World Transport Policy and Practice
Volume 24.2
July 2018

space required
to transport **60 people**

car   uber   autonomous car

CONTENTS

Dr. Joachim und Hanna Schmidt Stiftung für Umwelt und Verkehr

The first 6 months of 2018 have seen the usual combination of good news and bad news. The good news is really very good. On 4th June 2018 the World Health Organisation (WHO) launched its "Global Action Plan on Physical Activity 2018-2030" (GAPPA). The launch took place in Lisbon Portugal. It was attended and launched by the WHO Director General Dr Tedros and the Prime Minister of Portugal as well as Ministers of Health, Education and Sport and a total of 300 guests. The gala event was a great success and was supported by a formal lunch hosting 60 mayors from across Portugal and discussing the role of city level interventions, as well as a 2.5 hour workshop on promoting walking and cycling in cities. Walk21 Director Bronwen Thornton and ECF Director Randy Rzenicki presented on walking and cycling respectively, providing the compelling case and participating in the panel discussions along with Mario Alves from the International Pedestrian Association and others.

More can be found here #BeActive and view www.who.int/lets-be-active/en/

Contact: letsbeactive@who.int

"Regular physical activity is proven to help prevent and treat noncommunicable diseases (NCDs) such as heart disease, stroke, diabetes and breast and colon canceer. It also helps prevent hypertension, overweight and obesity and can improve mental health, quality of life and well-being. Yet, much of the world is becoming less active. As countries develop economically, levels of inactivity increase. In some countries, these levels can be as high as 70%, due to changing transport patterns, increased use of technology, cultural values and urbanisation."

Source WHO (2018): More Active People for a Healthier World

The WHO has carried out a very well organised scientific and public policy exercise to identify the links between lack of physical activity in our increasingly sedentary world and the increase in non-communicable disease" (NCDs) which include obesity, diabetes and cardio-vascular dis-eases. The high quality scientific work has been translated into clear policy advice on what can be done to increase levels of physical activity and this emphasises the importance of walking and cycling (as well as many other varieties of physical activity) and what can be done to boost walking and cycling.

The importance of this recognition of walking and cycling for public heath cannot be under-estimated. For many decades in all parts of the world walking and cycling have been neglected as politicians and professional groups focus on infrastructure (which means new roads, airport capacity and high speed rail) and on vague commitments (not clearly defined and not backed by evidence) to improve connectivity, competitiveness and regenerate the economy. The result of this narrow economic focus has been a decline in walking and cycling and the transformation of many urban environments into "obesogenic environments" where it is very difficult to make journeys on foot or by bike because of longer distances, road traffic danger and poor quality walking and cycling infrastructure.

The WHO has now shown how we can transform these environments to harness the public health benefits of walking and cycling and this is now being communicated to national government and city mayors. This journal congratulates the WHO and its dedicated professional staff for providing a sound, solid basis for a transformation of public health and transport policy.

In practical terms this means that we should now adopt a general 20mph/30kph speed limit on all roads where there are mixtures of pedestrians, cyclists and vehicles and provide the infrastructure that will boost walking and cycling. This also suggests the widespread adoption of Vision Zero, along the lines of the Swedish policy introduced in 1997 with the key message that death and serious injury in the road traffic environment will trend to zero.

Now for the bad news. Meanwhile back in the world of powerful individuals and groups who think in terms of billions on "infrastructure" and "connectivity" it is

business as usual on making sure that the demand for physical transport goes up and as a consequence we get more pollution, more carbon emissions, more loss of nature and biodiversity and a serious worsening of conditions for pedestrians and cyclists.

A recent communication from the European Commission sets out a budget plan for making all sustainable development goals much less likely to happen and for a deepening crisis of public health as set out in GAPPA:

EU Budget: Commission proposes increased funding to invest in connecting Europeans with high-performance infrastructure
06/06/2018

As part of the next long-term EU budget 2021-2027, the European Commission is today proposing to renew the 'Connecting Europe Facility', with a budget of €42.3 billion to support investments in the European infrastructure networks for transport (€30.6 billion), energy (€8.7 billion) and digital (€3 billion).

This represents a 47% increase compared to 2014-2020 (Comparison in current prices for EU-27 in 2014-2020 vs. EU-27 in 2021-2028. The increase is of 29% in constant prices of 2018.), showing the EU's commitment to a well-connected and integrated Union where citizens and businesses can fully benefit from free movement and the single market. For 2021-2027, the Commission is proposing to strengthen the environmental dimension of the Connecting Europe Facility, with a target of 60% of its budget contributing to climate objectives. This will help reinforce the Energy-Union, fulfil the EU's commitments under the Paris Agreement and consolidate Europe's global leadership in the fight against climate change.

Source:
https://ec.europa.eu/transport/themes/infrastructure/news/2018-06-06-eu-budget-commission-proposes-increased-funding-invest_en

The budget announcement puts "improving mobility" at the centre of its objectives but this is not defined. We have known for many decades[1] that accessibility is a very desirable component of transport planning and spending and we should seek to increase accessibility by making it easier for all groups (rich and poor) to access all the things they need to access (health care, education, jobs, training etc) in ways that maximise the opportunities presented by walking, cycling, local buses and trams. This also requires public policy to make sure that the things we need to access are near to people and not far away. Any objective using the terminology "improve mobility" is likely to lead to more miles/kms travelled and as things get further away it is inevitable that there will be more car trips and fewer bike/walk/bus trips. More mobility is not an acceptable public policy goal just as more energy consumption or more food intake or more drug use is not acceptable.

The budget statement from the commission raises, for the first time, a military objective:

For the first time ever, the Connecting Europe Facility will also support civilian-military dual use transport infrastructure with €6.5 billion. The objective is to adapt Europe's transport network to military requirements and to improve military mobility in the EU. This will make an important contribution to a fully-fledged Defence Union by 2025, which is a political priority of this Commission. Today's proposal delivers on the Joint Communication from November 2017 and Action Plan from March 2018.

This is astonishing and takes transport policy and spending into an entirely new dimension and one that is not at all clear. Just what does the Commission mean by "military requirements"? Historically we know the Romans relied on an extensive network of roads to impose military rule on subject regions and tribes and it was important to move legions around the Empire as quickly and efficiently as possible to subdue anyone who objected to rule

1 Schaeffer, K H and E Sclar (1980) Access for all: transportation and urban growth, Columbia University Press, ISBN 0231051654, 9780231051651

from Rome. Is this the kind of thing we can look forward to into the future and if not it would be helpful to produce a clear statement from the military about their requirements.

With this ridiculous insertion of a military objective into transport planning and thinking the European Commission has done more damage to EU unity and support for the EU than the many UK armies of "Brexiteers" have managed so far.

As an alternative to "military requirements" I would like to suggest that the Commission orientates itself around how transport spending can contribute to delivering UN Sustainable Development Goals (SDGs) and as a reminder to the Brussels elite working on military requirements this is what they should be working on:

United Nations Sustainable Development Goals

http://www.un.org/sustainabledevelopment/sustainable-development-goals/

Goal 11: Make cities inclusive, safe, resilient and sustainable

Develop a vision for your building, street, and neighbourhood, and act on that vision. Are there enough jobs? Are you close to healthcare? Can your children walk to school safely? Can you walk with your family at night? How far is the nearest public transport? What's the air quality like? What are your shared public spaces like? The better the conditions you create in your community, the greater the effect on quality of life.

Goal 12: Ensure sustainable consumption and production patterns

Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all. Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty.

Sustainable consumption and production aims at "doing more and better with less," increasing net welfare gains from economic activities by reducing resource use, degradation and pollution along the whole lifecycle, while increasing quality of life. It involves different stakeholders, including business, consumers, policy makers, researchers, scientists, retailers, media, and development cooperation agencies, among others.

It also requires a systemic approach and cooperation among actors operating in the supply chain, from producer to final consumer. It involves engaging consumers through awareness-raising and education on sustainable consumption and lifestyles, providing consumers with adequate information through standards and labels and engaging in sustainable public procurement, among others.

Goal 13: Take urgent action to combat climate change and its impacts

Climate change is now affecting every country on every continent. It is disrupting national economies and affecting lives, costing people, communities and countries dearly today and even more tomorrow.
People are experiencing the significant impacts of climate change, which include changing weather patterns, rising sea level, and more extreme weather events. The greenhouse gas emissions from human activities are driving climate change and continue to rise. They are now at their highest levels in history. Without action, the world's average surface temperature is projected to rise over the 21st century and is likely to surpass 3 degrees Celsius this century—with some areas of the world expected to warm even more. The poorest and most vulnerable people are being affected the most.

Affordable, scalable solutions are now available to enable countries to leapfrog to cleaner, more resilient economies. The pace of change is quickening as more people are turning to renewable energy and a range of other meas-

ures that will reduce emissions and increase adaptation efforts.

This issue of the journal returns once again to some of the major themes that are globally and regionally significant to improve transport outcomes and shape a transport policy, spending and prioritisation regime that is 100% ethical. "Military requirements" (whatever these are) are totally irrelevant to the serious issues around death, injury, public health, child-friendly cities and quality of life.

The article by Dr Gosavi and his colleagues attempts to identify factors that influence use of a non-motorized, non-personalized mode of transport like walking, cycling and public transport in a mid-sized Indian city (Vadodara) and conclude that mere improvements to public transport may not reduce the use of private vehicles. A holistic approach which encompasses construction of infrastructure supporting non-motorized mobility is essential.

The article by Amol Subhash Dhaigude, "An exploratory study on the pattern of traffic accidents in India" addresses the globally significant problem of 3,200 deaths every day in traffic crashes of various kinds and a forecast of annual deaths in India of 250,000 by 2025:

"According to a report released by the Ministry of Road Transport and Highways, there is one death every 4 minutes due to a road accident in India; over 16 children die in road accidents every day; and about 1200 crashes occur daily. Without increased efforts and new initiatives, the total number of road traffic deaths in India is likely to cross the mark of 0.25 million by the year 2025"

The authors conclude with 8 recommendations for action to bring about a significant improvement in India in road safety.

Also included in this issue is a summary of a "Future Urban Mobility" report by Arthur D. Little and its partner, UITP. The report assesses the mobility maturity, innovativeness and performances of 100 cities worldwide through 27 criteria. The mobility score per city ranges from 0 to 100 index points; the maximum of 100 points is defined by the best performance of any city in the sample for each criterion.

"The mobility systems of tomorrow should be intermodal, personalized, convenient and connected, and encourage the use of more sustainable modes of transport (public transport, cycling, walking), while integrating new mobility solutions, such as autonomous vehicles (AVs)".

Finally we have a book review of "Three Revolutions. Steering Automated, Shared and Electric Vehicles to a better future" and this continues the discussion we have had in previous issues around the consequences, benefits, disbenefits and unintended consequences of the growing interest in EVs and AVs. The review concludes that automated and electric vehicles are certainly on track to shape the future but it is not a better future than the one we could design with large reductions in vehicle numbers and vehicle kilometres driven.

John Whitelegg
Editor

An exploratory study on the pattern of traffic accidents in India

Mridula, Amol S. Dhaigude, Harsh Maheshwari, Swati Choraria

Abstract
According to the National Crime Records Bureau of India (NCRB), traffic accidents accounted for 52.8% of the total unnatural deaths in India in 2015. In this study, we examine the patterns of road accidents in India with special focus on their antecedents. Data for the study is sourced from the latest NCRB reports and the Ministry of Road Transport and Highways. Parametric tests conducted on the data do not point to any significant differences in traffic accidents between the festival and non-festival months, or different seasons of the year. However, we do find a significant difference in traffic accidents in states with high domestic tourism compared to those with low domestic tourism. Further, we conduct a regression analysis, which shows that accidents increase with age and that males tend to be involved in more number of accidents than females. Our findings will prove useful for policy makers in devising appropriate strategies to reduce accidents on roads. Theoretical and managerial implications along with policy level interventions are also discussed.

Key words: Road accidents, domestic tourism, incident management, safety, India.

Factors influencing use of a non-motorized, non-personalized mode of transport in a mid-sized Indian city

Dr. Nachiket Sharadchandra Gosavi, Dr. Lakshmikanth Hari, Prof. Dinesh S Hegde

Abstract
This research attempts to identify factors that influence use of a non-motorized, non-personalized mode of transport like walking, cycling and public transport in an mid-sized Indian city. Based on four criteria the city of Vadodara was chosen for the research. With no intervensions the city is likely to face a congested urban future. From the analysis of data, it was observed that at least seven factors were influencing use of non-motorized, non-personalized mode/s. The analysis reveals that mere improvements to the public transport facility may not reduce the use of private vehicles. A holistic approach which encompasses construction of infrastructure supporting non-motorized mobility and devising fiscal policies that increase out of pocket expenditure is required.

Key Words: Non-motorized transport; public transport; policy; mid-sized Indian city; Factor analysis.

An exploratory study on the pattern of traffic accidents in India

Mridula, Amol S. Dhaigude, Harsh Maheshwari, Swati Choraria

Introduction

Road accidents are one of the biggest causes of unnatural deaths in the world (King, King & Hair, 2015). Globally, every year, more than a million people lose their lives and another half a billion are injured in road accidents (World Health Organization, 2015). Given the enormity of the situation, the UN General Assembly declared the years, 2010-2020 as the 'Decade of Action for Road Safety' to highlight road accident issues and promote safety measures. Developing countries in Asia and Africa (Nantulya & Reich, 2002, Jinadasa et al., 2013) are major contributors to the high number of road accidents in the world. Factors such as high population density, poor infrastructure, increasing private motor ownership, poor driver training and lack of execution of traffic regulation can also be attributed to this rising number of accidents in Asia and Africa (e.g., Jacobs, G. D., & Sayer, 1983; Odero, Garner & Zwi, 1997; Obeng-Atuah et al., 2017). Road accidents in low and middle-income countries are increasing monotonically and are a cause of concern. Without appropriate action by 2020, road injuries will be the third leading contributor to the global burden of disease and injury. A large proportion of the road crash victims in low and middle-income countries, such as India, are vulnerable road users such as pedestrians and cyclists. (Whitelegg, 2015; King, King & Hair, 2015; Nanga et al., 2017). Therefore, in this study, we explore the patterns of road accidents in India, a developing country with moderate levels of income and high population.

While road safety is observed to be improving in developed and developing countries, however, in India it continues to worsen (Dandona, 2006; Mooren & Sarkissian, 2017). According to a report released by the Ministry of Road Transport and Highways, there is one death every 4 minutes due to a road accident in India; over 16 children die in road accidents every day; and about 1200 crashes occur daily. Without increased efforts and new initiatives, the total number of road traffic deaths in India is likely to cross the mark of 0.25 million by the year 2025 (NCRB, 2015). India has a complex and coordinated system of transport networks to promote economic and social development and ensure fair distribution of goods and services. Traffic accidents are an indicator of bottlenecks in the smooth flow of economic resources. Studying trends and patterns of traffic accidents in India is necessary for devising appropriate preventive strategies. The National Crime Records Bureau (NCRB) has identified that traffic accidents accounted for 52.8% of the total unnatural deaths in 2015. The NCRB defines traffic accidents as those accidents, injuries and deaths that occur on roads, railways, and railway crossings (NCRB, 2015). The present study explores the patterns of traffic accidents in India. These accidents are an outcome of the interplay of various factors, such as different seasons of the year, festivals, age, gender and alcohol abuse of the driver, tourism patterns, length of road networks, and non-adherence to road safety regulations etc. (WHO, 2015). Such accidents result in injuries, fatalities, disabilities, and hospitalization, thereby increasing the socioeconomic costs borne by the country. Figure 1 shows the number of road accidents in India for the period 2011-2015. These accidents cost a country approximately 3% of its gross domestic product (WHO 2017).

There is an urgent need to recognize and address the worsening situation of road deaths and injuries (Singh, 2017). The purpose of our research is to understand and identify the patterns of road accidents in India. We have focused on the antecedents of road accidents to provide meaningful insights, thereby enabling decision-makers to plan strategies more effectively. Based on literature review, given in section 2, we narrow down on four vital factors affecting road accidents: festivals, tourism, seasons of the year, and driver's age and gender. The study addresses the following questions:

1. What is the relationship between festivals and road accidents?
2. Is there any relationship between different seasons of the year and road accidents?
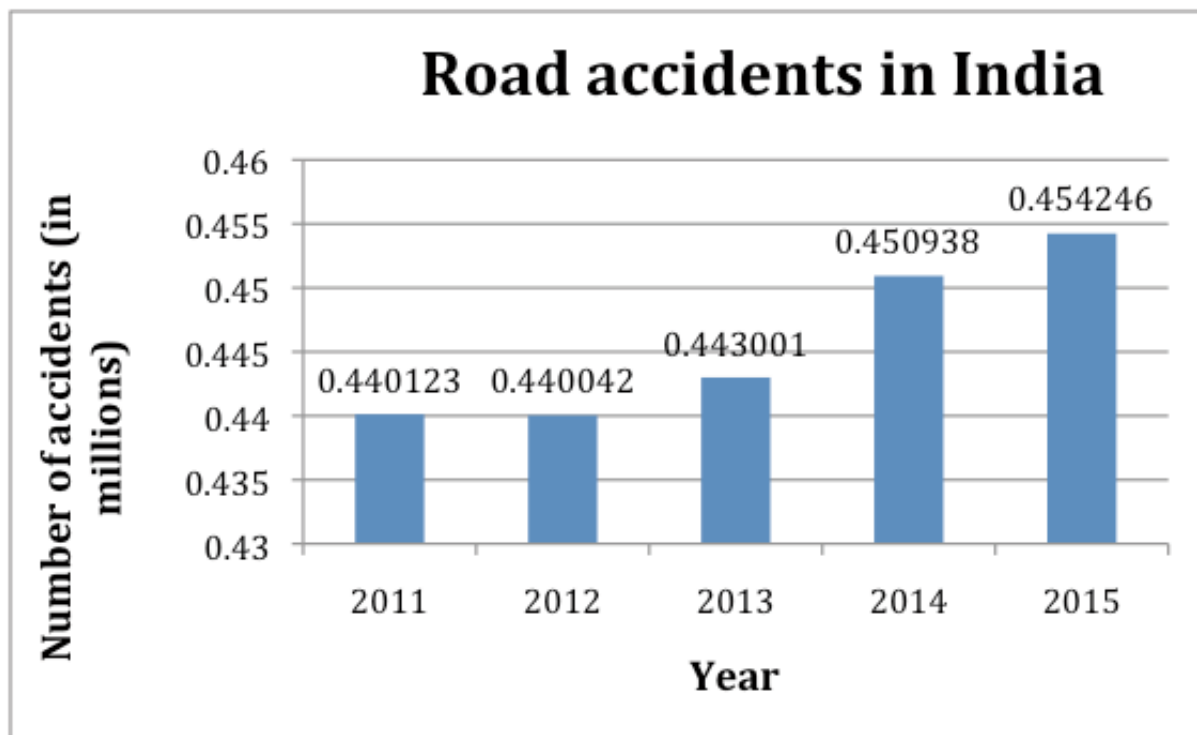
Figure 1: Number of road accidents in India (2011-2015)
Source: - Retrieved from Ministry of Home Affairs, National Crime Records Bureau, 2015

3. How does tourism impact road accidents?

4. What is the role of the driver's age and gender on traffic accidents?

Our data is collected from reports published by the NCRB. We use descriptive statistics, one-way ANOVA analysis, and standard multiple regression analysis to identify patterns in the data. Results show that while festivals and seasons have a negligible impact, factors such as high tourism footfall, driver's age and gender play a significant role in road accidents.

