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A SUSTAINABLE TRANSPORT APPROACH TO ROAD SAFETY AND ACCESSIBILITY IN THE URBAN CONTEXT

(Joint Plenary Session 1 of the Provisional Programme)

Final Draft

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A Sustainable Transport Approach to Road Safety and Accessibility in the Urban Context

ABSTRACT

Worldwide, road traffic accidents account for 1.2 million deaths per year. According to the World Health Organisation, this figure is likely to double by 2030, making road traffic accidents the fifth leading cause of death worldwide. Apart from fatalities, the rate of injuries is also very high. It is estimated that for every traffic-related death, nearly 50 people are likely to be hospitalized and 80 to 100 people are likely to receive care for minor injuries.

India has one of the worst road safety records in the world, with around 126,896 road traffic fatalities in 2009. It is estimated that 17-18% of these fatalities occur in urban areas. This poses a serious threat as the country is rapidly urbanizing.

The decline in the level of road safety can largely be attributed to the increase in the number of motor-vehicles on the road. This increase has resulted in a high level of traffic congestion in a number of cities. Often, city governments have responded to this problem by increasing the road infrastructure available to motor-vehicles. This infrastructure augmentation is often at the cost of the accessibility needs of non-motorised and pedestrian transport. These modes are forced to share road space with fast-moving vehicles, which has resulted in a worsening safety scenario.

Many developing cities around the world have realized the severity of this problem and have successfully addressed this issue through sustainable transport principles, like redesigning urban streets, provision of public transport corridors, segregation of pedestrian and non-motorised traffic from motorized vehicles, transit oriented development, and so on.

This paper seeks to address the problems of road safety and accessibility synonymously. The paper documents some of the sustainable transport principles in reorganising urban streets and analyses its impact on road safety and accessibility, thereby drawing lessons for addressing this issue in the Indian context.

1 Road safety: A growing concern

Worldwide, road traffic crashes account for about 1.2 million deaths every year. According to the World Health Organisation, this figure is likely to double by 2030, making road traffic accidents the fifth leading cause of death [1]. About 260,000 of all road traffic fatalities are of children [2]. Furthermore, over 90% of the world's road fatalities occur in low-income and middle-income countries, which account for only 48% of the world's registered vehicles [3].

Table 1 – Leading Countries in Road Traffic Fatalities

Sl. No.	Country	Income Level	Road Traffic Fatalities (2005)
1	India	Low	105,725
2	China	Middle	96,611
3	United States of America	High	42,642
4	Russia	Middle	35,972
5	Brazil	Middle	35,155

Source: [3]

India leads the world in the number of annual reported traffic fatalities [4]. India recorded a total of 126,896 road traffic fatalities in 2009, a 7.32% increase from the previous year [5].

Table 2 – Road Traffic Fatalities in India

Year	Fatalities	Population (Mn)	Fatalities / Million Population
1997	77,000	955	81
1998	79,900	971	82
1999	82,000	987	83
2000	78,900	1002	79
2001	80,900	1027	79
2002	84,059	1051	80
2003	84,430	1068	79
2004	91,376	1086	84
2005	98,254	1103	89
2006	105,725	1120	94
2007	114,590	1136	101
2008	118,239	1147	103
2009	126,896	1164	109

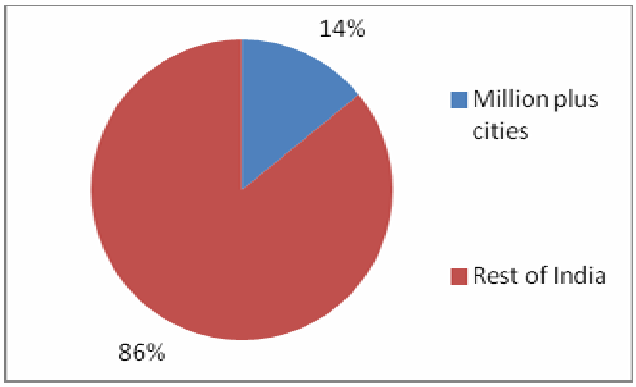
Source: [5]

