) (Sankhye et al., 2009). By 2030, this proportion is likely to increase to around seventy percent. A similar proportion of the new jobs will be generated in these economic hot spots (Brar et al., 2014; Sankhye et al., 2009). For these economic hubs to realize their true potential, unhindered movement of resources (both goods/services and people) is required (Small, 2007). Despite the fact that Indian mega cities record vehicle ownership that are a fraction of those observed in the cities of the western world, premature congestion has become a common occurrence (Pucher et al., 2005; Pucher et al., 2007, Wilbur Smith Associates, 2008). Crumbling infrastructure supporting non-motorized mobility, deficient investments in non-personalized modes (Pucher et al., 2005, Wilbur Smith Associates, 2008, Sreedhar, 2012) has increased the risk perception about the use of these modes (Rahul and Verma, 2013). This increased risk perception, alongside increasing per capita in-

come and easy availability of credit (loans) is alluring individuals to modes supporting private mobility. With a skyward vehicle ownership trajectory (Durgay et al., 2007), the projected speeds on major corridors of the mega cities are likely to drop to a fraction of the fuel efficiency norm (Wilbur Smith Associates, 2008; Sreedhar, 2012). Further, public transport use in Indian cities is recording an all-time low (Times of India, 2018). With no interventions curtailing use of modes supporting private mobility, Indian urban scape is on a polluted and congested trajectory.

Symptoms of this became evident, with Delhi requiring to experiment with the odd-even formula. Additionally, according to a WHO (World Health Organization) report ten of the most polluted cities were situated in India (World Health Organization, 2015). For ensuring that the economic potential of these cities is realized, suitable investments in transport infrastructure matching the expectations of the residents (Das and Pandit, 2013) are required. In this context, it becomes imperative to understand mobility in mega cities. Here, the mega city is a city with a population in excess of eight million or eighty lakhs (a category devised by the Wilbur Smith Associates study commissioned by the Ministry of Urban Development in the year 2008).

In the first section, the transport problems faced by Indian mega cities are introduced. The need for analysing commute trip data is explained in the second section. Road infrastructure and vehicle ownership in the Indian mega-cities is scrutinized in the third section. The fourth section attempts to answer the critical question of how far do people commute in these cities. Mode shares and mode preferences are analysed in the fifth section. The study concludes by suggesting policies that can render the Indian mega cities sustainable.

2. Need for analysing commute data

'Travel' is a derived demand. Assuming 'trips' as an unit of measuring travel, literature classifies them into two. These are commute trips and non-commute or leisure trips. Commute trips are defined as trips undertaken for accessing jobs, i.e. between work place and residence, whereas the latter class of trips are those trips

that do not fall under commute trips, i.e., accessing health services, trips undertaken for entertainment etc. The former category of trips not only has a defined origin and destination, but are undertaken with consistency.

In the context of India more than half the commute trips, i.e., approximately 58% of the trips are generated in urban India, whereas the four mega cities account for around seven percent of these (Chandramoulie, 2011). The regularity of commute trips leads to peaks in traffic flow. This would mean that at least half of the congestion in urban areas may be attributed to commute trips. A dearth of a quality mass transport and a crumbling infrastructure supporting non-motorized mobility (walking and cycling) in urban areas of India (Pucher et al., 2005; Pucher et al., 2007; Wilbur Smith Associates, 2008) has led to the proliferation of private vehicles. As a result, premature congestion, reduced speeds and over reliance on private vehicles has become the common characteristics of urban India (Wilbur Smith Associates, 2008; Sreedhar, 2012). It is estimated that by 2030, two-wheeler density in urban India would increase a bit less than four times and is likely to be three hundred and ninety-three (393) per thousand, whereas the four-wheeler ownership densities projected to increase four folds and is likely to be around 48 vehicles per thousand (Wilbur Smith Associates, 2008; Sreedhar, 2012). With level of economic activities in mega cities increasing, which in turn results in more jobs getting generated, private vehicle based commute may result in the speeds (in the largest cities) reducing to eight kilometres per hour (Wilbur Smith Associates, 2008; Sreedhar, 2012). For ensuring that economic potential of these cities is realized, an understanding of commute trips is necessary.

3. Vehicle ownership and road infrastructure

With increased risk perception linked to use of walking, cycling and public transport as a mode, private vehicle sales in urban areas are on a skyward trajectory (Rahul et al., 2013). In this context the present section attempts to understand vehicle ownership trends in the Indian mega cities. The primary reason attributed to congestion is the excess use of vehicles

using personal mobility i.e., two-wheelers and four-wheelers.

Despite the fact that over the decade 2001-11, the proportion of registered vehicles in the mega-cities to the total stock of registered vehicles reduced from 11.97% to 9.19%, vehicle stock in the mega-cities increased by six million four hundred thirteen thousand five hundred and sixteen (6413516) units and was registering a compound annual growth rate of 7.04% (Road transport year book 2011-12, 2014). the stock of vehicles supporting personal mobility in the mega-cities increased by 5,879,426 units and accounted for ninety-one percent of the increase (Road transport year book 2011-12, 2014). More than half of the increase in private vehicle ownership in mega cities can be attributed to Delhi (56.78%). A bit less than a third of the increase in private vehicles can be associated to Chennai (31.50%), whereas Mumbai records a moderate increase in private vehicles of approximately fifteen percent (14.48%), whilst Kolkata records a negative growth of around three percent. This negative growth could be associated to the deregistration/deletion of vehicles registered prior to 1993.

Despite two-wheeler ownership as a proportion of total registrations of two-wheelers reducing from 10.09% to 7.88 %, two-wheelers account for seventy percent of this increase. The stock of two-wheelers grew at a CAGR (compound annual growth rate) of 7.52%. Half of the increase in the two-wheeler stock arises from Delhi (52.71%), Chennai contributes a third (35.5%) of the increase, whereas Mumbai explains approximately fifteen percent (14.62%) of the addition. at the same time two-wheeler ownership showed a decline in Kolkata (-2.83%).

Similar to two-wheeler ownership trends of mega-cities, four-wheeler ownership (Here four wheelers include both cars and jeeps) as a proportion of total stock of registered four-wheelers too showed a decline. Over the decade 2001-2011, four-wheeler ownership reduced from 28.67% to 20.57%. Four-wheeler ownership explain around thirty percent of the increase in the vehicle stock and recorded a robust decadal growth rate of 6.89%. On delineating, it is observed that unlike car ownership which grew at a CAGR of 7.41%, jeep

ownership shrunk at a CAGR of 2.16%, or alternatively, car ownership showed a net increase of one million, seven hundred seventy-three thousand seven hundred and eighty units, whereas jeep ownership recorded a net reduction in registration of twenty eight thousand, two hundred fifty-one units. More than two-third of the increment in four-wheeler ownership may be assigned to Delhi (66.43%). Chennai accounts for one fifth of the increase (22.04%), while the four-wheeler stock in Mumbai grew by around fourteen percent (14.08%). Due to the deregistration of vehicles registered prior to 1993, Kolkata showed a negative growth of two percent (-2.54%).

Barring the city of Chennai, wherein the percentage of vehicles supporting private mobility, i.e., two-wheelers and privately owned four-wheelers, reduced from 92.08% to 87.09%, the share of vehicle supporting personal mobility has increased. In Delhi, the proportion of these vehicles increased from 89.49% to 91.19%. Mumbai recorded the fastest increase in vehicle supporting personal travel and these increased from 75.89% to 87.22%. While in Kolkata vehicles used for personal mobility increased from 80.95% to 84.61%.

With increase in per capita incomes and no policies restrictions curtailing ownership of private vehicle ownership, ownership of vehicles used for personal mobility are likely to increase exponentially. In literature it is observed that there exists a saturation to ownership of vehicles. The measure of ownership of vehicles is vehicle density or number of vehicles per thousand individuals. For understanding the level of vehicle ownership and comparing the four mega cities, vehicle densities are contrasted. According to the estimates of the 12th five year (2012-17) working group on urban transport, two-wheeler and four-wheeler density were one hundred and nine (109) and twelve (12) respectively and by 2021 these densities were likely to increase four-folds, i.e., two-wheeler density would have been three hundred and ninety-three (393) per thousand and four-wheelers were projected to be forty-eight (48) per thousand (Sreedhar, 2012) In contrast to the base line scenario, the two-wheeler density in Delhi, Mumbai, Kolkata and Chennai were two hundred and sixty-nine (269), eighty-four (84), forty-one (41)

and five hundred and seventeen (517) respectively, whereas the four-wheeler density is 135, 48, 44 and 132 respectively. In the context of two-wheeler density Mumbai and Kolkata appear to have certain resemblance to the assumed baseline density, whereas for the four-wheeler density, all the cities have far exceeded the baseline estimates. This would mean that business as usual policies would only render the city unsustainable and that immediate interventions are sought. At the going rate of vehicle ownership the speeds on urban corridors are likely to reduce to eight kilometres per hour, i.e., speeds far below the optimal speed band.

Although the above results indicate a congested urban future, congestion per say is a function of vehicle ownership~vehicle use and road length/road space. In this backdrop, the present road infrastructure of the mega cities is analysed. According to urban infrastructure benchmark, road density in an urban area ought to be 12.25 km/sq. km while at least 11% of the urban developed space must be roads (Ahluwalia, 2014). In comparison, the road density of Delhi, Mumbai, Kolkata and Chennai was 21.14, 3.31, 9.87 and 6.52 km/sq. km, respectively. Roads covered approximately 18%, 10%, 6% and 10% of the developed space in these cities. Unlike Delhi, both the road density as well as space allocated for road construction is far less than the norm. This result gives the impression of road infrastructure under provisioning. Re-development/constructing new roads in the latter cities is an expensive proposition, and even then whether these cities can construct their way out of congestion remains a pertinent question (Pfleiderer and Dieterich, 1995). For devising policies that curtail use of modes supporting personal mobility, an understanding of commute distances is required.

