Research 2024/25

THE ROLE OF SEATBELTS IN PREVENTING FATALITIES AND SERIOUS INJURIES IN LONG DISTANCE BUS CRASHES IN SOUTH AFRICA

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Commissioned by the Innovative Road Safety Engineering Solutions Working Group (IRSES-WG) of the National Road Traffic Engineering Technical Committee (NRTETC) which resorts under the National Road Safety Steering Committee (NRSSC).	
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ACRONYMS

AARTO	Administrative Adjudication of Road Traffic Offences
CBRTA	Cross Border Road Transport Agency
CDC	Centre for Disease Control
CPA	Consumer Protection Act
DoT	Department of Transport
ECRS	Enhanced Child Restraint Systems
FSI	Fatal and Serious Injuries
GDP	Gross Domestic Product
IRSES-WG	Innovative Road Safety Engineering Solutions
ITF	International Transport Forum
IS	Injury Severity
MC	Major Crash
MCIU	Major Crash Investigation Unit
NHTSA	National Highway Traffic Safety Administration
NLTA	National Land Transport Act
NRSSC	National Road Traffic Engineering Technical Committee
NRTA	National Road Traffic Act
NRTETC	National Road Traffic Engineering Technical Committee
OHSA	Occupational Health and Safety Act
PREs	Provincial Regulatory Entities
RTMC	Road Traffic Management Corporation
SSA	Safe System Approach
SABOA	Southern African Bus Operators Association
SABS	South African Bureau of Standards
SADC	Southern African Development Community
SDG	Sustainable Development Goal
TNTT	Trauma Nurses Talk Tough
WHO	World Health Organisation

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1 INTRODUCTION

1.1 Background

According to the World Health Organization (WHO) report, 1.19 million people die, and between 20 and 50 million are injured (often resulting in disabilities) from road traffic crashes every year. Most of (92%) road deaths occurred in low- and middle-income countries (World Health Organisation 2023). The WHO further indicates that In South Africa, the road traffic mortality rate (per 100 000 population) is 24.5 deaths per 100 000 (WHO 2023 published based on 2021 data) with South Africa ranking number 183 of 202 countries, or within the bottom 10% of worst performing countries.

In the case of Africa, road traffic accidents constitute 25% of all injury related deaths and over 75% of road traffic casualties are in the economic productive age of 16–65 years (Woldegebriel 2019).

According to the Road Traffic Management Corporation (RTMC), even though not acceptable, road crash fatalities decreased from 14071 in 2016 to 11883 in 2023, a reduction of 15.5% over the 8-year period. The mortality rate in South Africa in 2023 was 19.4 from 25.2 in 2026 (Figure 1). The National Road Safety Strategy (NRSS) target for South Africa to reduce fatalities by 50% from 2010 is depicted below (RTMC 2024).

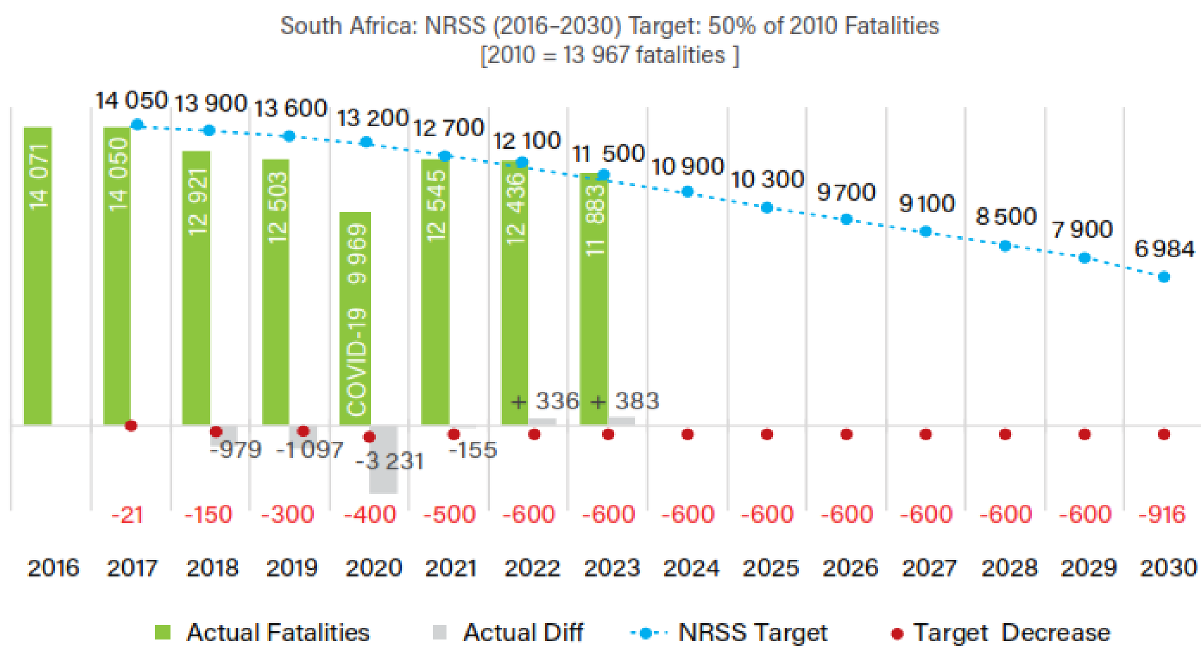

Figure 1: Target – National Road Safety Strategy (South Africa)

International research found that the most severe and most common type of bus crashes is roll-overs, and the studies have found that injuries are more severe if occupants are no wearing seatbelts (Albertsson 2005). The most severe injuries occur when unbuckled passengers are thrown out through the windows or get stuck under the bus (Albertsson 2005).

In South Africa, long-distance bus (passenger transport) travel is grouped as part of the public transport sector, under the formal road-based transport category. It is regulated and monitored to ensure safety, efficiency, and accessibility for passengers traveling between cities or provinces (Mitullah et al., 2017). The South African Bus Operator Association defines long distance bus transport as formal transport (Southern African Bus Operators Association, 2024):

"Long-distance bus services are formal and well-structured, mostly (although some metropolitan areas operate their own bus services) operated by private companies with regulated schedules, fares, and safety protocols".

It is acknowledged that long distance bus travel complements other transport modes like minibus taxis, trains, and flights, especially in areas where train networks are underdeveloped or unreliable (Venter 2010). However, long-distance bus travel is a critical link in South Africa's transport network, offering accessibility and affordability for diverse populations across vast geographical areas. Rural areas for example in South Africa are characterized by poor transport infrastructure, limited access to public transport, and high transport costs (Mashiri 2010). Long distance bus services cater to these passengers traveling long distances, between urban centres, smaller towns, and rural areas across provinces – especially improving rural connectivity for commuters. Providing an economical alternative to air travel and private car use for long distances (Mashiri 2010).

Long distance passenger services in South Africa are (SABOA, 2024):

- Scheduled and operate on fixed timetables, stopping at predetermined points.
- Luxury service providers offer premium seating, onboard amenities like Wi-Fi and refreshments, targeting business and leisure commuters.
- Provide affordable transport options for low- and middle-income countries such as South Africa.

1.2 South Africa's response to address road traffic deaths and injuries

The Safe System Approach (SSA) to road safety, which South Africa is a signatory since 2011 through the Decade of Actions, is a holistic strategy aimed at eliminating fatalities and serious injuries within the road transport system. The Safe System Approach (SSA) is premised on the notion that humans should not be killed or seriously injured because of the mistakes they make.

The SSA acknowledges human fallibility and emphasizes the need for a forgiving road environment that minimizes the consequences of errors. If a road user does make a mistake, that action should not lead to death or severe injury or lifelong disability. Central to the SSA is the recognition that road users are fallible and will make mistakes, even if alert and intending to comply with the road rules. As a result, vehicles and road infrastructure need to be designed to discourage errors and protect against the consequences (damage and injury) when errors do occur.

This approach is structured around five key pillars: Safe Road Users, Safe Vehicles, Safe Speeds, Safe Roads, and Post-Crash Care (Figure 2).

Figure 2: Safe System Approach (US Department of Transportation, 2022)

To execute the functions and activities associated with the SSA pillars, institutional management of these road safety functions is essential. From an institutional road safety management perspective there is a need for political buy-in (lobby and advocacy as well as support for education, legislative changes), dedicated funding for road safety initiatives as well as research and innovation to inform the use of best practices and new technologies in support of road safety.

1.3 Research overview

Crashes where Long-distance buses are involved mostly result in mass casualties due to the large number of passengers involved.

A total of 455 buses were involved in fatal crashes between 2018 and 2022 with 487 fatalities recorded (RTMC 2023). A strong argument could be made that had passengers worn seatbelts, the number of fatalities and/or serious injuries could have been less.

The impact of crashes extend beyond human tragedy. Economic costs from crashes, including healthcare expenses, loss of productivity, and damage to infrastructure, are estimated at 3% of South Africa's GDP annually (World Bank, 2018). Moreover, the psychological and social toll on victims and their families is incalculable.

Limited research is available specific to studies that consider the effectiveness of seatbelts in long-distance bus crashes. However, the general principles of occupant restraint apply, and indications remain that properly worn seatbelts can prevent passengers from being thrown from their seats during sudden stops or collisions, thereby reducing the likelihood of severe injuries. Seatbelts prevent occupant interactions, contact with the bus interior, and ejection during crashes.

1.4 Motivation for the review

The high road traffic crash rates as well as the number of injuries and deaths associated with passenger transport / long-distance buses on South African roads underscore the urgent need for systemic interventions. Seatbelt use has been recognized and accepted as an integral part of road safety management strategies (institutional road safety management) to prevent and reduce road traffic injuries and fatalities. Addressing the interplay of driver and in this instance passenger behaviour, road conditions, vehicle maintenance, and regulatory enforcement can substantially enhance passenger safety. Policymakers, operators, and stakeholders must collaborate to transform South Africa's roads into safer spaces for all users, particularly those relying on long-distance bus services.

Research to assess the effect of wearing seatbelts in buses was identified in 2022 by the Innovative Road Safety Engineering Solutions Working Group (IRSES-WG) of the National Road Traffic Engineering Technical Committee (NRTETC) which resorts under the National Road Safety Steering Committee (NRSSC).

1.5 Research objective and research approach

The objective of this report is to conduct a desktop study as well as an analysis of existing crash data that will provide a better understanding of the impact of seatbelt wearing in long distance passenger buses towards providing scientific guidance for informed decision making for policy and regulation in support of reducing injuries and fatalities in long distance bus crashes.

