Ref. Ares(2023)8802452 - 21/12/2023

TRANS-SAFE

TRANSFORMING ROAD SAFETY IN AFRICA

HORIZON-CL5-2021-D6-01-11:
Radical improvement of road safety in low- and medium-income countries in Africa

D1.1 Results of accident analysis and SoA review

UNIFI

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101069525. The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the CINEA nor the European Commission are responsible for any use that may be made of the information contained therein.

Summary Sheet

Deliverable Number	D1.1
Deliverable Name	"Results of accident analysis and SoA review"
Full Project Title	TRANS-SAFE – Transforming Road Safety in Africa
Responsible Author(s)	Niccolò Baldanzini, Simone Piantini
Contributing Partner(s)	All WP1 partners
Peer Review	Oliver Lah, TUB, Boitumelo Manala, WI
Contractual Delivery Date	28-02-2023
Actual Delivery Date	05.12.2023
Status	Final draft
Dissemination level	Public
Version	V1.0
No. of Pages	67
WP/Task related to the deliverable	WP 1 / Task 1.1
WP/Task responsible	WP 1
Document ID	TRANS-SAFE_D1.1 "Results of accident analysis and SoA review"
Abstract	The deliverable report the crash statistics for Ghana, Rwanda, South Africa and Zambia, with a special focus on the recent years.

Legal Disclaimer

TRANS-SAFE (Grant Agreement No. 101069525) is a Research and Innovation Action project funded by the EU Framework Programme Horizon Europe. This document contains information about TRANS-SAFE core activities, findings, and outcomes. The content of this publication is the sole responsibility of the TRANS-SAFE consortium and cannot be considered to reflect the views of the European Commission.

Public (PU) — fully open (automatically posted online)
Sensitive — limited under the conditions of the Grant Agreement
EU classified —RESTREINT-UE/EU-RESTRICTED, CONFIDENTIEL-UE/EU-CONFIDENTIAL, SECRET-UE/EU-SECRET under Decision 2015/44

Table of Contents

Funded by the European Union

Funded by the European Union

LIST OF FIGURES

Funded by the European Union

LIST OF TABLES

Funded by
the European Union

LIST OF ABBREVIATIONS

Acronyms	Full meaning
BRRI	Building and Road Research Institute
CHoCOR	Culpable Homicide Crash Observation Report
CPI	Consumer Price Index
CSIR	Council for Scientific and Industrial Research (Ghana)
CSIR	Council for Scientific and Industrial Research
ESRA	E-Survey of Road Users' Attitudes
GIS	Geographic Information Systems
GRSF	Global Road Safety Facility
HGV	Heavy Goods Vehicle
HPR	Healthy People Rwanda
IHME	Institute for Health Metrics and Evaluation
KSI	Killed and Serious Injured
LDV	Light Delivery Vehicle
MINJ	Minor INJured
MTTD	Motor Traffic and Transport Department (Ghana)
MV	Motor Vehicle
NISR	National Institute of Statistics of Rwanda
PDO	Property Damage Only
PTW	Powered Two-Wheeler
RNP	Rwanda National Police
RTC	Road Traffic Crash
RTI	Road Traffic Injury
RTMC	Road Traffic Management Corporation
RTSA	Road Transport and Safety Agency (Zambia)

Funded by
the European Union

SAPS	South African Police Service
SSATP	African Transport Policy Programme
STATS SA	Statistics South Africa
TIRF	Traffic Injury Research Foundation
TVP	Total Vehicle Population
VRU	Vulnerable Road User
YLL	Years of Life Lost prematurely

Funded by
the European Union

EXECUTIVE SUMMARY

This document reports the results of a meta-analysis of the current crash statistics in the four countries involved in the Demonstration Pilots within the TRANS-SAFE project. This document is intended to provide an overview of road accidents and to help identify the most vulnerable user groups in each country. The analysis also points up similarities and differences among the four countries, thus supporting the future implementation of the replication activities of the Demonstration Pilots in appropriate contexts.

The meta-analysis approach was commonly decided by the partners, after a preliminary analysis of the data sources, which revealed barriers to directly access national databases. On the contrary reports from national agencies and research papers from Universities and other independent institutions are sufficiently available. These sources contain adequate information to fulfil the initial objective of the document.

The document is structured in four main chapters, respectively for Ghana, Rwanda, South Africa and Zambia. Each chapter largely reproduces the same structure: an initial section on general statistics, dedicated sections to each user group or mode of transport (pedestrians, cyclists, powered two-wheelers, cars, public transports, heavy good vehicles) and a final one on national databases. Two optional sections may be available with additional relevant information, which cannot be appropriately framed in the previous sections, or with information on a national database.