4. How far do people commute?

Newman (2006), Marchetti (1994 and Zehavi (1980) have shown that distances determine the preferred mode type. Conversely, it may be stated, assuming the mode choices as a constant, commute distance determines the mode preferences. In this context the present section attempts to identify the preferred commute distance. The analysis has been carried out at the urban, mega-city (aggregate)

and individual city level. To identify parallels between urban commute travel, such an analysis was essential.

4.1 Urban:

It may be reckoned that urban India generates around fifty-six percent of the commute trips, i.e., a whopping 115,697,564 trips. These trips have been classified into nine distinct categories namely, "no travel", "0-1 kms", "2-5 kms", "6-10 kms", "11-20 kms", "21-30 kms", "31-50 kms", "51+ kms", and "commute distance not reported" (Refer Figure.1 for graphical representation).

The statistical mode of commute distance is "2-5 kms" class. The modal class accounts for more than a quarter of trips (26.25%), while a bit less than a quarter of the (23.97%) of the workers declare their working place as their place of residence. Around a sixth (17.87%) of commute trips are for a distance of less than a

kilometre, whereas approximately fifteen percent (14.64%) of the workers travel 6-10 kilometres for accessing jobs. These four distance classes constitute more than four-fifth of the trips. More than six percent of the workers travel between 11-20 kilometres. Around three percent of the workers commute for 21-30 kilometres. Workers commuting for '31-50 kilometres', '51 plus kilometres' and workers who have not declared their commute distance constitute 2.34%, 2.02% and 2.15% respectively.

From the analysis of commute distances, it may be reasoned that the economic shadow of 'urban India' spreads to around ten kilometres, i.e., beyond this distance the size of the distance class shrinks.

4.2 Mega-cities:

The four mega cities as a whole generate around twelve (11.66%) percent of urban commute trips, or approximately seven

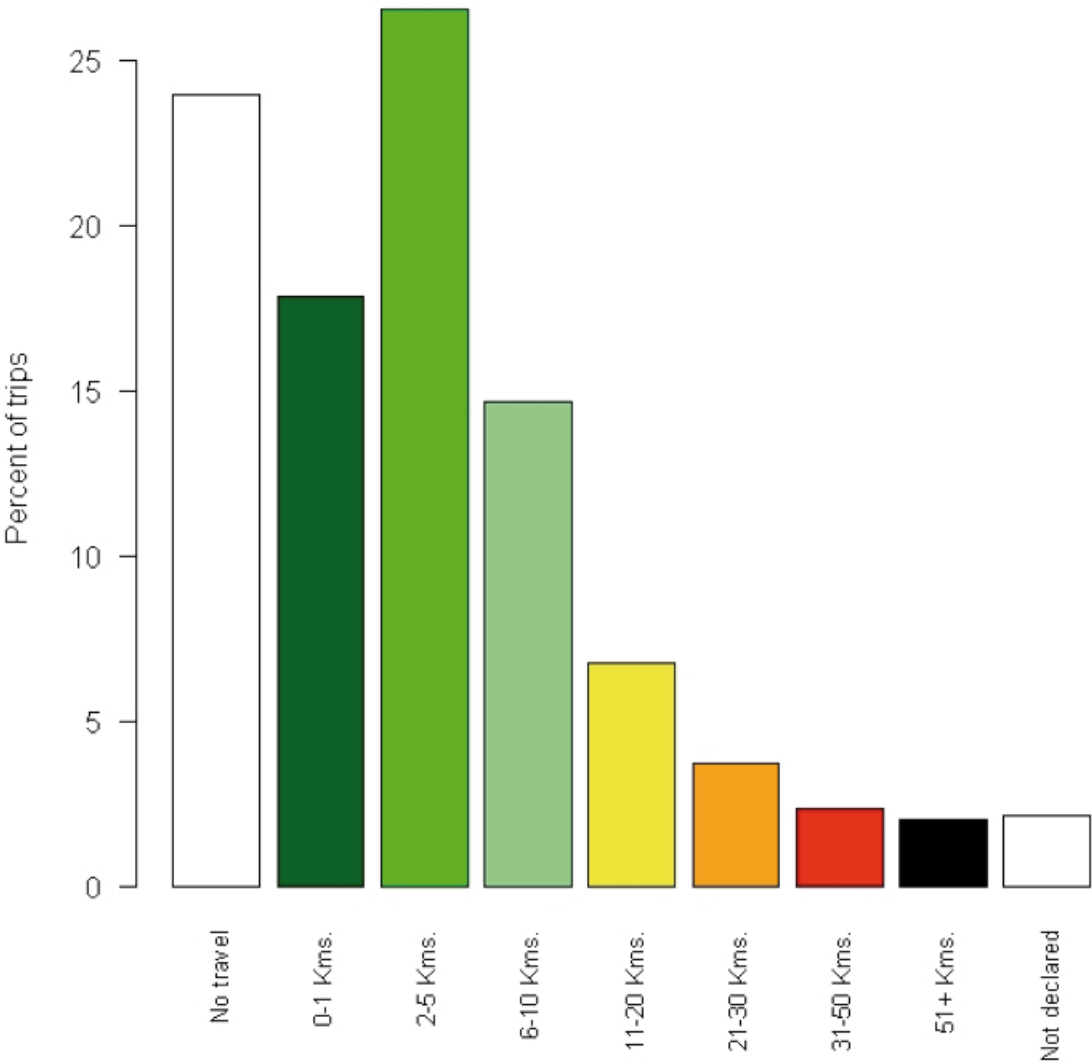


Figure 1: Structure of commute distances in urban India

(6.73%) percent of total commute trips and total to 13,484,681 trips. Around fifth of the workers travel for a distance between two and five kilometres (21.98%), while a bit less than a fifth (19.36%) of workers reside at their place of work. Similar to the characteristics of urban commute distances, the '2-5 Kilometres' distance class is the statistical mode. (Refer to Figure: 2 for commute distance characteristics of mega cities (aggregate))

Around seventeen percent (16.36%) of the workers commute a distance of less than one kilometre. A bit less than a fifth of the workers (18.56%) travel a distance between six and ten kilometres, while more than a tenth (12.25%) of the workers commute a distance between eleven and twenty kilometres. These distance class categories explain around nine-tenth (88.51%) of the commute trips. More than five percent (5.35%) of the trips are

for a distance between 21-30 kilometres, whereas three percent of (2.88%) of workers travel for a distance between thirty and fifty kilometres. A negligible proportion (0.87%) of the workers travelled for more than fifty kilometres for accessing work, whereas around two percent (2.39%) of the workers did not declare the distance that they travelled for accessing work.

On contrasting total urban commute trips to the commute trips of mega cities, it may be inferred that unlike the urban trips, the gap between the modal class and the next largest class has reduced and appear to be converging. From the distribution of commute distances, one may infer that in contrast to urban India, people tend to commute longer distance in mega cities of India and that economic activities are spread up to twenty kilometres of the urban suburbia.

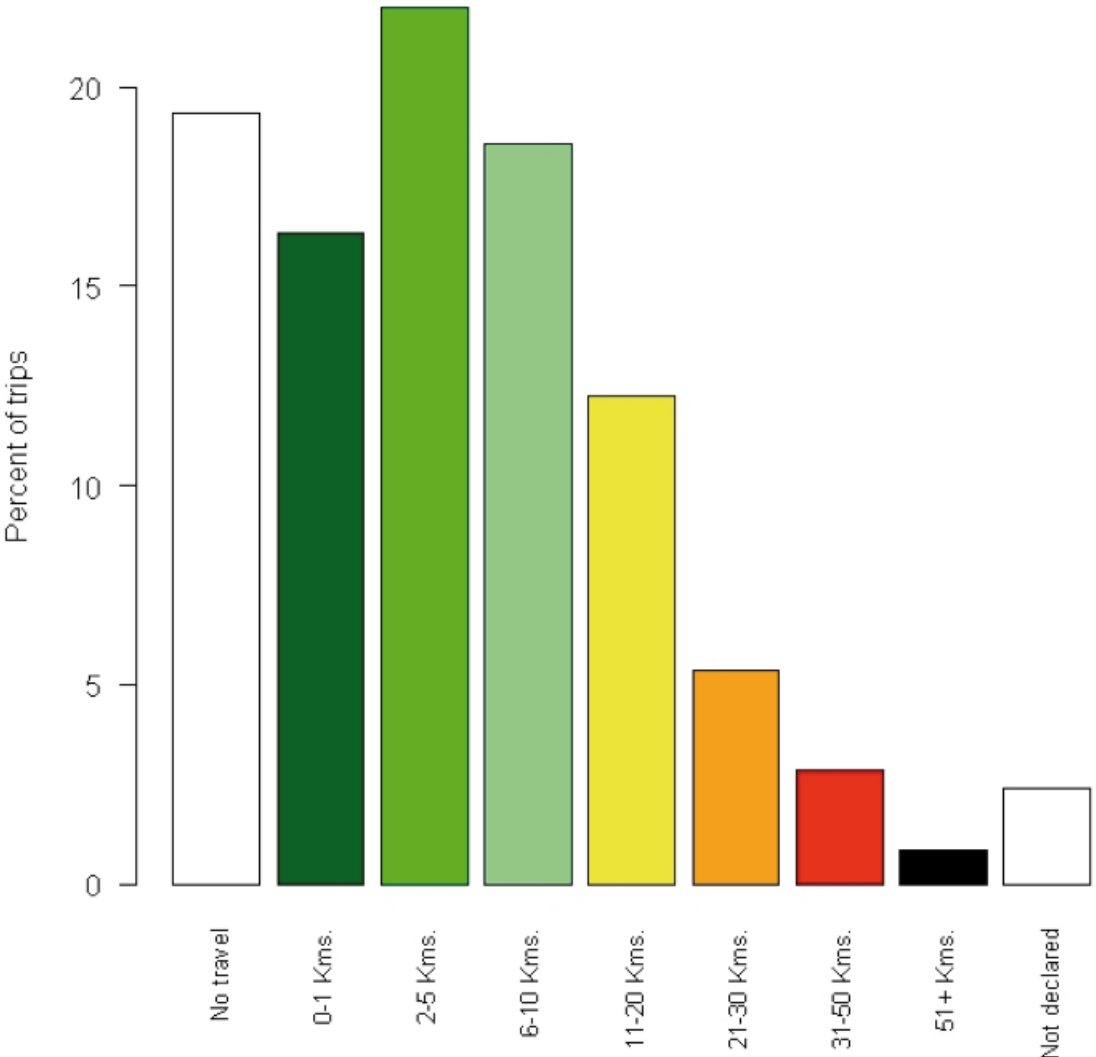


Figure 2: Structure of commute trip distances in Mega-cities of India (aggregated).