1.6 Expected research outcomes

To provide international and national context regarding seatbelt wearing in long distance buses to form a baseline:

- from which further research can be conducted
- as input into related National Policies

1.7 Collaborators

The collaborators in this research are:

- Road Traffic Management Corporation (RTMC)
- Council for Scientific and Industrial Research (CSIR)

2 MAJOR CRASH INVESTIGATIONS: DATA ANALYSIS

2.1. Introduction

As indicated in Chapter 1, South Africa faces significant challenges in road safety, particularly concerning long-distance buses, which are a critical mode of transport for intercity and rural travel. The high crash rates on South African roads have raised concerns about passenger safety, operational practices, and regulatory enforcement.

A study published by the RTMC March 2023 found that a total of 455 buses was involved in 323 fatal crashes with 487 fatalities recorded in such crashes. The Gauteng province recorded the highest number of fatal crashes where buses were involved with 23.5% or 76 fatal crashes where buses were involved. The lowest number of 'bus' fatal crashes were recorded in the Northern Cape province with 1.9% or 6 such fatal crashes (Road Traffic Management Corporation 2023).

2.2. Approach

To inform this study, data collected by the MCIU from 1 January 2018 to 1 December 2024 are analysed. All data conforms to the RTMC definition of Major crashes.

The Road Traffic Management Corporation (RTMC) is the State-Owned Entity in South Africa with the mandate to ensure 'Safe Roads in South Africa'. One of the Units within the RTMC is the Major Crash Investigation Unit (MCIU) with the responsibility to perform technical investigations of all major, fatal and serious injury crashes that occur on South African Roads. The criteria for the investigation a Major Crash (MC) is as follows:

- five (5) or more died in a crash;
- crash involving vehicles carrying dangerous goods or hazardous chemicals where there is a fatality and spillage of the dangerous goods or hazardous chemicals;
- a crash that the Corporation deems necessary to investigate, especially for research purposes.

Fatalities recorded by the MCIU include deaths during a major crash and/or persons who died within 30 days after the crash occurred due to injuries occurring from the crash

The analysis below considers fatal crashes, fatalities, serious injuries and then provide an overview of Fatalities and Serious Injuries (FSI), which is the metric used by the United Nations (UN), to report on and analyze the severity of crashes. It serves as a critical indicator for understanding the human impact of road traffic incidents (World Health Organisation 2020):

Serious Injuries typically include non-fatal injuries that require hospitalization, result in significant impairment, or cause long-term consequences. These injuries often exclude minor injuries like bruises or scratches.

However, the WHO indicates that definitions of "serious injuries" can vary between regions or countries, but they generally align with UN and WHO standards. South Africa aligns and report to the UN in relation to the FSI reporting standard.

2.3. Crash analysis findings

The crash data set 2018 – 2024 consist of 660 major crashes investigated by the MCIU. Note that 2020 was not an average year with lower numbers throughout due to COVID and 2024 data is until 1 December 2024, not a full calendar year due to the data mined for this study on 2 December 2024.

Crash data are provided in provincial context within the following nine South African provinces: Eastern Cape (EC), Free State (FS), Gauteng (GP), KwaZulu-Natal (KZN), Limpopo (LP), Mpumalanga (MP), Northern Cape (NC). Northwest (NW) and Western Cape (WC).

2.3.1. Major crash investigations

All major RTMC crash investigations

Table 1 provide an overview of major crashes investigated by the MCIU between 2018 and 2024

Table 1 All Major Crashes investigated by the RTMC MCIU (N=660)

Year	EC	FS	GP	KZN	LI	MP	NC	NW	WC	**Total**
2018	21	17	3	20	19	9	3	13	9	114
2019	13	8	12	27	19	11	2	4	9	105
2020	8	13	5	13	11	7	2	6	9	74
2021	13	12	6	13	18	13	5	11	10	101
2022	16	10	10	22	19	17	8	7	3	112
2023	16	8	9	11	13	8	8	2	9	84
2024	16	5	3	8	12	8	4	6	8	70
Total	**103**	**73**	**48**	**114**	**111**	**73**	**32**	**49**	**57**	**660**

Percentage wise, most major crashes between 2018 - 2024 took place in KwaZulu-Natal (17.30%), followed closely by Limpopo (16,8%) and the Eastern Cape (15.6%), depicted in the Figure 3 below.

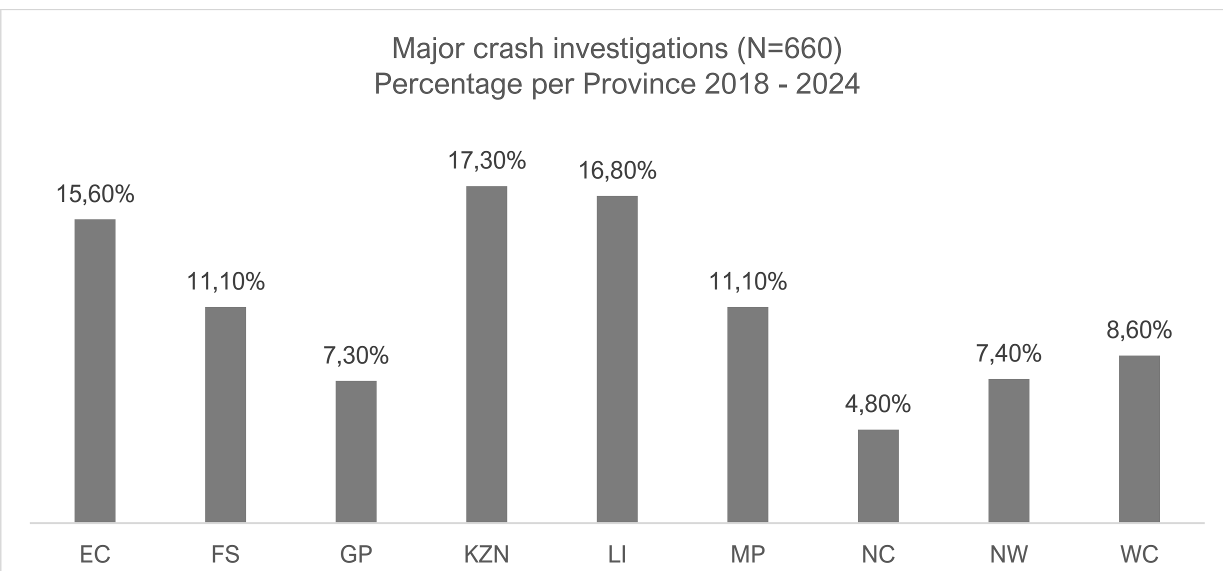

Figure 3: Major crash investigations – percentage per province

Fatalities recorded in RTMC major crash investigations

Table 2 provides an overview of all fatalities recorded in major crashes (N=660) conducted by MCIU for the period 2018 -2024. In the 660 crashes, 4448 fatalities were recorded.

Table 2 All Major Crash fatalities (N=4 448)										
Year	EC	FS	GP	KZN	LI	MP	NC	NW	WC	Total
2018	134	125	16	140	144	70	18	79	66	**792**
2019	70	60	80	169	154	67	11	25	52	**688**
2020	80	74	33	115	64	48	13	38	54	**519**
2021	104	78	36	95	103	75	29	63	63	**646**
2022	106	66	61	163	133	108	55	51	24	**767**
2023	112	46	42	66	122	49	52	12	49	**550**
2024	100	26	24	56	118	48	23	33	58	**486**
Total	**706**	**475**	**292**	**804**	**838**	**465**	**201**	**301**	**366**	**4,448**

Although more major crashes occurred in KwaZulu-Natal, the number of fatalities recorded (Figure 4) in Limpopo (18.8%) was slightly higher than KwaZulu-Natal (18.10%).

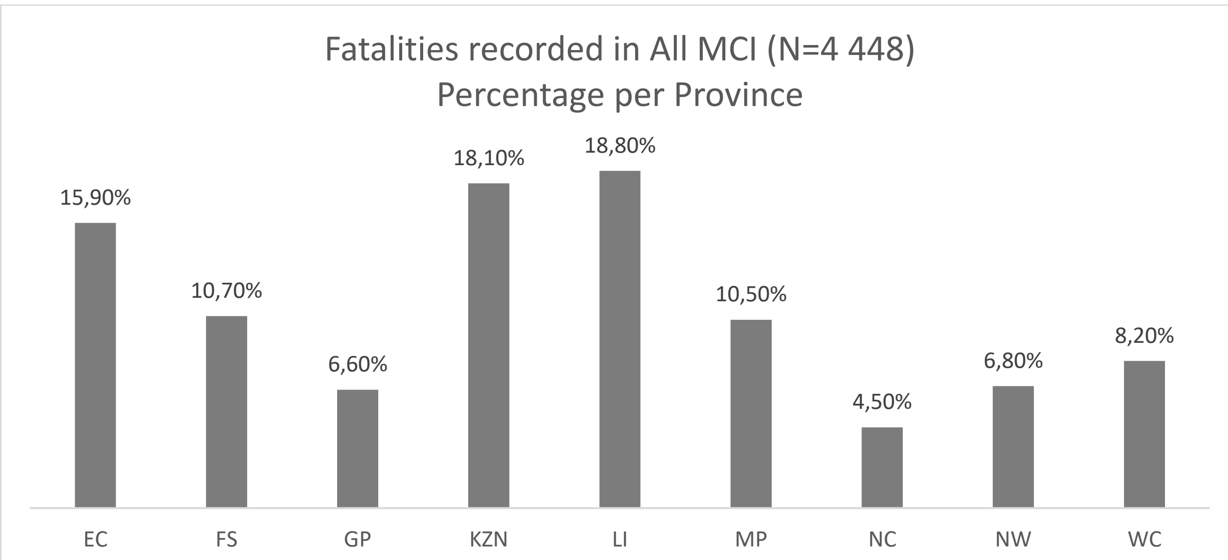

Figure 4: Fatalities in major crashes – percentage per province

Serious injuries recorded in RTMC major crash investigations

Table 3 provide an overview of serious injuries (N=3042) recorded in major crashes.

