

# Towards Safe Public Transport – A Case of Delhi Transport Corporation (DTC)

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## ABSTRACT

*Road accidents have been a major safety issue and are causing a significant loss to the economy. To minimise this economic loss, one needs to be able to assess the existing road safety scenario of the public transport undertakings and plan safer bus routes in cities. Public transport whether road or rail based are considered as the safest mode of travel for most people across the globe. In absence of a database at world level focusing only on traffic safety associated with buses, individual data sets/information has been presented in this paper from various countries from the developed as well as from the developing parts of the world. The case of India and particularly the case of Delhi Transport Corporation (DTC) which operates public transport buses in Delhi has been elaborated in this paper. In order to plan safe public transport routes in any city, it is important to understand the road safety scenario of public transit buses in the cities of urban India. Few Indian bus corporations operating in major metropolitan cities have been undertaken for this study. An attempt has been made to carry out a detailed spatial and temporal analysis of all the DTC bus accidents, to understand the causes of accidents, the probable remedial solutions to avoid the crashes and the way forward.*

**Keywords:** *Road Safety, Planning Safe Public Bus Transport, Bus Crashes*

## INTRODUCTION

Road traffic crashes are one of the leading causes of deaths in the world from past several years and its burden is borne majorly

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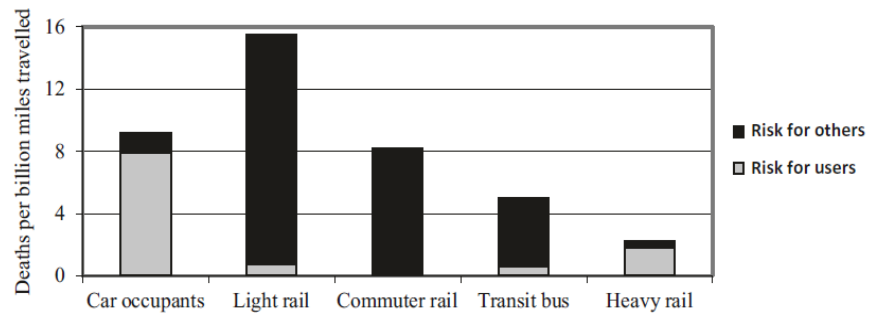
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by the private vehicle modes. However, the road traffic crashes and injuries involving bus transportation are very less; and it is seen as one of the safest modes of transport to commute [(Truong & Currie, 2019); (Schepers, Lovegrove, & Helbich, 2019)]. For instance; studies have shown that the risk of fatality due to a traffic crash is eight times more while travelling by a car than travelling in a bus, while the same risk is increased up to 50 times when you are walking (Sam, Daniels, Brijs, Brijs, & Wets, 2018). Bus transport is often seen as an alternative by urban practitioners to private vehicle modes as well, in order to reduce the overall exposure of humans to road traffic crashes.

Buses form the marginal groups when it comes to the whole vehicle populations in any country or a city. Their proportion mostly lies about one per cent or even less of the total vehicle population (Cafiso, Graziano, & Pappalardo, 2013) and public transport buses constitute of even lesser percentage amongst them. In addition to this, the total number of crash fatalities involving buses are also comparatively very less than the other modes of transport (Fig. 1). Thus, there is a possibility of negligence or lesser attention towards the road traffic crashes involving buses and similar reflection was felt while searching for literature on the subject.

**Fig. 1: Crash fatality rates per billion passenger miles travelled**



Source: (Litman, 2012).

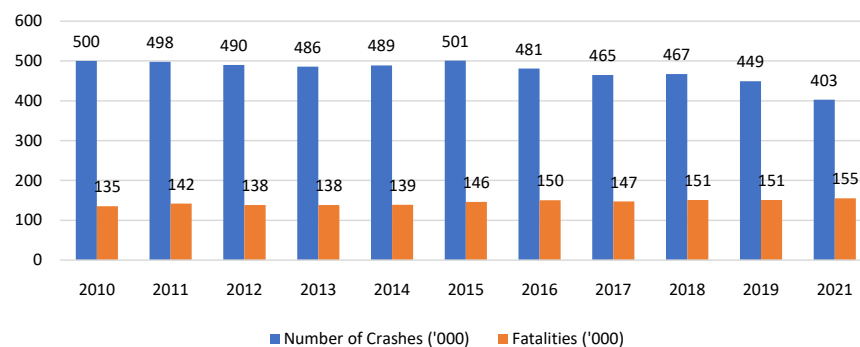
### BUS-BASED PUBLIC TRANSPORT IN INDIA

From decades, buses in India are one of the most important means of transport for intercity travel, as well as intracity trips. The bus systems are well-planned and widely used by commuters especially in few of the cities. The mega cities and few million plus cities are heavily dependent on bus transport. The work trip information as collected by the Census of India in 2011, showed that 22 per cent of India's workforce commutes daily using a bus (Tiwari & Nishant, 2018). However; the population of buses is on a continuous decline as the total share of buses in the

vehicle fleet has gone down to even less than one per cent, which was around 11 per cent in 1951 (Road Statistics Yearbook, 2017). This shows the declining trends of bus transport in the country, but as our cities are growing, the need for planning and designing public transport in form of buses is rising. More importantly, a safer public bus transport will be vital to the sustainable urban growth and towards achieving the Sustainable Development Goal SDG-3.6 by 2030, states to halve the number of global deaths and injuries from road traffic accidents.