4.3 Delhi or National Capital Territory of Delhi:

The city of Delhi is spread across nine districts. Of these nine districts, the districts of 'New Delhi' and 'Central Delhi' are completely urban, whereas the other seven districts are observed to have semi-urban development. Considering these districts are within fifty kilometres of New Delhi, these districts may be considered as the economic shadow of Delhi. Further, a bulk of these regions are under the jurisdiction of the different municipal corporations, i.e., an elected urban body controlling civil services.

The NCT of Delhi accounts for around five percent (4.52%) of the urban commute trips and more than a third (38.77%) of the commute trips undertaken in mega cities. Similar to commute distances of urban India and mega cities, the statistical modal class of Delhi too is '2-5 kilometres.' The

modal class explain a bit less than quarter of the commute trips, i.e., 24.41%. Around sixteen percent (15.84%) of the workers' state that their place of work and place of residence is the same, i.e., do not have to undertake trips to access jobs. (Refer figure three).

Similar to urban India, only sixteen percent (16.04%) of workers undertake commute trips up to a kilometre and bit more than a sixth (18.2%) of the commute trips are for a distance between six and ten kilometres. For accessing jobs, Around fifteen percent (14.87%) of the workers travel between eleven and twenty kilometres, while six percent (6.21%) of the workers travel for a distance between twenty-one and thirty kilometres), whereas the percentage of workers traveling for a distance between thirty-one and fifty kilometres reduces to around three percent (2.91%). Workers commuting for more than fifty kil-

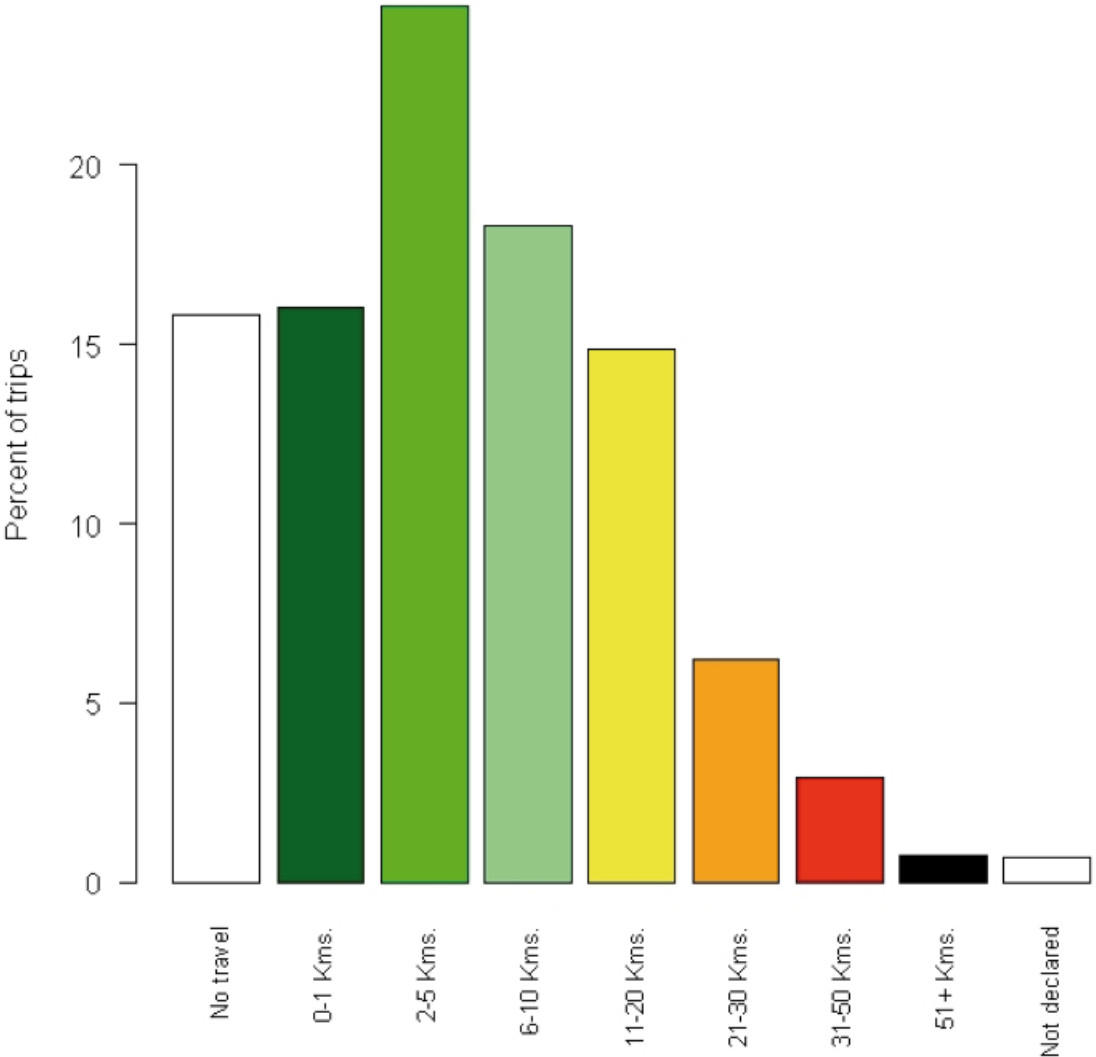


Figure 3: Structure of commute trips with respect to distance in the city of Delhi.

ometres and those who have not disclosed the distance between their residence and place of work total to a percent of the trips (1.43%).

From the analysis of Delhi’s commute data, it may be inferred that similar to the mega-cities data, Delhi’s economic shadow region extends to up to twenty kilometres, i.e., a distance class beyond which percent of commute trips peter out.

4.4 Mumbai:

The city of Mumbai is spread across two contiguous districts namely Mumbai and Mumbai (suburban). Both these districts are urban. For the analysis of commute trips both districts have been considered as a group and is addressed as Mumbai.

Approximately four (4.15%) percent of the urban commute trips and a third (35.64%) of the commute trips undertaken in the

four mega cities are carried-out in Mumbai.

“No travel” emerges as the modal class and accounts for a fifth (19.63%) of the commute trips. (Refer to figure 4)

The distance class ‘Two-five kilometres’ comprises around eighteen (18.87%) percent of the trips and is the second largest class. This is followed by the classes ‘Six to ten kilometres’ and ‘up to one kilometre.’ These groupings describe 17.65% and 16.83% of the trips. While trips for a distance between eleven and twenty kilometres and twenty-one and thirty kilometres explain 12.14%, and 6.10% of the work trips. Trips greater than thirty kilometres account for approximately five percent (5.05%) of the commute trips, while less than four (3.73%) percent of the workers could not detail their commute distance.

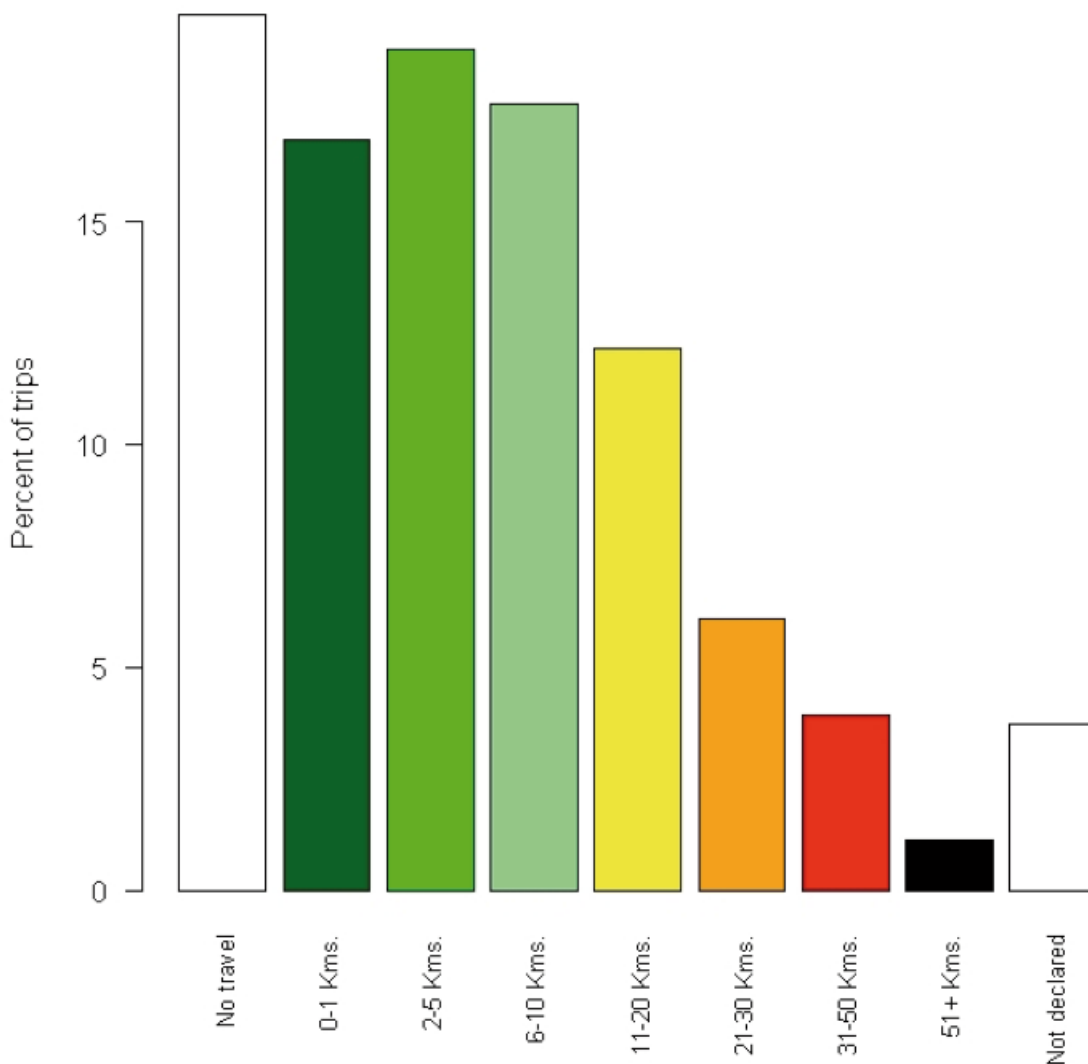


Figure 4: Structure of commute trips with respect to distance in the city of Mumbai.