Table 3 All Major Crash serious injuries (N=3 042)										
Year	EC	FS	GP	KZN	LI	MP	NC	NW	WC	Total
2018	177	76	22	100	96	24	4	49	50	598
2019	86	47	58	212	112	26	3	23	39	606
2020	110	47	11	69	15	30	2	7	50	341
2021	34	23	15	101	42	34	23	32	60	364
2022	54	89	74	65	53	71	27	26	10	469
2023	34	16	20	94	106	37	36	10	16	369
2024	74	13	9	19	67	47	8	9	49	295
Total	**569**	**311**	**209**	**660**	**491**	**269**	**103**	**156**	**274**	**3042**

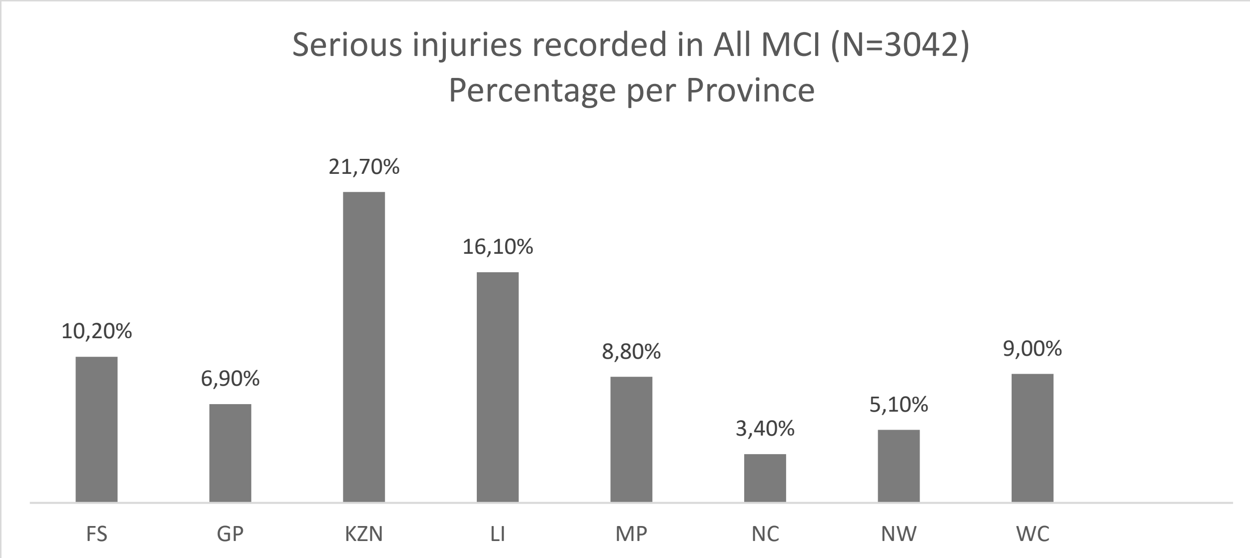

Figure 5: Serious injuries – percentage per province

Figure 5 indicates that KwaZulu-Natal recorded 21.7% of all the serious injuries, followed by 16.1% in Limpopo and 10.2% in Eastern Cape.

Fatalities and Serious injuries recorded in RTMC major crash investigations

When fatalities and serious injuries are combined as per the UN reporting standard (FSI), a total of 7490 FSIs were recorded in the 660 crashes investigated by MCIU (Table 4).

Table 4 All Major Crash FSIs (N=7 490)

Year	EC	FS	GP	KZN	LI	MP	NC	NW	WC	Total
2018	311	201	38	240	240	94	22	128	116	**1,390**
2019	156	107	138	381	266	93	14	48	91	**1,294**
2020	190	121	44	184	79	78	15	45	104	**860**
2021	138	101	51	196	145	109	52	95	123	**1,010**
2022	160	155	135	228	186	179	82	77	34	**1,236**
2023	146	62	62	160	228	86	88	22	65	**919**
2024	174	39	33	75	185	95	31	42	107	**781**
Total	**1,275**	**786**	**501**	**1,464**	**1,329**	**734**	**304**	**457**	**640**	**7,490**

Figure 6 provides an overview of FSI distribution per province. Combined, Limpopo still recorded the most FSIs (19.5%). However, the Eastern Cape and KwaZulu-Natal, percentage wise recorded very similar FSIs.

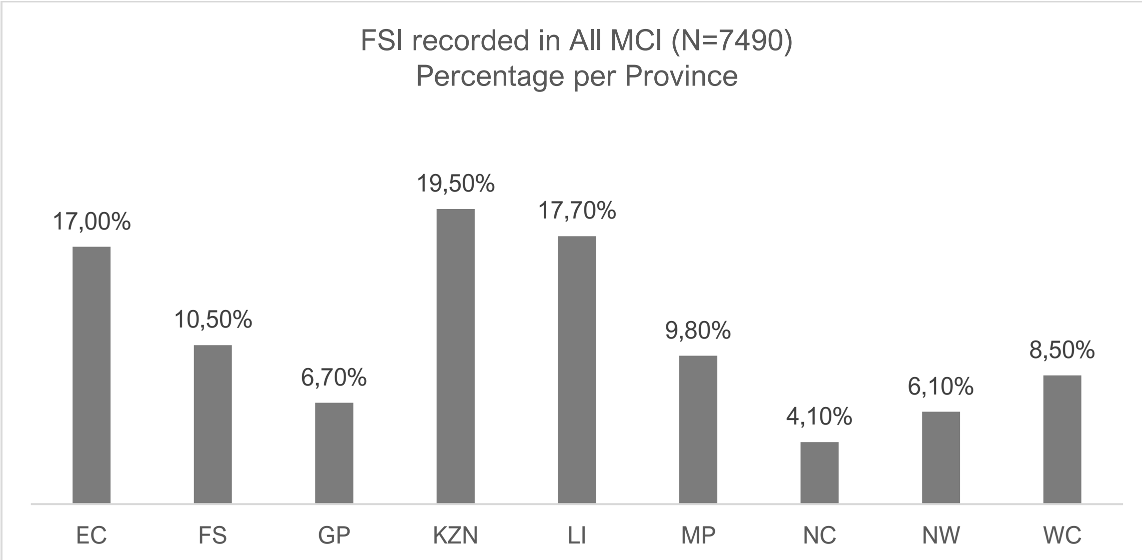

Figure 6: FSI recorded in MCI – percentage per province

2.3.2. Long distance bus crashes

During the period 1 January 2018 to 1 December 2024, 62 major bus crashes were investigated by the MCIU. This constitutes almost 10% of all major crash investigations. Table 5 below provide an overview of bus crashes investigated according to year and province. Limpopo (15) has through the years been the province where most bus crashes have been investigated, followed by KwaZulu-Natal and Western Cape (10 bus crashes each) and the Eastern Cape (6 major bus crashes).

Table 5: All Major Bus Crashes (n=62)

Year	EC	FS	GP	KZN	LI	MP	NC	NW	WC	Total
2018	2	0	0	2	3	1	0	0	1	**9**
2019	1	1	1	2	2	0	0	0	1	**8**
2020	1	1	0	1	1	1	0	0	0	**5**
2021	1	0	0	3	1	0	0	0	1	**6**
2022	2	1	2	0	1	2	2	0	1	**11**
2023	1	2	0	1	2	1	0	0	2	**9**
2024	1	1	0	1	5	2	0	0	4	**14**
Total	**9**	**6**	**3**	**10**	**15**	**7**	**2**	**0**	**10**	**62**

Figure 6 below show the increase in bus crash investigations between 2018 and 2024. For 2023 and 2024 the number of bus crashes investigated by the MCIU has almost doubled.

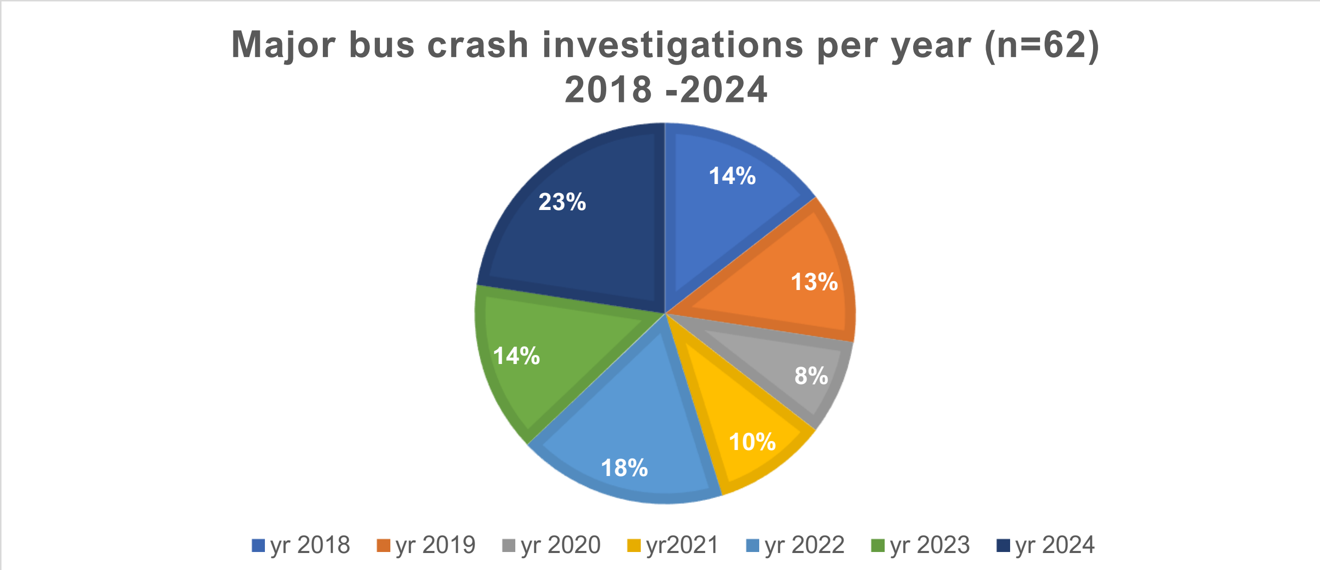

Figure 7: Percentage of major bus crash investigations per year 2018 – 2024

The maximum number of bus crashes investigated in a year was 14 in 2024 and the year with the lowest number of bus crashes investigated was during Covid when travel was limited in 2020 (5 crashes).

Bus crash fatalities recorded

During the five-year period 580 fatalities were recorded in the 62 bus crashes. The year 2024 also recorded the highest number of fatalities in bus crashes (146), with Limpopo recording the highest number of fatalities for bus crashes. Although the Eastern Cape was ranked fourth in terms of the number of bus crashes investigated, the Eastern Cape were second in terms of severity, recording 116 fatalities during the five-year period,

The average number of fatalities per bus crash is 9.4. Note that 45 (30.1%) of the 146 fatalities in 2024 was recoded in one bus crash where 45 of the 46 occupants died.

Table 6: All Major Bus Crash fatalities (n=580)

Year	EC	FS	GP	KZN	LI	MP	NC	NW	WC	Total
2018	18	0	0	10	25	5	0	0	10	**68**
2019	6	7	6	13	38	0	0	0	5	**75**
2020	25	6	0	8	6	9	0	0	0	**54**
2021	31	0	0	22	5	0	0	0	5	**63**
2022	12	10	15	0	7	16	13	0	11	**84**
2023	11	12	0	6	42	7	0	0	12	**90**
2024	13	6	0	8	73	17	0	0	29	**146**
Total	116	41	21	67	196	54	13	0	72	**580**

Serious injuries recorded in major bus crashes

Table 7 provide an overview of the serious injuries sustained in major bus crashes. In the 62 bus crashes investigated by the MCIU over the five-year period, 986 serious injuries were reported – an average of 15.9 people seriously injured in bus crashes.