In terms of road safety, India is the leading country in the world in total road fatalities and the numbers are on a rise yearly. An average 0.15 million fatalities happened in India in last four years (2015-19), which is almost 11-12 per cent of global road fatalities. As can be seen from Fig. 2, the number of crashes has been on a slow decline but the number of fatalities has been steadily increasing in the past decade. This indicates the severity of crashes in the country.

**Fig. 2: Road traffic crashes and fatalities in India**



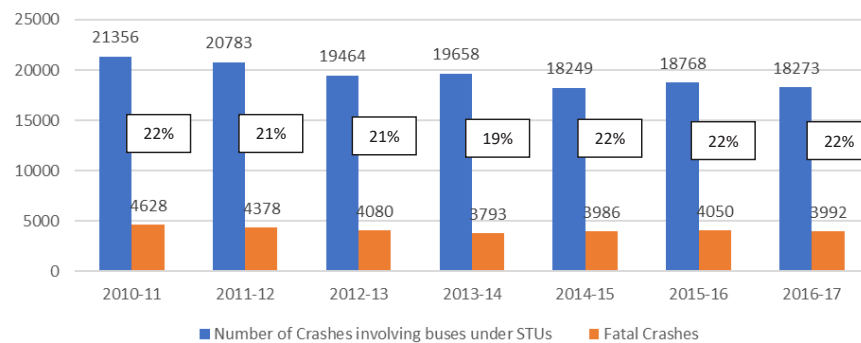
Source: Ministry of Road Transport and Highways, Government of India.

Buses are involved in 5-10 per cent of the total crashes and fatal road traffic crashes as per the Ministry of Road Transport and Highways (MoRTH's) official nationwide crash records. These shares are higher than the European or Western counterparts of the world, where buses were involved in around one per cent of the total crashes and even lesser share in terms of fatal crashes. However, these Indian shares are lower than what were observed in other developing nations such as Ghana or Bangladesh.

Besides 5-8 per cent of all the victims losing lives in the fatal crashes involving buses, are the bus occupants. These numbers are showing the countrywide statistics which might be different for public buses in cities or may vary region-wise.

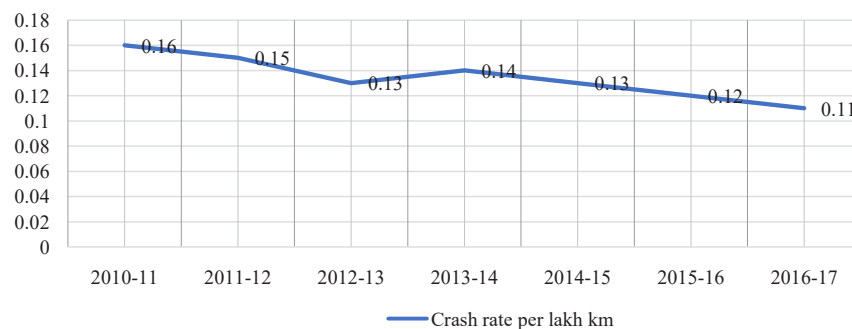
In India, transport is a state subject and thus public buses are operated by different State Transport Undertakings (STUs) and Special Purpose Vehicles (SPVs). It is important to note here that due to limited technical capacity of public transport planners in these organisations, the importance of data collection and analysis in planning safer routes in the cities is missing. Ministry of Road Transport and Highways (MoRTH) and Central Institute of Road Transport (CIRT) have been compiling the performance parameters for all the Indian STUs from past few years. Figure 3 shows the performance of all the STUs in India in terms of road traffic crashes and fatalities. There has been a minor decline each year in the total number of crashes involving buses and the fatalities as well. Figure 4 also shows the declining trend in the rate of road traffic crashes per one lakh kilometre of buses driven. However, the ratio of

**Fig. 3: Road traffic crashes and fatalities involving buses in India (under State Transport Undertakings)**



Source: Transport Research Wing, Ministry of Road Transport & Highways and; Central Institute of Road Transport.

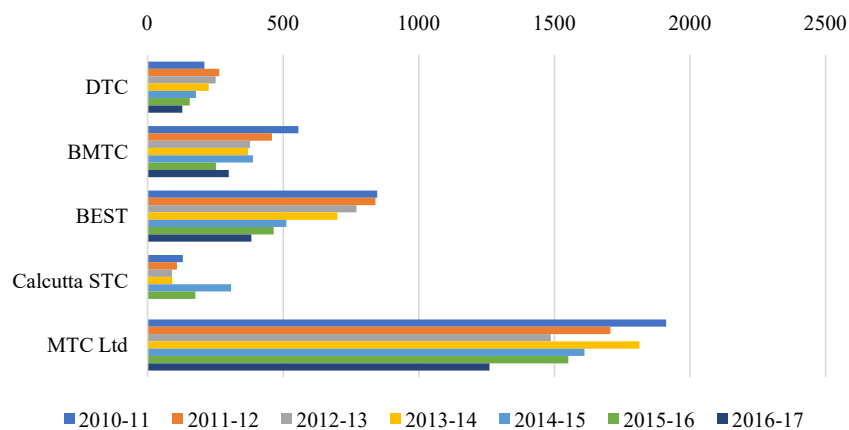
**Fig. 4: The rate of road traffic crashes involving public buses per one lakh km of vehicle driven**



Source: Transport Research Wing, MoRTH and Central Institute of Road Transport.

fatal crashes to the total crashes still remains the same (shown in boxes in Fig. 3). This indicates the increased severity of the bus crashes over the years. Also, as discussed earlier, the number of buses in the total vehicle fleet are decreasing in India and it could be a possible reason for the decline in road crashes involving buses. During this seven-year period (2010-17 in Fig. 5); states of Maharashtra and Andhra Pradesh have been the states with highest road traffic crashes involving public buses.