The results evidenced that:

- in the four countries pedestrians are largely the most vulnerable road user group. Resources should be dedicated to improve pedestrian safety, since school children are primarily attend school on foot and are thus exposed to risky conditions. Better infrastructure, protective for pedestrians, is necessary as well as an action to reduce RTC contributing factors associated to human behaviour (both intentional and unintentional).

- cars are often the most relevant offending vehicle, but in South Africa and Zambia driver and occupants represent a relevant share of victims. Thus an action on cars drivers would produce the dual benefit. In Rwanda the involvement of cars in RTCs is rapidly decreasing.

- HGVs represent a treat in Ghana, Rwanda and South Africa, and actions should be taken to support the driver in implementing a safer driving style, even with the support of assistance systems (e.g. after market ones).

- Motorcycle safety is a problem in Ghana and Rwanda, while it is not among the top priorities in the other countries.

- Cyclist safety is still an unresolved problem in Zambia, as figures do not show any improvement in recent years.

1. INTRODUCTION

Deliverable 1.1 reports the results of a meta-analysis of the current crash statistics in the four countries involved in the Demonstration Pilots within the TRANS-SAFE project. This document is intended to provide an overview of road accidents and to help identify the most vulnerable user groups in each country. The analysis also points up similarities and differences among the four countries, thus supporting the future implementation of the replication activities of the Demonstration Pilots in appropriate contexts.

The meta-analysis approach was commonly decided by the partners, after a preliminary analysis of the data sources, which revealed barriers to directly access national databases. On the contrary reports from national agencies and research papers from Universities and other independent institutions are sufficiently available. These sources contain adequate information to fulfil the initial objective of the document.

The document is structured in four main chapters, respectively for Ghana, Rwanda, South Africa and Zambia. Each chapter largely reproduces the same structure: an initial section on general statistics, dedicated sections to each user group or mode of transport (pedestrians, cyclists, powered two-wheelers, cars, public transports, heavy good vehicles) and a final one on national databases. Two optional sections may be available with additional relevant information, which cannot be appropriately framed in the previous sections, or with information on a national database.

About TRANS-SAFE

The TRANS-SAFE project involves national, regional, and city level demonstrations to test different types of innovative and integrated Safe System solutions, complemented by a comprehensive toolbox, capacity development, policy support and replication activities. To maximize impact, the project brings together in a consortium, highly committed cities, road safety agencies and experts from both Europe and Africa. Building on numerous synergistic projects, networks, and a strong technical experience among partners, the consortium will deliver on project objectives through highly effective and innovative approaches to sustainable road safety development, thereby ensuring that road safety systems and interventions from this project deliver on the recommendations of the Road Safety Cluster of the African-EU Transport Task Force, adopted in 2020. The consortium members have experience and expertise in Africa-related research as well as development-related research in collaboration with local actors in various countries of Africa at many levels. Ultimately, the project will help deliver on the Joint EU-Africa Strategy (JAES) and advance countries' progress towards the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs). TRANS-SAFE leverages on existing partnerships to collaboratively design sustainable interventions that aim to radically transform road safety systems in Africa.

2. GHANA

In this chapter the most recent and relevant reports and research papers on the Ghana crash statistics are analysed to depict the recent safety conditions on the roads. The documents allow the identification of both major trends and the most relevant user groups, which road safety initiatives should focus on.

2.1. GENERAL STATISTICS

The National Road Safety Authority of the Ministry of Transport is the primary player for road safety in Ghana. Its mission is to reduce road traffic crashes and casualties in Ghana through the development, promotion, co-ordination of policies and regulation of road safety standards. The analysis conducted on 2016 crash data revealed that 2084 people were killed. In the period 1991-2019, 10,365 crashes occurred per year, and they resulted in:

- 47,783 fatalities:
- 147,208 serious injuries
- 200,703 minor injuries

Statistics from 2018 shows that the road user class with the highest share of fatalities continued to be pedestrians (824; 39.5%) followed by motorcycle users (437; 21%), bus occupants (364; 17.5%), and car occupants (223; 10.7%). The crash statistics in 2019 shows that, in total, there were 10,808 crashes and 2073 fatalities representing an increase of 9.8% in the number of crashes and an increase of 2.6% in fatalities over the 2018 figures. The road user class with the highest share of fatalities are still pedestrians (36.7%), followed by motorcycle users (28.0%) and then bus occupants (14.4%). Pedestrian fatalities increased by 11.7% in 2019 when compared to 2018. Detailed investigation into motorcycle crashes for 2018 and 2019 revealed that motorbikes (two-wheelers) accounted for 87.3% of all motorcycle fatalities. Tricycles and auto rickshaw accounted for just 11.8% and 0.9% of fatalities, respectively.