Table 7: All Major Bus Crash Serious Injuries (n=986)										
Year	**EC**	**FS**	**GP**	**KZN**	**LI**	**MP**	**NC**	**NW**	**WC**	**Total**
2018	71	0	0	33	21	1	0	0	22	**148**
2019	29	7	24	102	37	0	0	0	1	**200**
2020	71	2	0	19	5	19	0	0	0	**116**
2021	1	0	0	38	4	0	0	0	28	**71**
2022	11	63	42	0	12	43	6	0	10	**187**
2023	4	8	0	30	79	7	0	0	0	**128**
2024	0	4	0	4	58	34	0	0	36	**136**
Total	**187**	**84**	**66**	**226**	**216**	**104**	**6**	**0**	**97**	**986**

FSI for bus crashes 2018 - 2024

Combined, the FSI count for the period 2018 -2024 amounts to 1566 fatalities and serious injuries. Bus fatalities and serious injuries account for 21% of all fatalities and serious injuries recorded for 2018 -2024.

Table 8: All Major Crash FSIs										
Year	**EC**	**FS**	**GP**	**KZN**	**LI**	**MP**	**NC**	**NW**	**WC**	**Total**
2018	89	0	0	43	46	6	0	0	32	**216**
2019	35	14	30	115	75	0	0	0	6	**275**
2020	96	8	0	27	11	28	0	0	0	**170**
2021	32	0	0	60	9	0	0	0	33	**134**
2022	23	73	57	0	19	59	19	0	21	**271**
2023	15	20	0	36	121	14	0	0	12	**218**
2024	13	10	0	12	131	51	0	0	65	**282**
Total	**303**	**125**	**87**	**293**	**412**	**158**	**19**	**0**	**169**	**1,566**

Type of crashes associated with long distance buses

Type of crashes associated with long distance bus crashes are depicted in figure 8 below. Most crashes (38.7%) were buses that overturned. Crashes where vehicles overturn are often associated with fatigue, loss of control. Head on crashes were the second most occurring type of crash (24.2%). Head on crashes are associated with undivided carriage ways, dangerous overtaking.

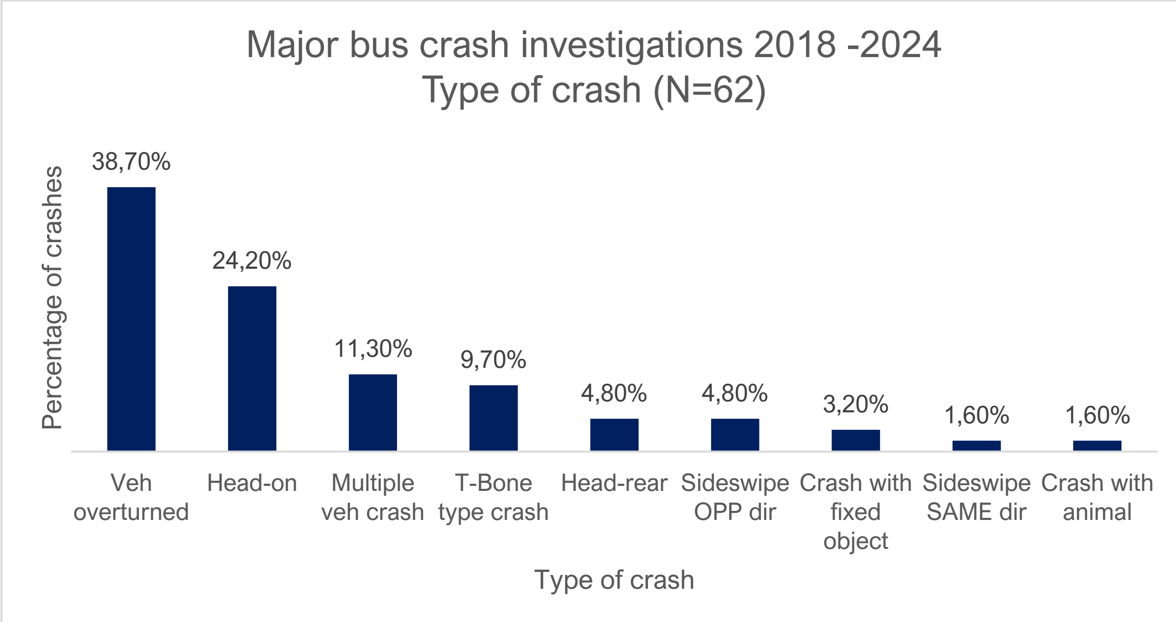

Figure 8: Type of crash associated with long distance bus crashes.

Although the data provided considers buses as the theme it should be noted that often other vehicles and road users are also involved.

Almost 50% (46.9%) of fatalities were due to vehicles overturning (Figure 9). Head on collisions were the crash type with the second most fatalities (23.3%) with vehicle overturned and head on crashes contributing to the bulk of all fatalities totalling 70.2%.

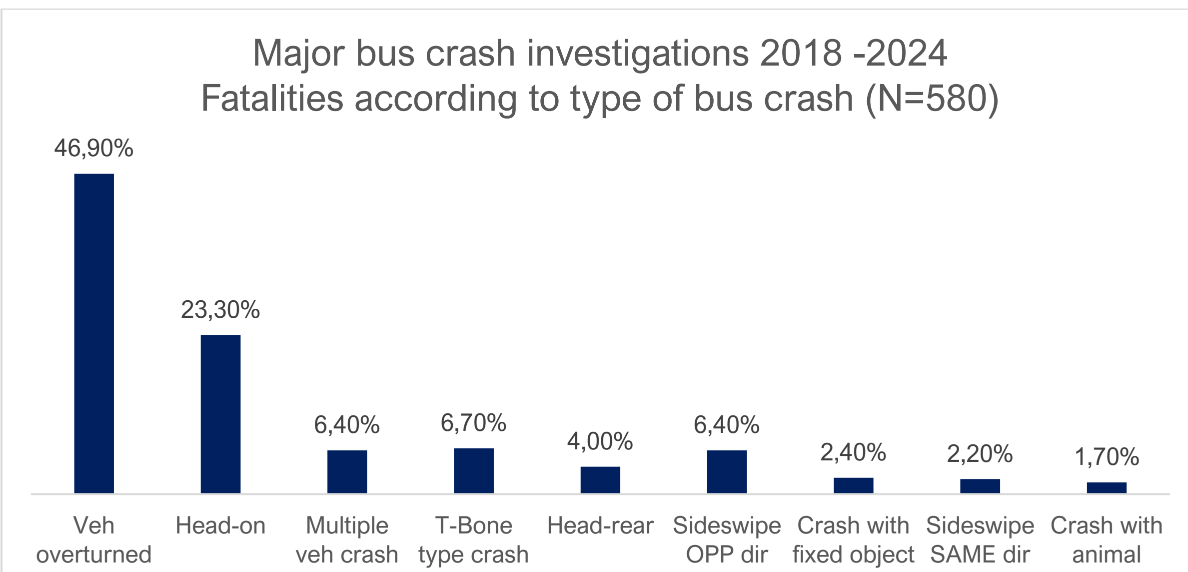

Figure 9: Type of crash associated with long distance bus crashes.

Table 9 provide an overview of the severity of injuries associated with each crash type. Crash severity provides an index of the average number of injury type per crash type. Sideswipe in the same direction crashes had the largest injury severity (13.0), followed by sideswipe crashes in the opposite direction (12.3) and vehicle overturning (11.3). The severity of a crash or crash type is the number of fatalities per crash or crash type.

Table 9: Injury severity (IS) according to crash type							
Crash Type	**Number of Fatal Crashes**	**Fatalities**	**Serious Injuries**	**FSIs**	**IS Fatal**	**IS Serious**	**IS FSI**
Vehicle overturned	24	272	515	**787**	11,3	21,5	32,8
Head-on	15	135	189	**324**	9,0	12,6	21,6
Multiple vehicle crash	7	37	26	**63**	5,3	3,7	9,0
T-Bone type crash	6	39	47	**86**	6,5	7,8	14,3
Head-rear	3	23	58	**81**	7,7	19,3	27,0
Sideswipe opposite direction	3	37	82	**119**	12,3	27,3	39,7
Crash with fixed object	2	14	47	**61**	7,0	23,5	30,5
Sideswipe same direction	1	13	0	**13**	13,0	0,0	13,0
Crash with animal	1	10	22	**32**	10,0	22,0	32,0
Total	**62**	**580**	**986**	**1 566**	**9,4**	**15,9**	**25,3**

Considering FSI severity per crash type, sideswipe type crashes had the highest severity with 39.7 FSIs per sideswipe in the opposite direction crash. FSI severity for vehicle overturned type crashes were second most with 32.8 FSIs per crash. Most serious injuries were also sustained in vehicle overturning crashes (88.8%) with 272 fatalities, 515 serious injuries which totals 787 FSIs in the 24 vehicle overturned type crashes.

Contributory factors to major bus crashes

Figure 10 illustrates the major contributory factors that potentially play a role in fatal and serious bus crashes. As indicated in the figure below, the human factors play the largest role in crash causation.