2 Road safety scenario in Indian cities

It is very difficult to correctly estimate the actual number of road traffic accidents in India, largely due to the underreporting of accidents. It is therefore also very difficult to estimate the actual number of accidents in urban areas. As per the National Crime Records Bureau (NCRB), a total of 421,628 road traffic accidents were reported in India in the year 2009 [5]. 35 one-million-plus cities,

which account for about 9.2% of the country's population, reported 59,372 road traffic accidents [5]. Factoring in the number of cities in India with less than one million residents, it can be estimated that urban areas account for around 17-18% of total road traffic accidents and fatalities.

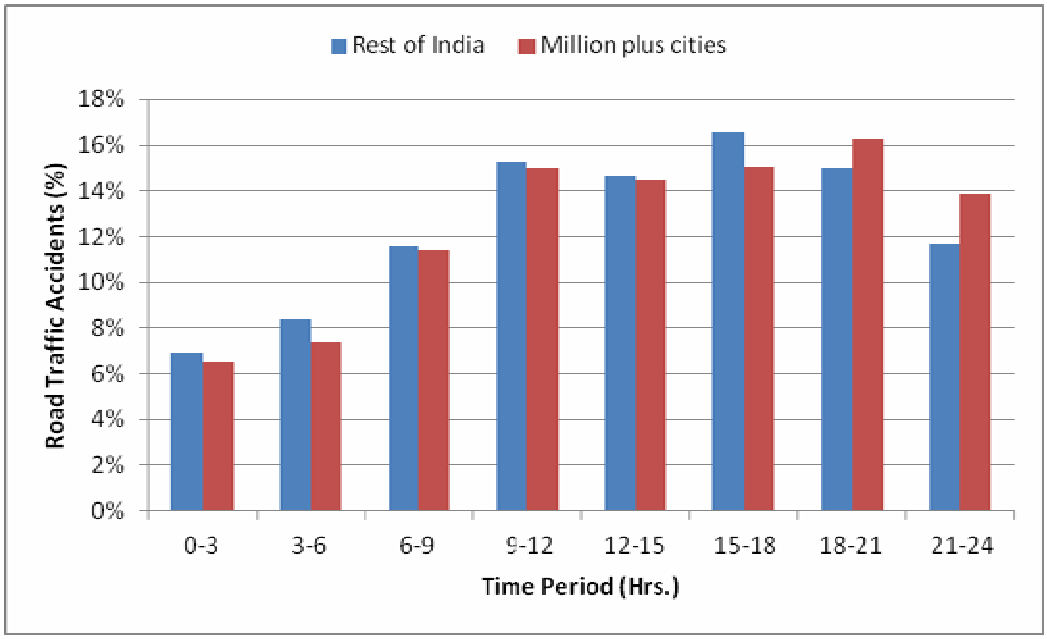
Figure 1 – Road Traffic Accidents in Urban Areas vs. the Rest of India (2009)



Source: [5]

Due to varying characteristics, road safety acquires a very different dimension in the urban versus rural context in India. NCRB study [5] showed that cities with one-million-plus population record more road traffic accidents during the evening period (6PM-midnight) as compared to the rest of the country (Figure 2). This may be due to higher speeds on account of the lower traffic on roads. Drunk driving and poor visibility may also contribute to the higher rate of accidents.

Figure 2 – Distribution of Road Traffic Accidents by Time of Day in Million Plus Cities and Rest of India (2009)



Source: [5]