The rest of the paper is divided into 6 sections: Section 2 outlines the literature review. Section 3 explains the methodology adopted and Section 4 explains the results of the analysis. Section 5 discusses the contribution, section 6 summarizes our findings, and finally section 7, gives direction for future research, and discusses the limitations of the study.

2. Literature Review

It is of vital importance to study and identify the patterns of road traffic accidents in motorized countries. The literature review reveals the following evidential research on traffic accidents:

Road accidents and time of the year

According to the NCRB (2009) and Singh (2016) and Mohan (2009) reports, nationally, more accidents tend to occur between April and June. Jha et. al, (2004) point to the prevalence of road accidents during winters and the rainy season. This pattern of accidents needs to be studied to understand fatality risk due to extreme weather conditions.

Further, traffic accidents are found to be more common around festival times in Thailand, India and Bangladesh. (Tanaboriboon & Satiennam, 2004; Hoque et al; Boontob, 2009, Huang et al, 2016) This can be attributed to increased alcohol consumption around festival time.

Road accidents and tourism

Singh (2016) reports that there is huge variation in accidents across the Indian states. States with lower density of popula-

tion and tourism levels, such as Jharkhand and Himachal Pradesh, experience less number of accidents compared to states such as Tamil Nadu (Ministry of Tourism, 2016-17). Moreover, the NCRB (2009) reports that national highways account for one-third of traffic accidents. These trends suggest a relationship between traffic accidents and tourism.

Road accidents and driver's demographics

Kanchan et al. (2012), Bayan et al. (2013) and Ratan Tata Trust (2011) deduce that younger males and older females experience higher number of accidents in India. Shibata & Fukuda (1994) indicate that male unlicensed drivers are more prone to injury due to road accidents. Regarding age, (Mohan, 2009) children comprise only 6% of the fatalities, though their share in the Indian population is 32%; however, the middle-age groups (30-59 years) are over-represented by about 70%. These studies highlight the role of demographic variables like age and gender in mediating occurrence of traffic accidents. Table 1 highlights the key research papers on road accidents.

3. Methodology

Advances in technology have made it possible to collect, assemble, and organize large amount of data and make it available for research. Therefore, it is now possible to employ prevailing data for research. Accordingly, we opt for secondary data analysis to sieve for further insights. While secondary data analysis is supple and can be operated in numerous ways, it has similar impact on the outcomes like primary data (Johnston, 2017). In this paper, we source data from the NCRB, the most authentic database available on the subject under study, thus increasing the impact and usability of our findings (NCRB, 2015). NCRB, in association with the Ministry of Transport and Highways, collects data on traffic accidents comprising of (i) Road Accidents (ii) Railway Accidents and (iii) Railway Crossing Accidents, as these are the major contributors to accidental deaths in India. The number of traffic accidents in the country has increased by 0.7% (NCRB, 2015).

Hypotheses

The Ministry of Culture, the Govt. of India, has recognized many religious and regional festivals that attract several domestic and

Sr. No.	Antecedent of road accident	Papers
1	Festivals	Hall (1987), Carlsen (2004); Radun & Radun (2006); Sharma & Harish (2006); Siviroj et al. (2012); Shahid et al., (2015); Islam et al., (2016)
2	Seasons	Satterthwaite (1976); Nofal & Saeed (1997); Åkerstedt et al., (2001); Radun & Radun (2006); Ma, Shao & Zhang, (2009); Andersson & Chapman (2011); Zhang et al., (2016); Malmivuo et al., (2017)
3	Tourism	Page & Meyer (1996); Wilks, Watson & Faulks (1999); Bentley & Page (2001); Eitzinger & Wiedemann (2007); Rosselló & Saenz-de-Miera (2011); Su & Wang (2016)
4	Gender	Yagil (1998); Åkerstedt & Kecklund (2001); Al-Balbissi (2003); Holland & Hill (2007); Bener & Crundall (2008); Santamariña-Rubio et al., (2014); Shen & Neyens (2015); Li, Yan & Wong (2015); Cordellieri et al., (2016)
5	Age	Rutter & Quine (1996); Åkerstedt & Kecklund (2001); Krahé & Fenske (2002); Turner & McClure (2003); Javouhey et al., (2006); Holland & Hill (2007); Møller & Haustein (2014); Shen & Neyens (2015); Whitelegg (2016)

Table 1: Antecedents of road accidents
Source: Developed by authors

High domestic tourism (in million)	Low Domestic Tourism
Tamil Nadu	Arunachal Pradesh
Uttar Pradesh	Jharkhand
Andhra Pradesh	Chhattisgarh
Karnataka	Manipur
Maharashtra	Tripura

Table 2: States with highest and lowest domestic tourist visits in India
Source: Developed by authors

foreign tourists to the host states. Some major festivals, such as Eid, Janmashtami, Muharram, Onam, Diwali, Christmas etc., attract much higher number of tourists (Ministry of Culture, 2015). The level of infrastructure and facilities prove insufficient to manage the increased number of traffic on roads. Total domestic tourist visits during 2016, was 1044 million for the top five states in the country (Ministry of Tourism, 2016). Table 2 lists the 5 states with the highest and lowest tourism footfalls in India.

Therefore, we hypothesise that:

1. There is a significant difference in the number of traffic accidents that occur during festival periods (June-December) vs non-festival (January-June) months of the year. This is under the assumption that people drive more rashly during festivities.

2. There is a significant difference in traffic accidents in states with high domestic tourism vs. states with low domestic tourism. This leads us to assume that people are less attentive to road safety while travelling.

3. According to the Indian Meteorological Department, weather pattern in India comprises of summer (April-June), winter (December-March), and monsoons (July-September). These seasons bring with them extreme heat or cold, fog, smog, heavy rains, and landslides, leading to both deterioration of roads and capabilities of people in general, and travellers in particular. Therefore, we hypothesise that a relationship exists between seasons and road accidents.

4. We have also used a regression model to predict the number of traffic accidents according to the driver's age and gender, and the model is as follows:

$$y = a + x_1 b_1 + x_2 b_2 + e$$

Where:
  y = *number of traffic accidents,*
  a = *constant,*
  x_1 = *age of the driver, and*
  x_2 = *gender of the driver*

The population for this research includes all citizens of India who have experienced road accidents. The latest published data on traffic accidents is obtained from reports published by the National Crime Records Bureau for the year 2015.

Sample:

There are a total of 29 states in India. Our sample of 13 states represents 80% of the population of the country. See Table 3 below.

Tools

Results are tabulated and analysed using the IBM SPSS Statistics 20 software. Descriptive statistics are used to summarise the main features of the data gathered. t-test is used to compare the differences in traffic accidents during the festival and non-festival months, and also the differences in states with low domestic and high domestic tourism. One-way ANOVA is used to compare traffic accidents occurring during different seasons of the year. Standard multiple regression analysis is used to predict the relationship between demographic variables and the number of traffic accidents.

States	Population composition (in %)
Andhra Pradesh	4.08
Odisha	3.47
Rajasthan	5.67
Tamil Nadu	5.96
Telangana	2.97
Uttar Pradesh	16.49
West Bengal	7.55
Bihar	8.58
Gujarat	5
Karnataka	5.05
Kerala	2.76
Madhya Pradesh	6
Maharashtra	9.28

Table 3: States with highest population in India
Source: Developed by authors

4. Results

The purpose of this study is to explore the patterns of road accidents in India. Our total sample size is 13 states. Table 4 shows the normality tests and Table 5 represents the descriptive test results.

Normality tests

The assumption of normality is tested using the Shapiro-Wilke normality test (SW=.926, df=13, p=.303). Results indicate that the assumption of normal is reasonable.

Shapiro-Wilk test of normality			
	Statistic	Df	Sig.
Accidents	.926	13	.303

Table 4
Source: Developed by authors

Descriptive statistics

The average accidents reported in India for the year 2015 is 32291 (SD=16903.58).

	N	Sum	Descriptive Statistics		Std. Deviation	Variance
			Mean			
			Statistic	Std. Error		
Traffic Accidents	13	419783	32291.00	4688.211	16903.584	285731151.00

Table 5
Source: Developed by authors

t-test

We conduct an independent sample t-test to compare differences in traffic accidents during festival and non-festival months of the year. We do not find any significant difference in the scores for festivals (M=15679.38, SD=8376.018) and non-festival months (M=16611.62, SD=8536.79); two-tailed t(24)= -.281, p=.781. These results suggest that the number of traffic accidents do not change with the occurrence of festivals during the year. See Table 6.

Months	N	Mean	SD	T	P	Df
Festival	13	15679.38	8376.018		.781	
Non-festival	13	16611.62	8536.786	-.281		24

Table 6: Comparing differences in traffic accidents during festival and non-festival months
Source: Developed by authors

Among the 13 states under study, we find a statistically significant difference between states with low domestic tourism (M=4395.20, SD=17806.668) and states with high domestic tourism (M=44577, SD=6281.259); two-tailed t(8)= 4.578, p=.001. These results indicate that the number of road accidents change in states with low domestic tourism compared to states with high domestic tourism.

Months	N	Mean	SD	T	p	Df
Low domestic tourism	5	4395.20	17806.668		.001	
High domestic tourism	5	44577	6281.259	4.578		8

Table 7: Comparing differences in traffic accidents in states with low and high domestic tourism
Source: Developed by authors

ANOVA

We conduct a one-way ANOVA to compare traffic accidents during winters, summers and monsoons. We do not find any significant difference between seasons at the p<.05 level for the three seasons [F(2, 36)=.12, p=.888)]. Since the results are not significant, we conduct post-hoc tests. The above results suggest that traffic accidents occur equally at all times of the year, despite change in the seasons.

	Sum of squares	Df	Mean square	F	P
Between groups	4342713.282	2	2171356.641	.120	.888
Within groups	653916092.6	36	18164335.91		
Total	658258805.9	38			

Table 8: Comparing differences in traffic accidents during different seasons
Note: N=13
Source: Developed by authors

Regression

We use standard multiple regression to test if age and gender significantly predict traffic accidents in India. The assumptions of linearity, independence of errors, homoscedasticity, unusual points and normality of residuals are met. Statistically, age and gender significantly predicted traffic accidents, $F(2, 19) = 6.187$, $p=.009$, adj.$R^2 = .331$. All variables are statistically significant, $p < .05$.

Variable	*B*	SE_B	β
(Constant)	11579.109	3729.265	
Age	509.255	319.782	.284
Gender	-6343.364	2011.478	-.560*

Table 9: Regression coefficients and standard errors
Note: * p<.05; *B*= unstandardized regression coefficient; SE_B = standard error of the coefficient; β = standardized coefficient.
Source: Developed by authors

The regression model is:

$$Y = 11579.109 + 509.255x_1 + (-6343.364) x_2$$

The above results indicate that age and gender explain 33.1% of the variability in traffic accidents. These accidents increase

Hypothesis	p value	Test	Decision
H1	.781	t-test	Rejected
H2	.001	t-test	Accepted
H3	.888	ANOVA	Rejected

Table 10: Summary of Hypothesis testing.
Source: Developed by authors

with age and also males tend to experience more accidents than females.

We do not find any difference in accidents based on seasons and festivals during the year. Thus, traffic accidents occur throughout the year, equally. However, states with high domestic tourism experience more number of accidents compared to states with low domestic tourism. Further, age and gender have a significant impact on the number of traffic accidents in India.

5. Discussion

Statistical results indicate that there are no significant differences in accidents based on seasons and festivals during a year. This implies that traffic accidents occur throughout the year, equally. 3.7% of road accidents occur due to poor weather conditions throughout the year (NCRB, 2015). Out of these, 1.7% can be attributed to poor visibility. These findings find support in a study conducted in British Columbia, which cites weather as the fifth most frequent cause of casualty in traffic accidents. In many ways, the typical weather-related casualty resembles the typical alcohol-related casualty in that they are both high-speed vehicle runoffs that occur at night at a curve in the road in rural areas and involve young male drivers (Mercer, 1986). This has important implications for road safety management in Indian states that experience subnormal temperatures. These states should integrate weather conditions during the planning stage of road design to reduce the volume of motor vehicle traffic by means of better land use.

Studies in Bangladesh indicate that a majority of traffic accidents take place during the festive months of October to December. This can also be attributed to the monsoons that occur during this time. (Huang et al., 2016; Hoque et al., n.d.). During festivals such as Diwali, Holi and Sankran-

thi in India, vehicle occupants can be protected from the consequences of collisions with roadside objects through better infrastructure planning. The driving population must be sensitised against over-speeding, overloading, and competitive road behaviour. Traffic enforcement and road checking must be increased during festivals.

Indian states with high domestic tourism footfall experience more number of accidents compared to states with low domestic tourism footfall. This suggests an uneven pace of infrastructural development with regard to road safety in India. Other studies by Sharma et al. (2004), and Ratan Tata Trust (2011) confirm a geographic variation in road traffic accidents in India. Although 80% of India's road length consists of village roads (MORTH, 2009) and road traffic accidents rank fourth among the causes of deaths in rural India (Ministry of Home Affairs, 2015), there is little epidemiological data available on accidents in rural areas. Further, there is no research on geographic distribution of accidents according to tourism propensity of the Indian states. This indicates a potential lack of road safety initiatives in states with high domestic tourism. Drivers are more likely to be inattentive and misjudge the distance and speed of the leading vehicle (Islam & Kanitpong, 2008). Therefore, there should be provisions for slow-moving traffic and for vulnerable road users, regular speed limit signs, systematic removal of roadside hazards, and improved lighting and markings. These studies also highlight the important role that the traffic police play in road safety initiatives. Traffic authorities must reduce the time taken to respond to accidents. A centralised system must be in place to monitor road traffic accidents through CCTV cameras; road reflector lights must be installed; traffic networks should be improved and training should be provided to local traffic police.

Regression results also reveal that age and gender have a significant impact on the number of traffic accidents. In India, male to female ratio among road traffic accident fatalities was 6:1 (NCRB, 2015). This predominance of male victims is apparent through studies from all across the country. A review of published work on road traffic incidents shows that males account for more than 80% of victims as compared to women. This has been explained due to limited exposure of Indian women to outdoor activities and their limited access to vehicles (Dandona et al, 2006; Jha et al, 2004; Zeibots & Elliott, 2011). However, there has been an increase in the proportion of women victims over the years as more women leave home for employment. Majority of the women victims are observed to be pedestrians (Dandona and Mishra, 2004) or pillion riders (Fitzharris et al, 2009). Gender differences in traffic accidents highlight the importance of making helmets compulsory for all male and female drivers and the need to improve police regulation of Driving Under Intoxication (DUIs).

With regard to age, evidence indicates that 48.9% of all road traffic fatalities in India are in the age group of 18-45 years (NCRB, 2015). Additionally, a majority of the victims of non-fatal road traffic accidents are also in the same age group (less than 45 years of age). Traditionally, road traffic accidents are known to be a leading cause of trauma-related mortality and morbidity among young adults. However, recent studies have found these to be an important cause of traumatic injuries among the elderly as well. Studies from different parts of India show that elderly (more than 60 years of age) account for up to 6% of the road traffic accidents victims (Jha et al, 2003; Ganveer & Tiwari, 2005; Patil et al, 2008). With regard to child occupants, most studies observe that persons under the age of 20 years account for up to 21% of RTA victims. These studies show that driving licenses must be issued with stringent guidelines that monitor the age of drivers (Honorato, 2015). There is a need to educate those below 18 years on safe pillion and passenger riding, and unsafe driving habits. Adults above 45 years must monitor their visual and cognitive health to ensure road safety.

Thus, the results of this study indicate a need for various stakeholders – pedestrians, drivers, vehicle passengers, local administration and the government – to come together to improve road safety and road planning measures in India. There is a need to identify vulnerable populations, and develop and implement guidelines for training of drivers, crash-protective vehicular design, increase sensitivity towards traffic laws, and improve road safety in different parts of the country.

6.Conclusion and Policy Implications

The aim of this study is to examine the nature, antecedents and pattern of traffic accidents occurring in India.

The results indicate that there are no significant differences in traffic accidents during festivals or due to seasons change. However, traffic accidents increase in states with high domestic tourism. Age and gender play an important role in the pattern of traffic accidents in India.