Rapid urbanization implies intensification of urban mobility, which in a lack of facilities for walking and cycling, poor or no existing public lighting and bad conditions of the roads, results in increased accident and fatality risks. In this context the annual cost of care related to vehicle accidents is estimated to $230 million (Boateng, 2021a).

At a local level several studies have focused on the analysis of the crash data collected in the Greater Accra Region (29 districts) in the period 2005-2014. The results demonstrated that males were mostly involved in road traffic crashes compared to females (Afukaar et al., 2003; Hesse & Ofosu, 2014; Oppong, 2015). Concerning fatalities, males accounted for 73.7% of all fatalities resulting from road

Funded by
the European Union

traffic accidents (percentage similar to the previous period 1994-1998) whereas female fatalities stood at 26.3% in the same period. The percentage of male fatalities appears similar to the period 1994-1998 (73.1%), showing the consistency of the problem. The trend of road crashes varies by the type of road user and the type of vehicle, showing how pedestrians, car occupants and bus and minibus occupants are the most involved (Afukaar et al., 2003; Amo & Meirmanov, 2014; Hesse & Ofosu, 2014).

An E-Survey of Road Users' Attitudes (Vias Institute, 2019) conducted on 378 road users between 2019 and 2020 found that in the last 12 months they have used the following modes of transport: 99.7% car-passenger, 97.1% pedestrian, 96.0% public transport, 61.6% cyclist, 56.3% car-driver, 51.9% Powered Two Wheelers. Survey responders stated to feel safer using public transport or when they are car-occupants, followed by being a pedestrian or a cyclist, while being a Powered Two Wheelers Road user shows the latest safety rate.

More recently Adanu (Adanu et al., 2023) focused their research on head-on collisions founding that cars, minibuses, Heavy Good Vehicles, and motorcycles are the leading vehicle types to be involved. They classified six years (2013–2018) of road crash injury outcomes in four severity levels (fatal injury, hospitalized injury, minor injury, and no injury), and fatalities in "died on the spot" or "died within 30 days" of the crash (data come from the Ghana National Road Traffic Accident Database). The study confirms the small percentage of females involved in crashes (only 2%, head-on crashes), and that more passengers (51.5%) than drivers (48.5%) were injured or killed in the crashes. Additionally, authors found how around 87% of head-on collision casualties were between 20 and 60 years old, with the range 40-60 years old the most frequent (61.5%). Sixty percent (60%) of crashes occurred in the daylight condition and the vast majority (99%) on dry road surfaces. Urban and rural roads showed similarities (47% vs 47.5%), with 80% on straight and flat roads and more than 80% not at junction. Cars predominated with their 40%, followed by motorcycle (23%), minibus (13%) and HGV with around 11%.

Trying to identify Road Traffic Crash causing factors, Nyamuame (Nyamuame et al., 2015) found a positive correlation between the RTC trend and the population growth. Fatalities and serious injuries increased 38% and 26%, respectively, while Greater Accra region recorded the highest number of cases relative to the other regions, because most of the population lives in this area. The study was based on crash data between 2005 and 2014 (from the National Road Safety Commission).

In the Accra Metropolitan area (25 out of 29 districts), within the decade 2011-2020, there was a reduction in the number of crashes, minor injuries, serious injuries, and deaths compared to the first five years of the decade (Figure 1). Regrettably, 2020 showed a plus 32% of the deaths (103 to 136) compared to 2019 (Accra Metropolitan Assembly, 2021). Compared to previous literature, the report showed an increment in the percentage of females that lost their life (12%, year 2020) or have been seriously injured (19%, year 2020) in traffic crashes, and highlighting that young males are almost 3 times as likely to be killed in a road traffic crash as young females. In the same study, the circulating park was characterized, and *Cars, SUVs and pickups* were the most common vehicles with roughly 60% of registrations (Figure 4).

Figure 1: Number of crashes/victims in Accra Metropolitan area by year (Accra Metropolitan Assembly, 2021)