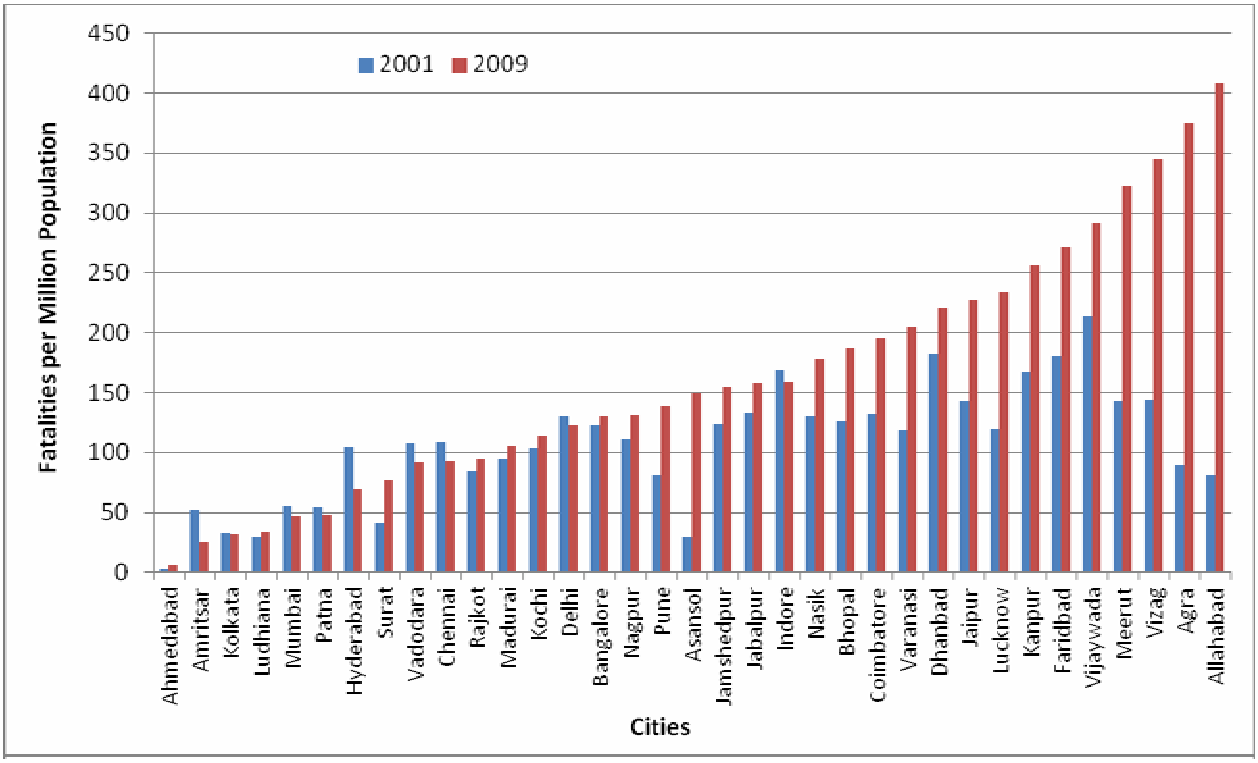
Pedestrians and bicyclists are estimated to constitute a large proportion of road traffic fatalities [6]. A comparative evaluation of road traffic fatalities in India vis-a-vis those in Delhi reveals that pedestrians and bicyclists accounted for 63% of total fatalities in Delhi compared to 11.4% for the country as a whole [6].

Table 3 – Road Traffic Fatalities by Category of Road Users in Delhi and Rest of India

Sl. No.	Mode	Occurrence	
		Delhi (2001 - 2005)	All India (2009)
1	Truck / Tempo	2	25.7
2	Bus	5	10.1
3	Car / Jeep	3	16.9
4	Auto Rickshaw	3	5.2
5	2 Wh.	21	20.7
6	Bicycle	10	2.6
7	Pedestrian	53	8.8
8	Others	3	10
9	Total	100	100

Source: [5], [6]

Figure 3 – Temporal Change in Road Traffic Fatalities in Cities with One-million-plus Population (2001 - 2009)



Source: [5]

It can be seen that small and medium towns have witnessed a dramatic increase in the number of fatalities per million population. Allahabad recorded the greatest increase in fatalities per million people – 405% from 2001 to 2009 - followed by Agra (319%) [5].This may be due to the fact that a majority of the victims in these cities are pedestrian and non-motorised transport users that are

affected by increases in vehicle speeds. It is a well documented phenomenon that small increases in urban speeds increase road traffic death rates dramatically.