Despite the growing burden of road traffic fatalities and injuries, road safety has received insufficient attention from the government. The main reason for this is that the problem of road traffic accidents does not belong to any specific agency, either at central, state or local Government levels. There has been no centralised leadership to ensure coordination of efforts to address the problem holistically in India. This situation needs to be addressed so that responsibility is clearly assigned, implementation is streamlined, and duplication is avoided. Further, India's road infrastructure is currently not supported by any formal national road safety policy despite the awareness that it featured high on the list of total number of road fatalities. A fresh attempt to develop road safety policy was initiated by Ministry of Highways and Transport, G.O.I., at the insistence of the World Bank in 2003, where the government aimed to make 'Safer Roads for Everyone' (BankBazaar, 2018).

Many countries, particularly in the developed world, have experienced a sharp reduction in road traffic accidents over the past couple of decades by adopting a systems approach (Larsson, Dekker &

Tingvall, 2010) to road safety that emphasises environment, vehicle, and road user interventions, rather than only focusing on direct approaches aimed at changing the behaviour of road users. It is considered an international best practice by the WHO. (WHO, 2011). For instance, Sweden's Vision Zero campaign emphasises zero harm in health and safety on highways (Whitelegg & Haq, 2006). It has been extended to many parts of Europe and America because it highlights a multidisciplinary approach to road safety targeting goals that integrate roadway design, speeds, enforcement, behaviours, technology, and policies (Sweden, 2016).

The goal of a safe systems approach is to ensure that mistakes by drivers or pedestrians do not lead to an accident and if an accident does occur, it does not lead to death or any fatal injuries.

This responsibility must be shared by policy makers, planners, engineers, vehicle manufacturers, enforcement officers, road safety educators, health agencies combined while every road user, whether they drive, cycle or walk, is responsible for complying with the system's rules (Haq & Whitelegg, 2014). This ensures safer roads, safer speed, safer vehicles and safer road use. An open system of road safety will consider demographic, legal and environmental variables while designing road safety and training measures. Road accidents is not related to the deaths, casualties and vehicles. These are few tangible entities of the entire phenomenon. Whitelegg (2016), unearths and critics the latent aspects road accidents. He argues that things like air pollution, climate change, fiscal burdens, obesity and related health impacts, community disruption, energy consumption and equality and social justice are key elements of the mobility practices.

Current efforts to address the problems of road safety are minimal in comparison to what can be done. While there are many interventions that can save lives, political will and commitment at central, state, and local government levels are essential. Therefore, we recommend that the results of this paper may be integrated with the elements that the Indian Government has pledged to follow to improve safety on Indian roads:

a. Raise awareness about issues related to road safety

Road deaths and injuries are predictable and preventable (WHO, 2004, page 7). The paper highlights the immense number of road traffic accidents. This necessitates that the government should escalate its efforts to endorse awareness about road safety and all its aspects. This includes the implications of road accidents and the steps needed to be taken to reduce the number of incidents. The purpose of this is to enable and empower people on the road in for them to take on a meaningful role in promoting road safety.

b. Launch a Road Safety Information Database

Due to paucity of data, our research was limited to 2015 road traffic statistics. This points to a need for governmental intervention in increasing the quality of data collection, transmission, analysis and crash investigation by extending a hand to Union Territories, States and local bodies.

c. Safer Road Infrastructure

As traffic accidents occur more in high domestic tourism density states and among younger males, a road safety policy must ensure better standards of design and safety of urban and rural roads. Intelligent Transport Systems (ITS) is to be put in use to ensure efficient and safe transport system which will be on par with international best practices (Mittal, 2008). Further, India's economic and ethnic inequalities are evident in the budgetary allocation to road safety. While efforts have been made to spend on new roads and motorised mobility in India, this benefits only the car drivers. For instance, in Kolkata, 90% of the 16 million residents are deprived of funding for walking, cycling, public transport and safer streets. This budgetary inequality simultaneously promotes increased pollution, low quality healthcare, social injustice, and deaths and injuries in the

road traffic environment. (Whitelegg, 2015).

Thus, a safe system approach is suggested. Such an approach would help segregate traffic as well. Traffic moving in different directions and different speeds should be separated by different lanes using barriers or dividers. This helps separate opposite lanes of traffic and can help avoid accidents.

d. Safer Vehicles

Private automotive venture must take a stand in ensuring that the vehicles they produce are in line with international standards so that they pose least threat in terms of safety on the roads and harm to the environment. For this, the safety features must be monitored from the stage of design, production, operation and maintenance of vehicles. Enhanced technological features such as cameras and proximity sensors can help avoid collisions and increase the awareness of the driver.

e. Safer Drivers

Our research indicates that male drivers suffer higher number of road traffic accidents. This implies that measures are needed to ensure that only highly capable and competent drivers are behind the wheel by making the system of driver licensing stricter. Highway Patrolling on National and State Highways will also be increased in number and frequency. There should be better vetting of tourists before giving vehicles on rent, especially in areas with uneven terrain, in states with high domestic tourism. Creation and implementation of stringent criteria for re-issuing of driving license to individuals above the age of 40. Their response to visual stimuli should be retested. Further, the license re-issuing period should be reduced to 10 years for individuals above the age of 40.

f. Safer conditions for Vulnerable Road Users

The OECD suggests that a safe system approach would help segregate road users (OECD, 2010). The needs of people on the road (including the physically challenged, the vulnerable and non-motorized transport) should be taken into account during the design and construction of all road facilities. Town planners, highway, engineers, traffic engineers and architects will have to keep 'best practices' while working on roads. One of the key dangers on the roads in India is that different types of road users share the same space. Under a systems approach, the aim is to provide separate routes for different users to protect vulnerable road users. For example, the government authorities may focus on creating or expanding cycle pathways; construct and maintain footpaths; or work with schools to develop safer walking routes for children.

g. Emergency Medical Amenities for Accidents on the Road

Everyone who is involved in accidents on the road requires quick, superior medical care. The main features of such medical care must include efficient rescue operations and first aid at the accident site, as well as transporting the injured to the hospital for further care. Further, the government must ensure that all hospitals near National Highways/ State Highways are equipped to care for those who are injured in road accidents sufficiently.

h. HRD and Research for Road Safety

Our paper is one of the few that highlights road safety issues in India. We believe that programmes on road safety research must be encouraged. This includes identifying priority areas, funding research, founding research and academic institutions etc. The results of such research can be disseminated by the government through workshops, training, publication, conferences and websites. (Mittal, 2008)

These policy initiatives may fortify institutional, legal and financial environment at a city, regional and national level to improve Indian road safety. They suggest that road traffic accidents are predictable and preventable and require safe and thoughtful management. (Whitelegg, 2015; Sweden, 2016).

7. Limitations of the study and scope for future research

This is purely a secondary data, cross-sectional study. Research can be made richer using primary time-series data. Further, the latest data available in India is from 2015 and may not reflect current trends. The study does not reflect unreported traffic accidents in India.

However, further research can be done regarding the influence of road conditions on accidents, and differences in accidents in rural/urban areas. Driver-related variables such as cognitive and sensorimotor behaviour can also be studied. We encourage budding researchers to take this research forward.

Author details:
Mridula
PGDM 2017-19,
T A Pai Management Institute.
Email: mridula.19@tapmi.edu.in

Amol S. Dhaigude (corresponding author)
Assistant Professor (Operations and Information Science),
T A Pai Management Institute.
Email: amold@tapmi.edu.in

Harsh Maheshwari
PGDM 2017-19,
T A Pai Management Institute.
Email: harshm.19@tapmi.edu.in

Swati Choraria
PGDM 2017-19,
T A Pai Management Institute.
Email: swati.19@tapmi.edu.in

References
Åkerstedt, T., & Kecklund, G. (2001). Age, gender and early morning highway accidents. Journal of sleep research, 10(2), 105-110.

Åkerstedt, T., Kecklund, G., & Hörte, L. G. (2001). Night driving, season, and the risk of highway accidents. Sleep, 24(4), 401-406.

Al-Balbissi, A. H. (2003). Role of gender in road accidents. Traffic injury prevention, 4(1), 64-73.

Andersson, A. K., & Chapman, L. (2011). The impact of climate change on winter road maintenance and traffic accidents in West Midlands, UK. Accident Analysis & Prevention, 43(1), 284-289.

BankBazaar. (2018). What the government has done for road safety: National road safety policy. Retrieved from https://www.bankbazaar.com/driving-licence/details-national-road-safety-policy.html

Bayan, P., Bhawalkar, J.S., Jadhav, S.L. & Banerjee, A. (2013). Profile of non-fatal injuries due to road traffic accidents from an industrial town in India. International Journal of Critical Illness and Injury Science, 3(1) doi: 10.4103/2229-5151.109409

Bener, A., & Crundall, D. (2008). Role of gender and driver behaviour in road traffic crashes. International Journal of Crashworthiness, 13(3), 331-336.

Bentley, T. A., & Page, S. J. (2001). Scoping the extent of adventure tourism accidents. Annals of Tourism Research, 28(3), 705-726.

Boontob, N., Aniwattakulchai, P., Kanitpong, K., Poonbon, S. & Anurakamolkul, C. (2009). In-depth accident analysis due to roadside hazard: Thailand case study. Proceedings of the Eastern Asia Society for Transportation Studies, 7.

Carlsen, J. (2004). The economics and evaluation of festivals and events. Festivals and Events Management, 246-259.

Cordellieri, P., Baralla, F., Ferlazzo, F., Sgalla, R., Piccardi, L., & Giannini, A. M. (2016). Gender effects in young road users on road safety attitudes, behaviors and risk perception. Frontiers in psychology, 7, 1412.

Dandona, R. & Mishra, A (2004) Deaths due to road traffic crashes in Hyderabad city in India: Need for strengthening surveillance. National Medical Journal of India, 17(2), 74–79. Retrieved from http://www.nmji.in/Issue%2017-2%20PDF/original%20 article/oart2.pdf

Dandona, R. (2006). Making road safety a public health concern for policy-makers in India. The National medical journal of India, 19(3), 126-133.

Dandona, R., Kumar, G. A., Dandona, L (2006) Risky behavior of drivers of motorised two wheeled vehicles in India. Journal of Safety Research, 37(2), 149-158

Eitzinger, C., & Wiedemann, P. (2007). Risk perceptions in the alpine tourist destination Tyrol—An exploratory analysis of residents' views. Tourism Management, 28(3), 911-916.

Fitzharris, M., Dandona, R., Kumar, G. A. & Dandona, L (2009) Crash characteristics and patterns of injury among hospitalised motorised two-wheeled vehicle users in urban India. BMC Public Health, 9(11). doi:10.1186/1471-2458-9-11. Retrieved from http://www.biomedcentral.com/1471-2458/9/11

Ganveer, G. B., Tiwari, R. R (2005) Injury pattern among non-fatal road traffic accident cases: A cross-sectional study in Central India. Indian Journal of Medical Science, 59, 9-12.

Government of Sweden, (2016). Vision Zero. Retrieve from http://www.visionze-roinitiative.com/

Hall, C. M. (1987). The effects of hallmark events on cities. Journal of Travel Research, 26(2), 44-45.

Haq, G., & Whitelegg, J. (2014). The Insanity of Normality: Reconceptualising the Road Safety Debate. World Transport Policy and Practice, 20, 3.

Holland, C., & Hill, R. (2007). The effect of age, gender and driver status on pedestrians' intentions to cross the road in risky situations. Accident Analysis & Prevention, 39(2), 224-237.

Hoque, M., Ashraffuzaman, M., Sarkar, S., Ahmed, S.N., Hoque, S., Mahmud S.M.S., & Rahman, M.W. (N.D.) Road accidents during festivals and vacations in Bangladesh. Retrieved from http://ari.buet.ac.bd/Personal%20Websites/Sohel/Sohel%20Mahmud%20Web%20page/Publication_%20All%20paper%20and%20abstract%20for%20WEB/International%20Conferences/4bFull%20Paper_%20ROAD%20ACCIDENTS%20DURING%20FESTIVALS%20AND%20VACATIONS.pdf

Huang, L., Adhikary, K.P., Choulagai, B.P., Wang, N., Poudyal, A.K. & Onta, S.R. (2016). Road traffic accident and its characteristics in Kathmandu Valley. Journal of Nepal Medical Association, 55(203), 1-6. Indian Meteorological Department (2015). Frequently asked questions. Retrieved from http://imd.gov.in/section/nhac/wxfaq.pdf

Islam, M. & Kanitpong, K. (2008). Identification of factors in road accidents through in-depth accident analysis. International Association of Traffic and Safety Sciences, 32(2), 58-67. Retrieved from https://doi.org/10.1016/S0386-1112(14)60209-0

Islam, M., Akter, S., Mohiuddin Imran, M., Hossain, I., & Hassan, N. (2016). Festival Time Transportation Demand Modeling in Bangladesh. Int. J. Sci. Eng. Investig, 5(48), 40-44.

Jacobs, G. D., & Sayer, I. (1983). Road accidents in developing countries. Accident Analysis & Prevention, 15(5), 337-353.

Javouhey, E., Guerin, A. C., & Chiron, M. (2006). Incidence and risk factors of severe traumatic brain injury resulting from road accidents: a population-based study. Accident Analysis & Prevention, 38(2), 225-233.

Jha, N., Srinivasa, D. K., Roy, G. & Jagdish, S (2004) Epidemiological study of road traffic accident cases: a study from south India. Indian Journal of Community Medicine, 29(1), 20-24.

Kanchan, T., Kulkarni, V., Bakkannavar, S.M., Kumar, N. & Unnikrishnan, B. (2012). Analysis of fatal road traffic accidents in a coastal township of South India. Journal of Forensic and Legal Medicine, 19. 448-451.

Krahé, B., & Fenske, I. (2002). Predicting aggressive driving behavior: The role of macho personality, age, and power of car. Aggressive Behavior, 28(1), 21-29.

Li, X., Yan, X., & Wong, S. C. (2015). Effects of fog, driver experience and gender on driving behavior on S-curved road segments. Accident Analysis & Prevention, 77, 91-104.

Ma, Z. L., Shao, C. F., & Zhang, S. R. (2009). Characteristics of traffic accidents in Chinese freeway tunnels. Tunnelling and Underground Space Technology, 24(3), 350-355.

Malmivuo, M., Luoma, J., & Porthin, M. (2017). Studded and unstudded winter tires in fatal road accidents in Finland. Traffic injury prevention, 18(5), 550-555.

Mercer, G. (1986) Aspects of weather-related casualty traffic accidents, British Columbia, 1984. Journal of Safety Research Ministry of Culture, Government of India (2015). Result framework documents. Retrieved from http://www.indiaculture.nic.in/

Ministry of Home Affairs, National Crime Records Bureau, Government of India. (2015). Accidental deaths and suicides in India. Retrieved from http://ncrb.nic.in/StatPublications/ADSI/ADSI2015/adsi-2015-full-report.pdf

Ministry of Road Transport and Highways Research Wing, Government of India. (2015). Road accidents in India. Retrieved from http://morth.nic.in/showfile.asp?lid=2143

Ministry of Tourism, Market Research Wing, Government of India. (2016). India tourism statistics: At a glance. Retrieved from http://tourism.gov.in/sites/default/files/Other/India%20Tourism%20Book%20English.pdf

Mittal, N. (2008). Policies and programs for road safety in developing India. Jounal of Emergency Trauma Shock, 1(1), 42-49. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2700566/

Mohan, D. (2009). Road accidents in India. Transportation Research and Injury Prevention Programme.

Møller, M., & Haustein, S. (2014). Peer influence on speeding behaviour among male drivers aged 18 and 28. Accident Analysis & Prevention, 64, 92-99.

Mumbai Traffic Police (2009) Retrieved from htttp://www.trafficpolicemumbai.org.

Nanga, S., Odai, N. A., & Lotsi, A. (2017). Survival pattern of first accident among commercial drivers in the Greater Accra Region of Ghana. Accident Analysis & Prevention, 103, 92-95.

Nantulya, V. M., & Reich, M. R. (2002). The neglected epidemic: road traffic injuries in developing countries. Bmj, 324(7346), 1139-1141.

National Crime Records Bureau, Ministry of Road Transport & Highway (2015). Law commission of India, Global status report on road safety 2015. Retrieved from http://ncrb.gov.in/StatPublications/ADSI/ADSI2015/adsi-2015-full-report.pdf

Nofal, F. H., & Saeed, A. A. W. (1997). Seasonal variation and weather effects on road traffic accidents in Riyadh city. Public health, 111(1), 51-55.

Obeng-Atuah, D., Poku-Boansi, M., & Cobbinah, P. B. (2017). Pedestrian crossing in urban Ghana: Safety implications. Journal of Transport & Health, 5, 55-69.

Odero, W., Garner, P., & Zwi, A. (1997). Road traffic injuries in developing countries: a comprehensive review of epidemiological studies. Tropical Medicine & International Health, 2(5), 445-460.

Organisation of Economic Cooperation and Development. (2010). Towards zero: Ambitious road safety targets and the safe system approach. Retrieved from http://www.oecd.org/publications/towards-zero-9789282102640-ru.htm

Page, S. J., & Meyer, D. (1996). Tourist accidents: an exploratory analysis. Annals of Tourism Research, 23(3), 666-690.

Patil, S. S., Kakade, R. V., Durgawale, P. M. & Kakade, S. V (2008) Pattern of road traffic injuries: A study from western Maharashtra. Indian Journal of Community Medicine, 33, 56-57.

Radun, I., & Radun, J. E. (2006). Seasonal variation of falling asleep while driving: an examination of fatal road accidents. Chronobiology international, 23(5), 1053-1064.

Ratan Tata Trust. (2011). Epidemiology of Road Traffic Accidents in India: a Review of Literature.

Rosselló, J., & Saenz-de-Miera, O. (2011). Road accidents and tourism: The case of the Balearic Islands (Spain). Accident Analysis & Prevention, 43(3), 675-683.

Rutter, D. R., & Quine, L. (1996). Age and experience in motorcycling safety. Accident Analysis & Prevention, 28(1), 15-21.