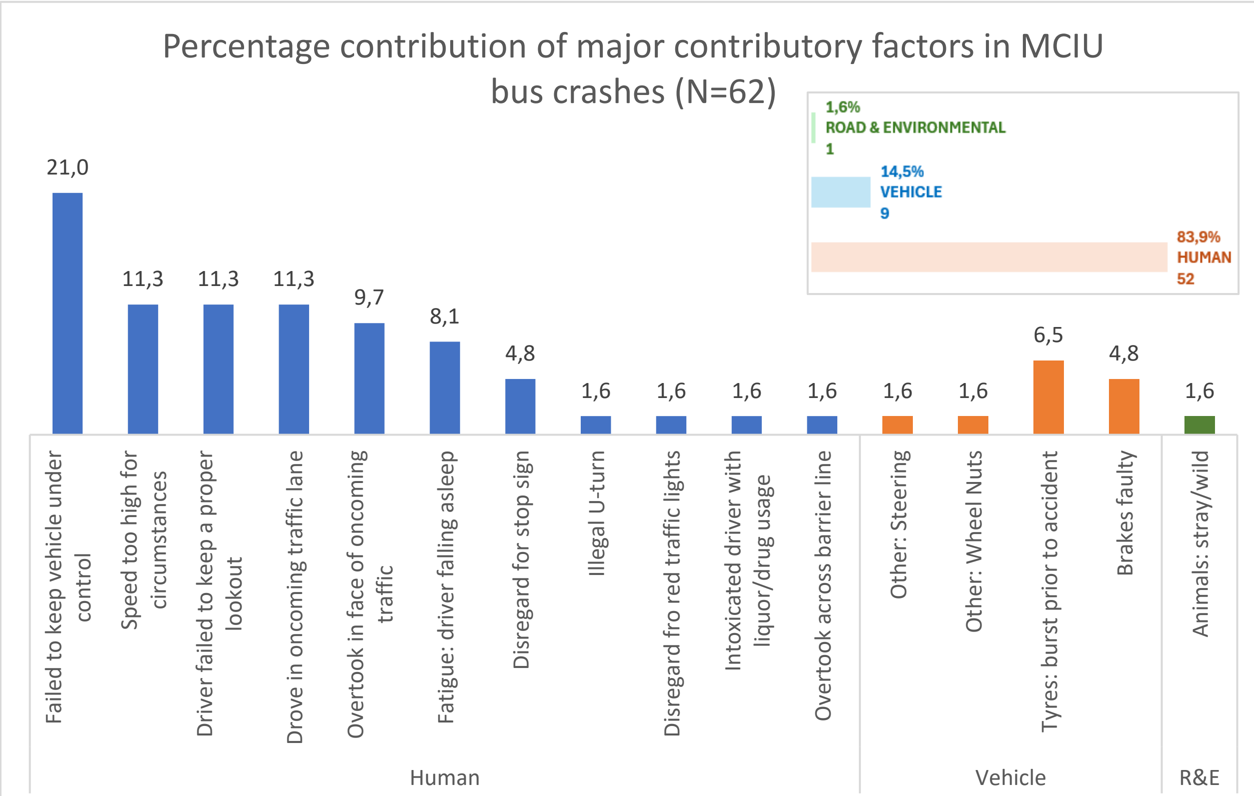

Figure 10: Percentage contribution of major contributory factors associated with long distance bus crashes investigated by the MCIU.

Figure 10 indicates that for the period 2018-2024 human factors were cited as the largest contributing factor to bus crashes in South Africa. Mostly failure to keep the vehicle under control (21%) were cited as the biggest factor contributing to crashes, followed by (11.3% each):

- Speed too high for circumstances
- Driver failed to keep a proper lookout
- Drive into oncoming traffic

Figure 10 shows that in terms of vehicle factors, tyres that burst were the most cited cause of crash due to vehicle factors. For this study, animals in the roadway were the contributory factor mostly cited as an environmental cause of crashes (only one such crash recorded).

2.3.3 Discussion of contributory factors to bus crashes

Fatigue

Studies have identified driver fatigue as a leading cause of bus crashes in South Africa, especially for long-distance routes (Venter 2010). A study focusing on long-distance bus drivers in Ghana found that irregular shifts and prolonged driving hours were associated with higher rates of road traffic crashes (Amoadu 2024).

Drivers often work extended hours without adequate rest, leading to impaired decision-making and slower reaction times. Extended driving periods without adequate rest can lead to driver fatigue, impairing reaction times and decision-making abilities (Venter 2010).

Speed too high for circumstances

Speeding and reckless driving further exacerbate the risks. A safe speed is one that is appropriate not only for the usage/type and quality of the road but also for a country's vehicular fleet and the type and mix of the road users (Kumfer 2019).

Speeding is defined as "exceeding the posted speed limit or driving too fast for current conditions" and is a primary crash causation factor (Forbes 2012). Higher speeds increase both the likelihood of collisions and the severity of outcomes for all road users, including that of bus passengers. The relationship between speed and crash severity is well-established. As vehicle speed increases, the kinetic energy involved in a collision rises exponentially, leading to more severe injuries. This principle applies universally, including to long-distance buses. Research indicates that higher speeds result in more serious injuries for both the driver responsible for the crash and other parties involved (Forbes 2012).

The Safe System Approach advocates that a reduction in kinetic energy transfer, primarily through speed management, is a core tenet of the Safe System Approach (Kumfer 2019). A safe speed is one that is appropriate not only for the usage/type and quality of the road but also for a country's vehicular fleet and the type and mix of the road users. The management of vehicular speed therefore includes setting speed limits that reflect those considerations and reduce the likelihood of death or injury in the event of a crash (these are known as survivable speed limits) as well as preventing speed limit violations (speeding) (Towards Safe System Infrastructure: A Compendium of Current Knowledge n.d.).

Overcrowding

Overcrowding is prevalent occurrence on long-distance buses serving low-income communities and rural areas not only in South Africa but internationally as well. The research also found that overcrowding is more severe during peak travel seasons, such as holidays, when demand for long-distance travel increases (Dube et al., 2017).

Economic pressures on passengers, who seek affordable travel, and on operators, who maximize revenue by exceeding capacity limits, contribute to this issue (Mashiri et al., 2010). Dube et al (2017) state that overcrowding is common practice to maximize profits, compromises stability and increases the likelihood of rollovers during crashes (Dube & Gumbo, 2017). In South Africa, overcrowding is often linked to economic constraints, with passengers willing to endure unsafe conditions to access cheaper transport options (Gumbo & Dube, 2017). Similar patterns are observed in other developing nations where the lack of affordable and reliable alternatives forces passengers to rely on overcrowded buses (Onyenemezu & Ibe, 2014). There is thus a need for better monitoring and better regulation in this space (Mashiri et al., 2010; Ogwude, 2016).

Overcrowding has serious consequences for the severity of crashes. Overcrowded buses can obstruct the driver's view, interfere with manoeuvring, and lead to distractions caused by standing passengers or excess baggage in the cabin (Venter & Mashiri, 2010). Excessive weight from overcrowding compromises the stability and braking efficiency of buses, increasing the likelihood of rollovers, particularly on curves and uneven roads (World Bank, 2018). In addition, overcrowded buses impact the structural integrity of the bus by placing stress on the vehicle's suspension, tires, and braking systems, accelerating wear and increasing the probability of mechanical failure (Gumbo & Dube, 2017). Passengers seated in aisles or standing are more vulnerable as they lack proper restraint systems and protection (Mashiri et al., 2010).

Roadworthiness of buses

Although the roadworthiness of vehicles, including buses, is governed by the South African NRTA 93 of 1996, which mandates regular vehicle testing, studies highlight gaps in compliance and enforcement. Insufficient maintenance and a lack of regular inspections of buses contribute to mechanical failures. Common issues include brake malfunctions, tire blowouts, and steering problems, which are critical factors in severe bus crashes (Mashiri et al., 2010).

More recent research by Venter and Mashiri (2017) indicates that mechanical failures, particularly involving brakes, tires, and steering mechanisms, account for a significant percentage of long-distance bus crashes in South Africa. Such failures are often attributed to inadequate maintenance and poor enforcement of roadworthiness checks.

In addition, Mashiri et al. (2010) point out that many long-distance bus operators use aging fleets, some of which exceed 20 years in operation. These older buses are more prone to mechanical issues, particularly if not maintained to rigorous standards.

Dube and Gumbe (2017) found that mechanical inspections are often superficial, focusing on easily detectable faults while neglecting critical areas like structural integrity and electronic systems. Gumbo and Dube (2017) found that:

- Brake failures account for a high proportion of high-speed collisions involving buses, leading to mass casualties.
- Tire blowouts, often caused by worn or underinflated tires, are a common trigger for rollovers, especially on highways.
- Steering malfunctions contribute to head-on collisions, as drivers are unable to maintain control on curved or uneven roads.

While roadworthiness testing is mandatory, corrupt practices and fraudulent issuing of certificates undermine the integrity of the system. Bus operators may bypass inspections by bribing officials or using unlicensed testing facilities.

Roadway and environmental factors

Internationally, roadway and operational factors influence crashes involving buses specifically due to the bus sizes and operation services (Chimba 2010). The position of the bus, the bus on the travel lane, presence or absence of on-street shoulder parking, posted speed limit, lane width, median width, number of lanes per direction and number of vehicles per lane has a higher influence on bus crashes compared to other roadway and traffic factors. Buses were found to, because of their size, have a higher exposure to oncoming and turning traffic and a higher probability of crashes compared to those traveling on the right most lanes. The same factors were found to influence injury severity though with varying magnitudes compared to crash frequency (Chimba 2010).

Wider lanes and medians were found to reduce probability of bus crashes while more lanes and higher volume per lane were found to increase the likelihood of occurrences of bus-related crashes (Chimba 2010). In addition, roadways with higher posted speed limits excluding freeways were found to have high probability of crashes compared to low-speed limit roadways.

Poorly maintained roads, including potholes, inadequate signage, and poorly lit highways, increase the likelihood of crashes. Rural areas, where long-distance buses often operate, are particularly affected by substandard road conditions (Gumbo & Dube, 2017).

2.4. Regulation and licensing of long-distance passenger transport

South Africa is the gateway to many other African countries and at a regional level, the Southern African Development Community (SADC) Protocol on Transport, Communications, and Meteorology (1996) provides a regional framework for the harmonization of transport policies among SADC member states. The framework assists with promoting standardized licensing and safety practices for cross-border transport as well as facilitating regional cooperation to improve road transport networks and services. Although long-distance bus travel in South Africa is an important component of public transport, challenges include (Dube et al., 2017; Venter et al, 2010):

- Road safety concerns due to high crash rates on South African roads.
- Variable levels of service quality and comfort among operators.
- Competition with informal or unregulated transport services (including minibus taxis).

Nationally the Department of Transport (DoT) and provincial authorities regulate long-distance bus operators through permits and service standards (SABOA, 2024). Operators must comply with roadworthiness checks, driver fitness requirements, and passenger safety regulations.

The National Land Transport Act (NLTA) 5 of 2009 is the principal legislation governing land-based public transport, including long-distance bus travel. It aims to establish an integrated, sustainable, and efficient transport system. The NLTA ensures the proper registration and operation of long-distance bus companies, which ultimately need to assist and contribute to the long-distance bus industry becoming contributing to safety and reliability.

The National Road Traffic Act 93 of 1996 regulates road traffic safety and vehicle standards in South Africa and makes provision for safety in long distance passenger buses. Unfortunately, although at a national level there are provision for regulating road safety in relation to long distance buses, indications are that enforcement of road safety laws remains inconsistent (World Bank. 2018). The National Road Traffic Act mandates regular inspections and roadworthiness tests, but implementation gaps often allow unfit vehicles to operate.