'No travel' emerging as the modal class appears to be anomalous. The only reason attributable to this is a large thriving unorganized production sector operating from squatter settlements. At an aggregate level, Mumbai appears to be following the pattern of 'mega-cities.'

4.5 Kolkata:

Unlike Delhi or Mumbai, the city of Kolkata is spread across a single fully urban district named Kolkata. The city generates around two percent (1.47%) and thirteen (12.60%) of the urban and megacity commute trips respectively. Similar to Mumbai, 'No travel' emerges as the modal class. (Refer figure 5)

More than a quarter (28.88%) of the commute trips are explained by the modal class. Commute trips for a distance between two to five kilometres represent a fifth (20.43%) of the trips, whereas a bit

less than a fifth (19.41%) of the trips are accounted in the class of trips titled 'Up to one kilometre. Eighteen percent of the (18.22%) of the trips are for a distance between six and ten kilometres. Less than a tenth of the commute trips (9.77%) are for a distance exceeding ten kilometres, on the other hand three percent (3.29%) of the workers did not disclose the distance between their residence and place of work.

From the analysis of Kolkata's commute data, it may be inferred that the economic shadow of Kolkata extends to ten kilometres. The more than a quarter of the work force residing at the place of their work points to an influx from the adjoining districts/states, and/or a burgeoning informal service sector.

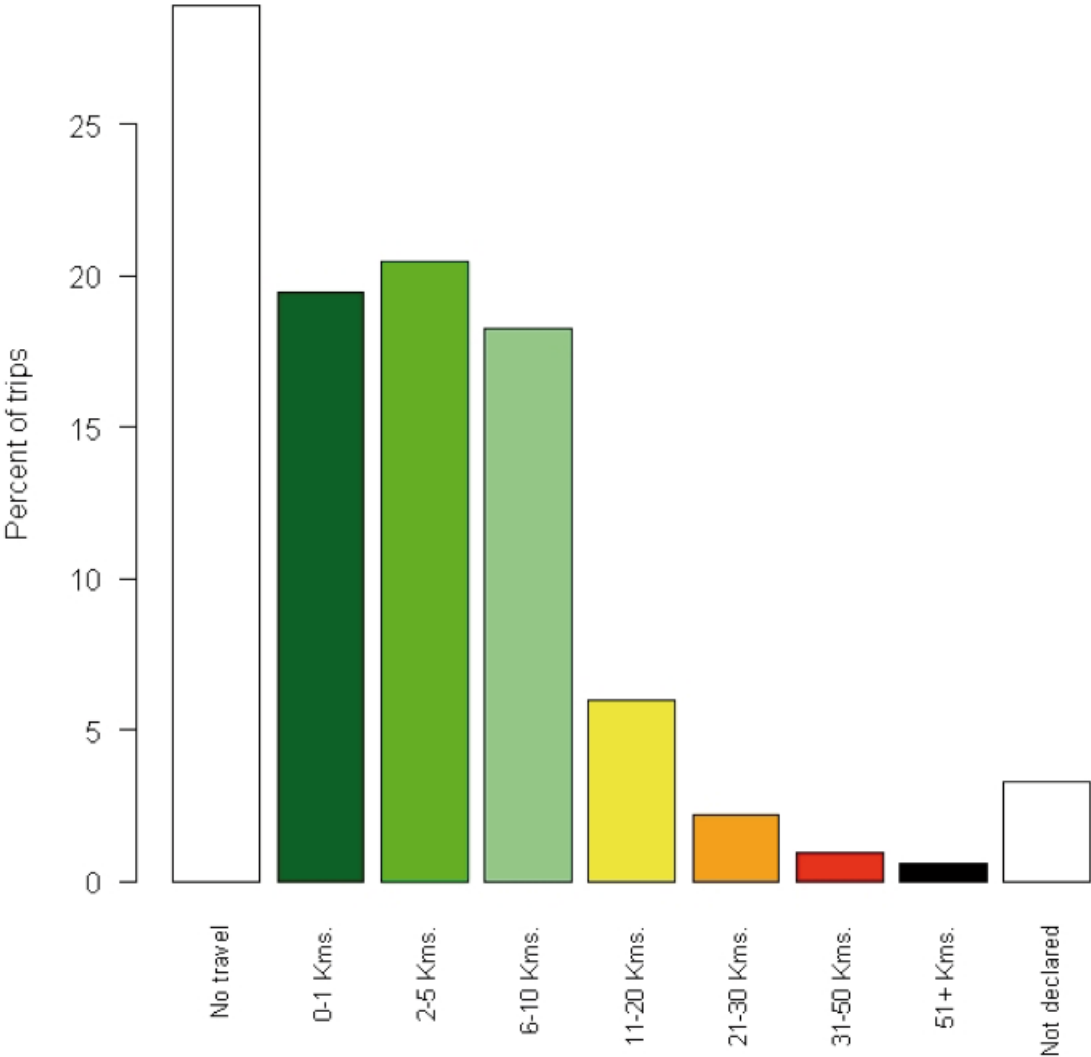


Figure 5: Structure of commute trips with respect to distance in the city of Kolkata.

4.6 Chennai:

Like Kolkata, Chennai too is spread across a fully urban solitary district of its own name. The city generates around one million, seven hundred and fifty-one thousand, eight hundred and twenty-four trips, which is around thirteen (12.99%) percent of the commute trips generated in mega cities and less than two percent (1.51%) of the total urban commute trips. Similar to Delhi, the statistical modal class is two to five kilometres. This class accounts for a quarter (24.79%) of the commute trips. (Refer to figure 6)

Commute trips for a distance between six to ten kilometres account for a fifth of the trips, i.e., 22.15%. 'no travel' explains approximately a similar proportion of trips, i.e., 19.88%, in contrast the commute trips for a distance up to one kilometre fall to thirteen percent of the commute trips (13.08%). A bit more than a tenth of the

trips (10.78%) are for a distance between eleven to twenty kilometres. Commute trips for a distance in excess of twenty kilometres constitute approximately six (6.41%) percent of the trips undertaken for accessing jobs. Around three (2.991%) percent of the workers did not disclose their distance between their residence and the place of work.

Unlike the other three mega cities, commute distances appear to be concentrated towards the two-ten kilometres grouping and is almost half the commute trips (46.94%). This could indicate towards a more private vehicle centric development. From the analysis of commute distances, it may be inferred that the mega cities do not follow a discernible pattern. Thus it may be concluded that devising an enveloping policy catering to all the mega cities is difficult. In this backdrop it becomes important to ascertain the mode preferences.

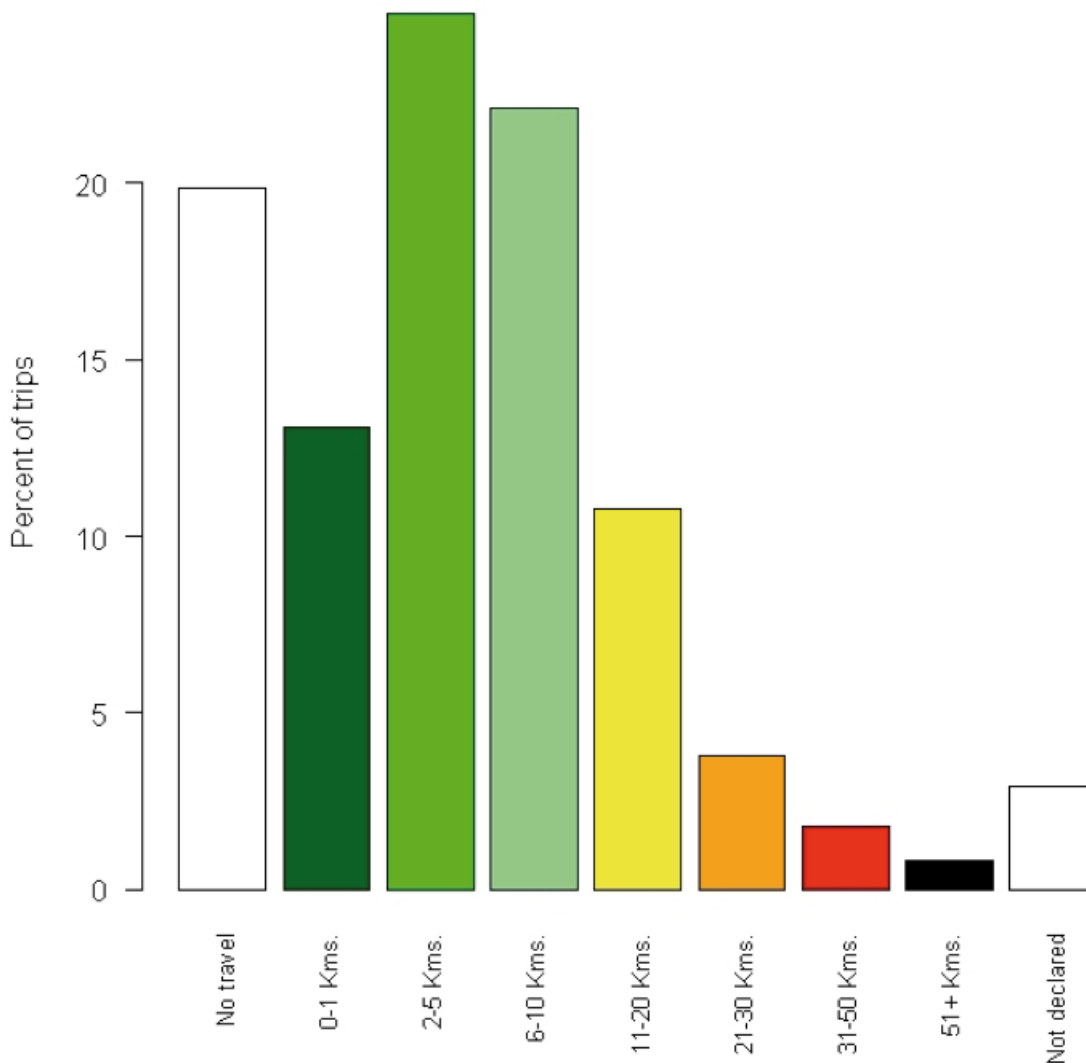


Figure 6: Structure of commute trips with respect to distance in the city of Chennai.