Santamariña-Rubio, E., Pérez, K., Olabarria, M., & Novoa, A. M. (2014). Gender differences in road traffic injury rate using time travelled as a measure of exposure. Accident Analysis & Prevention, 65, 1-7.

Satterthwaite, S. P. (1976). An assessment of seasonal and weather effects on the frequency of road accidents in California. Accident Analysis & Prevention, 8(2), 87-96.

Shahid, S., Minhans, A., Puan, O. C., Hasan, S. A., & Ismail, T. (2015). Spatial and temporal pattern of road accidents and casualties in peninsular Malaysia. Jurnal Teknologi, 76(14).

Sharma, A., & Harish, D. (2006). Head injury: The principal killer in road traffic accidents. JIAFM, 28(4), 0971-0973.

Sharma, B. R., Singh, V. P., Sharma, R. & Sumedha (2004) Unnatural deaths in northern India: A profile. Journal of Indian Academy of Forensic Medicine, 26(4), 140 – 146

Shen, S., & Neyens, D. M. (2015). The effects of age, gender, and crash types on drivers' injury-related health care costs. Accident Analysis & Prevention, 77, 82-90.

Shibata, A. & Fukuda, K. (1994). Risk factors of fatality in motor vehicle traffic accidents. Accident Analysis and Prevention, 26(3), 391-397.

Singh, S.K. (July, 2016). Road traffic accidents in India: Issues and challenges. World Conference on Transport Research. Elsevier.

Siviroj, P., Peltzer, K., Pengpid, S., & Morarit, S. (2012). Helmet use and associated factors among Thai motorcyclists during Songkran festival. International journal of environmental research and public health, 9(9), 3286-3297.

Su, J. M., & Wang, Y. M. (2016). An Analysis on the Characteristics of Traffic Accidents at Tourist Attractions: Taking Nantou County in Taiwan as an Example. In Bridging the East and West (pp. 198-205).

Tanaboriboon, Y. & Satiennam, T. (2004). Traffic accidents in Thailand. IATSS Research. 29(1).

Turner, C., & McClure, R. (2003). Age and gender differences in risk-taking behaviour as an explanation for high incidence of motor vehicle crashes as a driver in young males. Injury control and safety promotion, 10(3), 123-130.

Whitelegg, J. (2015). Mobility: A new urban design and transport planning philosophy for a sustainable future. Straw Barnes Press

Whitelegg, J. (2016). Mobility: A New Urban Design and Trasport Planning Philosophy for a Sustainable Future. CreateSpace Independent Publishing Platform.

Wilks, J., Watson, B., & Faulks, I. J. (1999). International tourists and road safety in Australia: developing a national research and management programme. Tourism Management, 20(5), 645-654.

World Health Organisation. (2011). Global plan for the decade of action for road safety 2011-2020. Retrieved from http://www.who.int/roadsafety/decade_of_action/plan/plan_en.pdf

World Health Organisation. (2015). Global status report on world safety. Retrieved from http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/

World Health Organization, 2015. Global Status Report on Road Safety 2015. WHO, Geneva, Switzerland.

Yagil, D. (1998). Gender and age-related differences in attitudes toward traffic laws and traffic violations. Transportation Research Part F: Traffic Psychology and Behaviour, 1(2), 123-135.

Zhang, G., Yau, K. K., Zhang, X., & Li, Y. (2016). Traffic accidents involving fatigue driving and their extent of casualties. Accident Analysis & Prevention, 87, 34-42.

Zong, F., Zhang, H., Xu. H., Zhu, X. & Wang, L. (2013). Predicting severity and duration of road traffic accident. Mathematical Problems in Engineering, Hindwai Publishing Corporation. Retrieved from http://dx.doi.org/10.1155/2013/547904

Staying competitive: How operators can adapt to the surge of technical advancements in urban mobility
Francois-Joseph Van Audenhove

Major technological developments, such as big data, artificial intelligence and the Internet of Things, as well as the emergence of new, compact forms of energy, have opened up a range of new options for individual mobility. Customers now expect fast, reliable, convenient and personalized mobility services, and this can create both challenges and opportunities for mobility solutions providers – both traditional players as well as "new mobility" players. If they are to remain competitive in the short term and relevant in the long term, all operators must adapt to evolving customer needs and to the surge in technical advancements and innovations driven by this fourth industrial revolution.

Assessing the maturity, innovativeness and performances of today's mobility systems

Current trends and new mobility solutions may lead to very different mobility ecosystems in the future. The global demand for passenger mobility in urbanized areas is set to double by 2050. Meanwhile, the number of individual journeys taken daily has grown exponentially since 2015, putting increased pressure on existing urban mobility systems. Even larger growth is expected in the field of goods mobility, especially in dense urban areas, due to the increasing importance of e-commerce and the accompanying boom in demand for last-mile delivery.

Arthur D. Little recently released the third edition of its Urban Mobility Index, assessing the mobility maturity, innovativeness and performances of 100 cities worldwide through 27 criteria. The mobility score per city ranges from 0 to 100 index points; the maximum of 100 points is defined by the best performance of any city in the sample for each criterion.

The overall results find that most cities still need to work intensively on improvements to their mobility systems. The global average score of the 100 cities surveyed is 42.3 out of a possible 100 points. This means that, worldwide, the average city has unleashed less than half of the potential of its urban mobility system, a state of affairs that could be remedied by applying best practices across all its operations.

Only 10 cities scored more than 50 points, out of which eight are European cities and two Asian (See Figure 1, page 28). The city-state of Singapore achieved the highest score with 59.3 points, followed by Stockholm (57.1 points), Amsterdam (56.7 points), Copenhagen (54.6 points) and Hong Kong (54.2 points). This indicates that even the highest-ranking cities have considerable potential for improvement.

Establishing a vision for a city's future mobility system

Mobility visions and policies do not cover requirements. A lot of mature cities do not yet have clear visions of what their mobility systems should look like in the future, and coherent strategies for getting there. In addition, management of urban mobility still often operates in environments that are fragmented and hostile to innovation, and an increased level of collaboration is required between public and private mobility stakeholders.

In order to address future mobility challenges, cities and mobility solutions providers must adopt more comprehensive and coordinated approaches to manage mobility supply (See figure 2, page 29). They must also move towards more proactive approaches to demand mobility management in order to better influence behaviors in space and time. The mobility systems of tomorrow should be intermodal, personalized, convenient and connected, and encourage the use of more sustainable modes of transport (public transport, cycling, walking), while integrating new mobility solutions, such as autonomous vehicles (AVs). Convergence through digitalization constitutes a major opportunity to reinvent mobility systems as they gradually evolve to embrace "mobility-as-a-service", moving from ownership of individual transport modes towards usage of multiple mobility modes as services.

At all levels, legislation is being introduced

to drive change. Regulation is expected to play an important role, as it is generally geared towards creating the required framework for the sound introduction of new mobility solutions and ensuring these will positively contribute to reaching the optimal system. It will also be a critical driver to foster sustainable innovation.

Rethinking sustainable mobility policies at city and national levels

The solution for the future is an interconnected, multimodal mobility system with increased convenience and efficiency, tailored to the city's growth project and balancing economic development and well-being. Transport authorities should address four key dimensions as they seek to rethink their sustainable mobility policies at the levels of cities and nations:

• A visionary strategy: Developing a long-term political vision and deciding on objectives based on the strategic alignment of all key public and private mobility stakeholders. This alignment will ensure a balance between visionary ideas and project feasibility.

• Mobility supply management: Extending transport offerings for citizens, with views to "deliver solutions" rather than "delivering transport" to provide user-friendly, multimodal solutions that meet everyone's needs.

• Mobility demand management: Defining ways to encourage people to adjust their behavior towards usage of sustainable transport modes, such as walking, cycling and public transport.

• Funding: Ensuring the financial viability of public mobility (including new mobility solutions) through finding the right balance between public and private sources and funding from direct and indirect beneficiaries.

Defining a differentiating strategy and vision

In the Future of Mobility 3.0 study, Arthur D. Little and its partner, UITP, have identified five key dimensions for mobility solution providers to consider when defining their visions and strategies to differentiate themselves within extended mobility ecosystems:

• Sense of purpose: Defining a sense of purpose (or "reason to exist") by reviewing mission statements, brand platform and values, in order to secure differentiation in the marketplace. These changes should engage external and internal stakeholders alike: externally through emblematic proof along the customer journey; and internally by driving transformation at all levels of the organization.

• Branded customer experience: Increasing offering attractiveness and transforming customers into fans by better understanding mobility behaviors and customer needs; developing a superior customer experience across all touch points along the end-to-end journey; and a customer-centric commercial offering which takes into account differentiated customer needs.

• Operational excellence: Maximizing utilization of assets and improving effectiveness and efficiency of all functions across the value chain through effective long-term capex planning; designing and operating future-proof transport and maintenance plans; and selectively implementing opportunities via innovation and digital technologies.

• Ecosystem integration: Providing consumers with flexible, efficient, integrated and user-oriented mobility services through developing integrated mobility visions and transport plans; increasing collaboration across mobility stakeholders; and implementing the concept of Mobility-as-a-Service to trigger a move from personal ownership towards usage of integrated transportation solutions.

• Transformation: Successfully managing

the company transformation in terms of leadership, culture, organization and talent management to remain competitive in the short term and relevant in the long term – a shift that involves willingness to embark on a journey from the "era of productivity" to the "era of creativity".

In the new report, Future of Mobility 3.0, Arthur D. Little and the UITP elaborate further on those dimensions and detail 12 imperatives for mobility solutions providers to consider when defining their sustainable visions and strategies. The report also includes case studies of mobility solutions providers demonstrating good practices. The full study can be accessed here: http://www.adlittle.com/en/insights/viewpoints/future-mobility-30.

Author details:
François-Joseph Van Audenhove
Partner, Arthur D. Little

Email:
vanaudenhove.f@adlittle.com

Ranking

Global Average 42.3

Urban Mobility Index

below average | average | above average

28 32 36 40 44 48 52 56 60

Singapore
Stockholm
Amsterdam
Copenhagen
London
Hong Kong
Vienna
Paris
Zurich
Helsinki
Tokyo
Berlin
Madrid
Munich
Shanghai
Prague
Barcelona
Shenzhen
Warsaw
Tallinn
Brussels
Lausanne
Guangzhou
Frankfurt
Milan
Stuttgart
Nantes
San Francisco (CA)
Seoul
Beijing
Dubai
New York
Montreal
Toronto
Moscow
Istanbul
Santiago de Chile
Boston
Hanover
Wuhan
Manila
Mumbai
Melbourne
Osaka
Nanjing
Hyderabad
Turin
Cape Town
Chicago
Portland
Washington, D.C.
Bangalore
Sydney
Curitiba
Mexico City
Lima
Chennai
Buenos Aires
Lisbon
Bogota
Chongqing
Rome
São Paulo
Xi'an
Athens
Kolkata
Ankara
Cairo
Saint Petersburg
Rio de Janeiro
Los Angeles
Bangkok
Chengdu
Jakarta
Miami
Tianjin
Kinshasa
Riyadh
Kuala Lumpur
Addis Ababa
Salvador
Johannesburg
Philadelphia
Dallas
Ho Chi Minh City
Lahore
Karachi
Tehran
Shenyang
Lagos
Caracas
Dhaka
Amman
Houston
Jaipur
Delhi
Accra
Hanoi
Atlanta
Baghdad
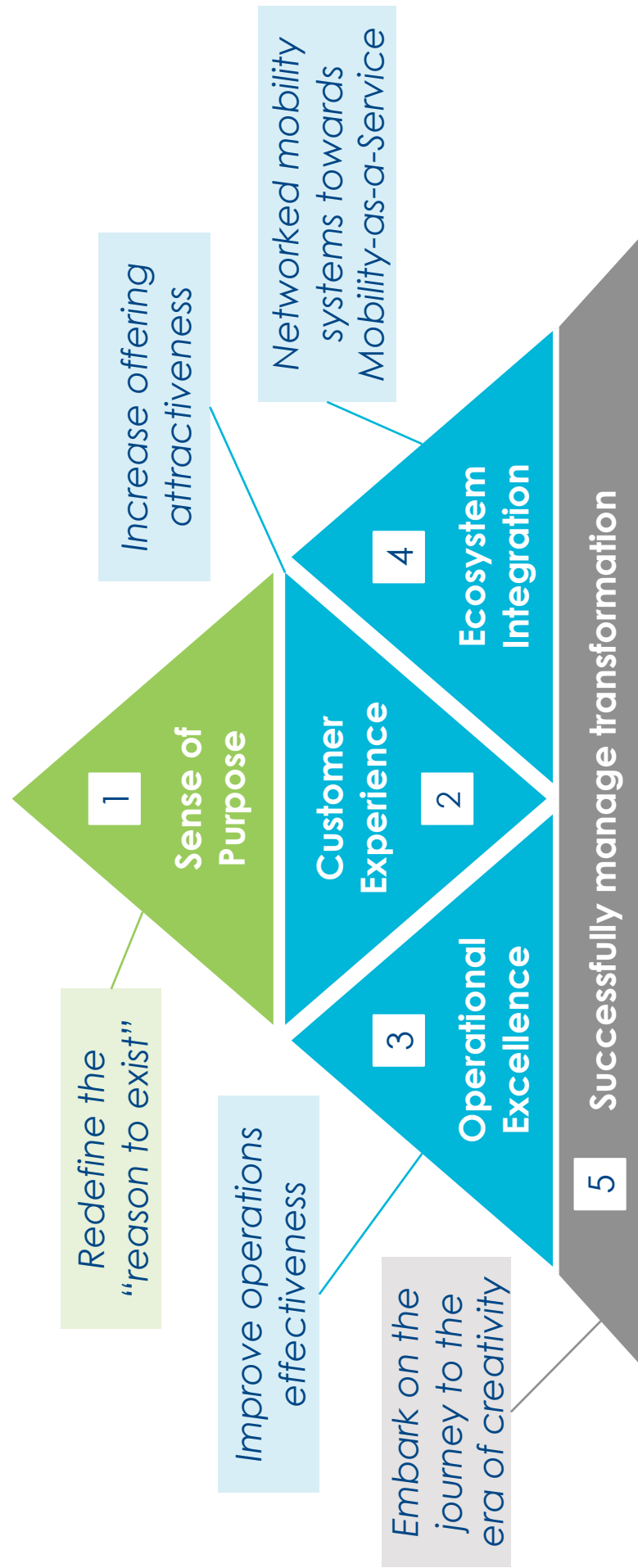
Source: Arthur D. Little Urban Mobility Index 3.0; UITP is independent of this index, which does not necessarily reflect its opinion; 100 index points for city that would achieve best performance on each criteria.

Figure 1: Arthur D. Little Urban Mobility Index - City Ranking

Strategic Directions for mobility solutions providers to remain *competitive* in the short term and *relevant* in the long term

- Increase offering attractiveness
- Networked mobility systems towards Mobility-as-a-Service
- Redefine the "reason to exist"
- Improve operations effectiveness
- Embark on the journey to the era of creativity

1 Sense of Purpose

4 Ecosystem Integration

2 Customer Experience

3 Operational Excellence

5 Successfully manage transformation

Source: Arthur D. Little & the UITP, Future of Mobility 3.0

Figure 2: Strategic directions for mobility solutions providers

Factors influencing use of a non-motorized, non-personalized mode of transport in a mid-sized Indian city

Dr. Nachiket Sharadchandra Gosavi, Dr. Lakshmikanth Hari, Prof. Dinesh S Hegde

Introduction

India is one of the fastest urbanizing economies. It is estimated that by 2030 more than half of India's population would be residing in cities of various sizes. For these cities to make most of available growth opportunities, people must have means to move seamlessly. However, the paucity of reliable mass transport in most cities interrupts movement of people and has led to proliferation of private vehicles in most cities and towns. In India, there is strong preference over two-wheelers and four-wheelers for personal usage. These categories of vehicles together constitute more than three-fourths of India's vehicle stock. This has caused heavy reliance on fossil fuels which is passively making road transport especially urban transport to be a significant contributor of greenhouse emissions. In the absence of suitable fiscal measures, the use of private vehicles is a non-reversible process (Taubenböck et al., 2009). Owing to this over-dependence on private vehicles, ten of the most polluted urban areas (of the world) are situated in India. Given this backdrop, alongside making provision for free flow of traffic, the carbon footprint of the urbanscape needs to be curtailed. Though the Indian government has initiated the National Urban Transport Policy (NUTP-2006), where the onus is on movement of people rather than vehicles, the primary focus of transport planners appears to be on constructing their way out of congestion, that is construct more roads.

For reducing the carbon footprint of urban transport, existing literature offers solutions in the form of compact and mixed development. However, due to the organic growth of Indian cities, the cities tend to have both compact and mixed development. Hence, it may be concluded that the alternative forwarded by existing literature fails to address the problems faced by the Indian urban scape. Hence, the likely solution to the Indian urban transport woes is promoting the use of non-motorized, non-personalized modes of transport. Non-motorized transport are those modes that do not use fossil fuels for its propulsion, that is walking, cycling, cycle-rickshaws, animal drawn carts and alike, while non-personalized transport indicates all those modes that are fuel efficient and have a very small per capita carbon footprint, that is, mass transport, intermediate public transport and alike. With the fast-increasing per capita incomes, vehicle ownership in urban India is on a skyward trajectory posing severe environmental concerns. Against this socio-economic and environmental background, this paper identifies factors that influence the use of a non-motorized, non-personalized mode of transport and looks at policy measures that can deter individuals from using private vehicles.

Having introduced the study agenda in the first section, the second section of the paper analyses transport in the context of the Indian urbanscape. Based on the observed mode shares and comparing it with the ideal modal proportion, a city that is likely to face a congested transport future is identified in the third section. In the fourth section, the need for a questionnaire, the process of scale development and the method of sampling are detailed, while the data is analysed in the fifth section. The results are discussed in the sixth section. In continuation of the same, implications for developing a sustainable urbanscape are elucidated.