3 The declining accessibility of urban roads

The decline in the level of road safety can largely be attributed to the increase in the number of motor-vehicles on the road. This increase has resulted in a high level of traffic congestion in a number of cities. Often, city governments have responded to this problem by increasing the road infrastructure available to the motor-vehicle. This is made possible by developing wider motorways, flyovers, elevated roads, median barricades, etc. This infrastructure augmentation is often at the cost of the accessibility needs of non-motorised and pedestrian transport. Footpath widths are reduced, or sometimes eliminated completely, in order to widen roads. Median barriers are installed to prevent pedestrians from crossing. Thus, pedestrians and cyclists are forced to share road space with fast-moving vehicles, which has resulted in a worsening safety scenario.

As non-motorised transport becomes increasingly difficult and unsafe, commuters that can afford it, switch over to motorised transport. This reduces the volume of non-motorised transport, especially bicycling, which creates further justification for giving infrastructure priority to the motor-vehicle over non-motorised transport.

Further, when augmenting road infrastructure, the focus is often on increasing speed and/or traffic volume capacity for motor-vehicles. The emphasis is on moving as many vehicles, as quickly as possible, from one end of the road to the other. This tends to negatively impact local access of land uses along and near the road, as priority is given to thoroughfare traffic. This affects all modes of transport, motorised as well as non-motorised.

Thus, there are two kinds of conflicts that take place on the road; one, a conflict between modes of different speed capacity, (that is motorised versus non-motorised transport); and two, a conflict between fast-moving thoroughfare traffic versus local accessing vehicles. In both conflicts, the main aggravating factor is speed, or rather the variance in speed; and the negative fallout of both these conflicts is on safety and accessibility.

In high-income countries, like the United States, cities which were developed in the post motor-vehicle era, were designed with a well-defined road hierarchy that was meant to prevent speed conflict. For instance, local streets were provided for direct access to residential units, whereas as freeways were meant for fast-moving thoroughfare traffic. However, cities in emerging countries like India, were never designed around the motor-vehicle. Thus, the categorisation of roads into different hierarchies is often impractical in the Indian context. A main road in an Indian city can be both a local access street, as well as a major arterial road.

Thus, this paper seeks to address the problems of road safety and accessibility synonymously. It puts forth the argument that by following sustainable transport principles, described in subsequent sections, one can address both the issues of safety and accessibility simultaneously.

4 Major factors impeding road safety and accessibility

As discussed earlier, the main factor impeding road safety and accessibility is speed. A study in New South Wales, Australia showed that speeding is a very significant explanatory factor in road accidents, accounting for about 40% of road deaths [7]. Two aspects of speed impact the likelihood of a vehicle meeting with an accident - the high speed of the vehicle, and the difference in its speed from the average speed of all vehicles on that road.

High Speed:

High speed affects road accidents in two ways - firstly, it increases the likelihood of a crash and secondly, it increases the severity of a crash when it happens. Excessive vehicle speed reduces a driver's ability to negotiate curves or manoeuvre around obstacles in the roadway, extends the distance necessary for a vehicle to stop, and increases the distance a vehicle travels when the driver reacts to a hazard. One study shows that the risk of causing death or injury in an urban 60km/h speed zone increases rapidly even with relatively small increases in speed [7]. The casualty crash risk at 65km/h is about twice the risk at 60km/h. At 70km/h, the casualty crash risk is more than four times the risk at 60km/h. The following table shows the casualty crash risk at various speeds relative to 60 km/h.