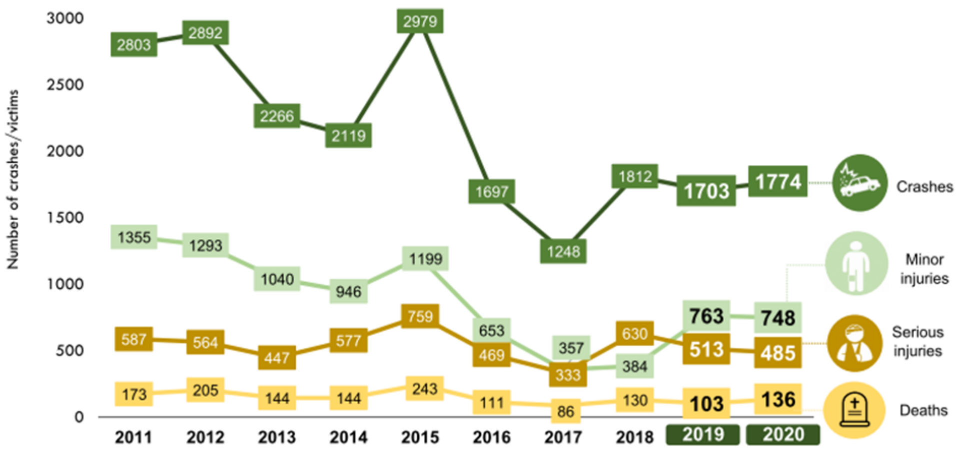


Figure 2: Number of deaths in Accra Metropolitan area by year and transport mode (Accra Metropolitan Assembly, 2021)

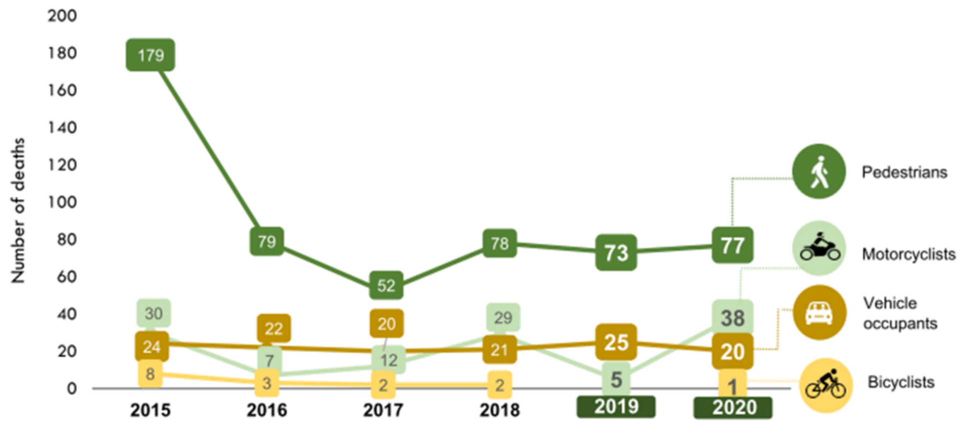


Figure 3: Number of serious injuries in Accra Metropolitan area by year and transport mode (Accra Metropolitan Assembly, 2021)

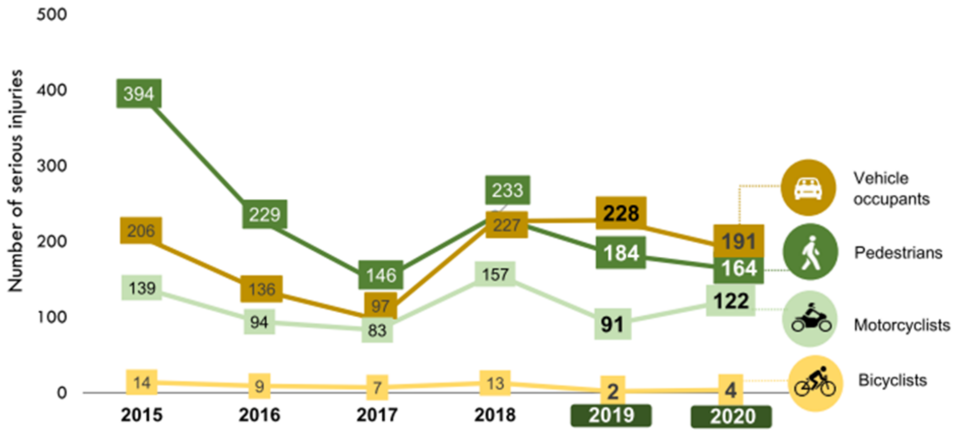
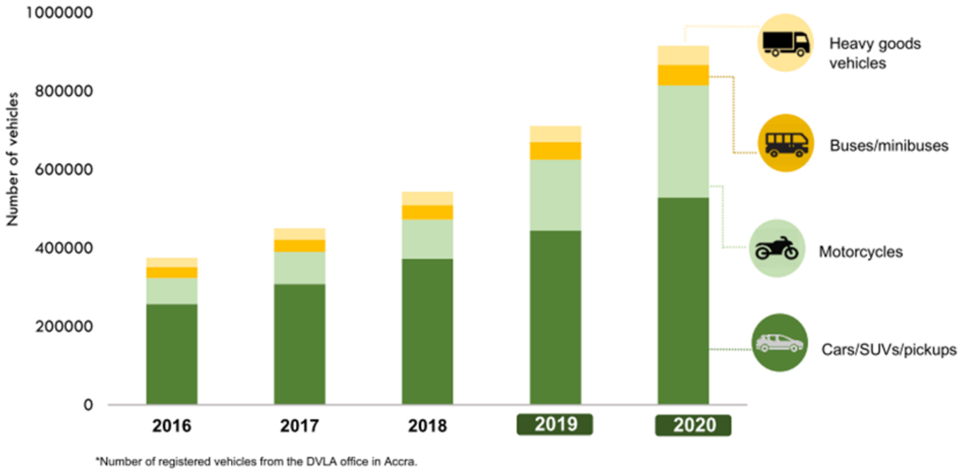