A Brief Literature Review

The mobility crisis (Pucher et al.,2004; Pucher et al.,2007) in the urban centres may be attributed to the unplanned, haphazard development at the urban fringe (Dupont, 2007; Dutta, 2012). The peripheral growth of cities/urban areas is assumed to lead to urban core decay. In the context of Indian urban agglomerations, the aforementioned notion appears to be erroneous. The following paragraphs primarily focuses on urban transport in the context of Indian cities with over a million population.

A study by Gosavi et al.(2016) shows that the average urban density of the cities with over a million population far ex-

ceeds the densities observed in European and American urban agglomerations. Additionally, it has been postulated that unplanned urban growth leads to an increase in trip distance, while the scrutiny of the Census-2011 data reveals that more than two-thirds of the commute trips are for a distance less than five kilometers. Even after acknowledging the fact that this data pertains to urban areas as defined by the census office, the likelihood of the characteristics of the commute trip changing is unlikely. (The census office not only records the cities and urban agglomerations, but also standard urban areas as defined by Census-1971 and census towns. Here census towns are those settlements that satisfy the following three parameters: i) have a minimum population of five thousand individuals, ii) at least three-fourths of the male population is employed in a non-agricultural activity and iii) has a minimum density of four hundred individuals per square kilometre (400 persons/sq km)). The plausible reason for this submission is that according to a World Bank Report (Vishwanath et al., 2013) more than a third of the new towns are situated in the economic shadow region of an erstwhile city. Even with the inclusion of these towns more than half of the commute trips are for a distance that can be negotiated using non-motorized, non-personalized modes. Therefore, the inclusion of the latter two categories will not lead to a downward bias.

The dearth of a quality public transport along with a deficient infrastructure supporting non-motorized movements (Wilbur Smith Associate, 2008) is forcing people to shift towards modes that are perceived to be safer, that is, use of two-wheelers and cars (Rahul and Verma, 2013). Indian cities/urban agglomerations with over a million-population account for more than two-third of the two-wheeler stock and more than three-fourths of the cars sold (Saxena, 2016). India being an aspirational society, every increase in income leads to an exponential increase in vehicle ownership (Dargay et al., 2007). As a consequence, by 2020-21 four-wheeler ownership is likely to increase four folds and there would be around forty-eight cars per thousand. Similarly, two-wheeler ownership would increase more than three

folds and there would be around 393 vehicles per thousand (Sreedhar, 2011). According to a study by Mahendra et al. (2015), two-wheeler ownership is an intermediate phase, and with the passage of time, that is, with increase in PCI (per capita income), two-wheeler ownership is likely to be transformed into four-wheeler ownership. Increase in privately owned vehicles would result in vehicle speeds that are far below the fuel efficiency norm (Wilbur Smith Associate, 2008). Indian urban scape is already facing pre-mature congestion (Pucher et al., 2007). With speeds, far below the fuel efficiency norm and an exponential increase in private vehicle ownership, the Indian urban scape is likely to become one of the most polluted. It is time that the primary focus of Indian urban transport and town planners shift to decongesting the urban roads.

To ensure smooth movement of vehicles, a recent study proposes constructing 19,000-25,000 kilometers and re-surfacing 2.5 billion square meters (sq. m) of urban roads (Sankhe et al., 2015). According to urban infrastructure benchmark, road density in an urban area ought to be 12.25 km/sq. km while at least 11 percent of the urban developed space must be roads (Ahluwalia, 2011). As of 2014, in comparison, the road density of Delhi, Mumbai, Kolkata, Chennai, Bengaluru and Hyderabad was 21.14, 3.31, 9.87, 6.52, 9.23 and 10.84 km/sq. km, respectively. Roads covered approximately 18 percent, 10 percent, 6 percent, 10 percent, 11.9 percent and 9.5 percent of the developed space. Unlike Delhi, both the road density as well as space allocated for road construction was far below the norm. It is thought that by constructing more roads the urban scape can be decongested, but observations contrary to this have been noticed (Pfleiderer and Dieterich, 1995). Considering that these cities have grown organically and that development of transport corridors lag human settlements, given the cost of resettlement, constructing more roads is an expensive proposition.

A study by Tertoolen et al.(1998) has shown that users of private vehicles are reluctant to use both public transport and non-motorized transport. This would mean that private vehicle users shifting to non-

motorized, non-personalized modes is less likely. From these inferences, it may be deduced that at the present rate of two-wheeler and car ownership, within a decade the urban roads would be transformed into virtual parking spaces (Sreedhar, 2011). It is interesting to note that urban congestion in India is occurring when vehicle ownership is a fraction of that observed in the developed world. In this context, transport planners and town planners will not have an easy way decongesting cities/urban agglomerations.

The other alternative for decongesting the urban scape is constructing transit system. Although, the average density of the cities/urban agglomerations appear to support heavy rail transit (hrt) or metro, the commute distances do not appear to support this. In terms of costs, constructing a pedestrian walk 1 km long and 2 m (meters) wide and a bike lane 1 km long and 3 m wide costs 1/350th and 1/12th the cost of constructing a metro line 1 km long (Fabian et al., 2010). Keeping costs constant that is equal to cost of constructing a kilometre-long metro line, the carrying capacity of equivalent pedestrian walks and bike-ways would be 840,000 and 705,000 individuals respectively (Fabian et al., 2010). Since walking and cycling facilitate last mile connectivity, investing in infrastructure supporting these modes would surely reduce the carbon footprint of urban transport and make the urban transport sustainable. This transformation is possible if and only if these investments prompt mode shifts from personalized modes to transits including non-motorized modes. Non-motorized transport (NMT) not only provides last mile connectivity, but the infrastructure catering to non-motorized modes also has a bearing on public transport patronage.

Over the last two decades, neither the quality nor the level of service of public transport has improved (Pucher, 2004; Singh,2005). This inference has been drawn from the fact that a mere 1 percent of the total vehicle stock constitutes public transport vehicles (Saxena, 2010) and that public transport ridership is estimated to vary between 3 percent and 44 percent (Wilbur Smith Associates, 2008). In this context, it may be deduced that the

reduction in public transport ridership requires to be viewed in the context of deteriorating quality of infrastructure catering to both, public transport services and non-motorized modes. Nonetheless not many studies attempt to investigate these interlinkages. Presently, transport policies implemented in Indian urban areas appear to be piecemeal and mode specific that is improvement in public bus transport etc. As a result, improvements in public transport may not directly improve modal shares (Poudenx, 2008). A recent newspaper article confirmed these apprehensions. Over the last five years (2009-2014), the ridership of Ahmedabad BRTs had fallen by 18 percent (Kaushik, 2015) and the utility 'Janmarg' has been incurring a loss of around 600 million Rupees (~60 crores). This phenomenon indicates the possibility of other factors influencing the use of a non-personalized mode. Given this background and for understanding the factors that are likely to influence the use of non-motorized, non-personalized modes, in the next section, a city/urban agglomeration that suffers from or is likely to suffer from private vehicle bias has been identified.

City Selection

This section identifies a city/urban agglomeration that is likely to face a congested urban future. In a study commissioned by the Ministry of Urban Development in 1998, titled 'Traffic and Transportation policies and strategies in Urban Areas in India,' larger cities were classified into three segments namely cities having a population between one-two million, two-five million and population in excess of five million, while in the subsequent study (study conducted by Wilbur Smith Associates, 2008), larger cities were classified into four segments namely cities with a population between one-two million, two-four million, four-eight million and cities with a population in excess of eight million. Even though the latter study has provided the indicative mode shares for these categories, this study does not draw up a desired range of commute modes. In a similar context, the former study has primarily differentiated the modes into three classes namely mass transport, cycling and other modes, while the study conducted in 2008 differentiates the modes into six categories. These cate-

gories are walking, cycling, two-wheelers, public transport, cars and Intermediate Public Transport (IPT). For making the results comparable, walking, public transport and IPT have been considered under the class of mass transport, while modes facilitating private mobility such as two-wheelers and cars have been clubbed together under the category of other modes. Walking is an integral part of any and every trip. More so, walking becomes a dominant feature of the last mile connectivity in trips undertaken using mass transport. Due to the smaller carbon footprint of IPT viz private modes, IPT is considered a part of mass transport.

A study by Gosavi et al. (2016) has shown that there exists a progression in transport planning that is, depending on the size and the density of the city, transport systems need to be developed. Conversely, it may be inferred that the present transport problems are not incidental, but tend to be routed in the growth of the city (Dupont, 2001; Pucher et al., 2007; Pucher et al, 2004; Sreedhar,2011; Wilbur Smith Associates, 2008). This would mean that mode proportions similar to those observed in the category of cities having a population between two-four million may be seen in cities that are on the cusp of crossing into the two-four million population category.

Sr no.	Category	Mass Transport*	Mass Transport (after removing IPT) *	Desired	Cycling*	Desired	Other modes*	Desired
1	1-2 million	45	37	50-60	19	20-30	36	15-25
2	2-4 million	41	35	60-70	18	15-25	41	15-20
3	4-8 million	53	46	65-75	11	15-20	36	10-20
4	8million	73	66	70-80	8	15-20	19	10-15

Table 1: Ideal mode proportions for the different city categories
Note: '*' implies figures taken from [8] and RITES (2007). The above proportion is in terms of percentages.
Source: adapted from the commissioned report titled Traffic and Transportation Strategies and Policies in Urban Areas in India.

Extrapolating the desired mode proportion from the 1998 study and contrasting it with the observed mode proportion of the 2008 study, it may be inferred that urban transport is on an unsustainable course. Additionally, it may be commented that with the exception of cities having a population in excess of eight million, the mass transport proportion fall far short of the norm. In case IPT is excluded from mass transport, this class of cities also appear to be unsustainable. On scrutinizing the mode proportions in Table-1, it is observed that with an increment in the city category (increase in the population of a city), the ideal proportion as well as the observed share of mass transport increases. This rule is violated in the case of cities having a population between two-four million.

In consideration of all these facts, an attempt to identify such a city is undertaken in the next subsection.

City Selection Criteria

For identifying the city/urban agglomeration to be studied, four parameters were considered. These parameters are a) a population asymptotically less than 2 million (20 lakhs), that is, UAs with a population above 1.75 million, b) more than half the population residing in the primary city of the urban agglomeration, c) documented history of non-motorized transport, and d) a high economic growth potential supported by documentary evidence.

Only three urban agglomerations satisfied the first condition. These UAs are Bhopal, Thrissur and Vadodara. On applying

the second condition, Thrissur had to be eliminated as more than 80 percent of its residents lived outside the primary urban settlement. For the third parameter, that is history of non-motorized mobility, both Bhopal and Vadodara fared equally well. The primary differentiating factor between Bhopal and Vadodara was high growth potential. Unlike Bhopal, Vadodara is forecast to be one of the next megapolis of India (Brar et al., 2014; Sankhe et al., 2010). Thus, for the case study of a mid-sized city, the city of Vadodara was chosen.

The case of Vadodara becomes interesting as this city has been the first to experiment with a public-private partnership in public transport. Besides, the city has been nominated for the smart city project. In addition, India Today Survey of 2013 ranked Vadodara as the topper in the emerging cities category. The parameters considered were the quality of classrooms, expenditure on education, crime rates, economic growth and investment generating potential.

In terms of geography, the city has a location advantage. It is an important hub on the Delhi-Mumbai rail freight corridor and an important chemical industry centre on the Vapi-Ahmedabad industrial belt. Further, it may be noted that Vadodara UA is the third largest agglomeration of Gujarat and is considered the cultural capital of Gujarat.

Over the last two decades, the area under Vadodara Urban Development Authority has increased from 108 sq. km to 162.61 sq. km. These revisions took place in 1996 and 2012, respectively. On scrutiny of the municipal and town statistics, it was observed that the area under the jurisdiction of Municipal Corporation had steadily increased from 133 sq. km (as of 2002) to 162.61 sq. km (as of 2012). This increase was sequential, that is, land under Municipal Corporation jurisdiction increased by 15.95 sq. km in 2005-06 and in the subsequent revision, the land under the municipal corporation was increased to 158.7 sq. km. These revisions were carried out without changing the master plan. This indicates absorption of already developed area/areas into the jurisdiction of Vadodara Municipal Corporation.

This unplanned development has led to a gap between the proposed development and the actual growth of the city (Dutta, 2012). As a result, transport corridors are being developed much after human settlements. This unplanned growth is resulting in extensive use of private vehicles. In this context, the next section examines the vehicle growth trends.

Road Infrastructure and Vehicle Ownership Trends in the city of Vadodara

'Road' is a generic term used not only for the carriageway, but also the pedestrian walks, road separators, traffic signals and any such construction including any furniture that facilitates movement of people. With an understanding of this definition, road construction norms were examined. Subsequently, the present status of Vadodara's roads was compared with the norm.

According to the norm, the road density for cities with a population in excess of a million ought to be 12.6 kms/km2 while 11 percent of the urban area should be roads (Ahluwalia, 2011). Besides, roads are expected to follow a hierarchy in terms of the width of roads, that is, an expressway ought to be 90-metre-wide while an arterial road, sub-arterial road and a distributor road must be 60 metres, 30 metres and 15 metres wide, respectively (Brar et al.,2014) This width includes both, a pedestrian walk on either side as well as a road separator. In addition, the norm states that there must be a graded crossing after every 150 metres. In case a graded crossing cannot be provided, provision for an under bridge/over bridge is required (Indian Roads Congress, 1990). As per the statistics of Municipal towns and cities (Hudda, 2014) the total road length under the jurisdiction of Vadodara Municipal Corporation was 1,068.86 kilometres and the area under Vadodara Municipal Corporation as per the 2012 revision was 163 square km; this indicated a road density of 6.55 km/square km, which was approximately half that of the norm. As stated in the introductory lines of this section, 'roads' is a generic term that includes footpaths and signalled crossings. Referring to this, the present status of infrastructure catering to pedestrians was analysed. According to the records of Va-

dodara Municipal Corporation, there are no specific rules for constructing footpaths and they are constructed on an as-and-when basis. This fact corroborates the findings of Sreedhar (2011) and Wilbur Smith Associates (2008). In the context of pedestrian safety, at present Vadodara has only 32 signalled crossings or a crossing for every 33 kilometres, a distance incomprehensible on feet. This would mean that pedestrians are sharing their right of way with fast-moving vehicles. This phenomenon is likely to result in further increase in the use of private vehicles (Rahul and Verma, 2013) and would feed into the vicious circle of vehicle ownership. The private vehicle ownership proportions support this proposition. Two-wheelers (77.17 percent) and cars (12 percent) constitute around ninety percent of the vehicle stock of Vadodara city (Saxena, 2016). Over the last five years (2013-2017), the two-wheeler stock grew at a compound annual growth rate of around seventeen percent, whereas the stock of cars increased at twenty percent.

From the road transport year book 2011-12 and Census of India-2011, two-wheeler, car and aggregate vehicle density (density is measured as vehicles per thousand individuals) in Vadodara was estimated to be 387, 56 and 504, respectively. On comparing vehicle densities to the projections of the 12th Five-Year Plan (2012-17), it can be observed that vehicle ownership had already breached the projected vehicle density.

The above discussion reveals that road provision for 60,000 two-wheelers and 10,000 cars would have to be done every year. Assuming road space requirement of 40 m2 for a car and 10 m2 for two-wheeler, this translates to a road provision of around 1,000,000 m2 or 1km2 every year. In standard road dimensions, this provision is equivalent to constructing 10 kilometres long and 100 metres wide road or road space equivalent to a road 33 km long and 30 m wide. At the present rate, the existing road infrastructure would get exhausted within a decade, that is get converted into parking spaces. Given this mismatch between road construction rates and increasing private vehicle ownership, Vadodara seems set for a congested fu-

ture. In case, the town planners intend to implement the proposals of Angel et al. (2011), wherein cities are expected to construct a maze of arterial roads a kilometre apart, the city of Vadodara would have to add another 98 kilometres of roads and increase the area under roads by 9.8 sq. km. Despite these proposals, whether these newly constructed roads can compensate for the above-mentioned mismatch or whether these roads would induce new traffic (Pfleiderer and Dieterich, 1995) remains a pertinent question. Existing facts show that road expansion for facilitating private vehicles may not be a viable strategy.

What do the commute trips reveal?

For understanding the travel dynamics in the city of Vadodara, commute trips are considered. Here commute trips are trips undertaken for accessing jobs and do not include other trips like trips undertaken for accessing education and alike. From Figure 1, it is observed that of the 657,456 (six hundred fifty seven thousand four hundred and fifty six)trips (the unit of analysis is the individual), a fifth (20.12 percent) of the population does not need to commute, while approximately 40 percent of the population commutes for a distance of less than five kilometres. Thus, it may be inferred that approximately 62.03 percent of the population commutes for a distance that can be travelled using non-motorized modes such as walking, cycling (Angel et al., 2011) and alike.