This would help in determining the proportion of private vehicles used for commute trips.

5. Mode preferences

In the preceding section, it was reasoned that an uniform policy addressing the mega cities may not be possible. Additionally, it may be reckoned that the type of mode is a function of distance and modes supporting personalized mobility are energy inefficient. This would mean that for making the mega cities sustainable an understanding of mode preferences is necessary. This analysis would help in identifying cities which are plagued by private vehicle use. Unlike the earlier analysis, in the present analysis only mode preferences in the individual cities have been analysed. To get a clearer picture of the mode preference, commute trips under the category of 'No travel' have been ex-

cluded. Commute modes are divided into nine categories, which are walking, cycling, two-wheelers, four-wheelers, intermediate public transport or IPT, bus, train, waterways and others. Due to the per capita carbon footprint, walking, cycling, IPT, bus and train are considered as environmentally sustainable modes, whereas two-wheelers, four-wheelers are considered polluting modes. As waterways and others are a negligible proportion of the total trips, inferences about the level of emissions/per capita carbon footprint can not be drawn.

5.1 Delhi or NCT of Delhi:

After the removal of trips under the category of 'No travel', NCT of Delhi generates around four million, three hundred ninety-nine thousand, eight hundred and thirty-one (4399831) trips. (Refer figure 7 for mode preference for Delhi)

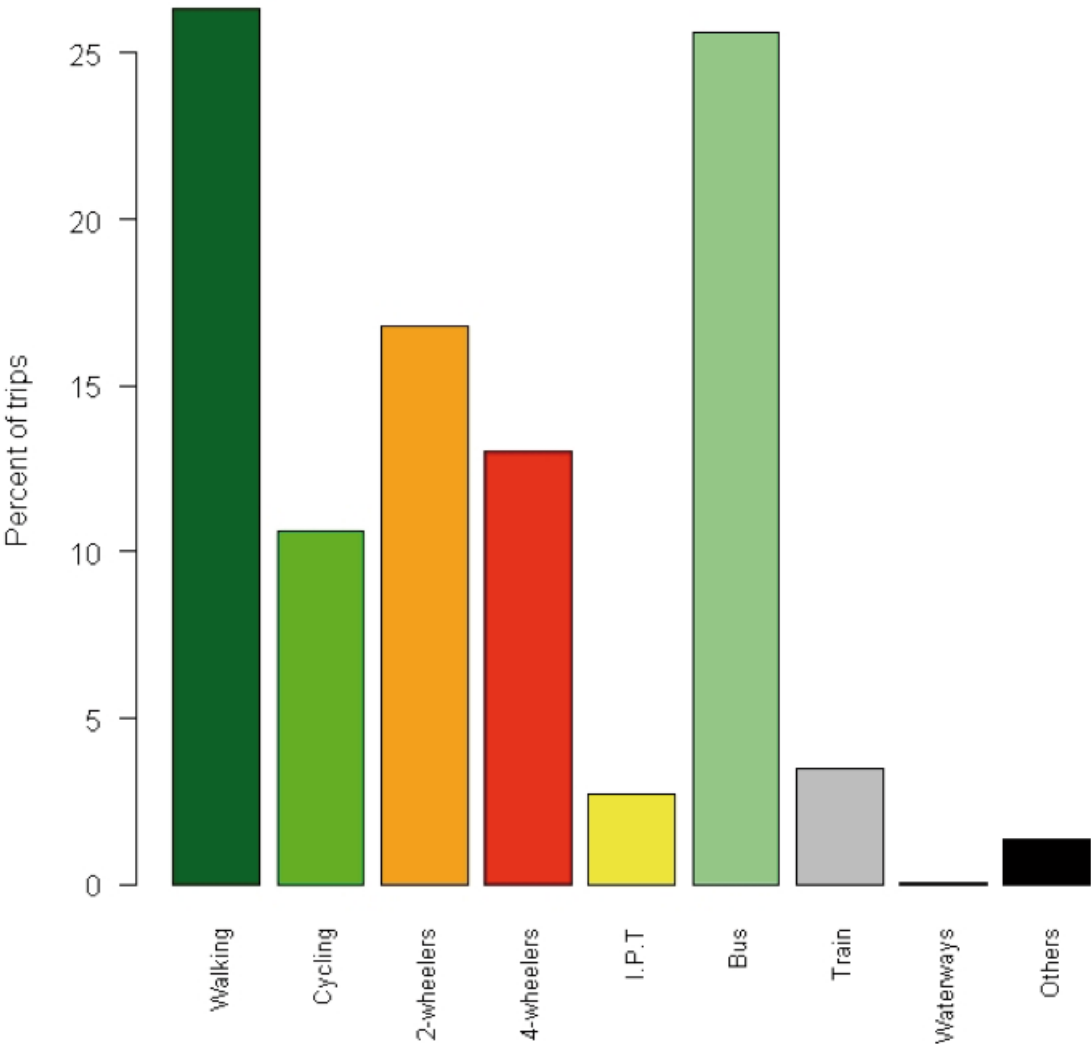


Figure 7: Classification of trips with respect to mode in the city of Delhi.

More than a quarter of the trips are on feet (26.32%). Approximately a similar proportion (25.65%) use bus as the primary mode of commute. Cycle is the preferred mode in around a tenth of (10.63%) of the commute trips. while intermediate public transport in the form of rickshaws (three-wheeler taxi) and taxis are used as a principal mode in less than three percent (2.74%) of the trips for accessing work. Waterways and other modes are used as a mode in less than two percent (1.4%) of the commute trips. Jointly two-wheelers (16.76%) and four-wheelers (13.01%) account for approximately thirty percent (29.77%) of the trips. If it is assumed that carpooling or two-wheeler sharing doesn't occur, and that each vehicle is used only ones, i.e., no trip chaining occurs, then it may be inferred that approximately sixteen percent (16.78%) of the two-wheelers and more than a quarter of the four-wheeler stock (26.06%) are being used for accessing work. Even though forty-two

percent of the metro measuring around 124 kilometres was commissioned by 2006, trains accounted for less than four percent (3.49%) of the trips. This meant that train as a commute mode had not become popular. For Delhi to be on the environmentally sustainable growth trajectory, vehicle dependent commute requires to be curtailed. The share of cycling, IPT and train commute needs to be increased.

5.2 Mumbai:

In contrast to one-fifth of the commute trips where no distance needs to be travelled, in four million eight hundred six thousand four hundred and fifty-nine commute trips, i.e., exclusion of the category of 'No travel,' some mode is used. (Refer figure 8)

Around a third (31.07%) of the commute trips are undertaken on feet. This is followed by trains (30.80%). Bus based commute make up a fifth (20.41%) of the

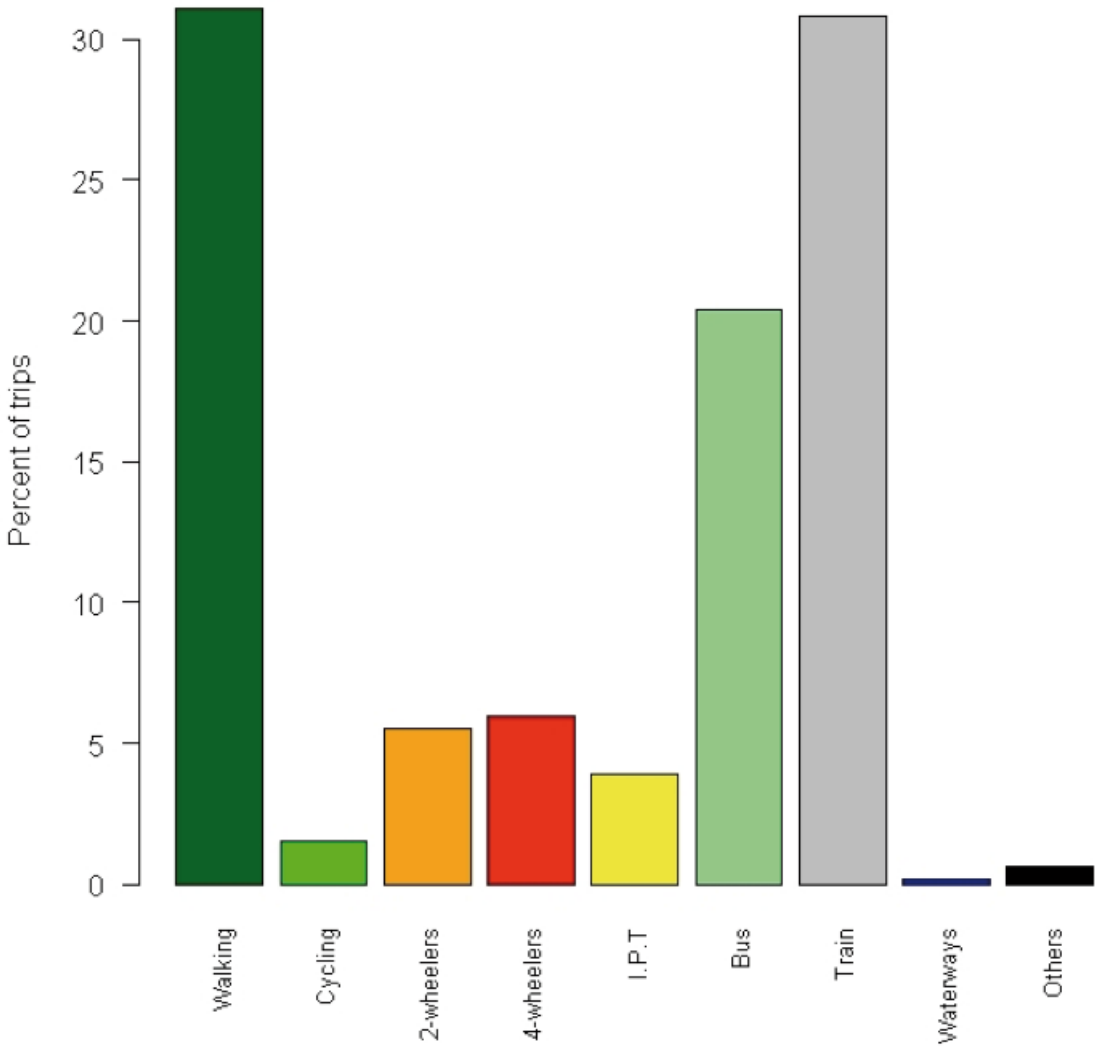


Figure 8: Classification of trips with respect to mode in the city of Mumbai.