The Cross Border Road Traffic Act 4 of 1998 regulates cross-border transport operations between South Africa and neighbouring countries. Although the Cross-Border Road Transport Agency (CBRTA) oversees safety for buses traveling internationally it faces logistical challenges in monitoring compliance (CBRTA, 2019).

Although the Occupational Health and Safety Act (OHSA) act 85 of 1993 and the Consumer Protection Act (CPA) 68 of 2008 do not specifically cater for long distance passenger transport, it does make provision for safety in the workplace, which includes long distance bus drivers. The CPA makes provision for the rights of consumers using public transport services, including long-distance buses.

Provincial regulations further govern public transport services, including long-distance bus operations. These regulations are aligned with national legislation but address specific provincial needs, such as route allocation and service oversight.

The key legislation and policy frameworks governing long distance bus travel and by association road safety in South Africa is listed in table 1 below.

Table 10: Key legislation and policy frameworks governing long distance bus travel in South Africa	
Legislation / policy framework	**Stipulations**
National Land Transport Act (NLTA) No. 5 of 2009	• Licensing requirements for public transport operators, including long-distance bus services. • Development of integrated transport plans by municipalities and provinces to improve public transport systems. • Regulation of fares, routes, and schedules through operating licenses issued by Provincial Regulatory Entities (PREs).
National Road Traffic Act (NRTA) No. 93 of 1996	• Enforces roadworthiness of vehicles, including buses, through regular inspections. • Sets safety standards for buses, such as the installation of seatbelts and emergency exits. • Governs speed limits, hours of service, and driver fitness to minimize crashes caused by fatigue or negligence. • Focuses on ensuring passenger safety during long-distance travel.
Cross-Border Road Transport Act No. 4 of 1998	• Licensing of bus operators providing international routes. • Promotes efficient cross-border passenger services while ensuring compliance with international safety standards. • Addresses issues like passenger rights, service quality, and dispute resolution.
Occupational Health and Safety Act No. 85 of 1993	• Requires bus operators to ensure safe working conditions for drivers and staff. • Emphasizes fatigue management, regular medical checks for drivers, and provision of safe equipment.
Consumer Protection Act No. 68 of 2008	• Requires operators to provide clear information on fares, routes, and schedules. • Prohibits unfair business practices, such as overbooking or unsafe travel conditions. • Establishes mechanisms for customer complaints and dispute resolution.

2.5. Recommendations for improving long distance commuter bus safety

Proposed measures to reduce harm can either be to decrease the probability of a crash (active safety) or minimize the consequences, (passive safety), and in case of an injury-related incident, enhancement of rescue and medical treatment (Albertsson 2005). The research puts forward several policy and regulation measures to influence the safety of long-distance buses.

2.5.1. Education regarding the use of seatbelts

Comprehensive training programs focusing on fatigue management, speed regulation, and emergency response can significantly improve driver behaviour (Venter et al., 2018).

Figure 11: Eastern Cape Road Safety Campaign 2024

Educating passengers about their rights to safe transport could create market pressure for operators to prioritize roadworthiness. Mashiri et al. (2010) suggest that visible safety certifications on buses could empower consumers to choose safer options e.g. Figure 11.

2.5.2. Road design and maintenance

Investing in better road maintenance, clear signage, and designated rest stops for long-distance drivers is critical to reducing risks (Mashiri et al., 2010).

2.5.3. Investment in technology to monitor driver behaviour

The adoption of technologies such as GPS tracking, speed limiters, and collision avoidance systems can help monitor and mitigate risky driving behaviours. The adoption of vehicle monitoring systems (e.g., telematics) to track mechanical performance and enforce pre-trip inspections has been successful in other contexts and could be applied to South Africa's long-distance bus sector (World Bank, 2018).

2.5.4. Enforcement

Ensuring stricter adherence to roadworthiness inspections and passenger load limits through regular audits and penalties. Venter et al. (2017) advocate for stricter auditing of testing centres and the establishment of independent oversight bodies to ensure compliance with roadworthiness standards.

Regular random roadside inspections, as proposed by Mashiri et al. (2010), can deter operators from using unfit buses.

Government subsidies or tax breaks for operators investing in newer fleets and rigorous maintenance could reduce economic barriers to compliance (Gumbo & Dube, 2017).

One of the most effective measures to improve occupant safety is the use of seatbelts. In-vehicle restraint systems or seatbelt research has been conducted since the 1970’s.

3 IN-VEHICLE RESTRAINT SYSTEMS (SEATBELTS)

3.1 Introduction

Seatbelt use is one of the most effective ways to save lives and reduce injuries in motor vehicle crashes. According to Centre for Disease Control (CDC), wearing seat belts can reduce injuries and deaths in motor vehicle crashes by approximately 50% (Centre for Disease Control and Prevention, 2011).

In the United States, seatbelt use saved an estimated 147,246 lives between 1975 and 2001 (Glassbrenner, 2016). The National Highway Traffic Safety Administration (NHTSA) of the USA recommended that wearing a seat belt is one of the safest choices that drivers and passengers can make on the road (Chandran A 2010).

The International Transport Forum Road Safety Annual Report 2022, state that the period between 2010 and 2019 saw a marked drop in the number of car occupant road deaths in developed countries, especially in Greece, where fatalities dropped by 63%, and in the Republic of Korea, where they fell by 51%.

Ferrer and De Miguel (2001) conducted an in-depth analysis of road traffic accidents in Spain where buses were involved. By reconstructing these accidents and analysing injury reports, the authors assessed whether the severity of injuries could have been reduced if passengers had been wearing seat belts. Their findings suggest that the use of seat belts in buses could potentially mitigate the consequences of accidents, thereby supporting legislative measures to mandate seat belt installation and usage in buses (Ferrer and De Miguel, 2001).

3.2 Institutional management of seatbelt usage

3.2.1 Sustainable Development Goals

Seat belts remain the best vehicle safety device to protect passengers from being severely injured in a crash or being ejected from the vehicle, according to the UN Economic Commission for Europe (UNECE), which hosts the Special Envoy's office and the UN Road Safety Trust Fund, launched in 2018 (United Nations Economic Commission for Europe (UNECE) 2018, Han 2017).

This good practice supports the Sustainable Development Goal (SDG) specifically Target 3.6 that aims at halving the number of global deaths and injuries from road traffic crashes by 2030.

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Figure 12: United Nations SDG 3.6 halving the number of road traffic deaths.

3.2.2 International legislation

Laws mandating seatbelt use, coupled with strong enforcement and penalties, are crucial to ensuring widespread adoption. International seatbelt legislation has been enacted in many nations throughout the world, seatbelt usage varies widely from country to country, and substantial numbers of motor vehicle operators and passengers still do not use them (World Health Organization 2023). In countries that do enact seatbelt legislation, reductions of fatalities by more than 30 per cent have been observed.

According to the European Union (EU) legislation on all vehicles carrying passengers must comply with several technical requirements (United Nations, 2017). Technical specifications for seat belt use and installation stem from UN Regulation No. 16 (addendum 3 January 2021), which entered into force in 1970. In the following years, a growing number of countries introduced legislation to make the use of seat belts in vehicles compulsory. The United Nations Economic Commission for Europe (UNECE) regulations which govern seatbelts and child restraint systems in vehicles include (United Nations 2023):

- **UN Regulation No. 16**: This is the most widely recognized international requirement for seatbelt use in vehicles. It defines the requirements for effective safety belts, including tests for certification. Safety belts that meet this regulation must have a type of approval mark on the buckle tongue.
- **Regulation No. 44**: This regulation covers child restraint systems.
- **Regulation No. 129**: This regulation covers enhanced child restraint systems (ECRS).

Since 2019, new car seats must have front seat systems that can detect a passenger and make an audible warning if the belt is not attached. In addition, in relation to the UN regulations manufacturers must demonstrate that their seat belts and child restraint systems comply with these regulations. If they do, they qualify for EC type-approval, which means that tests have been done to ensure they meet the relevant requirements.

Since 2021, it is obligatory to fit all front and rear seats of M1 vehicles, as well as all front seats of M2 and M3 vehicles, with seat belt reminder systems for all new vehicles (UN regulation no. 16). Within the EU the ‘M-definition’, from M_1 to M_3, include all road vehicles with four or more wheels designed to carry passengers under a common classification. M_1 are described as vehicles that carries passengers comprising not more than eight seats, in addition to the driver's seat. M_2 are vehicles with more than eight seating and a mass not exceeding 5 tonnes, M_3 are like M_2 vehicles but exceed 5 tonnes. Both M_1 and M_2 allow for standing passengers, whilst this is not the case with M_3 vehicles. The M-definitions are also divided into classes (I–III) depending on field of application. M_2 or M_3 vehicles class I do not need to be equipped with seat belts whereas for class II seat belts are most often installed on all the seats. However, it is only mandatory with anchoring points from a regulation perspective. Class III vehicles are designed for seated passengers only and here all seats need to be equipped with a seat belt (United Nations 2023).

In Sweden the use of a seat belt and information about usage when traveling by bus is regulated in Traffic Ordinance (1998: 1276 Chapter 4 - 10a). All bus passengers three years or older should be seated in a place with a seat belt, if there is such a place, and should use the belt. If there is no seat belt available, it is allowed to stand in the bus (if the bus is approved for standing places). The legal responsibility to inform and make sure passengers under 15 use the belt are on the bus driver. Despite existing regulations there is no clear view on the usage rate of seat belts in buses, or on the commuters’ view of their own usage and the reasons to not buckle up. In addition, it is not known the frequency of drivers who inform passengers to ‘buckle up’ (Albertsson 2005).

The use of seatbelts has been made compulsory in all moving motor vehicles in Ghana through ACT 683 of 2004 and road traffic regulations of 2012 (Legislative Instrument 2180). In 2016, the National Road Safety Authority (NRSA) of Ghana reported that bus occupants accounted for 17.5% (third highest) of all motor vehicle fatalities (National Road Safety Authority, 2018). However, Okyere et al (2022) state that since the passage of the mandatory seatbelt legislation there has not been a significant improvement, with the seatbelt usage rate still unacceptably low.

3.2.3 South African legislation

In South Africa, seatbelt legislation is governed by Regulation 213 of the National Road Traffic Act, 1996 (Act No. 93 of 1996). This regulation outlines the requirements for seatbelt use for drivers, adult passengers, children, and infants. Within the legislation an adult is defined as a person over the age of 14 years or taller than 1.5 meters, a child as a person between the ages of 3 and 14 years, except where such a person is taller than 1.5 meters and a child as a person below the age of 3 years.