Figure 4: Circulating Park in Accra Metropolitan area by year (Accra Metropolitan Assembly, 2021)



Vulnerable Road Users – i.e., pedestrians, motorcyclists, and cyclists – represented 85% of road traffic deaths with pedestrians at the most (56%) and the highest proportion of deaths recorded among those aged 30 to 39 years (year 2020). Similar observations can be also drawn for serious injuries. Among pedestrians, vehicle–pedestrian collisions constituted 71% and 56% of the reported deaths in 2019 and 2020 respectively, while rear-end collisions constituted 9% and 13% of deaths in 2019 and 2020, respectively.

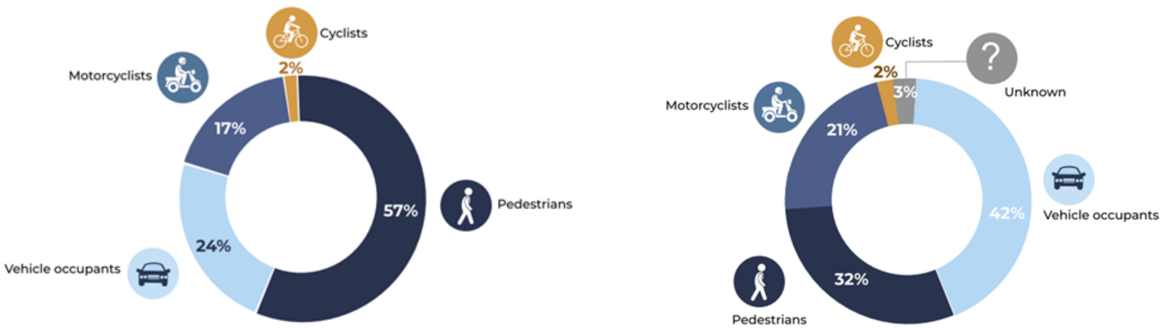
In a more recent report (Accra Metropolitan Assembly, 2023), pedestrians and motorcyclists were the users most at risk with 61% and 19%, respectively (Table 1). In the period 2019-2021, the most frequent causal vehicles of pedestrian deaths were cars or pickups (47%), buses and minibuses (22%), and motorcycles (16%). Motorcyclists lost their lives most frequently in single-vehicle crashes (32%) and in crashes with cars or pickups (27%). Cars and pickups were the most frequent mode of transport responsible for deaths (41%) overall, followed by buses and minibuses (18%).

Table 1: Deaths vs. vehicle type; year 2019-2021 data from the "Road Safety Annual Report 2021" (Accra Metropolitan Assembly, 2023)

	Car and pick up	Bus and minibus	HGV	PTW	Single Vehicle Crashes	Unknown	Total
Car and pick up occupants	41.9%	7.0%	18.6%	7.0%	18.6%	7.0%	**11.9%**
Bus and minibus occupants	41.2%	11.8%	17.6%	5.9%	23.5%	0.0%	**4.7%**
HGV occupants	12.5%	12.5%	50.0%	0.0%	0.0%	25.0%	**2.2%**
Motorcyclists	26.5%	14.7%	16.2%	4.4%	32.4%	5.9%	**18.8%**
Cyclists	25.0%	0.0%	75.0%	0.0%	0.0%	0.0%	**1.1%**
Pedestrians	46.6%	21.7%	6.8%	15.8%	0.0%	9.0%	**61.0%**
Unknown	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	**0.3%**
Total	**40.9%**	**17.7%**	**12.2%**	**11.6%**	**9.7%**	**8.0%**	**100.0%**