**Fig. 5: Total number of crashes involving Buses in Metropolitan Cities of India**



Source: Author, 2021.

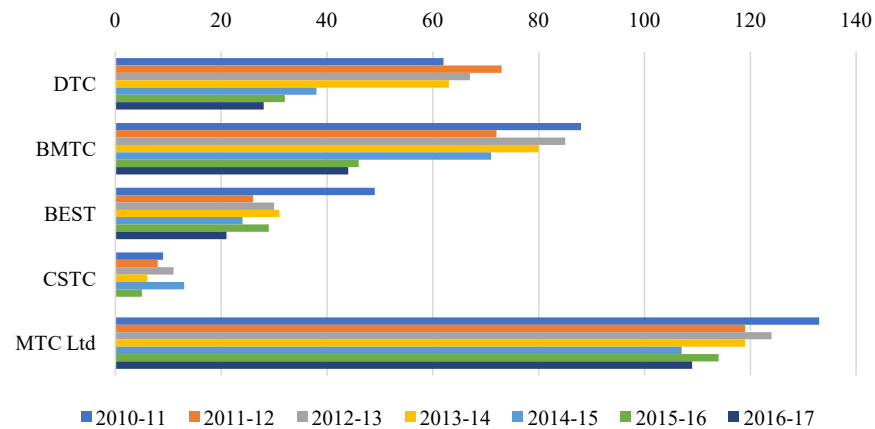
The STUs are also responsible for running buses in different cities under a state. In few cities, buses are run by the municipal undertakings or a private company as well. In order to understand the road safety scenario of buses in urban India, few Indian bus corporations operating in major metropolitan cities and whose crash data is available is shown below in Table 1 and Fig. 6, 7. It can be seen that Chennai city in the state of Tamil Nadu observes the highest crashes. The cities of Mumbai and Kolkata observe a smaller number of fatal crashes and this can be due to the low speeds in these cities due to higher congestion levels, and thus it results in lesser number of severe crashes. However, the ratio of fatal crashes depicts a different story where Delhi observes a greater number of fatal crashes out of its total crashes. This may be due to the availability of a vast road network (resulting in higher speeds) and Delhi being the most populous city of India. And thus, Delhi is being chosen as a case city to further investigate in the road traffic crashes related to buses.

TABLE 1: CRASHES AND FATALITIES INVOLVING URBAN BUS SERVICES IN INDIAN METROPOLITAN CITIES (AS PER FINANCIAL YEAR RECORDS)

STU/ Year	2010-11			2011-12			2012-13			2013-14			2014-15			2015-16			2016-17		
	Total Crashes	Fatal Crashes	Ratio of fatal crashes	Total Crashes	Fatal Crashes	Ratio of fatal crashes	Total Crashes	Fatal Crashes	Ratio of fatal crashes	Total Crashes	Fatal Crashes	Ratio of fatal crashes	Total Crashes	Fatal Crashes	Ratio of fatal crashes	Total Crashes	Fatal Crashes	Ratio of fatal crashes	Total Crashes	Fatal Crashes	Ratio of fatal crashes
<b>DTC</b>	209	62	30%	264	73	28%	251	67	27%	225	63	28%	178	38	21%	155	32	21%	128	28	22%
<b>BMTC</b>	556	88	15%	485	72	15%	378	85	22%	370	80	22%	388	71	18%	252	46	18%	299	44	15%
<b>BEST</b>	847	49	6%	840	26	3%	770	30	4%	700	31	4%	511	24	5%	465	29	6%	383	21	5%
<b>Calcutta STC</b>	130	9	7%	108	8	7%	90	11	12%	91	6	6%	308	13	4%	176	5	3%	-	-	-
<b>MTC Ltd Chennai</b>	1912	133	7%	1706	119	7%	1487	124	8%	1813	119	7%	1611	107	6%	1551	114	7%	1260	109	8%

Source: Transport Research Wing, Ministry of Road Transport & Highways and; Central Institute of Road Transport. (DIC – Delhi Transport Corporation, BMTC – Bengaluru Metropolitan Transport Corporation, BEST – Brihanmumbai Electricity Supply and Transport, Calcutta STC – Calcutta State Transport Corporation, MTC – Metropolitan Transport Corporation [Chennai] Limited).

**Fig. 6: Total number of fatal crashes involving Buses in Metropolitan Cities of India**



Source: Author, 2021.

### THE CASE OF DELHI

Delhi which is the capital of India can be seen as one of the severe affected cities, in terms of fatalities occurring in road traffic crashes involving buses. The city is heavily dependent on its bus transport system which travels around 10 per cent of the Delhi's vehicle kilometres but caters to 54 per cent of total passenger kilometer (PKM) demand and 76 per cent of the total public transport PKM demand (Suman, Bolia, & Tiwari, 2017). In addition to bus transport, there are metro services and informal modes of transport services as well.