On scrutinizing the modal proportion, it is observed that two-wheeler dominates the modal share of a bit less than a third of the trips, followed by cycling (20.92 percent), walking (17.75 percent), bus (7.18 percent), four-wheelers (5.53 percent), intermediate public transport like rickshaws and tempo (5.30 percent), trains (2.12 percent), other modes (0.63 percent) and water-ways (0.04 percent). It is thought that for urban transport to be on the environmentally sustainable trajectory at least sixty percent of the commute trips ought to be done using non-motorized, non-personalized modes, that is, walking, cycling, bus, intermediate public transport and alike. In the context of Vadodara, it is observed that the modal share is asymp-
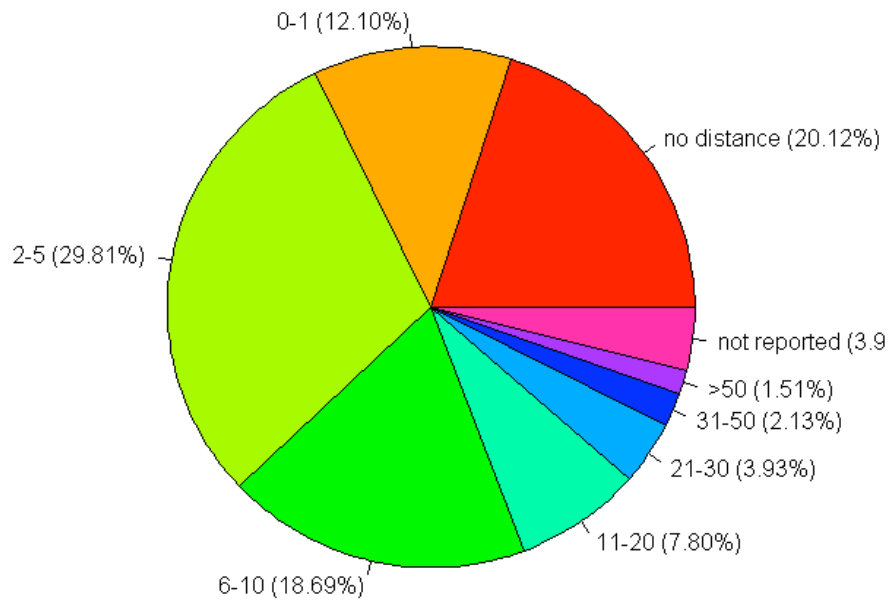
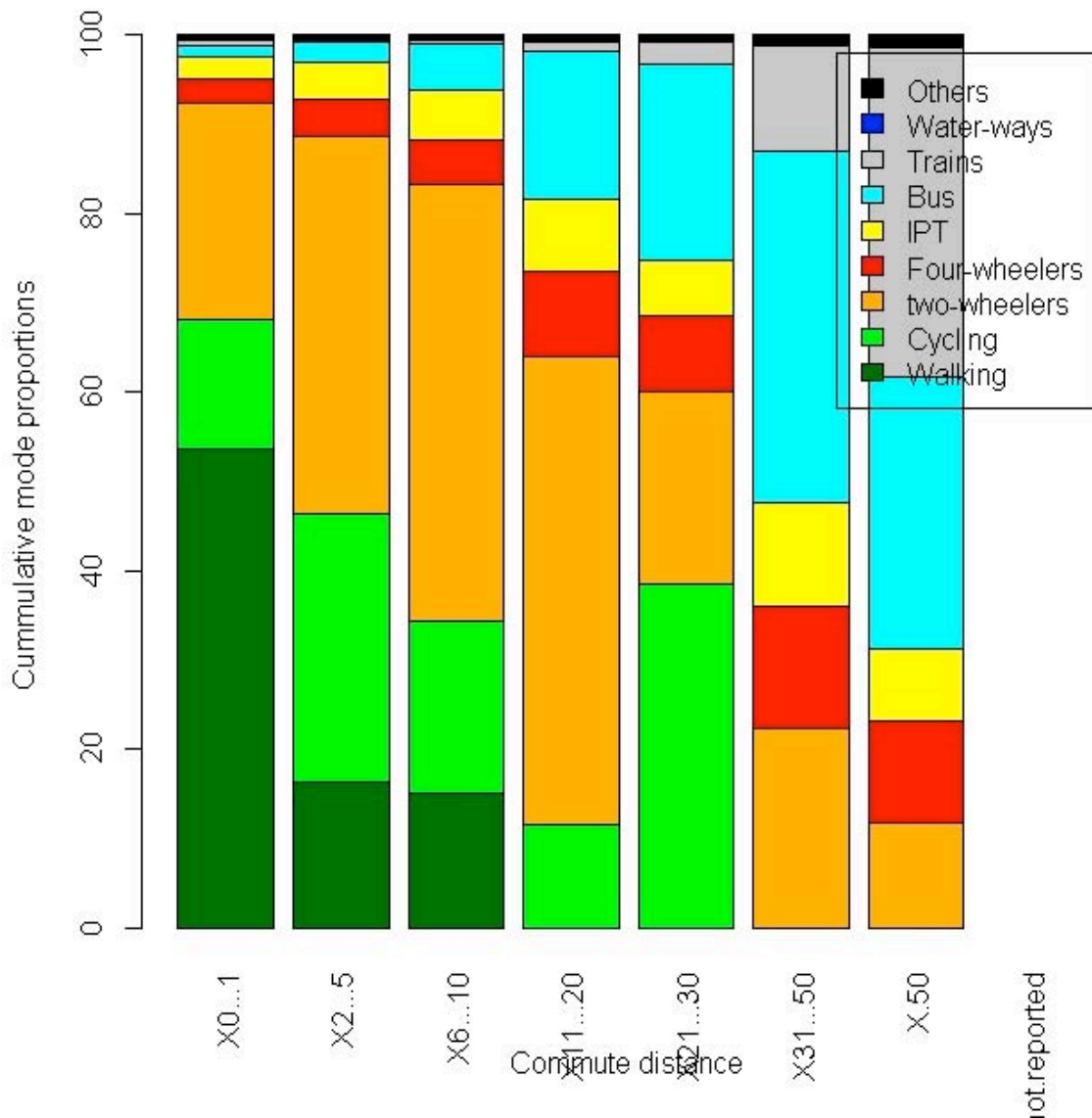**Figure 1:** Proportion of distance covered in commute trips (in kilometres)

Figure 2: Percentage of commute trips undertaken using different modes

totically close to this bench mark, but with time, the modal proportions are likely to diverge, that is, use of privately owned vehicles would increase. To ensure such detrimental changes to modal proportions do not occur, infrastructural requirements need to be assessed. For recognizing this, mode share for different commute distance intervals have been analyzed.

It may be reckoned that the commute data has been taken from Census-2011 and only the commute distances for Vadodara (urban) have been compared. From Figure 2, it is observed that for a distance of up to a kilometre, walking was the preferred mode (53.52 percent) followed by two-wheelers (24.43 percent), cycling (14.57 percent), four-wheelers (2.71 percent), IPT (2.61 percent), bus (1.19 percent), trains (0.64 percent), other modes (0.46 percent) and finally water-ways (0.05 percent). In contrast to the modal share for a distance up to a kilometre, the mode share preference for distances between 'two to five kilometres appear to have changed marginally. Two-wheelers have become the preferred mode (42.40 percent) of transit. This is followed by cycling (29.96 percent), walking (16.36 percent), four-wheelers (4.17 percent), IPT (4.11 percent), bus (2.25 percent), other modes (0.47 percent), trains (0.25 percent) and water-ways (0.02 percent), while for distances between six to ten kilometres, two-wheelers still remain the preferred mode (48.81 percent), followed by cycling (19.31 percent), walking (15.11 percent), IPT (5.56 percent), buses (5.26 percent), four-wheelers (5.06 percent), other modes (0.49 percent), trains (0.38 percent) and water-ways (0.02 percent). For a distance between eleven to twenty kilometres, two-wheelers still remain the preferred mode and the mode share increases to more than half. This is followed by cycles (11.46 percent), four-wheelers (9.56 percent), bus (16.53 percent), IPT (8.00 percent), trains (1.12 percent), other modes (0.72 percent) and water-ways (0.04 percent). For commute distances between twenty-one to thirty kilometres, an anomalous behaviour is observed. Cycling becomes a preferred mode and the mode share of cycles is a bit more than a third of the total mode share, that is, 38.46 percent. This is followed by bus (22.05 percent), two-

wheelers (21.62 percent), four-wheelers (8.39 percent), IPT (6.27 percent), trains (2.51 percent), other modes (0.67 percent) and water-ways (0.03 percent).

On scrutinizing the commute distance modal proportions, it is observed that for distances between thirty-one to fifty kilometres, bus becomes the preferred mode. The mode share of bus is a bit less than 40 percent (39.31 percent). The share of two-wheelers is a bit more than a fifth (22.36 percent), followed by four-wheelers (13.66 percent), train (11.86 percent), IPT (11.58 percent), other modes (1.14 percent) and water-ways (0.10 percent). With increase in distance, it appears that train becomes the preferred mode, that is, for commute distances in excess of 51 kilometres, the mode share of trains is more than a third (36.88 percent). This is followed by bus (30.44 percent), two-wheelers (11.79 percent), four-wheelers (11.28 percent), IPT (8.13 percent), other modes (1.35 percent) and water-ways (0.14 percent). Census-2011 has made a separate category for individuals who have not stated their commute distances. This data reveals that more than half of such trips used two-wheelers (53.09 percent), followed by bus (12.49 percent), train (12.16 percent), IPT (10.52 percent), four-wheelers (9.35 percent), other modes (2.17 percent) and water-ways (0.22 percent). The absence of walking and cycling in this category shows that commute trips using these modes have a specific origin/destination. Developing infrastructure for these modes would be relatively easier.

Scale Development and Sampling

For urban transport to become sustainable, mode shares require to be reversed, that is, public transport must substitute the private vehicles and must become the preferred mode. In the second section, it was recognized that improvements to public transport may result in Frieborgh-like public transport paradoxes, that is, improvement to public transport did not lead to a change in the mode share of private vehicles, but pedestrians and cyclists started to use public transport. To avoid these paradoxes, the present section attempts to understand the factors that influence the use of a non-motorized, non-

personal mode of transport. Additionally, from the scrutiny of pertinent literature, it was observed that studies on sustainable urban transport tends to be non-holistic, that is, mode-specific. As a consequence, a pre-tested questionnaire for identifying factors that influence use of a non-motorized, non-personalized mode of transport was not available and hence, a need for developing such a questionnaire was felt.

Questionnaire design
Using principal component analysis (PCA), eight factors that influence the use of the bus in the city of Edinburgh were mined Strandling et al.(2007). These factors were extracted from a larger set of 68 items. These factors were safety, preference for walking or cycling, problems with service provision, unwanted arousals (for example, crowding-related), preference for the car, bus fare, disability and discomfort, and self-image. A study by Ismail et al. (2012) identified three variables that influenced public transport preference in Malaysia. These variables were convenience, comfort and quality of service. On further scrutiny, it was observed that the top four attributes that influence overall customer satisfaction are frequency, a comfortable travel experience, on-board security and travel time. A study by Das and Pandit (2013) shows the need to identify the attributes of quality of service in India's urban bus transport. In addition, this study states that customer preference can be improved by working on these identified attributes.

A majority of the studies undertaken for understanding attributes influencing the use of transit have primarily concentrated on the quality of service and level of service of transit, but have not investigated the influence of quality of infrastructure supporting Non-Motorized Transport (NMT) on transit. Besides, from a review of the literature, it was deduced that the quality of infrastructure catering to the use of non-motorized modes is likely to have a bearing on transit. Hence, this investigation is required as the sustainable transport triad incorporates walking, cycling and transit, wherein walking and cycling must provide the last mile connectivity and that such comprehensive studies have not been done in the context of India. Hence, it becomes

necessary to understand the perception about the infrastructure supporting NMT, as well as preferences for non-motorised modes. Thus, for understanding the dominant factors influencing the mode choice, the need to design a questionnaire was felt. The questionnaire attempts to capture the quality of infrastructure catering to non-motorized movement, that is, walking and cycling.

Unlike Edinburgh or Malaysia, Vadodara's bus service is very weak and the mode share of 'bus' is a mere 4 percent. Therefore, the context of the questionnaire had to be developed in this perspective. Additionally, the construct 'safety' had a different connotation, that is, in Edinburgh, safety was in terms of alcohol use while the said problem does not exist in Vadodara (Gujarat being a dry state, alcohol consumption is banned in Gujarat). Safety in the context of Vadodara was defined as the likelihood of or perception about petty thefts while using public transport. Comparing Vadodara with cities having a good non-motorized infrastructure is difficult. Not only is the infrastructure underdeveloped, the city faces extreme weather conditions. These factors may have a direct bearing on the use of non-motorized modes. Thus, it may be suggested that use of these modes is not optional, it is rather compulsory. Consequently, questions that attempt to capture perceptions about infrastructure supporting NMT modes and its use are incorporated.

After reviewing the literature and discussing the constructs with town planning and transport experts, constructs like quality of infrastructure catering to non-motorized transport, quality of service provided by the transit service provider, income, age and other family attributes, individual preferences towards time required to wait for transit and distance that an individual is ready to walk to access transit were found to be important. Taking these constructs into account, detailed interview with five individuals who had used public transport was carried out. Based on these inputs, a questionnaire with 30 items was designed for understanding the factors that influence the use of a non-motorized, non-personalized mode of transport.

The questionnaire was divided into two parts; the first part was for collating demographic information such as age, income, number of adults in the family, number of vehicles owned, and number of license-holders in the family. In the second part, information about the nature of trip, whether the employer/parents pay for the trip and preference for the non-motorized, non-personalized mode of transport was asked. For checking the consistency of the questionnaire and to affirm that the questions were understood, pre-testing was done by administering the questionnaire to 30 individuals and the Cronbach's alpha was estimated. The value of the Cronbach's alpha was 0.67, which can be considered satisfactory. This showed that the questionnaire was consistent. Ensuing the testing and consultations with academicians and town planners and transport professionals the questionnaire was finalized. Three questions of the original questionnaire were found to be redundant and were dropped. The finalized questionnaire had twenty-seven questions. Seventeen questions used the five point Likert scale. The five-point Likert scale was preferred as this best resembles the normal distribution with the least number of options.

Sampling
Random sampling was used to collate the information. To ensure equiprobable participation, the questionnaire was administered within half a kilometre of a bus stop. Literature cites this distance as a non-motorized-friendly distance that people are ready to walk.

To administer the questionnaire, direct and postal modes were used. The latter option was exercised only in those cases where the respondent cited lack of time to participate. For the postal mode, a post box was hired for the duration of six months and a prepaid stamped envelope was given to the interested respondents. Of the 225 questionnaires distributed 150 questionnaires were received (a response rate of 67percent).

Analysis of data

To ensure that the respondent did not fill the questionnaire without understanding the question, question number 10 was reversed. It was assumed that question number 10 and question number 25 were to be used as check points. This assumption was made as question number 10 pertains to non-use of the municipal bus service, and such individuals will not wait for the bus (question number 25). In case inconsistent responses were received for the check questions, the instrument/response was removed. In addition, questionnaires which were partially filled and or had central bias were also removed. Only 104 responses were found suitable for the analysis. The value of Cronbach's alpha was 0.732. This value of alpha is considered to be satisfactory and shows that the instrument tends to capture the underlying variables.

Figure 3 graphically shows the age structure of the sample. The largest stratum of
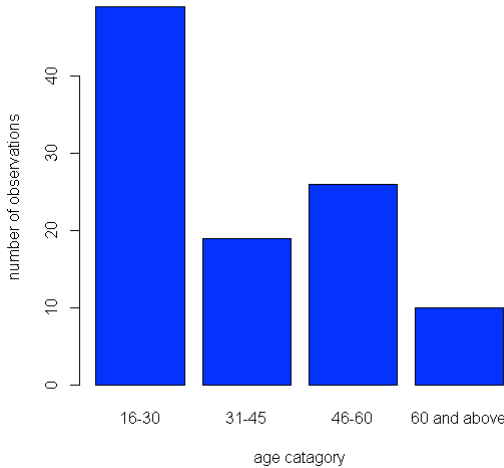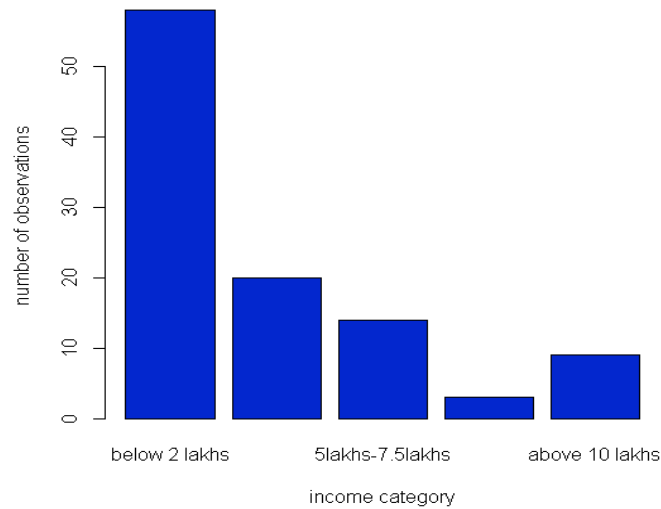

Figure 3: Age profile of respondents

Figure 4: Income profiles of the respondents

the sample was of the age group 16-30, which comprised of 47.11 percent while the smallest group was of the age group 60 and above comprising of 9.61 percent. Demographically, there was an under-representation of the age group 31-45, which constituted only 18.27percent of the sample. This can be attributed to the non-participation in the use of non-personalized, non-motorized modes.

The income structure of the sample is illustrated in Figure 4. A bias was observed towards the less than two hundred thousand income category. This constituted 55.77 percent of the sample size. This

higher proportion could be attributed to the student population that constitutes a major proportion of the age category 16-30 years.

To test for sample adequacy, the response matrix was subjected to the Kaiser, Meyer and Olkin (KMO) statistics and the Bartlett's test. The value of KMO was computed to be 0.62, and hence, the number of respondents was considered to be adequate. The p-value of the Bartlett's test was estimated to be 2.2*10-16 <0.01 meaning thereby the response matrix could be subjected to factor analysis.