The latest road safety report (Accra Metropolitan Assembly, 2023) also showed a two-year (2020–2021) retrospective linkage of police crash data and medical data from three referral hospitals focusing on road traffic fatality and serious injuries from three of the major tertiary hospitals in Accra. The hospital records showed 3385 casualties due to road crashes, among which 3115 were serious injured and 270 resulted in deaths. Fatalities and serious injuries by road user type showed a similar pattern to police records: pedestrians and motorcyclists were still the most fatally injured, while car-occupants the most serious injured. The analysis included only those deaths in hospital records that followed crashes documented to have occurred in Accra. Forty-five (45) hospital records were linked to police records, yielding a 17% matching rate. While the capture-recapture analysis estimated that the number of road deaths in Accra for the two-year 2020-2021 was 559, resulting in 2.1 times higher than police reports. Among behavioural risk factors speeding remains one at the most. Motorcycles top the list of vehicles observed to be speeding over the posted limit (60%), followed by cars and in general lightweight vehicles (50%), while buses and HGV drivers shown the lesser inclination.

Figure 5: Hospital deaths (left) and hospital serious injuries (right) by road user type; data 2020-2021 (Accra Metropolitan Assembly, 2023)



Noteworthy, in 2020 the percentage of motorcyclists that do not correctly use the helmet increased up to 69% among riders and up to 25% among passengers (Accra Metropolitan Assembly, 2023). Vice versa, the use of seatbelt among drivers and car-passengers drops significantly in 2020 compared to previous years, reaching the 66% among drivers and around 11% among passengers. Lastly, the report also points out the under-reporting phenomenon affecting official statistics, typically based on police records, and therefore the importance of using complementary data sources to get better estimates of deaths to improve outcomes (Accra Metropolitan Assembly, 2023), and it proposes the following recommendations:

Funded by the European Union

- Improve data collection systems in trauma hospitals to lift the data reliability, standardization, and accuracy.
- Police and hospital staff should consider using a person unique identifier.
- A periodically linkage of hospital and police data should be performed to assess the level of underreporting of official statistics and get a more realistic estimate.

2.2. PEDESTRIANS

According to the World Health Organization (WHO, 2018), pedestrians have the highest number of fatalities compared to other road users in Ghana. Pedestrian fatality in 2012 was 42% of the total of 1.800 deaths from 14.500 road crash injuries that happen annually in Ghana (Obeng al., 2017), by which the World Bank found that the number kept increasing up to 46% of all road fatalities until the end of 2018. It was found that 26% of the roads do not have formal footpaths, and 77% of the streets in Ghana do not have pedestrian crossings (World Bank, 2020).

A study on road traffic fatalities among children in Ghana shows that 19% of more than 9.800 total road deaths in a 5-year period were children, with 79% of those occurrences being child-pedestrian (Ackaah, 2010). Pedestrians were found to have a three times higher likelihood of getting killed in road crashes compared to drivers and riders, where children under the age of 10 years had two times higher death rates compared to adults of age 30-59 (Damsere-Derry et al., 2017). A study on road use behaviour of school children in Accra showed that female students behaved significantly more safely than male students. This result confirmed a previous study (Afukaar & Ackaah, 2006), where more boys (55%) died due to traffic crashes than girls (45%) (Yankson et al., 2020). However, a study by Setorwofia (Setorwofia et al., 2020) on Cape Coast Metropolis found that female, younger, and lower primary school children tend to be more vulnerable to getting involved in a crash.

The causes of road crashes involving school children in Ghana are varied. High-speed roads in settlement areas, reckless and undisciplined driving behaviour, low pedestrian safety knowledge and inexperience due to young age, and lack of pedestrian facilities has become the leading cause of the occurrence by far (Ackaah, 2010; Adom-Asamoah et al., 2015; Coleman, 2014; Setorwofia et al., 2020). Other contributing factors are vehicle worthiness and poor infrastructure condition (Coleman, 2014).

For the Northern Ghana, a study, based on the crash data from police reports between 2007 and 2011, shows that vulnerable and non-protected road users are the most exposed to traffic accidents (Damsere-Derry et al., 2017). The crashes reported for the region were extremely severe as 35% of all injury related to collision were fatal. The fatal causalities were between 21% among the victims of sideswipe collision and 41% among pedestrians and victims of rear-end collision. Females were more likely to die as pedestrians: 90% of all female causalities; while males were more likely to die as riders/drivers: 78% of all male casualty deaths. Pedestrians were 3 times more likely to die compared to drivers/riders. The odds of death among cyclists were about 4 times higher and about 2 times higher among motorcyclists.