Table 4 – Casualty Crash Risk relative to 60 km/h

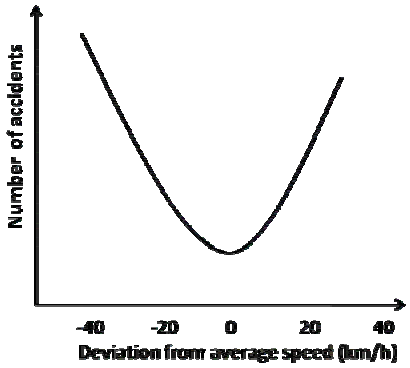
Sl. No.	Speed (km/h)	Risk relative to 60 km/h
1	65	Double
2	70	4 times
3	75	11 times
4	80	32 times

Source: [7]

Speed Variance

It has been well established that a critical factor in crash risk, along with the actual speed of the vehicle, is the variance in the speed of the vehicle from the average speed of all other vehicles on the road. One of the earliest such studies, conducted in 1964, showed that vehicles travelling at close to the average speed were less likely to meet with an accident than vehicles travelling much faster or much slower than the average speed [8]. More recent studies confirm this finding. This relationship is diagrammatically explained in the following graph.

Figure 4 - Representation of the relationship between deviation from average speed and number of accidents



Source: [9]

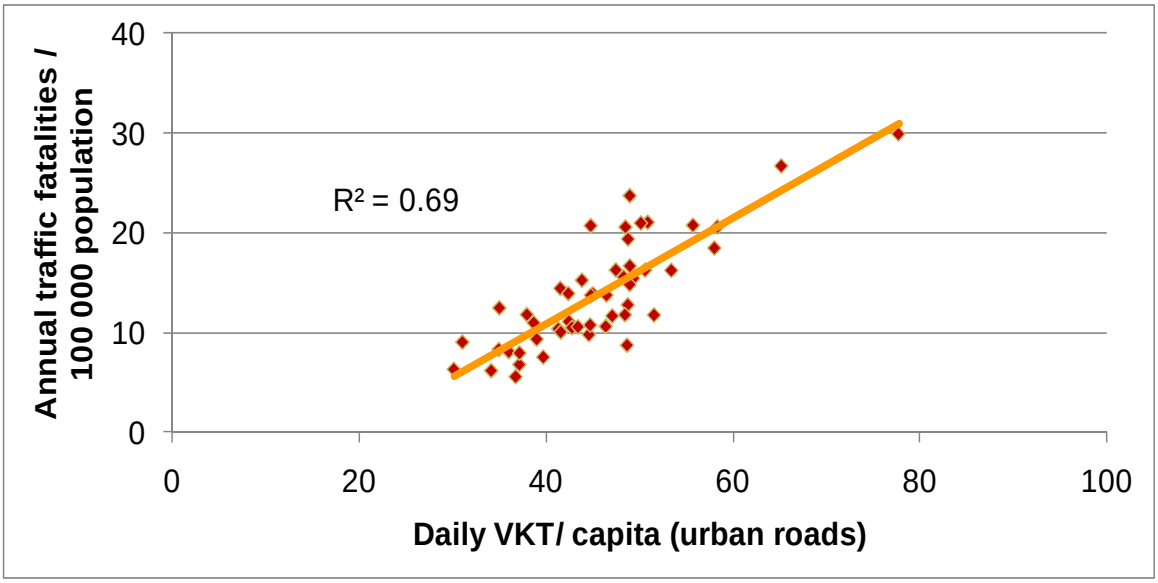
The reason why slower vehicles are vulnerable to accidents is that they often come into conflict with fast-moving vehicles. Vehicles are most vulnerable when they slow down at turns and intersections, thus placing them in direct conflict with fast-moving vehicles. As discussed earlier, this is a case of conflict between thoroughfare fast-moving vehicles and local accessing slow-moving vehicles.

Another point to note is that the greater the average speed of all vehicles, the greater is the variance between the average speed and that of a vehicle negotiating a turn. This increases the likelihood and severity of an accident.

High Vehicle Kilometres Travelled

At a city-level, apart from the average speed and speed variation of motor-vehicles, another critical parameter impacting safety is total volume of Vehicle Kilometres Travelled (VKT). Studies show that there is a strong positive correlation between the number of accidents in a city and its VKT, even after adjusting for relative size differences. A forthcoming study, using data from the United States, finds a positive correlation between daily VKT / capita (urban roads only) and annual traffic fatalities / 100,000 population [10].