Delhi's bus transport system is operated by two organisations namely: Delhi Transport Corporation (DTC) and Delhi Integrated Multi-Modal Transit System Limited (DIMTS). Out of these two, DTC has a greater number of buses (close to a fleet of 4000 urban buses) and caters to more passengers as well. DTC operates on more than 500 bus routes which covers the area of Delhi and few neighbouring rural counterparts as well.

As discussed in previous sections, Delhi witnesses' significant amount of road traffic crashes involving buses and has the highest ratio of fatal crashes involving buses amongst all metropolitan cities (Table 2). This section will detail out the characteristics of the road traffic crashes involving buses and specifically, DTC buses in Delhi. The focus is given on total crashes and the fatal crashes; as the injuries are mostly under reported in India as stated by {(Dandona, Kumar, Ameer, Reddy, & Dandona, 2008), (Mohan, Tiwari, & Bhalla, 2016)}.

TABLE 2: YEARLY ROAD TRAFFIC CRASHES AND FATALITIES IN DELHI

Year	Total crashes in Delhi	Total crashes involving DTC buses	Share of DTC bus crashes	Total fatal crashes in Delhi	Fatal crashes involving DTC buses	Share of fatal bus crashes	Total Fatalities	Fatalities in crashes involving DTC buses	Share of bus crash fatalities involving DTC buses
2013	7566	236	3%	1778	66	4%	1820	67	4%
2014	8623	189	2%	1629	39	2%	1671	40	2%
2015	8085	162	2%	1582	32	2%	1622	35	2%
2016	5671	130	2%	1548	29	2%	1591	32	2%
2017	5017	137	3%	1565	31	2%	1584	32	2%
2018	6515	109	2%	NA	21	--	1690	22	1%
2019	5610	128	2%	1433	32	2%	1463	32	2%

Source: Ministry of Road Transport and Highways, Government of India and Traffic Safety Cell, Delhi Transport Corporation (DTC).



TABLE 3: YEARLY ROAD TRAFFIC CRASHES INVOLVING PUBLIC BUSES IN DELHI

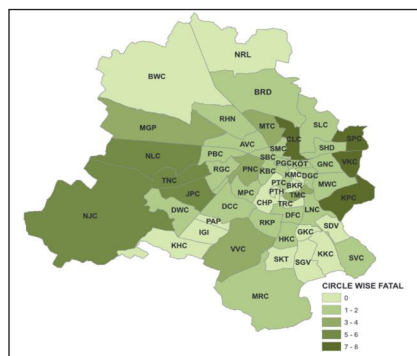
Year	Insignifi- cant	No. of Minor crashes	No. of Major crashes	No. of Fatal crashes	No. of Total crashes	Total Injuries	Total Deaths	Percentage of minor crashes	Percentage of major crashes	Percentage of fatal crashes	Avg. crashes per lakh kms
2013	2	151	17	66	236	175	67	64.0	7.2	28.0	0.07
2014	1	139	10	39	189	166	40	73.5	5.3	20.6	0.06
2015	-	115	15	32	162	127	35	71.0	9.3	19.8	0.06
2016	1	94	6	29	130	91	32	72.3	4.6	22.3	0.05
2017	1	92	13	31	137	109	32	67.2	9.5	22.6	0.05
2018	1	75	12	21	109	85	22	68.8	11.0	19.3	0.04
2019	1	87	8	32	128	98	32	68.0	6.3	25.0	0.05
Total/Avg	7	753	81	250	1091	851	260	69.0	7.4	22.9	0.06

Source: Traffic Safety Cell, Delhi Transport Corporation.

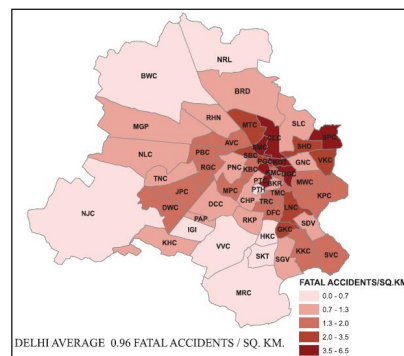
Table 2 shows the year-wise data for road traffic crashes and fatalities in Delhi; along with similar depiction of public DTC buses. Over the years, the total crashes in Delhi have reduced along with the crashes involving DTC buses but Table 3 shows that the ratio of fatal crashes out of total bus crashes remains constant which signifies the severity of such incidents. Also, year 2019 alone saw a sudden increase of 45 per cent in the number of fatalities, which were falling till the previous year.

A detailed account of the road traffic crashes involving DTC public buses for the year 2019 were collected from the Traffic safety cell of Delhi Transport Corporation (DTC). 70 per cent of these crashes in 2019 took place in an urban setting and rest in rural counterparts, since Delhi's buses also cover the nearby villages. Map 1 depicts the outer fringe portions of Delhi, which are not much urbanised yet, and which witness a greater number of fatal bus crashes. These include areas in North-east and Western fringes of Delhi such as Najafgarh, Vivek Vihar, Seemapuri, Civil Lines, Kalyanpuri, etc. Map 2 shows the total fatal crashes in Delhi in 2019, which highlights that the majority of the fatal crashes occurred in the central areas of Delhi. This can possibly be due to high population density, high mix of vulnerable road users, high speed vehicles, etc. in the Central and few north-eastern parts of Delhi.