South African legislation mandates seatbelt installation and usage in minibuses and midibuses registered after September 4, 2006, requiring seatbelts for every seat. A bus is however defined as a vehicle that is configured to carry more than 35 people. For buses designed to carry more than 35 passengers, the legislation does not explicitly mandate the installation of seatbelts for all seats. However, the driver's seat and the front passenger seat, if present, must be equipped with seatbelts.

In general, vehicles are required to be fitted with seatbelts and must have them installed in accordance with the relevant standards (Seatbelts must comply with the standard specification SABS 1080 and child restraints must comply with the standard specification SABS 1340). As of April 30, 2015, drivers must ensure that infants are seated in an appropriate child restraint. However, this requirement does not apply to minibuses, minibuses, or buses operating for reward. In addition:

- Seatbelts must be maintained in good working order and can only be removed for repair or replacement purposes.
- No adult shall occupy a seat fitted with a seatbelt unless they are wearing it.
- Adults should not occupy seats without seatbelts if other seats with seatbelts are available.
- Drivers must ensure that children use an appropriate child restraint or wear a seatbelt if a child restraint is unavailable.
- If no seatbelt-equipped seat is available, children must be seated in the rear seat if the vehicle has one.
- The driver is responsible for ensuring that all passengers wear seatbelts as required.

Non-compliance with seatbelt regulations under the Administrative Adjudication of Road Traffic Offences (AARTO) Act, is an offense and fines vary depending on the specific offense.

3.2.4 Motivation in support of further research

As public transport is a key mode of mobility, especially in intercity areas, implementing seatbelts aligns with broader road safety goals. Mandating seat belts not only protects passengers physically but also enhances their perception of safety when using buses. This can lead to increased trust and reliance on public transportation (Ferrer 2001).

The in-depth Spain study conducted by Ferrer and De Miguel (2001) puts forward several considerations, that support the motivation for ongoing research in South Africa to inform policy and legislation related to bus crashes in South Africa:

- By reconstructing real-world bus accidents and examining injury patterns, the research underscored how seat belts could have significantly reduced injury severity.
- Research could potentially demonstrate that even in controlled conditions like buses, the absence of restraints leaves passengers vulnerable to life-threatening impacts.
- The findings can provide empirical data supporting the need for mandatory seat belt implementation in buses.
- Research places seatbelts in context with other safety features like airbags and structural reinforcements, showing that seat belts offer a cost-effective and universally applicable solution that can be implemented across various types of buses.
- Research may encourage policymakers to prioritize regulations that make seat belts compulsory for all passengers, not just in private vehicles but also in public and commercial transport.

3.3 Towards safer vehicles (Pillar 3) – minimum standards for seatbelts in buses

The 'Safer Vehicles' pillar focuses on ensuring that vehicles are designed and maintained to prevent crashes and protect occupants during collisions. Minimum vehicle safety standards should include:

- Crashworthiness: Vehicles should be engineered to absorb and manage crash energy effectively, thereby safeguarding occupants.
- Occupant Protection Systems: Incorporation of features such as seat belts and airbags to reduce injury severity during crashes.
- Advanced Safety Technologies: Deployment of systems like Electronic Stability Control (ESC) and Automatic Emergency Braking (AEB) to prevent crashes.
- Vehicle Maintenance: Regular upkeep to ensure all safety features function correctly.

Within the SSA seatbelts, in the event of crash serves as:

- A primary restraint system: Seat belts are the first line of defence in protecting occupants by restraining them during sudden stops or collisions, thereby reducing the risk of contact with interior elements or ejection from the vehicle.
- Synergy with other safety features: The effectiveness of airbags and other restraint systems is enhanced when seat belts are used properly, as they help position occupants correctly.
- Legal Mandates and Compliance: Enforcing seat belt laws and promoting their use are critical strategies within the Safe System Approach to ensure occupant safety.

Kargar et al (2023) highlights that seatbelt use in low- and middle-income countries are still not adequate. Seatbelts can significantly reduce injuries during a crash by restraining passengers and preventing ejection as well as serious injuries and deaths sustained during impact. Research indicates that seat belts reduce the risk of fatal injury to front-seat passenger car occupants by 45% and the risk of moderate-to-critical injury by 50%.

Jamroziak et al (2020) investigated the effectiveness of different safety belt systems in protecting coach passengers during frontal collisions. The researchers conducted controlled crash tests simulating frontal impacts using dummies representing human passengers. The tests compared different restraint systems, including two-point lap belts, three-point belts, and no restraints. Sensors on the dummies measured key injury metrics such as head acceleration, neck forces, and chest deformation to evaluate the safety performance of each belt system. The study used computational models to simulate frontal impacts in a virtual environment. These models replicated real-world crash dynamics and enabled the analysis of injury mechanisms. Results from the crash tests were used to validate the accuracy of the computational models, ensuring their reliability in predicting injury outcomes. The models were then applied to a range of crash scenarios, varying speeds, and passenger positions to generalize the findings (Jamroziak et al., 2020). The research found only three-point safety belts meet all injury criteria within permissible standards, effectively reducing head acceleration and injury risk during frontal impacts. Whereas two-point safety belts or wearing no restraints resulted in higher head acceleration values, suggesting insufficient protection compared to three-point systems (Jamroziak et al, 2020).

Another reason for not using the seat belt on regional buses could be that those buses are not always equipped with seat belts, and it is not unusual during rush hours that passengers must stand up. This in turn would prevent passengers from forming a habit but also prevent them from understanding why they shall use a belt.

The design and usability of the seat belt were other factors which had an impact on usage. In the focus groups, participants reported that they did not use the seat belt on long trips to get more comfortable. If the belt is comfortable or not is an important factor which determines usage but not only on longer trips (Kidd et al., 2014). To make seat belts more comfortable appears to be important and different solutions have been suggested such as seat belt cushions (Shaaban, 2019).

In addition, it should be a requirement for seat belts to have a length and design to accommodate both large and small passengers. Regulatory changes so that seat belt requirements need to comply with belt usage requirements and that they are adjusted to ensure consistent use of force are recommended.

At speeds over 60 km/h seat belt usage should be mandatory, and all passengers should be offered a seat with a belt. At speeds of 60 km/h or less, belt requirements should be investigated further. At lower speed the measures with the greatest safety benefit are to ensure that all passengers are seated, rather than being belted.

3.4 Towards safer road users (Pillar 4) – educating users about seatbelts

The role of seatbelts within Pillar 4: Safer Road Users of the Safe System Approach is integral to reducing road traffic injuries and fatalities. The Safe System Approach acknowledges human vulnerabilities and aims to minimize harm when crashes occur, emphasizing the shared responsibility of all system components, including road users.

Seatbelts are a proven safety device that reduces the risk of severe injury or death during crashes by restraining occupants, preventing ejection, and distributing crash forces across stronger parts of the body. While seatbelts are a personal protective measure, they complement other elements of the safe system approach, such as safer vehicle designs (e.g., seatbelt reminder systems) and safer road environments to minimize crash likelihood.

Observations by Anund et al (2023) showed that seat belt usage differed depending on the type of bus operation. Seat belt usage was most common in charter bus traffic (92%) and less common in regional bus traffic (27%). For commercial traffic, the observed usage rate was 50%. The reason for using the seatbelt more often in charter and commercial bus traffic might be that the buses used for this type of service were more often of a better standard with more comfortable seats and better belts. It might also be because charter and commercial bus operation drive on roads with higher speeds, such as motorways, and then the passengers find it more justified to use the seat belt. However, it is difficult to determine exactly why there are such large differences between types of operation and probably it is dependent on all the reasons mentioned above.

There is a need to change perceptions regarding the wearing of seatbelts in long distance buses. According to Kidd et al. (2014) drivers are more likely to buckle up in response to an auditory and haptic reminder than a visual reminder.

The National Highway Traffic Safety Administration (NHTSA) has found that the prevalence of seatbelt use is significantly higher for females than for male occupants of vehicles (Chandran A 2010). This means, that seatbelt education and awareness campaigns need to be tailored to appeal to different target audiences.

Studies have found that the perception of safety and perception of severity of injuries if involved in a crash are closely linked to seat belt usage (Jermakian and Weast, 2018; Nambulee et al., 2019). Research by Wretstrand et al highlighted that it was less common to use a seat belt on short journeys, which were likely to take place in urban areas with lower speeds. Research showed that built-up areas were perceived as safe, which in turn made them less motivated to use the belt. Wrestand (2014) indicated that even for urban travelling at low speed (<60 km/h) seat belts need to be available for all passengers to provide seat belts on all seats (Wretstrand 2014).

A Ghanian study conducted in 2010 indicated that at the time, overall driver seatbelt use rate of 17.6% and 4.9% among front-right passengers (Okyere 2022). Another Ethiopian study interviewed 425 public transport drivers. The study found that overall, 69.6% of driver wore seatbelts. The majority (98.1%) of drivers indicated that they use seat belts to minimize injuries, 95.8% to prevent casualties, 92.5% to safeguard vehicle occupants, 29.9% to generate revenue for government and 22.8% to beautify the vehicle. Almost 80% of participants reported that wearing seat belt could save lives; and 29.6% of them wear belts because of stiffer penalties. For not using seat belts, more than 18% drivers reasoned that it is not a guarantee for safety and it “wastes time” to put the seatbelt on (Woldegebriel 2019).

3.5 Interventions to improve seatbelt usage

3.5.1 Education and awareness campaigns

Okyere et al (2022) concluded that education campaigns (workshops, public engagements, and publicity programs using electronic, print, and new media) are needed to encourage seatbelt use among intercity bus commuters. The research found that better knowledge about seatbelts and related laws was not necessarily associated with increased use, further public health measures are needed in addition to raising awareness of the importance of seatbelts.

The research strongly suggested that "the simple act of a driver reminding passengers about seatbelt use was strongly associated with increased usage" (Okyere 2022). Higher seat belt usage among drivers and announcements to 'buckle up' were associated with higher seat belt use among bus passengers. This is in line with earlier studies that show positive effects for children's seat belt usage if the driver announces that they need to put them on (Mehta and Lou, 2013). In addition, the researchers highlighted that this simple act is an effective but low-cost method to mandate or incentivize drivers to provide such messages more uniformly.

3.5.2 Facilitating behavioural change to encourage seatbelt use for bus occupants

Special attention needs to be given to increase seatbelt use among high-risk groups, such as Nambulee et al (2019) conducted research applying the Health Belief Model that advocates for behaviour change. The study provides insights into the psychological factors that influence seat belt use intentions among intercity bus passengers. The study focused on two demographic groups-teenagers and adults-to identify distinct determinants affecting each cohort's seat belt usage intentions (perceived severity of not wearing seatbelts and perceived barriers to wearing seatbelts. The research found that teenagers were significantly influenced by perceived Severity of consequences of not wearing seatbelts. Both teenagers and adults recognized the serious consequences of not wearing seat belts, their intention to use them increases. Barriers to wearing seatbelts were highlighted as discomfort or peer influence. In other words, how comfortable the seat belt is to use. If it feels uncomfortable then the passengers are less likely to use it children, young drivers, passengers, and occupants in rural areas where compliance rates are often lower. Factors considered important for understanding seat belt use in buses includes passenger's age and gender, origin and destination, time of day during the travel, the presence of a reminder in the form of a sign, badge or similar, if the driver has actively indicated that a seat belt should be worn and which seat one chooses to sit on.