Figure 5 - Relation Between Daily VKT / Capita And Annual Traffic Fatalities / 100,000 Population



Source: [10]

EMBARQ India

5 Traditional approach to addressing road safety in urban areas

Many cities around the world have recognised the severity of the road safety problem and have adopted various measures to address it. Much of the effort has focused on making vehicles safer against impact and improving road geometry to make roads safer for fast moving vehicles.

However, there is growing criticism of the effectiveness of these measures within the confines of urban areas. Critics of these measures argue that while they make the vehicle-user safer, they do not increase the safety of pedestrians, bicyclists, motorcyclists and other slower moving vehicles, who are the most vulnerable users of the roads. A study of road fatalities in the European Union found that almost 70% of urban area fatalities came from these vulnerable groups, of which 11% were bicyclists and 37% were pedestrians [11].

Furthermore, road design features which focus on making fast travel safe for vehicles require large tracts of land and are prohibitively expensive for cities in developing countries, like India. Further, they also promote a greater use of private motor-vehicles, which, as discussed earlier, has a negative impact on road safety.

Also, when existing roads are re-engineered to increase their motor-vehicle capacity and speed potential, it results in a deteriorating scenario for non-motorised transport and local accessibility.

6 The sustainable transport approach to road safety and accessibility

Many cities around the world have realised that safer motor-vehicles and re-engineered road geometry does not necessarily translate into a better safety record. These cities have tried to address this problem in a diametrically opposite manner. Rather than focusing on improving the safety of fast-moving vehicles, they have instead focused on two objectives: reducing the average speed of vehicles and reducing the total volume of vehicle kilometres travelled. The measures adopted to achieve these objectives are collectively known as the 'sustainable transport approach' to road safety. This includes the redesign of urban streets and transport systems, such that a greater emphasis is given to public transport, non-motorised transport and transit oriented development. The sustainable transport approach can also be categorised by the Avoid-Shift-Improve (ASI) framework, whereby the objective is to:

- Avoid growth in Vehicle Kilometres Travelled (VKT)
- Shift trips to safer and more sustainable modes, like public transport and non-motorised transport
- Improve the general conditions of transport, in terms of safety, time, cost, comfort, etc

This following sections describe four sustainable transport interventions to address the issues of safety and accessibility, namely (i) Redesigning the urban street, (ii) Promoting public transport, (iii) Promoting non-motorised transport and (iv) Transit Oriented Development (TOD). The effectiveness of various methods under these interventions is discussed, giving examples from international case-studies.

7 Redesigning the urban street

A barrier one has to overcome when thinking in the context of urban transport is that a city road is different from a regional highway. Here, speed is a tertiary measure of road efficiency that comes into consideration only after sufficient care have been taken to address issues of safety and accessibility. Thus, a critical intervention under the sustainable transport approach is to reduce both the average speed at which vehicles drive and the maximum possible speed on a given road. Note, these measures are applicable to the urban road; and traditional safety principles may be more relevant for highways.

The most common method adopted by cities to reduce speed is to set a speed limit. This method can be successful in cities with a high level of compliance and/or strong level of enforcement. However, studies have shown that in many cases speed limits are ineffective, as most cars drive at a speed that the drivers feel is safe for them, rather than the declared speed limit. A 1997 study from the US showed that raising and lowering speed limits had little or no effect on actual speeds. Although maximum speed changed by 5 km/h in some cases, the average change in the mean and 85th percentile speeds was less than 2 km/h [12].

Road engineering alternatives that seem more natural to the vehicle user are generally preferred. This entails a redesign of the road with more priority for public transport and non-motorised transport. Some of these measures are described below.