**Map 1: Fatal crashes involving buses in Delhi (2019)**



**Map 2: Fatal crashes in Delhi (2019)**

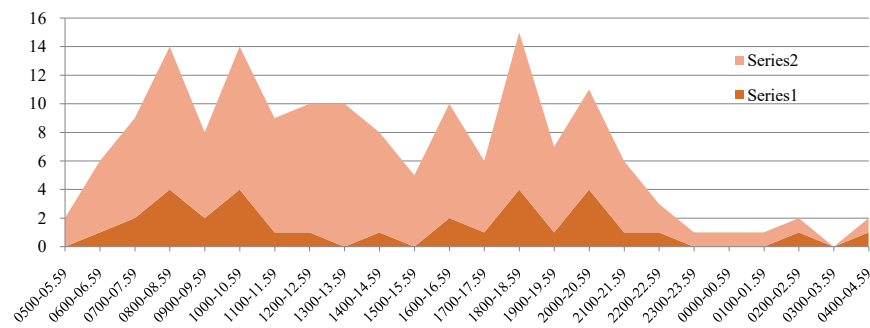


Source: Accident Research Cell 2019, Delhi Traffic Police.

The temporal distribution of occurrence of accidents throughout the week shows that Thursdays and Fridays witnessed more crashes and fatalities in the year 2019. Figure 7 depicts the crashes and fatalities as per the time of the day. It can be observed that starting from the morning when roads are less crowded, there is a rise in the crashes and fatalities respectively. This rise continues till office going hours and then reduces

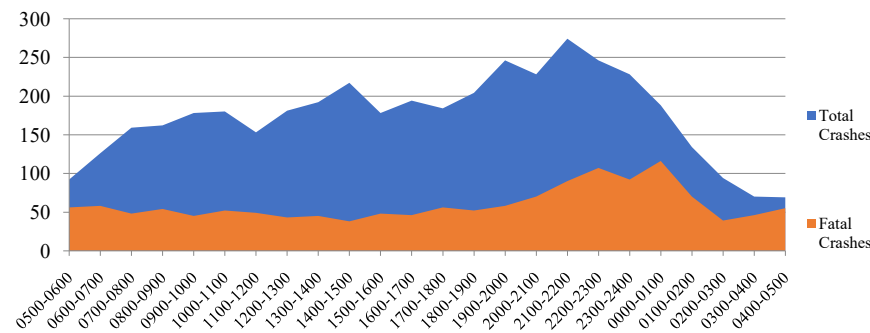
in the afternoon till evening peak hours where it rises again (when people return to home after work). The evening crest continues till 9 pm and then settles down. This might be due to the absence of daylight and subsequent inadequacy of street lights. The fatal crash peaks also follow the same trend, i.e., when the total number of crashes increase, there is a rise in the fatal crashes as well. Figure 8 shows the temporal distribution of overall crashes in Delhi in 2019 and it is different from the trend observed in bus crashes as shown in Fig. 9.

**Fig. 7: Temporal distribution of road traffic crashes and fatal crashes involving DTC buses in Delhi. Series 1-Fatal Crashes and Series 2-Total Crashes**



Source: Traffic Safety Cell, Delhi Transport Corporation.

**Fig. 8: Temporal distribution of road traffic crashes and fatal crashes in Delhi**



Source: Accident Research Cell, Delhi Traffic Police.

There are more than 500 routes of public buses being operated in Delhi, but certain number of routes have been identified from the DTC crash data of 2019, where the crashes and fatalities are higher. One fourth of the total crashes and almost one third of the total fatalities involving buses happened on these 10 routes mentioned in Table 4. Also, more than two-thirds of the fatal road crashes occurred in North and East Delhi.

TABLE 4: DTC BUS ROUTES IN DELHI WITH REPEATED  
CRASHES AND FATALITIES

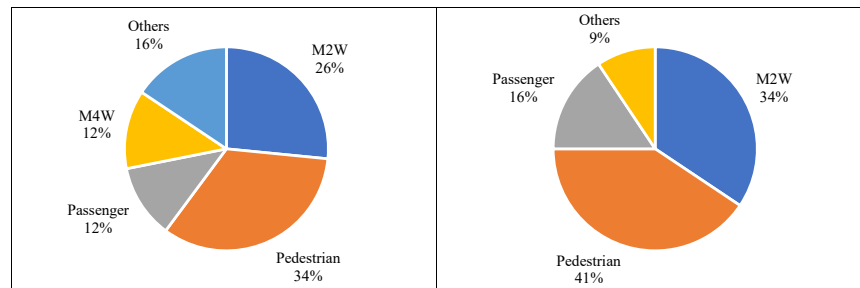
<i>Route No.</i>	<i>Origin</i>	<i>Destination</i>	<i>Fatal crashes</i>	<i>Total Crashes</i>
764	Najafgarh	Nehru Place	1	6
392	Mayapuri Depot	Noida Sector 62	2	5
971	Anand Vihar ISBT	Rohini Sector 1	2	5
234	Karampura Terminal	Shakti Nagar	1	4
427	Nizamuddin Railway Station	Mehrauli		4
33	Bhajanpura	Noida Sector43	1	3
347	ISBT Kashmere Gate	Noida Sector 34	1	3
423	Mori Gate Terminal	Ambedkar Nagar Terminal		3
8	Badarpur Border	Noida Phase 1	1	2
Outer Mudrika	Anand Vihar ISBT	Anand Vihar ISBT	1	1
<b>Total</b>			<b>10 (out of 32)</b>	<b>36 (out of 128)</b>

Source: Traffic Safety Cell, Delhi Transport Corporation.