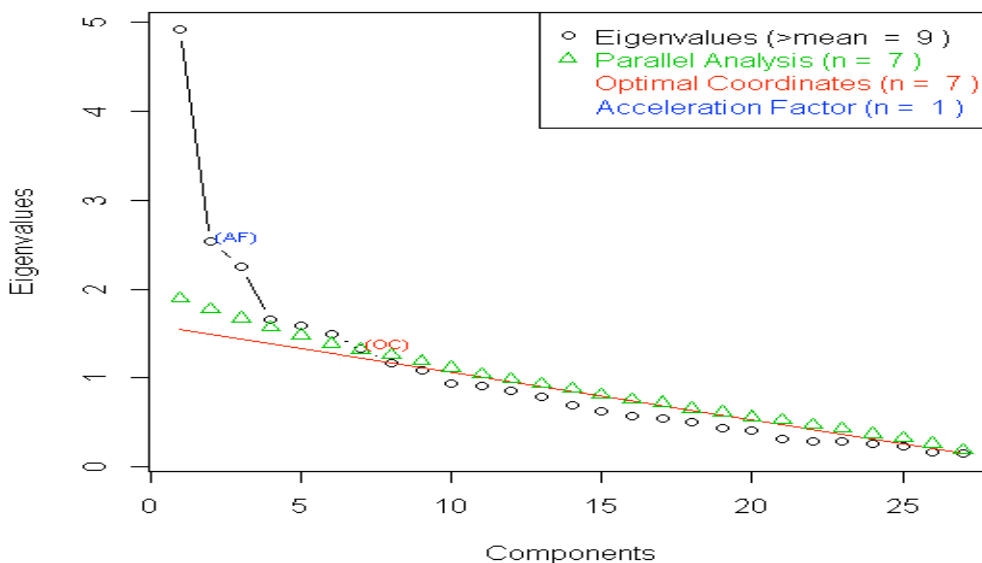As no a priori theoretical relations had

Figure 5: Results of scree plot and parallel analysis

been identified, exploratory factor analysis (EFA) was administered on the response set. As mentioned earlier, question numbers 10 and 25 were an attempt to capture the same underlying variable and hence, a subject to variable ratio of 3.8 was considered.

For identifying the number of factors to be retained, the Eigen values were computed and the response matrix was subjected to parallel analysis (Ledesma and Valero-Mora, 2007). Figure 5 shows the results of the analysis.

Nine values (factors) matched the Kaiser test (Eigen value>1), but the extracted factors need not be the optimal values. Therefore, the response matrix was subjected to parallel analysis and acceleration factor (elbow of the plot) analysis. Values on and above the line were considered as the optimal number of factors. This result was used for setting the factor extraction threshold. Using these results, exploratory factor analysis was conducted (Refer Appendix). The cumulative variance explained by these seven factors was 46.2percent.

On the basis of factor loadings, the items were re-arranged under these seven factors (See Table 2).

Of the above item separation, the following items had cross-loadings on multiple factors (see Appendix A):
• Age, which was loaded on Factor numbers 1, 2, 6 and 7 with factor loads of 0.133, -0.435, 0.291 and 0.483

• Number of motorized vehicles, which was cross-loaded on Factor 1 (0.460) and Factor 4 (0.538)
• Trip expense payment, which was loaded on Factor 1 (0.344), Factor 3 (0.333) and Factor 4 (0.223)
• Bus comfort loaded onto two factors, namely, Factor 1 (0.333) and Factor 7 (0.144)
• Bus-stop information loaded on three factors, namely Factor 1 (0.313), Factor 2 (0.408) and Factor 7 (0.220)
• Public transport use loaded on four factors, that is, Factor 1 (0.451), Factor 2 (0.386), Factor 3 (0.446) and Factor 7 (0.286)
• Footpath encroachment had a cross-loading on three factors - Factor 2 (0.162), Factor 3 (0.154) and Factor 6 (0.148)
• In-bus space loaded on Factor 3 (0.211) and Factor 2 (0.112)
• Public transport information on mobile loaded on two factors, that is, Factor 1 with a loading of (0.495) and Factor 2 (0.370)
• Preferred bus stop distance with a cross-loading on two factors, which were Factor 5 (0.486) and Factor 2 (0.344)
• Cycling preference loaded heavily on Factor 7 (0.359), Factor 3 (0.218), Factor 4 (0.180), Factor 5 (0.219) and Factor 6 (0.173)

Cross-loadings with a difference less than 0.2 imply that the extracted pattern is unclear.

Factor Number	Items under the factor
1	Bus-stop demarcation, Public transport efficiency, Public transport use, Footpath condition, Walk Preference, In bus safety, Information on mobile, Footpath infrastructure, Bus comfort
2	Public transport disenchantment, Bus-stop information, Footpath encroachment
3	Waiting time, Footpath disenchantment, In bus space, Laziness
4	Number of adults, Number of vehicles owned, Number of license holders
5	Waiting preference for bus and preferred distance for bus-stop
6	Income
7	Age, Kilometres per week travelled, Trip category, Cycling preference and road conditions

Table 2: Factor separations and underlying constructs

Factor Number	Items under the factor
1	Bus-stop demarcation, Public transport efficiency, Footpath condition, Walk Preference, In bus safety, Footpath infrastructure
2	Public transport disenchantment
3	Waiting time, Footpath disenchantment, Laziness
4	Number of adults, Number of license holders
5	Waiting preference for bus
6	Income
7	Kilometres per week travelled

Table 3: Factor structure after removing cross-loaded items

Table 3 depicts the new factor structure. This factor structure was derived after removing items with substantial cross-loading.

• Items loaded on Factor 1 represented the physical infrastructure while items loaded in Factor 2 were indicators of public transport disenchantment.

• Factor 3 encompassed variables like waiting time, footpath disenchantment and laziness. These factors are indicators of private vehicle preference.

• Factor 4 relates to family size. The items that cluster in this factor are number of adults in the family and number of license-holders. It can be inferred that the dearth of a quality public transport in Vadodara is increasing the need for owning a vehicle and a crucial pre-requisite to ownership is possessing a driving license.

• The variable that loaded in Factor 5 is a preference for waiting for a bus. This item denotes features related to reliability of public transport service.

As inferred from the literature, income plays an important role in not only determining vehicle ownership but also transport mode choice. 'Income' loaded independently of all the other variables in Factor 6 while Factor 7 had variable like average kilometres travelled per week. This would mean that not only the bus service ought to be reliable but should be able to cater to longer distances with the same reliability and comfort of a private mode.

As realized from the mode shares, even after five years of the reintroduction of the bus service, the mode share remained imperceptible at 4 percent. For increasing the mode shares of public transport, the seven identified factors would have to be con-verted into an actionable strategy. Literature classifies these actionable strategies into two broad classes, which are pull and push, also called as incentives and penalties. It may be recalled that in Section 3.2, it was observed that car density in Vadodara was 48 cars per thousand, that is, the projected density for 2021. Although as of 2012, two-wheeler density was below the 2021 projections at 333 per thousand, at the present growth rate of 8 percent the same would have surpassed the projections by 2015. This indicates that vehicle ownership needs to be curtailed.

The policy recommendations need to be based on the factors identified by the factor extraction exercise. At an aggregate level, one can classify the policy recommendations into two broad categories, namely improvements to public transport and curtailment of private vehicle use.

If these factors are to be further delineated into specific action points, then Factors 1, 2 and 5 are specific to the public transport service quality and supporting infrastructure. For addressing these concerns, there should be a re-allocation of funds from investments focussed on road surface improvement to investments that account for improvements supporting public transport. Hence, these investments not only have to recognize the importance of pedestrian walks, that is, an infrastructure that works as a station/platform for the public transport but also recognize the importance of signalled crossings. The latter infrastructure helps in improving the reliability of the public transport facilities by creating mode priorities. Reliability of public transport embodies features like waiting time preference (factor 5) or alternatively, quality of service is one of the identified factors affecting transit ridership.

Although Factor 3, 4 and 6 are dimensions that have a direct influence on vehicle ownership, 'one shoe fits all' approach cannot be used to reduce vehicle ownership. 'Income' as a factor not only influences vehicle ownership but is one of the key factors influencing both - the use of non-motorized modes, as well as public transport ridership- through the vehicle ownership demonstration effect. To curtail the latter effect, the perception of the use of non-motorized modes and transit needs to undergo a facelift. In other words, it must change from being modes of the poor to being modes of universal mobility. Likewise, to address income-induced demonstration effects, fiscal policies need to be envisaged.

Considering that the automobile sector has one of the largest forward and backward linkages, rather than the policy being restrictive in ownership, the policy ought to be restrictive in the use of private vehicles. As a result, these policies would not only help in curtailing private vehicle use but also create an avenue for subsidizing transit. As observed in the third section, the roads of Vadodara do not follow specifications, that is, they do not follow a hierarchy. Therefore, policies like congestion charging cannot be implemented in the short to the medium horizon. Further, as observed in Section 2, urbanscapes suffer from space constraints. In a similar context, it may be inferred that at the present rate of vehicle ownership growth, within a decade, the urban roads of Vadodara would be converted into virtual parking spaces. From these facts, it may be deduced that parking fees linked to a space scarcity index have a potential to curtail vehicle use. This would not only free up road space but would also increase the reliability of transit over longer distances and address concerns raised by Factor 7, that is, reliability of transit system over longer distances.

Conclusion

Historical mistakes like discontinuation of municipal bus services, expansion of road infrastructure at the cost of pedestrian walks and a non-existent policy for development of cycling infrastructure and promotion of cycling as a sustainable mode has led to the present urban transport woes.

Walking is an integral part of every trip, i.e., every trip begins and ends with walking. Even with this realization, the city authorities have not constructed proper pedestrian walks. According to the civic authorities, pedestrian walks are constructed on an as and when basis. Additionally, there is a paucity of graded crossings, foot-over bridges etc. This may be one of the reasons for the exponential increase in two-wheeler ownership. In addition, the present study reveals that pedestrian walks and infrastructure supporting pedestrian mobility has an influence on the success of public transport. In this backdrop, for the city to embark on the sustainable mobility trajectory, the first step is to follow the pedestrian walk norms of the Indian Roads Congress (ICR-1988), wherein the minimum width of a footpath was five feet and a graded/non-graded pedestrian crossing was to be provided after every 250-350 meters.

Even though, cycling was and is an important mode catering to trip distances upto 20 kilometres, cycling infrastructure in the form of cycling lanes, speed calming measures, exclusive right of way for non-motorized transport were not proposed. This has led to cycles (a slow moving mode) sharing the right of way with fast moving vehicles like cars, motorized two-wheelers and other heavy vehicles. Consequently, this has led to the increase in perception of threat, making cycling a mode of the underprivileged. For changing this perception, separate/wide lanes where vehicles cannot intrude need to be planned. Considering that cycle lanes and its planning were never a part of the planning process, planning and constructing this infrastructure is likely to be a daunting task. Therefore, micro-planning of transport infrastructure is required. For this ward level commute data which the Census of India-2011 has collated needs to be analysed and accordingly specific areas of the old city can be cordoned-off, while for greenfield developments in the periphery of the city rules for cycle lanes similar to Indian Roads Congress norms for pedestrian walks ought to be developed.

From the analysis seven factors that are likely to influence the use of a non-motorized, non-personalized mode of transport in Vadodara were identified. The analysis of these items and the present state of infrastructure reveal that the municipal authorities including the urban development authority need to re-define policy facilitating use of non-motorized, non-personalized modes of transit. The policy needs to re-think the idea of public transport as neither the present public transport infrastructure nor the level of public transport service match the expectations of the residents of city. In addition, the density of the city far exceeds the carrying capacity of buses. This would mean that for undertaking an image transformation of public transport, light rail transit or a similar system that will be able to match the expectation of the residents would have to be introduced.

From literature it is observed that private vehicle ownership and use are an irreversible process/habit, i.e., shifting to use of non-personalized, non-motorized modes requires a nudge in the form of incentives and penalties. Thus, for mode shifts to occur, fiscal policies, too, would have to be developed as income appears to play a significant role in influencing the use of or alternatively the non-use of non-motorized, non-personalized modes.

Based on the identified factors and the prevailing infrastructural conditions in the city of Vadodara, parking fees linked to scarcity of land is proposed. This policy is likely to result in freeing up of road space to improve the reliability of transit, as well as assist the local government in generating funds for revamping the non-motorized infrastructure, provide cross-subsidy to transit users, curtail the use of private vehicles and nullify income-linked demonstration effects related to vehicle ownership.

It may be reckoned that every city/urbanscape is unique in its characteristics and that the factors are likely to vary. Hence, for the Indian urbanscape to embark on the sustainable urban transport trajectory, similar studies need to be carried out across the Indian urbanscape. This would not only allow transport professionals to exploit regional synergies, but would give new insights about developing sustainable urban transport and its likely trajectory. Further with the Census-2011 collating ward level commute data and its availability, micro planning of mode priorities can be carried out.

Author details:
Corresponding author
Dr. Nachiket Sharadchandra Gosavi
Sardar Patel Institute of Economic and Social Research (SPIESR)

Email:
nachiket.gosavi@gmail.com

Dr. Lakshmikanth Hari
K.J. Somaiya Institute of Management Studies and Research

Prof. Dinesh S Hegde (Retd.)
National Institute of Industrial Engineering (NITIE)

References
Ahluwalia, I. J. (2011): Report on Indian Urban Infrastructure and Services. New Delhi: Planning Comission. Government of India.

Angel S, Parent J, Civco D.L and A.M. Blei (2011): Making room for a planet of cities.Lincoln Institute of Land Policy, Cambridge.

Brar, J., Gupta, G., Madgavkar, A., Maitra, B. C., Rohra, S., and M. Sunder (2014): India's economic geography in 2025: states, clusters and cities—identifying the high potential markets of tomorrow. New Delhi, McKinsey Global.

Dargay, J., Gately, D., and M. Sommer (2007): 'Vehicle ownership and income growth, worldwide: 1960-2030', The Energy Journal, 28 (4), 143-170.

Das, S., and D. Pandit (2013): 'Importance of user perception in evaluating level of service for bus transit for a developing country like India', Transport Reviews, 33(4), 402-420.

Dupont, V. (2007): 'Conflicting stakes and governance in the peripheries of large Indian metropolises–An introduction', Cities, 24(2), 89-94.

Dutta, V. (2012): 'Land use dynamics and peri-urban growth characteristics: Reflections on master plan and urban suitability from a sprawling north Indian', Environment and Urbanization Asia, 3(2), 277-301.

Fabian, H., Gota, S., Mejia, A., Leather, J., and A. Cities (2010): Walkability and Pedestrian Facilities in Asian Cities: State and Issues, Manila, Asian Development Bank.

Gosavi, N., Hegde, D., and L. Hari (2016): 'Density linked framework for planning mass transit in the context of Indian cities', World Transport Policy and Practice, 22(3), 16-25.

Hudda, (2014): Statistics of Municipal towns and cities 2011-12. Gandhinagar, Directorate of Economics, Government of Gujarat.

Indian Roads Congress. (1990): Guidelines for capacity of urban roads in plain areas. IRC code of practic,. New Delhi, Indian Roads Congress.

Ismail, R., Hafezi, M. H., Nor, R. M., and K. Ambak (2012): 'Passengers preference and satisfaction of public transport in Malaysia', Australian Journal of Basic and Applied Sciences, 6(8), 410-416.

Kaushik, H. (2015, September 2): BRTS fails, 18percent less bus users now, Times of India.

Ledesma, R. D., and P. Valero-Mora (2007): 'Determining the number of factors to retain in EFA: An easy-to-use computer program for carrying out parallel analysis', Practical assessment, research & evaluation, 12(2), 1-11.

Mahendra, A., Chanchani, R., and N. Ferenchak (2015): Motorized Two-Wheelers in Indian Cities: Case Study of Pune, 94th Annual Meeting Transportation Study Board.

Pfleiderer, R. H., and M. Dieterich (1995): 'New roads generate new traffic', World Transport Policy and Practice, 1(1), 29-31.

Poudenx, P. (2008): 'The effect of transportation policies on energy consumption and greenhouse gas emission from urban passenger transportation', Transportation, 42(6), 901-909.

Pucher, J., Korattyswaroopam, N., and N. Ittyerah (2004): 'The crisis of public transport in India: overwhelming needs but limited resources', Journal of Public Transportation, 7(3), 95-113.

Pucher, J., Peng, Z., Mittal, N., Zhu, Y., and N. Korattyswaroopam (2007): 'Urban transport trends and policies in China and India: impacts of rapid economic growth,' Transport Reviews, 27(4), 379-410.

Rahul, T. M., and S. Verma (2013): 'Economic impact of non-motorized transportation in Indian cities,' Research in Transportation Economics, 38(1), 22-34.

Sankhe, S., Vittal, I., Dobbs, R., Mohan, A., and A. Gulati (2010): India's urban awakening: Building inclusive cities sustaining economic growth, New Delhi, Mckinsey Global Institute.

Saxena, K. (2016):Road Transport Year Book (2013-15), New Delhi, Ministry of Road Transport and Highways.

Singh, S. K. (2005): 'Review of urban transportation in India', Journal of Public Transportation, 8(1), 79-97.

Sreedhar, E;. (2011). XII plan working group on Urban Transport. Ministry of Urban Development, Planning Comission, New Delhi, Government of India.

Stradling, S., Carreno, M., Rye, T., and A. Noble (2007): 'Passenger perceptions and the ideal urban bus journey experience', Transport Policy, 14(4): 283-292.

Taubenböck H, Wegmann M, Roth A, Mehl H, and S. Dech (2009): 'Urbanization in India–Spatiotemporal analysis using remote sensing data', Computers, Environment and Urban Systems, 33(3), 179–188.

Tertoolen, G., Van Kreveld, D., and B. Verstraten (1998): 'Psychological resistance against attempts to reduce private car use', Transportation Study, 32(3), 171-181.

Vishwanath, T., Lall, S. V., Dowall, D., Lozano-Gracia, N., Sharma, S., and H.G. Wang, (2013): Urbanization beyond municipal boundaries:nurturing metropolitan economies and connecting peri-urban areas in India (English), Washington D.C, The World Bank.

Wilbur Smith Associates. (2008): Traffic and Transport policies and strategies in Urban Areas in India. New Delhi: Ministry of Urban Development.