Encouraging and enforcing the consistent use of seatbelts among all vehicle occupants is a priority under this pillar. This includes public education campaigns to build awareness about seatbelt efficacy and legal enforcement to promote compliance.

The Portland, Oregon-based Trauma Nurses Talk Tough (TNTT) program, an educational intervention for injury prevention conducted in a hospital setting by trauma and emergency room nurses (Allabaugh et al., 2008), and a 2014 report from the NHTSA documented that a TNTT demonstration project in North Carolina successfully increased seatbelt usage among drivers resistant to using them (NHTSA, 2016). Moreover, seatbelt use can significantly decrease hospital costs, as we have demonstrated, and this finding suggests that interventions to increase seatbelt usage could be cost-effective. Due to significant differences in injury severity among different types of seatbelt use (Kent et al., 2011; Salzar et al., 2013). Arnund et al 2023 stated that Information about seatbelt requirements need to be proactively given to passengers. Partly through mandatory announcements about the use of seat belts by the driver in the bus, but also information through other media that seat belts are required and perhaps more importantly why they should be used.   Ideally, the announcements.

Severity of injuries

The use of seat belts in long-distance buses significantly mitigates the severity of injuries sustained during crashes. A systematic review and meta-analysis conducted by Fouda Marg et al, found that seatbelt use significantly reduces the risk of facial injuries by 44%, abdominal injuries by 13%, and spinal injuries by 44%. However, the study did not find a statistically significant difference in the risk of head, neck, thoracic, upper limb, and lower limb injuries between belted and unbelted passengers (Fouda Mbarga 2018).

Emergency care costs

The National Highway Traffic Safety Administration (NHTSA) estimates that lap/sash seat belts are 50% effective in reducing passenger fatalities in frontal crashes. Therefore, in addition to reducing the risk of death and serious injury, seatbelt use-regardless of the type of seatbelt there is an association with reduced hospital costs (Sikic 2009).

Injuries because of road traffic crashes are substantial hospital costs to individuals, families and society. Seatbelt use has a significant association with reduced hospital costs regardless of other measured factors (Han 2017). Seat belts prevent occupants from being ejected during a crash, a factor closely associated with severe injuries and fatalities. By restraining passengers, seat belts reduce the risk of contact with interior surfaces and other passengers, thereby decreasing the likelihood of traumatic injuries. Mean hospital costs were significantly lower for motor vehicle occupants wearing a lap–shoulder seatbelt even after adjusting for race, gender, age, type of occupants, type of crash, location of crash, time of crash, speed limit at crash, alcohol-impaired driving, year of crash, and type of health insurance, there were still significantly decreased hospital costs for motor vehicle occupants wearing a lap–shoulder seatbelt (84.7%), lap-only seatbelt (74.1%), shoulder-only seatbelt (40.6%), children seatbelt (95.9%), or booster (82.8%) compared to those not wearing a seatbelt.

Perceptions regarding seatbelt wear

There is a need to change perceptions regarding the wearing of seatbelts in long distance buses. A Ghanian study conducted in 2010 indicated that at the time, overall driver seatbelt use rate of 17.6% and 4.9% among front-right passengers. Okyere et al (2022) concluded that education campaigns (workshops, public engagements, and publicity programs using electronic, print, and new media) are needed to encourage seatbelt use among intercity bus commuters. The research found that better knowledge about seatbelts and related laws was not necessarily associated with increased use, further public health measures are needed in addition to raising awareness of the importance of seatbelts. Alternative measures could include law enforcement and fines. However, the research also strongly suggested that "the simple act of a driver reminding passengers about seatbelt use was strongly associated with increased usage" (Okyere 2022). In addition, the researchers highlighted that this simple act is an effective but low-cost method to mandate or incentivize drivers to provide such messages more uniformly.

Another Ethiopian study interviewed 425 public transport drivers. The study found that overall, 69.6% of driver wore seatbelts. The majority (98.1%) of drivers indicated that they use seat belts to minimize injuries, 95.8% to prevent casualties, 92.5% to safeguard vehicle occupants, 29.9% to generate revenue for government and 22.8% to beautify the vehicle. Almost 80% of participants reported that wearing seat belt could save lives; and 29.6% of them wear belts because of stiffer penalties. For not using seat belts, more than 18% drivers reasoned out that it is not guarantee for safety and it wastes time to wear (Woldegebriel 2019).

Behavioural change

Special attention needs to be given to increase seatbelt use among high-risk groups, such as Nambulee et al (2019) conducted research applying the Health Belief Model that advocates for behaviour change. The study provides insights into the psychological factors that influence seat belt use intentions among intercity bus passengers. The study focused on two demographic groups-teenagers and adults-to identify distinct determinants affecting each cohort's seat belt usage intentions (perceived severity of not wearing seatbelts and perceived barriers to wearing seatbelts. The research found that teenagers were significantly influenced by p*erceived Severity* of consequences of not wearing seatbelts. Both teenagers and adults recognized the serious consequences of not wearing seat belts, their intention to use them increases. Barriers to wearing seatbelts were highlighted as discomfort or peer influence. In other words, how comfortable the seat belt is to use. If it feels uncomfortable then the passengers are less likely to use it children, young drivers, passengers, and occupants in rural areas where compliance rates are often lower. Factors considered important for understanding seat belt use in buses includes passenger's age and gender, origin and destination, time of day during the travel, the presence of a reminder in the form of a sign, badge or similar, if the driver has actively indicated that a seat belt should be worn and which seat one chooses to sit on.

NHTSA has found that the prevalence of seatbelt use is for example significantly higher for females than for male occupants of vehicles (Chandran A 2010). Encouraging and enforcing the consistent use of seatbelts among all vehicle occupants is a priority under this pillar. This includes public education campaigns to build awareness about seatbelt efficacy and legal enforcement to promote compliance.

The Portland, Oregon-based Trauma Nurses Talk Tough (TNTT) program is an educational intervention for injury prevention conducted in a hospital setting by trauma and emergency room nurses (Allabaugh et al., 2008), and a 2014 report from the NHTSA documented that a TNTT demonstration project in North Carolina successfully increased seatbelt usage among drivers resistant to using them (NHTSA, 2016). Moreover, seatbelt use can significantly decrease hospital costs, as we have demonstrated, and this finding suggests that interventions to increase seatbelt usage could be cost-effective. Due to significant differences in injury severity among different types of seatbelt use (Kent et al., 2011; Salzar et al., 2013). Arnund et al 2023 stated that Information about seatbelt requirements need to be proactively given to passengers. Partly through mandatory announcements about the use of seat belts by the driver in the bus, but also information through other media that seat belts are required and perhaps more importantly why they should be used. Ideally, the announcements.

The successful implementation of seat belt regulations on buses requires not only the installation of appropriate restraint systems but also ensuring passenger compliance. Public awareness campaigns and strict enforcement of seat belt laws are crucial in promoting usage among bus occupants. Additional actions include:

- Increasing enforcement, including through checkpoints
- Making loans available to reduce the cost of child safety restraints
- Training caregivers to use child safety restraints correctly
- Social marketing campaigns

There is a need for support for drivers, to increase their own seat belt use, but also technical support to be able to get information about seat belt use on the bus they drive. Likewise, routines and timetables that give the driver the opportunity to wait for departure so that passengers have time to put on/off their seat belts are desirable.

Clearer enforcement by extending ticket control to also apply to control of seat belt use. If the bus has a ticket controller this person should also check seat belt usage and be entitled to fine those who do not use belt.

4 PROPOSED WAY FORWARD

This study was commissioned through a resolution of the Innovative Road Safety Engineering Solutions Working Group (IRSES-WG) of the National Road Traffic Engineering Technical Committee (NRTETC) which resorts under the National Road Safety Steering Committee (NRSSC) due to the growing concern of hight fatality and serious injury rates during long distance bus crashes due to concerns of the high number of fatalities in bus crashes.

4.1 Proposed future experimental research

The high number of FSIs recorded in major bus crashes on South African roads as well as the in-depth Spain study conducted by Ferrer and De Miguel (2001) puts forward several considerations, that support the motivation for ongoing research in South Africa to inform policy and legislation related to bus crashes in South Africa:

- By reconstructing real-world bus accidents and examining injury patterns, the research underscored how seat belts could have significantly reduced injury severity.
- Research could potentially demonstrate that even in controlled conditions like buses, the absence of restraints leaves passengers vulnerable to life-threatening impacts.
- The findings can provide empirical data supporting the need for mandatory seat belt implementation in buses.
- Research places seatbelts in context with other safety features like airbags and structural reinforcements, showing that seat belts offer a cost-effective and universally applicable solution that can be implemented across various types of buses.
- Research may encourage policymakers to prioritize regulations that make seat belts compulsory for all passengers, not just in private vehicles but also in public and commercial transport.

Further research will not only provide the South African context but will contribute to African as well as related global road safety.

4.2 Education and awareness campaigns

The general principles of occupant restraint in buses could apply, and indications remain that properly worn seatbelts can prevent passengers from being thrown from their seats during sudden stops or collisions, thereby reducing the likelihood of severe injuries. Seatbelts also prevent occupant interactions, contact with the bus interior, and ejection during crashes.

Research strongly suggested that "the simple act of a driver reminding passengers about seatbelt use was strongly associated with increased usage, higher seat belt usage among drivers and announcements to 'buckle up' were associated with higher seat belt use among bus passengers.

In addition, the researchers highlighted that this simple act is an effective, but low-cost method to mandate or incentivize drivers to provide such messages more uniformly.

It is recommended that similar effective education and awareness campaigns, specifically aimed at long distance bus and mini-/midibus taxis are conducted.

There is a need to change perceptions regarding the wearing of seatbelts in long distance buses.

4.3 Data recording and analysis

It is recommended that further in-depth analysis is conducted on especially long-distance bus related crash data.

It is also recommended that a medical expert compliment the RTMC Major Crash Investigation Unit (MCIU) on all major bus crash investigations, and that the injury type is recorded for all injury types for further research. The identification of injury type during bus crashes will provide an understanding of amongst many others, if wearing seatbelts in long-distance buses will in fact reduce FSIs during such crashes.

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