Road traffic crashes always happen between two road user groups. Figure 9 shows the other user group involved in crashes with DTC buses in Delhi and majority collisions were with pedestrians, followed by motorised two-wheelers (M2W). The same user groups are also the most vulnerable road users as can be seen in the fatal crash description. Figure 10 shows a similar description of the overall bus crashes in Delhi (involving DTC buses and various other private/government buses). It indicates a similar trend where M2W occupants and pedestrians are the majority victims. The only exception is in the case of bus passengers which are more prone to fatal crashes in case of DTC buses. This might be due to the ridership behaviour of DTC drivers or poor safety standards in DTC buses.

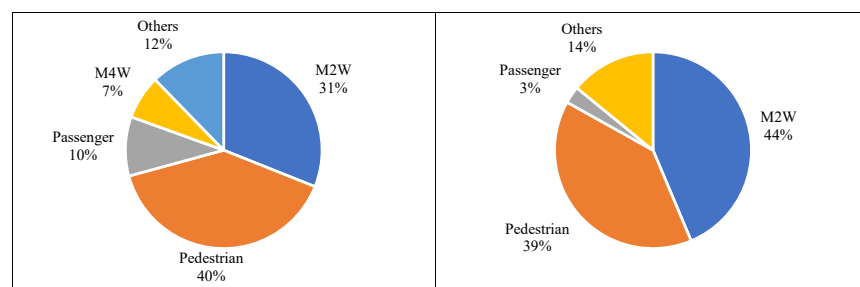
The likely reasons for all the crashes are supposed to be recorded while making the entry for the road traffic crash, but this practice is not followed well in Indian road safety ecosystem and thus useful datapoints

**Fig. 9: Left side - Road user group involved in total DTC bus crashes. Right side - Road user group involved in fatal DTC bus crashes (2019)**



Source: Traffic Safety Cell, Delhi Transport Corporation.

**Fig. 10: Left side - Road user group involved in total bus crashes in Delhi Right side - Road user group involved in fatal bus crashes in Delhi**



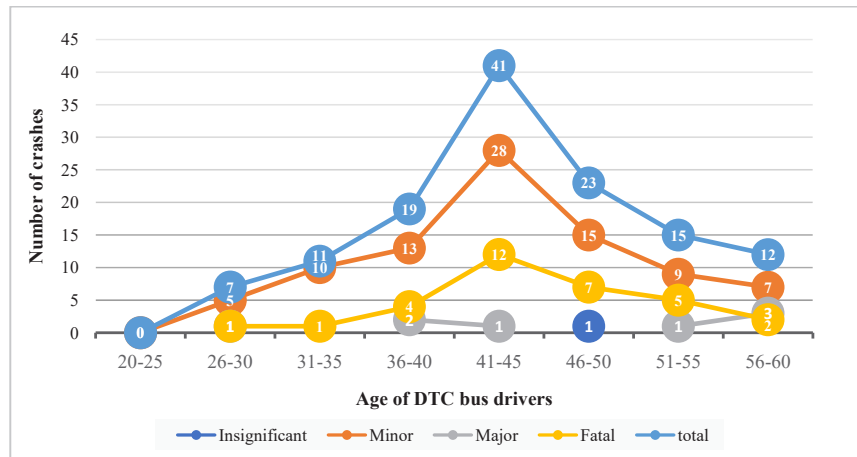
Source: Accident Research Cell, Delhi Traffic Police.

such as the causes of road traffic crashes and especially fatal crashes are mostly unknown. Few instances were recorded in the data obtained from DTC and it highlighted the causes of crashes such as rash and negligent driving, error of boarding/alighting passenger, mechanical failure etc. Figure 11 shows the age of drivers riding the buses and are involved in a crash. Interestingly, the age group of 35-50 years of drivers were more involved in the crashes. The road safety record for drivers on payroll against the drivers on contract showed almost same amount of crashes and fatalities.

### KEY FINDINGS AND DISCUSSION

The case city of Delhi shows that the ratio of fatal crashes involving public buses is still not declining, despite a decrease in the total number of crashes. Thus, the crash severity might be on an increase and needs to be under check. This can be due to a variety of reasons like high speed driver behaviour, infrastructure design flaws, etc. Majority of the crashes are happening in an urban setting but the fatal crashes

**Fig. 11: Age profile of the drivers of DTC buses in Delhi involved in road traffic crashes in 2019**



Source: Traffic Safety Cell, Delhi Transport Corporation

are more concentrated towards the fringe areas of Delhi. The possible reasons include a lack of self-enforcement amongst drivers while driving through non-urban settings.

The fatalities in case of crash with a DTC bus is mainly of a pedestrian and motorised two-wheeler occupant. These can be high due to the nature of these road users of being at a higher risk (and high exposure). Various external factors are responsible for this vulnerability as well, especially in case of a pedestrian who are devoid of basic facilities such as footpaths, bus stops, level boarding facilities, etc. All these infrastructures required for the public transport needs to be planned, designed and implemented well. High speed on empty roads during mornings and inadequate lighting facilities during nights, might be some of the probable reasons for spikes in crashes in a day.