APPENDIX

Factor structure for the EFA

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Unique-ness
Age	0.133	-0.435				0.291	0.483	.464
Income	0.183	-	0.159	-	-	0.952	0.157	0.005
No. of adults	-	-	-0.173	0.677	0.115	0.131	-	0.462
Number of motorized vehicle	0.460	-0.290	0.272	0.538	-	0.245	-0.152	0.249
Number of license holders	0.412	-0.170	0.181	0.755	-0.156	-	-0.202	0.124
Kilometres per week travelled	-	-	-	0.152	-	-	-0.475	0.729
Trips category	-	-	-	-	-0.158	-	0.480	0.728
Trip expense payment	0.344	-	0.333	0.223	-	-	-	0.702
Laziness	-		-0.446	0.247	-	-	0.196	0.695
Public transport disenchantment	-	0.503	-	-	-	-	-	0.729
Bus-stop demarcation	0.490	-	0.165	-	-	-	-	0.710
Public transport efficiency	0.571	-	0.125	-	-	-	-	0.632
Bus comfort	0.333	-0.319	-	-	-	-	0.144	0.780
Bus stop information	0.313	.408	-	0.145	-	-	0.220	0.664
Public transport use	0.451	0.386	0.446	0.145	-	-	0.286	0.338

Three Revolutions. Steering automated, shared and electric vehicles to a better future
Daniel Sperling, Island Press, 2018
Library of Congress Control Number: 2017951060

Reviewed by John Whitelegg

Transport and mobility are very difficult dimensions of human activity, public policy, social justice, public health, democracy and ethics and we don't "do" joined up, holistic interventions very well. This is probably why in both the US and EU most transport choices made by local and central government and commercial organisations make things worse and most transport spending of tax dollars is regressive. A disproportionate amount of spending goes to relatively affluent groups e.g. the subsidy given to electric vehicles (EVs) and those who do not own cars, cannot afford cars or choose a car-free life style are deprived of a "fair share". (Note 1).

This book is very firmly located within that discourse. It is an undiluted affirmation of some important choices about the future and these put the car and the use of vehicles at the centre of all of our thinking. The future will be far more car-dominated than it is now and this will be a "better" future because the vehicles will be electric (zero-emission) and driverless/autonomous because a very clever automatic system of control and operation will remove human error so no-one will be killed or injured in the road traffic environment. This future boils down to as many journeys as possible being made in cars and as much as subsidy as possible being directed towards the technology, the infrastructure (e.g. charging of EVs) and nuclear power to make sure we have enough electricity. The author supports nuclear power (page 25) with no mention at all of the huge literature on risk (Three Mile Island), cancers in children, cost and the degree to which wind, wave, tidal and solar can easily produce enough electricity for all our needs and comfortably so if we increase the use of walk, cycle and bus for shorter journeys in the world's city regions.

This view of transport and mobility and of the world that is being shaped by those

who sign up to the belief system of more cars and more infrastructure to support more cars is seriously worrying.

Sperling is clear on his views about cars e.g. they can be "sleek elegant" (page 36) and they can "outrace Porsche and Ferrari two seat sports cars leaping from zero to 60mph in less than 4 seconds". The admiration of speed is unethical. Speed kills children and driving any faster than 20mph on streets where there is any possibility of an interaction with pedestrians, cyclists or bus users is seriously anti-social behaviour and seriously damaging to children, the elderly and those with physical mobility problems. It steals freedoms from those not in cars.
The linkage of EVs and autonomous/driverless vehicles (AVs) with road safety improvements is perverse given the support for speeds that are incompatible with the need to protect children and the elderly and make sure our streets are people-friendly rather than devoted to large and growing numbers of vehicles capable of excessive speed.

The UK Times newspaper on 9th May 2018 carried an article under the title "Driverless Uber car chose to hit woman who died". This is the case of Elaine Herzberg in Tempe, Arizona who was killed by a driverless car (DC) on 18th March 2018:

> *"A self-driving car operated by Uber that killed a pedestrian allegedly detected her as she crossed the road but "chose" not to alter course"*
> The Times, 9th May 2018, page 13

The book has emerged from the prestigious Institute of Transportation Studies (ITS-Davis) at the University of California, Davis, where the author is the founding director. It is ironic that one of the most important contributions to the multi-dimensional nature of transportation has been made by Donald Appelyard, also based in California, in the late 1960s and early 1970s (Note 2). Appelyard showed that traffic (numbers of vehicles per day on your street) had a profound effect on the way people use streets. The higher the number of vehicles the less people activity, less interaction between neighbours and more social isolation became the

norm. Traffic shapes the way we live and Sperling has made a conscious decision to ignore this important social and health dimension. We can have people friendly and child friendly (Note 3) towns and cities but this depends on finding ways to reduce traffic and making very sure indeed that streets are for people and not expensive, technologically advanced traffic sewers. We can have delightful, calm, attractive, people friendly social spaces in towns and cities that are not traffic dominated and we know how to achieve that through urban design (Note 4). We can have cities that are world famous for producing best practice, very high environmental quality, very healthy travel behaviours and very low cost solutions (Note 5). This exists now in many European cities (Note 6).

Sperling gives very little attention to the huge debate globally and in the USA about public health and the steep increase in serious diseases associated with sedentary lifestyles. The more we sit in cars and avoid physical activity ("active travel") the greater the increase in non-communicable diseases (NCDs) including obesity, diabetes, cardio-vascular disease and some cancers (Note 7). His reference in the book title "To a better future" does not engage with the health consequences of a future where many more journeys are likely to be made by people in cars. Thanks to the work of the World Health Organisation and its global action plan to increase physical activity (GAPPA) we know that a "better future" is not compatible with a growing number of people opting for sedentary lifestyles and avoiding walking and cycling and the growing epidemic of NCDs that results from physical inactivity.

Sperling's view of a "better future" does not give the reader very much insight into the examples of the "better future" that are already in place today in those cities that have adopted a holistic view of transportation and mobility. Freiburg in southern Germany is a best practice, award-winning sustainable city with 25% of all trips everyday by car and 75% not by car. The 28% of trips by bike is achievable in most cities around the world but not if we put all our transportation eggs in the "automated, shared and electric vehicle" basket.

Sperling's use of language is very close to that analysed in Sach's thoughtful book "For the love of the automobile" (qv Sachs in Note 10) e.g. on page 1:

"We love our cars. Or at least we love the freedom, flexibility, convenience and comfort they offer. That love affair has been clear and unchallenged since the advent of the Model T a century ago".

The author does list examples of the "very high cost" of the "unequalled freedom and flexibility" on pages 2/3 but these costs do not lead to a view of a better future based on less car use and more use of the alternatives to the car.

It is correct to say that a proportion of any group of people "love their cars" but it is not correct to assert that this is a majority view or a "fact" or some kind of rule of law or Newtonian physics. It is not a universal truth and the existence of Freiburg in a country that is the home of Porsche, Mercedes, VW and BMW tells the opposite story. It is also unacceptable to ignore the voluminous output of serious transport academics and research projects over several decades to point out that these examples of "freedom, flexibility, convenience and comfort" are purchased at an enormous cost to public spending and these costs are not covered by drivers/car owners. The cost includes (globally) 3200 killed every day on the roads and huge denial of freedoms to children, the elderly, the mobility disadvantaged. These texts can be found in the writings of Illich, Kenworthy, Hillman, Plowden, Holzapfel and Whitelegg and there is no excuse for the use of the word "unchallenged" on page 1 of this book.

There is a serious flaw in the book's treatment of transport economics. On page 15 there is a misleading bar chart (figure 1.2 Comparative costs of travel by different means in the United States). This shows transit as having a relatively high cost per passenger mile largely due to the high level of subsidy. Sperling ignores the huge cost of maintaining, developing and delivering road transport which is the equivalent of subsidy to transit. He also ignores the very high cost of externalities

associated with vehicles. Externalities are the uncovered costs of climate change, air pollution, death and injury, and noise. UK studies show that car drivers pay less than 50% of the costs associated with the use of vehicles even when all fuel and road taxation is counted. Car use is heavily subsidised and is not considered at all in Figure 1.2 on page 15. On page 53 Sperling list a number of "key policy strategies" to achieve his "better future" and these include 5 bullet points asking for increased subsidies for EVs and AVs.

There is no mention of the debate in Europe around driverless and autonomous vehicles. This subject is dealt with in a wide-ranging review by Christian Wolmar (Note 8). Wolmar quotes a leading representative from the world of car makers (page 14 of his book):

"Our vision for the future is free from petroleum, free from emissions, free from accidents, free from congestion, and at the same time fun and fashionable…it is a vision that will transform the lives [sic] around the world, bringing people and cultures closer together, a future in which people, motor vehicles and roads coexist in harmony and a future where motor vehicles no longer have a direct impact on the natural environment"
Kevin Wale, General Motors

It is clear that car makers are not at all interested in huge increases in walking and cycling, urban design to create child-friendly cities which means huge reductions in numbers of cars and car trips and even more obviously are inclined to do whatever needs to be done to eliminate walking, cycling and public transport where this provides difficulties or conflicts with the total domination of cars e.g. another quote in Wolmar (page 20):

"The more one digs into the future envisaged by this new world of autonomy, the more it becomes clear that driverless scars are seen as a replacement for not just cars but other forms of transport too!"

and on page 79/80 of Wolmar

"Take cyclists, Carlos Ghosn, Nissan's CEO, is no fan of people on bikes. Indeed he hates them. In a speech in January 2017 to introduce a prototype DC he told CBNC that the arrival of the technology could be delayed by cyclists who he said, don't respect any rules usually."

"Ghosn said "One of the biggest problems is people with bicycles. The car is confused by [cyclists] because from time to time they behave like pedestrians and from time to time they behave like cars"

The chapter on transport by Polzin and Sperling reveals a number of errors and an absence of data, on behavioural change in transport choices. They assert (page 111) that bus passengers in the USA pay only 20% of the full cost of the service and the remaining 80% is subsidy. They avoid the discussion around what percentage of the total cost of car use is paid for by the user and how much is paid for by city, state and federal government. A more thorough analysis would link these data to the parallel situation in road transport and cars. When we take into account the full range of subsidies, costs and externalities associated with a car trip how does that compare with the 20/80 statement for buses? If we then factor in the detailed empirical information about the total costs (public and private) associated with "running" a city (Vivier, Note 5) how does that change the way we view subsidy, externalities, public finance and deficits?

The authors are not quite right when they say (page 113) "Transit has a broad constituency even though it serves relatively few people". The APTA 2017 (Note 9) fact book makes data available (Polzin and Sperling do not make data available):

Transit use in the USA is up 38% in the last 20 years

Transport use is growing:

...more popular.

Total Passenger Miles Traveled

1995 🚌 **39.8 billion**

2005 🚌🚌 **49.7 billion**

2015 🚌 🚌 **58.6 billion**

Total Number of Rail Systems

1995 🚊 **52**

2015 🚊🚊 **83**

Rail ridership has increased 86% since 1995.

...still growing.

Since 1996

👥👥 Population growth is up **20%.**

👥👥👥 Public transit ridership is up **30%.**

Source: see Note 9

The transit chapter relies on assertion not supported by evidence e.g. "cars are now more than 20% more efficient than buses (sic)" (page 115) and "If greenhouse gas reduction is the goal, the cheapest and easiest strategy is to reduce the carbon footprint of cars, not increase the occupancy of buses" (page 115).

Omissions are just as important as commissions. The transit chapter does not deal with urban space. A car carrying 1 person is very demanding in its use of

51

space and in the context of space in urban areas (land) having a very high monetary value. Why do we allocate scarce, high value land in our cities to grossly inefficient transport choices especially the one person in a car? Walking, cycling, trams
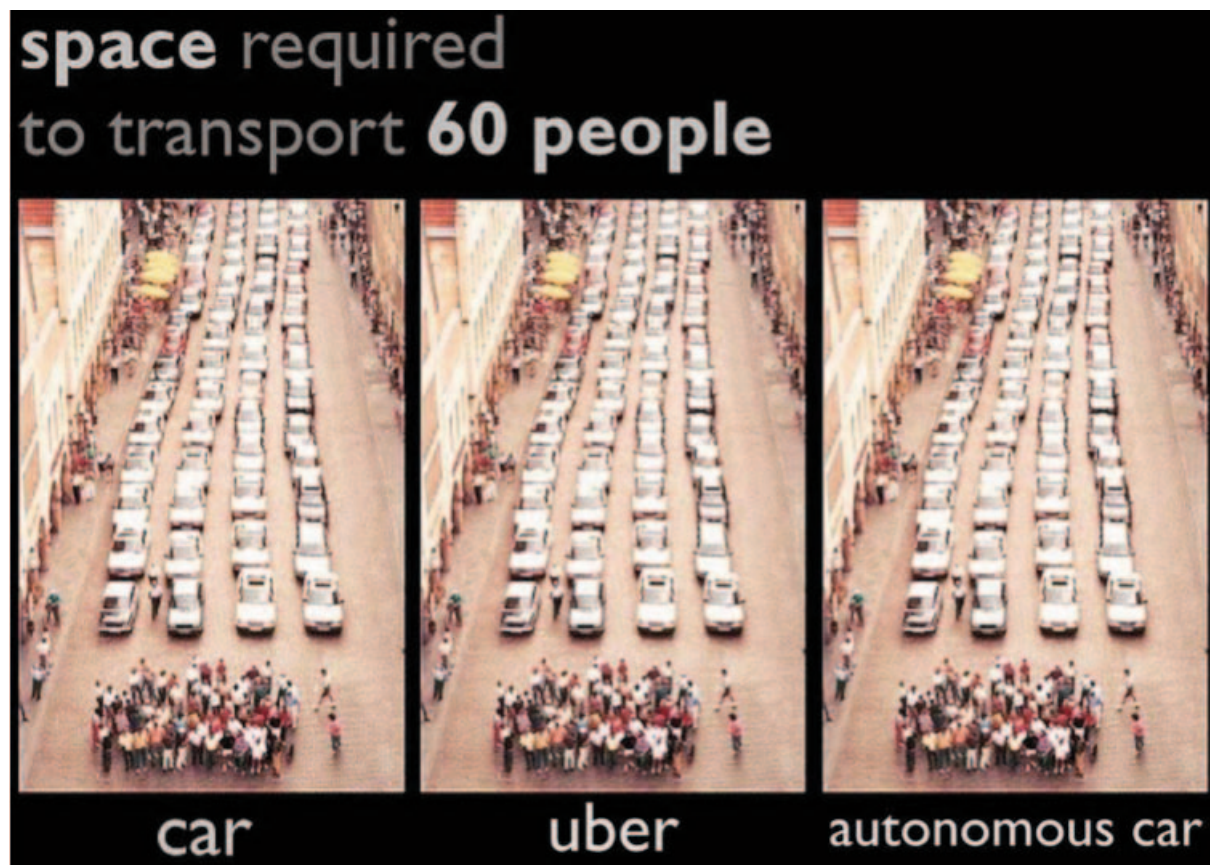

Source:
https://www.treehugger.com/cars/amount-of-space-required-to-transport-people-by-car-bus-or-bicycle.html

Source:
https://www.treehugger.com/cars/picture-worth-space-required-transport-60-people-car-uber-and-av.html

and buses are very efficient (see figures above). The data show that moving millions of people around on everyday journeys in metropolitan or city regions can be done more efficiently in terms of space by walk, cycle and transit but this is not given the attention it deserves in this chapter

It is very clear indeed that the new technology on offer in Sperling's "better future" is a very simple extension of a very old technology and a deepening of a very old ideology. It is all about making us all even more car dependent, transforming cities so that they give priority to cars and very little priority to improving the conditions that encourage walking, cycling, bus, tram and local rail as viable alternatives to the car.

The book gives very little attention to the work of dozens of authors and researchers who have documented the success of cities in moving away from car-centric thinking and creating safe, secure, clean, green, healthy, child-friendly places. This could have included Copenhagen's success in getting 50% of all trips every day for work and education accomplished by bike, Freiburg's achievements on modal split (<30% of all trips every day by car), Oslo's car free strategy, wide-area congestion charging in London and Stockholm, Berlin's 15% modal share for cycling and Zurich's sophisticated and well-used integrated public transport system.

Sperling has given us a clear view of his "better future" and it is helpful to have that stated in an authoritative piece of work from a respected transport research institute. There is an alternative to this better future and it is now up to all of us in the world of sustainable transport to articulate those alternatives and encourage decision makers and politicians at every level of government to be aware that there are choices.

References

Holzapfel, H and Lohbeck, W (2016) Does our future lie with electric dinosaurs? World Transport Policy and Practice 22.3, 26-27
http://worldtransportjournal.com/wp-content/uploads/2016/10/4th-Oct-opt.pdf

Schiller, P L (2016) Automated and connected vehicles: high tech hope or hype? World Transport Policy and Practice 22.3, 28-44
http://worldtransportjournal.com/wp-content/uploads/2016/10/4th-Oct-opt.pdf

Notes:
1. Whitelegg, J (2017) Mobility. A new urban design and transport planning philosophy for a sustainable future, Straw Barnes Press ISBN 13: 978-1530227877
2. Appleyard, D (1981) Livable Streets, Berkeley, University of California Press
3. Kenworthy, J (2018) Planning as if Children Mattered: A Case for Transforming Automobile Dependent Cities and Some Examples of Best Practice, World Transport Policy and Practice, 24,1, 12-59
http://worldtransportjournal.com/wp-content/uploads/2015/02/24.1opt.pdf
4. Gehl, J (2010) Cities for People, Island Press
5. Vivier, J (2006) Mobility in Cities Database. Better mobility for people worldwide. Analysis and Recommendations, UITP (Union Internationale Transports Publique), Brussels www.uitp.com
6. ITDP, Gehl Architects and Nelson Nyggard (2010) Our cities ourselves, 10 principles for transport in urban life, ITDP, New York
7. WHO (2018) Physical activity for health. More active people for a healthier world. Draft global action plan on physical activity, 2018-2030, World Health Organisation, Geneva
8. Wolmar, C (2018) Driverless Cars: On a road to nowhere London Publishing Partnership, 2018, 120 pages ISBN: 978-907994-75-3
9. American Public Transport Association (APTA), 2017 Fact Book, 68th edition, March 2018
10. Sachs, W (1992) For the love of the automobile. Looking back into the history of our desires, University of California Press