2.3. CYCLISTS

Rapid urbanization implies intensification of urban mobility, which, in a lack of facilities for walking and cycling, poor or no existing public lighting and bad conditions of the roads, results in increased accident and fatality risks. In a study on the attitude and perception of cycling Ransford found that "… *attitudes and perceptions regarding the environmental, financial, exercise and potential health benefits of cycling for transportation were very positive generally, and slightly stronger in females who had never cycled before than in males in the same group* …" (Acheampong, 2016). This positive attitude to cycling expresses the willingness to use bicycle as mode of transport and also for health benefits. The study shows also that there is a widely shared acceptance among the respondents to promote cycling program in urban Ghana, and Kumasi.

A further study on cycling in Ghana, with a focus on Accra, Quarshie has found that cycling in the Northern cities of Ghana was usual and more accepted as mode of transport than in the South, for instance in Accra (Quarshie, 2004). Cyclists are seen as a source of nuisance and the danger involved when using motor roads dissuades people from using bicycles. The dissuasion from using bicycles is mainly based on the danger cyclists are exposed to when cycling on motorways and intense traffic car roads. About 50% of the 700 persons interviewed in this study indicated unsafety as the reason to why they don't bike. This means that there is a need to integrate cyclists into the transport network to enable access and safety for cycling.

Ten years (2005–2014) of accident data from Northern Ghana, in Tamale, Bolgatanga and Wa Municipalities, were used in a study on bicycle crashes. In the region 90% of registered vehicles are motorcyclists and no formal data on bicycles were available. The study showed that during the decade 253 cyclists' causalities occurred in the three cities (Damsere-Derry & Bawa, 2018): 51% of the 253 causalities was fatal, 35% was serious and 13% was minor injuries. Among the cyclist causalities 93% was males and 7% was females. The decade's statistics for the three cities revealed that 297 were bicycle related accident victims, of which 86% was cyclists, 9% car occupants (drivers and passengers), and 3% was pedestrians. Among the collision types, 44% was rear-end, 27% was side-swipe and 15% was right-angled collision (Figure 6). Concerning the injury severity by colliding road users, 76% of cyclists died when they collided with HGVs (33 cases), while cycle-motorcycle collisions resulted in 57% deaths (47 cases; Figure 7).

Funded by
the European Union

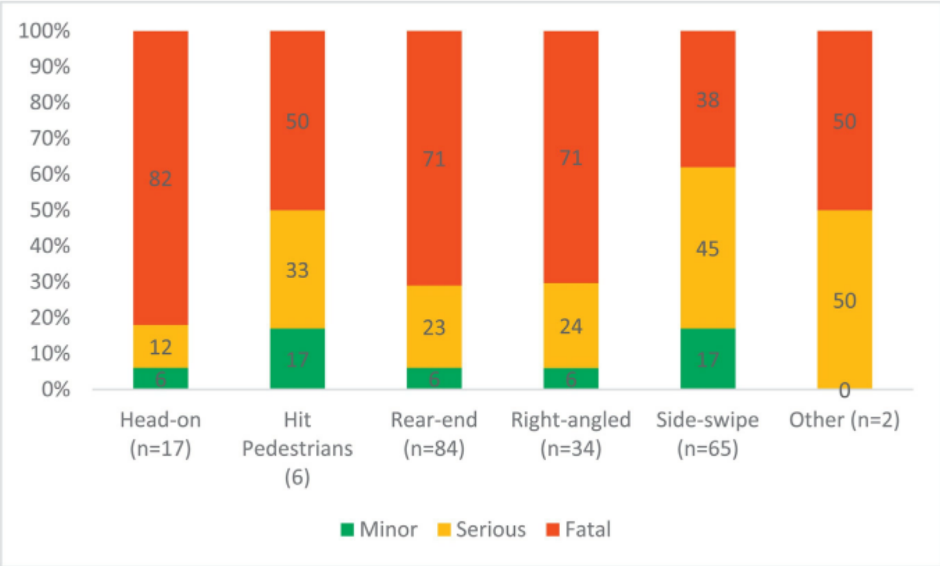


Figure 6: Cyclists' injury severity by collision types (Damsere-Derry & Bawa, 2018)