trips. Individually cycling, waterways and other modes are a negligible proportion of the trips and form 1.5%, 2% and 0.61% of the trips. IPT as a proportion of total commute trips is approximately four percent (3.9%), whereas private modes like two-wheelers (5.55%) and four-wheelers (5.96%) constitute a tenth of the (11.51%) of the trips. In terms of utilization of two-wheelers and four-wheelers, more than a fifth (20.53%) of the two-wheeler and around forty percent (39.25%) of the four-wheeler stock is used for undertaking commute trips. If these utilization proportions are viewed in the context of the share of two-wheelers and four-wheelers in the modal composition, it may be cherished that the present modal share of Mumbai appears to be on a sustainable trajectory, i.e., more than eighty-five percent of the commute trips are using non-personalized modes. For the city to remain on this path, transport policies need to be tweaked so that cycling is recognized as an important

part of the sustainable mobility trajectory and is facilitated to become an important mode of commute.

5.3 Kolkata:

It may be recollected that in Kolkata almost thirty percent (28.88%) of the commute trips were under the category of 'No travel.' In addition, this class was also the statistical mode. On accounting for 'no travel', the actual commute trips reduce to one million two hundred eight thousand three hundred and sixty-seven (1208367) trips. Walking with a share of more than a third (38.55%) is the dominant commute mode. A bit less than a third (31.07%) of the commute trips are undertaken using buses. (Refer to figure 9)

A tenth of the trips are using cycle, while both IPT and trains constitute approximately similar proportion of the commute trips, i.e., 4.13% and 4.74%. Around

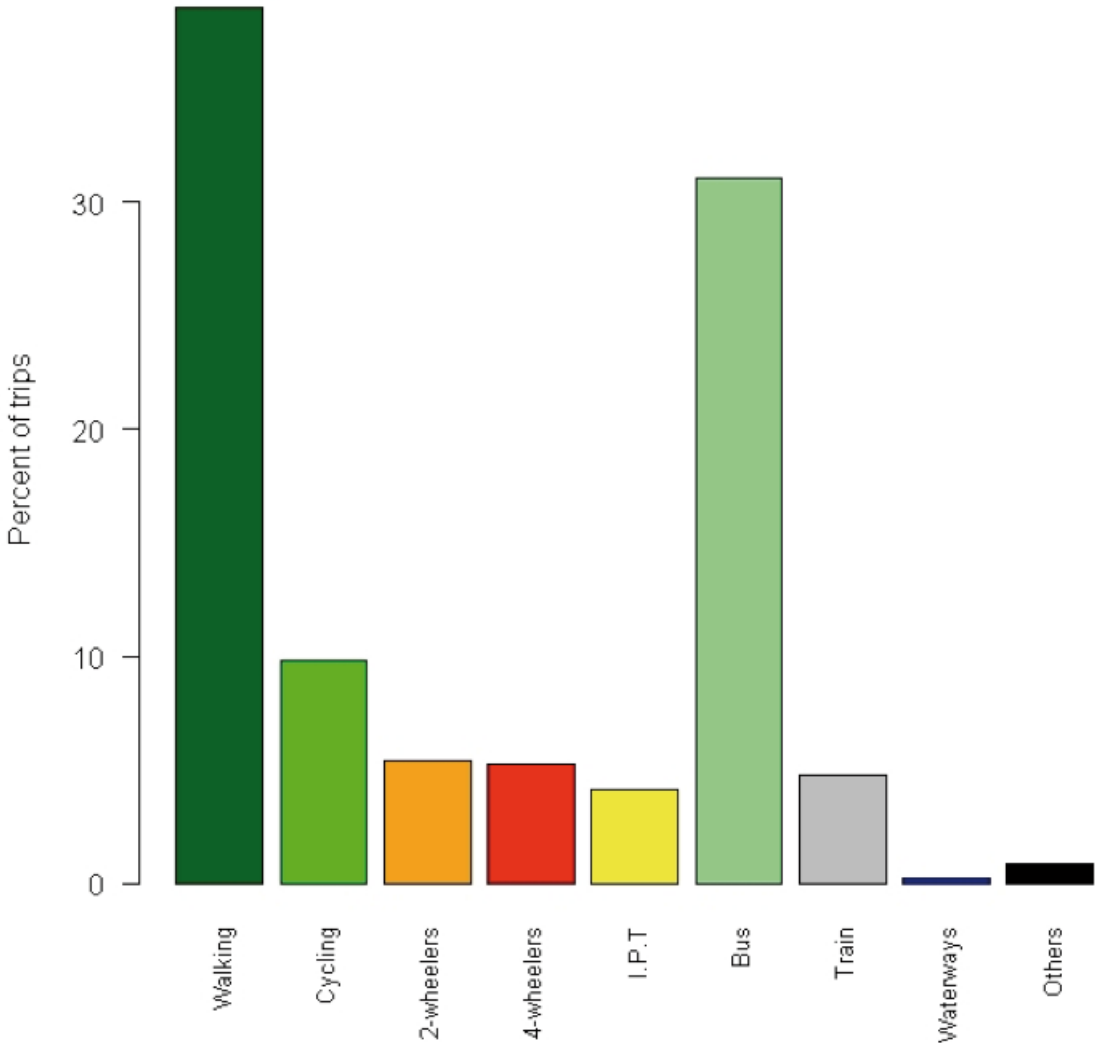


Figure 9:Classification of trips with respect to mode in the city of Kolkata.

one percent of the commute trips are using waterways and other descript modes. Two-wheelers and four-wheelers have a share of 5.39% and 5.28% respectively. On estimating the proportion of two-wheelers and four-wheelers that are used for commute trips, it is observed that approximately thirty-six (35.79%) percent of the two-wheelers and around thirty-three (32.87%) percent of the four-wheeler stock is used for accessing jobs. Looking at the low percentage of trains in the commute mode distribution, it may be inferred that Kolkata metro does not connect the residential areas to the business hubs. At an aggregate level like Mumbai, Kolkata too is on a sustainable growth path. But with increasing per capita income the share of bus is likely to reduce. Transport planners need to have a re-look at public transport so that the residential areas are linked to the business hubs and that the quality of this connectivity matches the expectations of commuters.

5.4 Chennai:

Of the million plus commute trips that Chennai generates, three hundred forty-eight thousand, one hundred and ninety-seven trips are under the category of 'no distance,' meaning that no mode preferences can be analysed for these commute trips. After accounting for this class of trips, two-wheelers appear to be the dominant mode. This mode represents around thirty percent (28.64%) of the trips. The second most significant commute mode is the bus, and accounts for a quarter (24.19%) of the trips, whilst the other environmentally sustainable modes make up a third of the trips, i.e., walking (19.96%) and cycling (12.26%). In terms of commute modes, four-wheelers are fifth most significant and totals to around eight (7.68%) percent of trips. Trains (3.74%) and IPT (2.69%) form around six percent of the total trips. Water ways (0.26%) and others (0.59%) are a negligible fraction of the commute trips. (Refer figure 10)