The case of Delhi's public buses found not performing good amongst the other major cities of India. A comparison of bus crashes between Indian context with the other developing and developed regions of world also comes out of this study as given in Table 5 below. It shows that the share of bus related crashes and fatalities in the developed nations such as USA, France and all countries of EU are very low as compared to India. Moreover, throughout the world, pedestrians emerge as the most impacted road user group to be affected by bus related crashes and thereby are the most vulnerable ones.

TABLE 5: COMPARISON OF BUS CRASHES OF INDIA VERSUS OTHER COUNTRIES

<i>Country/ Region</i>	<i>Developed/ Developing</i>	<i>Modal share of bus usage</i>	<i>Share of bus crashes out of total crashes</i>	<i>Share of fatal bus crashes out of total fatal crashes or share of fatalities</i>	<i>Major victims in bus crashes</i>
EU	Developed	8%	0.5%	3%	Car occupants and pedestrians
USA	Developed	2-3%	Less than 1%	Less than 1%	Other vehicle occupants and pedestrians
France	Developed	6-8%	1.5%	1.6%	Pedestrians and car occupants
Dhaka, Bangladesh	Developing	30%	42%	40%	Pedestrians and Cyclists
India	Developing	22%	5-10%	5-10%	Motorised two-wheeler occupants and Pedestrians

Source: Author.

## CONCLUSION AND WAY FORWARD

Buses are still considered as a safe mode of transport and thus the attention on this subject seems to be unimportant. But as can be seen in the crash records shown in previous section, there is a need to focus on reducing the crashes and their severity because a life lost in any way is a life lost and the burden it leaves behind on the family of the deceased is immeasurable. Also, a collision by bus will always be more severe when compared to other modes of vehicles or road users. The occupancy of buses is also high and thus the threat to a greater number of lives at any given time is higher. Thus, considering attaining the Sustainable Development Goal (SDG3.6) towards reducing the number of global deaths and injuries from road traffic accidents by half, planning of safer public transport routes gets imperative. And to accomplish this task it is critical to assess the existing road safety levels of the public transport undertakings operating in the cities. The road traffic crashes

where buses are indirectly involved such as a road user being hit by any vehicle colliding with a bus and getting injured or even dying, are also not a part of the majority database and discussion on road traffic crashes involving buses. These indirect involvements of buses are not considered in formal police complaints or crash records as well (Brenac & Clabaux, 2005). Thus, there are various irregularities in capturing the status of safety of this specific target group and its associated injuries and fatalities.

At the global level statistics especially of the developed nations such as the EU countries and USA show that the traffic crashes involving transit buses varies from 0.5 to 1.6 per cent share among all other modes of transport. The statistics for these developed regions of the world include all types of buses i.e., school buses, transit buses, tour buses, private company buses, etc. So, the number of crashes and fatalities attributed to public buses in these countries are even lower. The literature review undertaken shows that none of the studies or reports highlights the safety records or safety issues involving buses and particularly city public transit buses. It is seen that the developed nations have maintained much better data set on the accidents related injuries and fatalities on buses which in turn helps in undertaking corrective measures to minimise crashes involving buses and also help plan safer bus routes. On the other hand, very poor information is being maintained as far as the developing nations such as Ghana, Bangladesh, and India etc. are concerned.

The road safety situation in India is grim. In India alone buses are involved in 5-10 per cent of the total crashes and fatal road traffic crashes as per the MoRTH's nationwide crash records. Although bus still remains as a major mode of transport in urban areas but still the share of public transport is witnessed to be on a declining trend. Amongst the major metro cities, Chennai has the highest number of total and fatal crashes involving public transport buses. However, looking at the severity Delhi has more percentage of fatal crashes involving public transport buses. The analysis of DTC buses operating in Delhi which was found to be not performing so good in case of crashes and fatalities related to buses, can be used to examine other such cities of India as well.

Such baseline scenario assessments are very necessary and critical so as to first have a realisation of the problem and then plan for the strategies to improve the overall road safety situation. Precise data on number of crashes and details on each of these crashes are the first step to solve this major issue. The details include reason for crash, type of collision (rear end, head on, side impact, roll on etc.), speed of vehicles, road design etc. Safety audits at collision spots can be carried out by



the transport department team or the transport undertaking which is operating the buses in the cities.

In order to improve the performance of bus services in Delhi in terms of road safety, several measures can be taken up. The bus crash details of the year 2019 discussed show that pedestrians and two-wheeler occupants are the most vulnerable road user groups in the crashes involving public buses. Thus, there must be some measures to create sensitivity towards these road user groups. The few crashes where the bus passengers were injured/killed while boarding/alighting can be easily prevented by ensuring level boarding at bus stops and by ensuring proper functioning of automatic doors in the buses (provided they are available).

The bus body specifications are also a case of concern when it comes to ensuring safety. Research has shown that low floor buses with maximum height of 550 m from ground are suitable to prevent severe crashes and especially crashes involving running over by a bus (Kharola, Tiwari, & Mohan, Traffic Safety and City Public Transport System: Case Study of Bengaluru, India, 2010). Apart from the external design of the bus body, various internal safety mechanisms are also necessary to ensure safety. Such standards must be put in place at national level to direct manufacturing of vehicles and at the state/local level to direct purchase of standard buses.