- Provide narrower motorway lanes. The lane width of 3.5m per lane for highways is not desirable in the urban context. Narrower lanes encourage the motorist to drive slower. The less lateral space requirement is also more practical on old, narrow roads
- Create a naturally curving motorway. This can be achieved by the intelligent use of chicanes, curb extensions, chokers, bulb-outs, parking bays, bus bays, etc. Care should be taken to make these elements seem natural to drivers, and not like an artificial imposition.
- Provide wider footpaths, frequent pedestrian crossing, speed tables, refuge islands, etc. These improves both safety and accessibility for pedestrians.
- Finally, wherever possible and necessary, segregate vehicles at different speed levels and modes of different speed capacity. This includes the provision of turning lanes and service roads for slow-moving motor vehicles, and the provision of footpaths, bicycle lanes and bus lanes. The rationale behind this is that, as discusses earlier, a key factor contributing to crash risk is speed variance, wherein vehicles at different speeds come into conflict with each other.

8 Promoting Public Transport

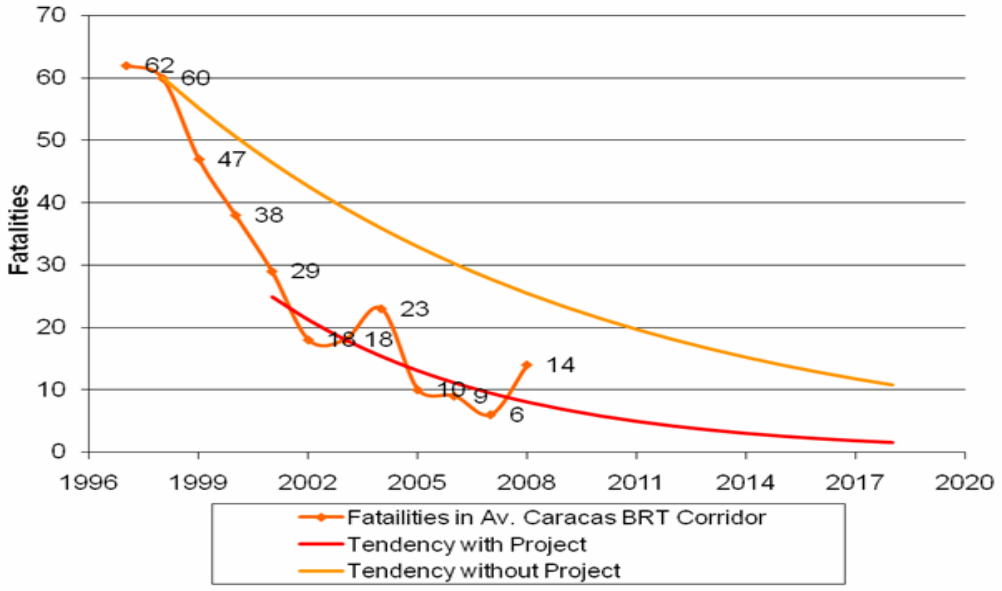
A positive benefit of a high quality public transport system is that it results in a modal shift from private transport towards the public transport system. This results in a reduction in total Vehicle Kilometres Travelled (VKT) for that city since the carrying capacity of public transport, per kilometre, is much higher than that of private transport. In the Brazilian city of Curitiba, the introduction of a Bus Rapid Transit (BRT) system resulted in a 28% modal shift from cars to BRT. This has led to a reduction of about 27 million auto trips per year [13].

As explained earlier, there is a strong positive correlation between VKT and road accidents. A reduction in VKT therefore generally corresponds to a reduction in accident rates. The introduction

of a public transport system may also slow the growth of VKT over time. Thus potential accidents, which may have taken place without the public transport system, are now averted.

An forthcoming study shows that Bogota's TransMilenio Bus Rapid Transit system has had a significant positive impact on road safety along the BRT corridor. Preliminary results on the Avenida Caracas corridor show that the number of fatalities along the corridor is, on an average, 60% lower due to the presence of the BRT system, compared to a scenario in which there is no BRT on the same corridor [14].

Figure 6 - Road safety impact of TransMilenio



BRT

Source: [14]

This finding fits into the Shift category of the Avoid-Shift-Framework (ASI), whereby a modal shift to public transport results in a drop in total VKT, which then results in a drop in accident rates.