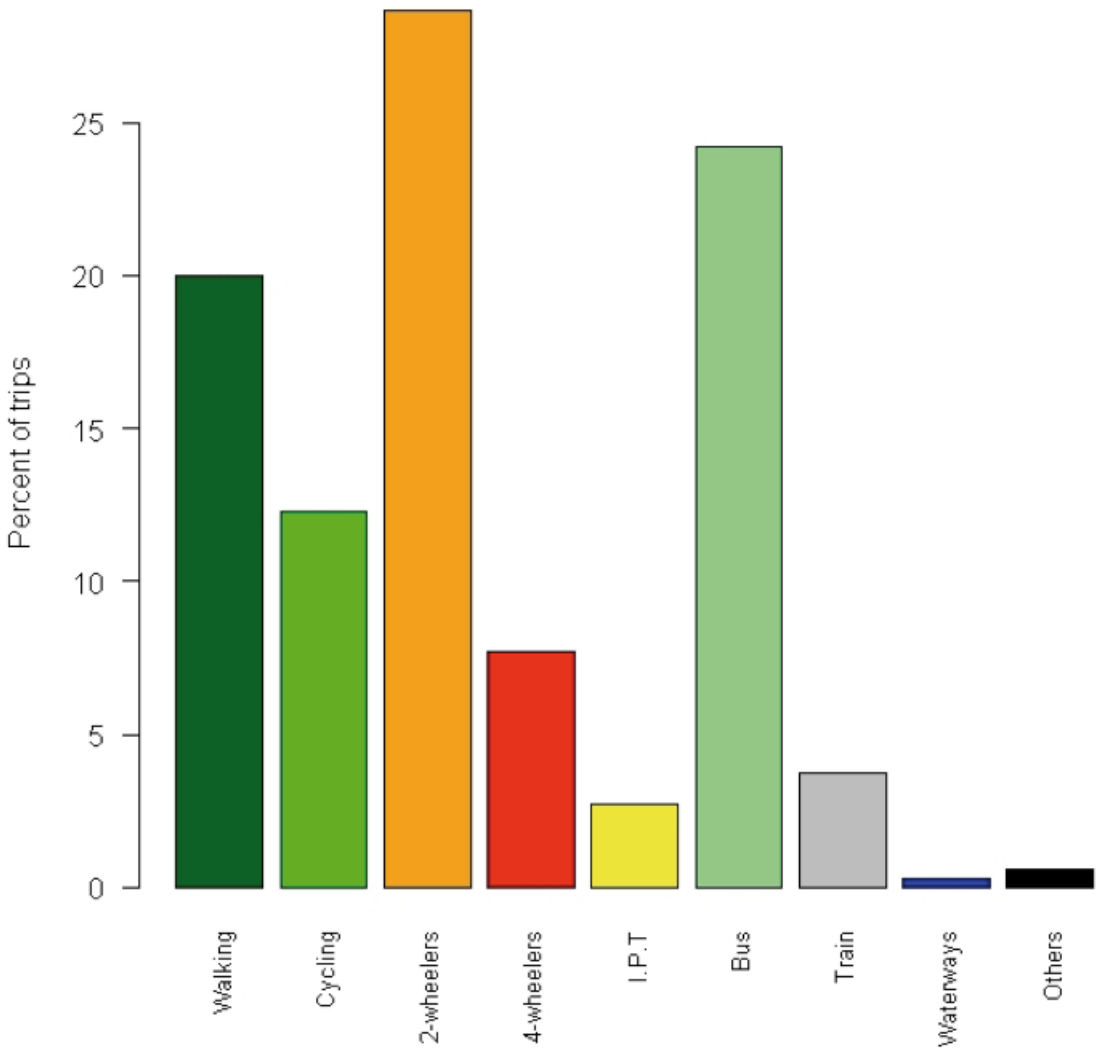


Figure 10: Classification of trips with respect to mode in the city of Chennai.

In terms of private vehicle utilization, approximately seventeen (16.76%) of the two-wheeler stock is used for commute, while around eight percent of the four-wheeler stock is utilized for undertaking work related trips. This analysis reveals that Chennai is primarily dependent on modes supporting personal mobility. With the advent of time and with no policy interventions in the form of congestion/parking fees, the mode of private vehicles vis-à-vis commute trips is likely to increase and push the city on an unsustainable course. It would be interesting to see, whether the introduction of metro/heavy rail transit would have an impact on the mode shares.

6. Conclusion

According to the National Urban Transport Policy-2006, more than sixty percent of the trips need to be using sustainable modes. Considering commute trips have a known origin and destination, achieving these proportions for commute trips is plausible.

From the analysis of commute distances, it may be inferred that devising a common urban transport policy for the mega cities is demanding. Not only does the size of the statistical modal class change, but even the statistical mode changes, i.e., the statistical mode of distance in the case of Mumbai and Kolkata is 'No distance', whereas the statistical mode for Delhi and Chennai is "Two-Five Kilometres." Class. Likewise, the mode preferences and priorities appear to be different, i.e., the preferred mode of commute in Chennai is the two-wheeler, whereas the primary mode in the other three cities is walking.

The low train/heavy rail transit system use requires to be investigated with caution. Either this transit system does not connect the residential areas to the business districts or the mode is unable to attract commuters, i.e., factors like inaccessible transit stations may be influencing the ridership.

Further it needs to be pointed out that commute trips are less than a fifth of the total trips. This would mean that the analysis of commute modes and commute distance can only give partial insights into re-

current congestion and congestion related externalities.

The lower vehicle utilization proportions of two-wheelers and four-wheelers in commute trips hints that private vehicle ownership occurs either due to a demonstration effect, or an income effect. To avoid these influences, incentives for using sustainable modes for commute trips need to be envisaged.

For ensuring commute trips adhere to a sustainable transport path, mode preferences over the different distance class need to be analysed. This is likely to give an understanding of commute mode preference/dominance, and accordingly city based transport policies which prioritize mode preferences can be conceived.

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There are no clean cars:

In the debate on how we will transport ourselves in the future, there is more to discuss than just technology. Our mobility culture must change.

Wolfgang Lohbeck, Helmut Holzapfel



Big and bigger. SUVs dominate the urban landscape. These vehicles are causing much more damage in cities than smaller vehicles would, explain our guest authors.

Photograph: imago

Is technology really the only relevant issue when we discuss the mobility of the future? Anyone following the current discussion encounters almost exclusively a discourse regarding various aspects of motor technology – electric cars, diesel motors, carbon dioxide in exhaust.

In fact, however, there is far more at issue, and technology is only one aspect of the real debate that needs to occur. To propel any vehicle, energy is always necessary. And even if fossil fuels are replaced by electricity or hydrogen, this changeover by itself cannot provide a solution. The fact is that the production of green electricity is demanding – ecologically as well as economically – a matter that is often simply ignored. Using other motors in cars will by itself not allow us to achieve a system of mobility that has reduced emissions or is independent of fossil-based raw materials on a long-term basis. To reach this goal, not only the hardware needs to change but also the software in our heads.

That entails, on the one hand, a transfor-

mation of urban transportation and, on the other hand, a thoroughgoing change in our behaviour and in the mobility culture. In 2050, most people will be living in metropolitan areas. Already today in such areas, the differences that can be found in the use of transport and the urban environment are enormous.

SUVs cause significant damage in cities

In automobile-orientated cities such as Stuttgart or Bochum, you will find huge numbers of persons tied up in traffic on any given day. In Copenhagen or Amsterdam, by contrast, more than half of the transport requirements are handled through the use of bicycles or by going on foot. It may take ten or 15 years to realise a local transformation of transport practices, but that is not longer than the time it takes to establish a new generation of automobiles.

While debates in Brussels continue regarding CO2 reductions through technical im-

provements, there has not been even a rough calculation or any support for the municipalities that have been able to reduce CO2 emissions by well over 30 percent through clever planning, thoughtful design of public spaces and support of the established environmental combination of foot, bicycle, bus and rail transport. Apart from the brief phase of a “free public transport” debate, urban planning experiments have virtually no role in the current discussion – despite the huge potential that is available simply through public transport. Only a very few German cities are receiving any support (from the Federal government in a “clean air” program) for such initiatives.

In this context, it must be made clear: There are no clean cars. The spectrum ranges from dirty battery production to the ostensibly clean “green electricity” (which is then not available for other uses), to recycling problems of gigantic dimensions, to microplastics produced by tyre abrasion. Cars – even the so-called clean ones – cannot deliver a solution. Our mobility culture in its entirety must change.

That begins with good public relations. Large SUVs cause far more damage – to streets and in accidents – in the urban environment than smaller vehicles do. It would be a highly important task for city governments to make these facts clear to their citizens; then it would be evident why such vehicles are not desired in the city. Instead of creating wider parking places with tax income, parking restrictions for automobiles that are too large would be a simple and economical measure.

Dismantling a culture of automobile status

Also the number of vehicles and the manner in which they are driven can and must change. Instead of allowing the current “culture” of a frenzied individual pursuit of speed to persist, the common interest including public transport must be given the top priority. The general aggression now found in automobile conveyance – also in the evermore hostile appearing car fronts – needs to be dismantled.

Not only is it the case that the potential gains to be achieved through another form of urban planning and a transformation of transport practices far exceed those to be found in new automobile technology. Also the advances in efficiency in new motor technology will be more or less nullified by the increasing size of vehicles, their larger engine power and higher weight, and also the increasingly aggressive driving behaviour. There is reason to fear that precisely this sort of development will occur with a new generation of electric automobiles.

Of course, there needs to be new “hardware” as our mobility evolves, and cars must be made to be as clean as possible. But above all, there must be fewer cars and they must be smaller. To make this possible, the infrastructure for new forms of transport must be realised with less reliance on automobiles – which means that the “software” in people’s minds has to change. The real discussion regarding the mobility of the future does not have to do with motors but rather with the dismantling a culture of seeking status through the automobile.

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Bless this Road: A Unique Approach to Community Education and Healing Road Trauma

Wendy Sarkissian

This is the second article I've written for this journal. The last one appeared in February 2017. Co-authored with my friend Dr Lori Mooren, it was called, "We need a louder road safety voice." See: <http://worldtransportjournal.com/wp-content/uploads/2017/02/27th-Feb-opt.pdf>

In that article, focusing on one example of a fatal crash that occurred on a rural road in Australia, we argued that we need to apply a system-focussed analysis to road safety. We told the story of my losing my husband in a car crash that should not have happened. We described it as "a classic illustration of a tragic system failure."

In this article, timed to align with the 2018 World Day of Remembrance for Road Traffic Victims (<https://worlddayofremembrance.org/>), I want to update readers about my healing journey and how building my awareness of road safety led me to take my "survivor mission" to increase safety on dangerous rural roads in Australia into completely uncharted waters. I explain how, with my friends and another bereaved person, I developed a model for a community event that combines many elements of both healing and activism.

We have called this innovative approach to road safety, Bless this Road. You can read about it on the Bless this Road blog at: <https://blessthisroad.blog>

I've always been an activist but I didn't realise how much that was in my DNA until my husband, Karl Langheinrich, drowned in front of me following a car crash in February 2016.

As I recovered, I asked, "Did this have to happen?"

Karl was the love of my life, my soulmate. We married late in life and our love of social justice held us together during our hard times. We worked closely together, always at each other's side. We built an

eco-house and pioneered innovative community engagement approaches in planning throughout Australia.

One rainy afternoon in early February 2016, Karl lost control of our car on a bend on a narrow, winding road near Uki, NSW. Our car tumbled into the Tweed River. Witnessing Karl's drowning and experiencing my powerlessness to save him shattered me completely, destroying my ability to work. And all my dreams. I could barely care for myself. Those few seconds snatched away all my identities. I was completely broken.

Months later, two friends encouraged me to tell the local council about my feeling that they were responsible for Karl's death. I delivered a Victim Impact Statement to Tweed Shire Council's traffic staff. They treated me with disdain; that only strengthened my passion for justice. I refused to allow Karl to be a "statistic" – I refused to accept that he could have died in vain.