The age group of the drivers, which is more prone to crashes needs to be investigated further for improving their performance while driving and subsequently reducing crashes and fatalities. They can be given special training sessions. Also, experienced drivers can be shifted to those routes where crashes are repeatedly happening (as shown in assessment). A monitoring mechanism of bus drivers and even conductors can be developed where on basis of their performance, they can be incentivised or disincentivised.

The time of the day when crashes are happening more must be further investigated. One of the reasons of increased crashes/fatal crashes during non-peak hours in a day is the increase in vehicle speeds and non-adherence to traffic rules. This is the responsibility of the transport undertaking or the bus agency to always maintain same driving discipline in a day. This can now very well be ensured using technology such as GPS, speed trackers, CCTV cameras, command centres, etc.

The Indian STUs operating in cities need to take cognizance of the matter and step up in their respective regions to improve their performance with respect to road safety of buses. There are few cities

such as Bengaluru where the STU i.e., BMTC carried out workplace alcohol prevention programme for bus drivers which is a progressive step. Mumbai's BEST Road safety awareness creation campaigns takes place yearly and are even organised by city bus organisations but more is needed to be done. BEST undertaking in Mumbai also went a step ahead and in partnership with Bloomberg and carried out a comprehensive plan involving measures such as crash investigation analysis, bus modifications, trainings by experts, online monitoring and even design changes in a terminal. This led to reduction of crashes by one-fourth and fatalities by one-third for the period of 2009-2016 in all bus related incidents. This can be carried out extensively with the support of government departments in all the urban buses. bus service organisations, with the primary aim to make bus transport safer for passengers and even other road users.

A comprehensive analysis of the best practices adopted across the globe have been briefed in this section. Globally, countries are adopting a zero-tolerance accident policy and modernising their urban and traffic infrastructures for safety. Numerous Western European and Asia-Pacific countries with substantial incomes have decreased their costs even further. Japan decreased its disease burden from road injuries by 42 per cent between 1990 and 2010, whereas Sweden reduced its disease burden by 30 per cent. For countries like India, case studies on interventions, policies, regulations, and institutional capacities to implement them in these high-achieving nations could provide invaluable lessons.

In the Netherlands the concept of Sustainable Safety has resulted in significant improvements (30 per cent reduced fatalities-2005) in vehicular safety. The Dutch "Sustainable Safety" idea of preventing human errors through good road planning, road design, and enhancing existing roads Three design tenets for road networks, roads, and streets are prioritised in this vision: functionality, homogeneity, and predictability. In the city of Paris, the Mayor has reduced the speed on all city roads to 30 kmph (2014). Sweden's Vision Zero road safety strategy prioritises safety over speed, with important measures including low urban speed limits, pedestrian zones, and barriers to separate automobiles and bikes. It suggested a 30 km/h speed limit and built 1,500 km of "2+1" highways where each lane of traffic takes turns using a centre lane for overtaking, saving many lives. It has built 12,600 safer crossings and implemented tough policing to reduce pedestrian deaths. It has also included the Traffic for an Attractive City recommendations for traffic safety and crime prevention (TRAST). Safety audit requirements are included in Swedish police guidelines.

In Europe, several measures are in place, including a reduction in

traffic speed, the isolation of vulnerable individuals from motorised traffic, the launch of awareness programmes, the addition of pedestrian crossings and the imposition of fines for violations of pedestrian areas. In the European Union, fines are mandated by law, either as part of a Road Traffic Act or pursuant to a particular legislative provision. In certain nations, police officers are permitted to determine the fine amount based on the specifics of the traffic incident. In Finland, Sweden, Norway, and Switzerland, the amount of a fine is determined by the offender's net income. In California, a new traffic law was implemented in September 2014, which minimised the state's high rates of bicycle accidents, injuries, and fatalities. Motorists were compelled to remain at least three feet away from cyclists when passing them on the road. In Oman in middle east region, the Royal Oman Police has installed both stationary and concealed speed cameras to monitor roadways. The number of fatalities on the road has decreased as a result of the implementation of harsher penalties for those who disregard traffic signals.

The Road Traffic Reduction Act gives London's authorities the power to restrict traffic volumes or the rate of expansion of traffic in specific locations in order to ease congestion and enhance air quality. The city of San Francisco has implemented something called the Better Street Policy. In order to better serve its citizens, New York City is investing in pedestrian infrastructure. Pedestrians have the right of way in Auckland via the Land Transport (Road users) Rule, which prohibits drivers from stopping or parking on a sidewalk. In the United Kingdom, reckless driving is punishable by a fine of up to £100 and the addition of points to the licence number. According to a department of transportation proposal, drivers who pass cyclists too closely will be subject to a UK £100 fine, a 25 kmph speed limit, and three penalty points. This is for a select few cities with high cycle traffic. In Germany, a computerised point system for traffic offences is in existence. If the violation endangers traffic safety, a driver may receive up to three points. The driver's licence is revoked after eight demerit points. The driver must pass a medical and mental assessment in order to regain their licence.

Apart from the various best practices mentioned above, an integrated approach is also a major requirement for reducing crashes and fatalities involving buses in our Indian cities. Apart from the bus operating agencies, equal responsibility rests in the hands of other city agencies to improve overall safety on roads. The road agencies need to plan, develop/modify their design criteria keeping in mind the importance of buses for cities and thus make necessary changes on roads, bus stops, bus bays, etc. to promote safety for all. The multiplicity of organisations dealing with urban transport as a subject is one of

the major causes for such high number of crashes and fatalities in our country and cities.

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