The BRT system adopted in Bogota and many other cities has the added advantage of being built largely on the existing road network. A good BRT system is generally accompanied with road re-design, wherein the road-width for private vehicles is streamlined and reduced. This improves the flow of vehicles and reduces the average speed on the road, thereby positively impacting road safety even further.

Further, a well-designed BRT is often the only transport alternative available to low-income individuals, senior citizens, children, physically challenged, non-resident visitors, etc. Thus, a BRT, like most mass transit systems, can improve the accessibility capabilities of a large section of the city's population.

9 Promoting Non-motorised Transport

Non-motorised Transport (NMT) consists primarily of walking and bicycling. A key objective of sustainable transport is to make streets more inclusive, by giving greater priority to NMT. The provision of more and better infrastructure for NMT gives the commuter a greater choice of mode-

alternatives when making a trip. Like in the case of public transport, this leads to a modal shift away from private transport, thereby reducing VKT and consequently accident rates.

A good NMT system includes a comprehensive pedestrian and bicycle network, signalled pedestrian crossings and so on. These provisions are made possible by shifting roadway priority away from private transport. The flow of private transport is, thus, generally smoother, but slower. This further improves road safety.

An often quoted example of the impact of NMT on road safety comes from the Netherlands. The Netherlands has created a system of local urban streets, known as *woonerven*, where pedestrians and cyclists have legal priority over motorists. The techniques of shared spaces, traffic calming, and low speed limits (30 km/h) are intended to improve pedestrian, bicycle, and automobile safety. All such roads are designed along the principle of homogeneity and predictability, making them safer for non-resident users [15]. The success of these measures is evidenced by their impact on the number of road fatalities, which were constantly increasing prior to their adoption. The number of fatalities increased from about 1,000 per year in 1950 to over 3,000 by 1972. Since the adoption of sustainable transport measures in 1973, the number of fatalities has gradually decreased to less than 1,000 per year today [16].

10 Transit Oriented Development

A Transit Oriented Development (TOD) approach to sustainable transport promotes residential and commercial mixed land-uses, designed to maximise access to public transport. Further, it incorporates well developed and integrated Non-motorised Transport (NMT) features, so as to ease access to public transport. A TOD neighbourhood is typically centred round a transit station, and surrounded by relatively high-density development with progressively lower-density development spreading outwards from the centre.

TOD helps enhance all of the above mentioned measures of sustainable transport, which includes the promotion of public transport and NMT, and thereby resulting in a reduction in VKT and average vehicle speed. TOD thus indirectly impacts roads safety and accessibility through these outcomes.

The city of Curitiba in Brazil is considered a good example of TOD. A city development plan made for Curitiba in 1943 had planned for exponential growth in automobile traffic, with wide boulevards radiating from the core of the city. The right-of-way for these boulevards was acquired, but many other parts of the plan never materialized. In 1965, a new Master Plan was adopted, wherein Curitiba was no longer allowed to grow in all directions from the core, but would grow along designated mass transit corridors. Additionally, land use policies were adopted that promoted high density and mixed land-use along the corridors. An integrated and exhaustive Bus Rapid Transit (BRT) system was developed along the previously wide boulevards, which resulted in a significant modal shift to public transport. Today, about 70% of Curitiba's commuters use the BRT to travel to work [13].

11 Conclusion

Fatalities from road traffic accidents in India have been growing at an alarming rate of 8% per annum for the last decade. It is estimated that 1 out of 5 road traffic fatalities happen in urban areas. With the growing urbanisation of the country's population, this situation will only deteriorate further if nothing is done to check it. Efforts to make vehicle-users safer have had a limited impact as they do not increase the safety of pedestrians, bicyclists, motorcyclists and other slower-moving vehicles who are the most vulnerable users on urban roads.

The road safety and accessibility approach in urban areas must focus on redesigning urban streets so as to reduce fatalities and injuries to vulnerable road users, while simultaneously increasing their accessibility capacity. Urban streets should prioritise the safe movement of pedestrians and other non-motorised transport users. Urban streets should also promote the usage of public transportation thereby decreasing the need for travel and improving road safety.

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