And I wanted the road fixed.

The local Council's insensitivity to my predicament and the content of my complaint radicalised me. I was still injured; they were "blaming the victim". With my two friends, Kev Cracknell and Dr Lori Mooren, I campaigned for repairs to that 650-metre section of road. On the Internet, blessedly, I found John Bevelander, who had lost Cecilia and Matilda, his wife and daughter, a year before on same spot on the Kyogle Road. We met and soon agreed to collaborate to heal our pain and frustration over these tragic deaths. And to support each other in moving forward.

With Kev and Lori, I lobbied the Council, the Coroner, wrote several journal articles, and contributed to newspaper articles. In November 2016, following a media conference, Lori and I nailed a poster of Karl on a tree at the crash site to commemorate the 2016 World Day of Remembrance for Road Traffic Victims.

Our lobbying helped to achieve over \$1 million of federal Black Spot funding to repair that dangerous stretch of road. With a guardrail, at least nobody would drive over the edge again. The Council's defensive-



November 2016

ness, secrecy, and litigiousness dampened my rejoicing, but it was great to have the road fixed.

Bless this Road

On 30 September 2018, in the Uki Hall, John Bevelander and I co-hosted Bless this Road to blend our two grieving communities: to share our sorrows, to thank all those who had helped us in the crashes and their aftermath and in our mourning, and to affirm that life continues. First, we shared a hard-hitting road safety workshop as a community education and capacity-strengthening project. And then – in a powerful community event – we gently moved

on to Matilda’s Rainbow Lunch, opportunities to write prayers and blessings for Karl, Matilda and Cecilia, the symbolic opening of The Matilda Way by the local Mayor, and embracing huge and heartfelt expressions of appreciation, gratitude, gift-giving, music, poetry, prayer and song.

Initial imaginings of Bless this Road

When I was co-planning Bless this Road with John Bevelander, we had these imaginings¹.

1. A collection of photos from Bless this Road taken by participants and by Wendy Sarkissian and Steph Vajda can be accessed via this link: <https://bless-thisroad.blog/photos-of-bless-the-road/>

At our event, we will remember three beautiful people who lost their lives on the Kyogle Road near Braeside Drive in Uki – in two separate car crashes. Cecilia Bevelander, her 15-year old daughter, Matilda Bevelander, and my husband, Karl Langheinrich, would be with us today if

that road had been properly planned, designed, and managed. But it was not and they died tragically in crashes there. Now that the road is repaired, we are gathering – friends and family of three greatly loved people – to celebrate their lives, to heal our brokenness in losing



them, to learn more about what constitutes road safety in the modern professional world, to bless the new road, to thank our helpers, to bless them and offer our prayers to our loved ones, and to say our final farewells for them. We have invited local people, our neighbours, friends, and family to accompany us on this final stage of our mourning journeys.

Safe Systems

Matilda and Cecilia Bevelander

What John Bevelander and I have learned since Matilda and Cecilia died (in January 2015) and Karl died (in February 2016) is that our roads need to be more forgiving. As driver error will always be with us, despite everything we do to eliminate it, we must put more emphasis on the design of the road: to have a Safe System to ensure that a moment's inattention will not result in a death sentence. Cecilia's momentary crossing the double line killed her and her daughter in a head-on crash. But actually, poor road design killed them. Equally, Karl lost control on a curve, the car skidded, and we fell 40 metres into the Tweed River below. He drowned in front of me and I barely escaped.



Karl Langheinrich

Karl's moment's inattention cost him his life. But actually, the Kyogle Road killed him as well, because there was no guardrail to stop us falling into the river below.



Components of *Bless this Road*

Part 1: Road Safety Workshop

We begin at 9:30 am with morning tea for Workshop participants. We will have a two-plus-hour workshop on road safety to explain – and work through – the principles of a Safe System approach. The workshop will take place in the small meeting room. We have a leading expert to guide us, Dr Lori Mooren, who earlier in her career was responsible of road safety for the whole state of New South Wales. We have an expert graphic facilitator (and local Nimbin

resident), Michelle Walker, a leading authority in graphic facilitation, who will do graphic recording of the whole workshop. (See <https://www.curiousmindsco.com.au/author/michelle/>)

The advice from workshop participants in the communiqué from this workshop will be sent to all senior politicians and road safety specialists throughout Australia and will be published in a UK online road transport journal in December.

The topic is sombre: road deaths and road safety. Not appropriate for carnival dress.





Graphic facilitator Michelle Walker recording



The first chart of recording



The second chart of recording

Part 2: Matilda's Rainbow Lunch

Then at 12:15, the whole focus shifts, as the road safety workshop participants leave the meeting room to greet and join with other participants who have arrived for the rest of the day.

We will now dress brightly in Matilda's favourite rainbow colours.

One corner of the hall will be lavishly decorated with rainbow decorations (Matilda's favourite!).

The final part of our day will be gift giving and appreciation — and speeches of thanks. We have gifts for many first responders, the police, emergency services and hospital staff who helped us. In all, forty certificates of appreciation will be handed out, as well as a dozen gifts of succulent plants (plants that are loved for their "resilience").



Now we are into high energy, bright colours and bright music — as we share Matilda's Rainbow Lunch and celebrate her life.

We will devour a gigantic rainbow cake.

Part 3: Opening of The Matilda Way and Gift Giving and Appreciation

In that mode, we move on to Part 3 — after lunch — to proclaim The Matilda Way. The Mayor of Tweed Shire, Cr. Katie Milne, will cut a huge purple ribbon — and held by Karl's and Matilda's friends — to formally proclaim this stretch of Kyogle Road (symbolically only) for evermore as The Matilda Way.

That was our imagining. And it all came true.

Bless this Road was the most moving and powerful event I have ever experienced.

Much-loved Northern Rivers legend, activist singer songwriter, Luke Vassella, softened our hearts with his sweet melodies. (For Luke's website, please see: <http://lukevassella.com/>)

Here is a link to me singing with Luke at Bless this Road: <https://blessthis-road.blog/reflecting-on-bless-this-road-change-of-heart-with-luke-vassella/>



That is what we were trying to achieve during the Bless this Road event: to share our grief and pain, to express our gratitude, and to build our individual and shared courage – as a community of mourners – to move on with our lives despite the tragedies we had experienced. We were building community.

I chose this song by American feminist activist singer, Holly Near. Called Change of Heart, it's a song about what happens to us when we are trying to build our courage and we witness someone else's courage. It resonated with my feelings that to undertake road safety activism from a cold start (and absolutely no experience) required a lot of courage. (See: <https://www.youtube.com/watch?v=SC4egRR3YL0>)



Cr. Isaac Smith, Mayor of the neighbouring City of Lismore, sent a welcoming message that showed how deeply he understood our shared intentions:

I am sorry that I cannot join you today, but I want to thank Wendy and all those who made this significant event happen.

Every individual and, indeed, every community, must make a choice on how to respond to tragedy. We see many examples of human nature at its worst when that response pulls people apart.

But what we see today is the best in us. What we see today is the inspiration and the restoration of trust in the human spirit.

By gathering here and blessing this road, we are all standing together in hope that our future will be brighter and that those who have scars may be healed.

This is a great example to all communities that the roads which inevitably create angst and loss, can also represent peace ... if we so choose.

The residents of Nimbin and the whole of Lismore Shire thank you all for gathering today to bless our road.

We devoured a huge rainbow cake at Matilda's Rainbow Lunch.

Accompanied by many of Matilda Bevelander's teenaged friends and two of Karl's





special young friends, Ashwin and Erin, Tweed Shire Mayor, Katie Milne, cut a purple ribbon and formally declared The Matilda Way to be open.

Now we can always call it by that new name and no longer "the crash site".

During the afternoon of gift-giving and ap-

preciations, Tony, a senior paramedic who attended on his own time, wept publicly, explaining to us how Bless this Road had caused him to radically reconsider his attitudes toward so-called "victims" of road trauma. They were real people, he now understood, with loved ones who cared deeply for them. He found that insight both heartening and healing.



For more information about *Bless this Road*, please go to <https://blessthisroad.blog>

Fundraising for the *Road to Healing* film

Road to Healing: a feature documentary about Wendy Sarkissian's activist life and her campaign for road safety in Australia

We would like to ask readers of this journal to join us in making a feature documentary about my life, about Karl and our life together, and about my campaign for justice and road safety. We have already self-funded the completion of a significant amount of filming for this project. We just need your help to complete the film.

We are initially asking for donations to raise \$5,000 to complete our filming. This includes costs for travel around Australia to meet with people who have personal and professional connections to John Bevelander and to me, as well as road safety specialists, community planners and activists, who will contribute to the film. This funding will also cover costs to complete filming (including cutaways and location shots) in NSW and Queensland.

When we achieve our primary goal, we are aiming to raise a further \$10,000 (through crowdfunding and/or grants) to contribute towards post-production, including editing, soundtrack, stock footage, and mastering.

We are not asking for large sums of money to make our film. This is our passion project. It requires only a little love and support to cover basic costs so we can properly share Wendy's story.

All donations will receive acknowledgements in all social media and online promotions of the film, as well as being included in film credits.

Links:

Road to Healing Vimeo film: <https://vimeo.com/301436756>

Go Fund Me: <https://www.gofundme.com/let039s-talk-about-safer-roads>

Road to Healing website: www.roadtohealing.com.au

Bless this Road blog: <https://blessthisroad.blog>

Author details:

Wendy Sarkissian PhD LFPIA

Widely regarded as one of Australia's leading community planners, Dr Wendy Sarkissian had a long and exciting career as a speaker, facilitator, author and planner until the 2016 car crash on the Kyogle Road near Uki in New South Wales that killed her husband and ended her working life.

She is now rebuilding her life in Vancouver, Canada.

Wendy is the co-author of four books on housing and planning.

To access her author page, see: https://www.amazon.com/s/ref=nb_sb_noss?url=search-alias%3Dstripbooks-intl-ship&field-keywords=wendy+sarkissian

Wendy would be delighted to communicate with anyone about any matter related to the contents of this article.

Please email her at: wendy@sarkissian.com.au