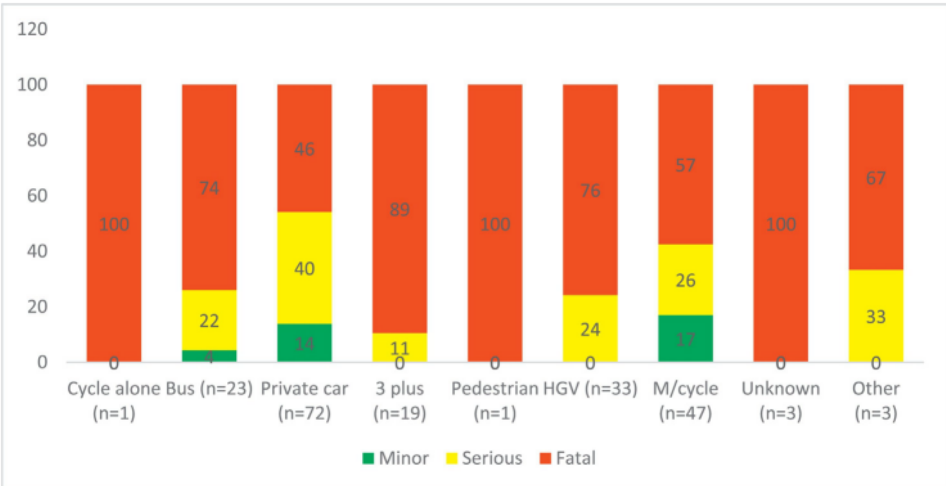


Figure 7: Cyclists' injury severity by colliding road user (Damsere-Derry & Bawa, 2018)

Road accidents among cyclists in Northern Ghana is very high, it causes the death of about 52% of all cyclists and 35% was involved in serious accidents, which required hospitalization. The data gathered for this decade showed that 54% of all cyclists involved in the accidents was blameless. The causes are mainly related to poor or non-existent bicycling infrastructure. In addition, car ownership has a higher status than cycling, therefore cyclists are perceived to be poor and have no advocates at the policy making and implementation level. Cyclists are therefore not considered in the construction of road infrastructure.

2.4. POWERED TWO-WHEELERS

Ghana experiences an increase in the use of motorcycles for commercial and private transportation of people and goods. The growth of motorcycles is associated with traffic congestion in urban areas and the limited availability of reliable and affordable public transport in rural areas (Agyemang et al., 2021). Although using motorcycles positively impacts social and economic aspects, the number of road crashes involving motorcyclists in Ghana is also escalating (Dapilah et al., 2017). Nonetheless, Garcia (Garcia et al., 2021) forecast that a rise in motorcycles can lead to 370 extra deaths and over 18,500 years of life lost prematurely per year in the only Accra Metropolitan Area.

The Motor Traffic and Transport Department of Ghana recorded that 6.166 motorcycles got involved in road crashes in January-December 2021, with a total of 1.282 deaths by the end of 2021. In 2021, motorcycle accidents contribute to 34% of all road crashes in Ghana, and the increase is estimated to be over 400% for the past decade (Issah, 2022). A study found that males were more likely to die as riders/drivers in the event of crashes, 78% of all male casualty deaths (Damsere-Derry et al., 2017).

According to Agyemang (Agyemang et al., 2021), the data showed that more rural area crashes occurred in the roadway with limited to no lighting at all, with head-on collisions found to be the most often type of crashes involving motorcyclists. Meanwhile, in urban areas, the crashes tend to involve traffic in the intersection and the highest proportion of crashes involved pedestrian-motorcycle. Furthermore, the number of road traffic accidents and deaths have corresponded to road traffic behaviour of motorcyclists, such as low awareness of helmet-wearing, driving/riding while having an altered perception of reality, and other reckless behaviour and disobeying traffic safety regulations (Dapilah et al., 2017). On the other hand, poor infrastructure conditions and motorcycle defects also contribute significantly to fatal injury outcomes across the country (Agyemang et al., 2021).

The high frequency and fatality rates at intersection was also pointed out by Tamakloe (Tamakloe et al., 2022). The study explores hidden rules associated with crash casualty injury severity outcomes at both signalized and non-signalized intersections using crash data spanning 2016–2018. Authors found that both median and shoulder presence were associated with Killed and Serious Injured crashes at signalized intersections. While KSI crashes at non-signalized intersections were associated with median presence and shoulder absence, minor injured crashes were associated with median absence and shoulder presence. Right-angle crashes led to KSI, and rear-end crashes led to MINJ irrespective of the control type at the intersection. Casualty age was more linked to non-signalized crash model: younger casualties sustained higher fatal/serious injuries than mid-ages. While weekday crashes were more correlated with crashes at signalized intersections, weekend crashes were found to be more associated with crashes at non-signalized intersections. The authors suggest, among others, the improvement of the efficiency of the licensing system, law enforcement and vehicle standards policies improvement (e.g., adopting appropriate state-of-the-art vehicle standards such as motorcycle anti-lock braking systems), adopting of red-light cameras at intersections, etc. (Tamakloe et al., 2022).

Educational programme such as motorcycle training schools seems to be also a good way to spread best practices among motorcyclists and more in general to reduce traffic violations (Ablin Consult, 2010; Akaateba et al., 2015).

2.5. CARS

The importance of car in road crashes was already evidenced in the section on general statistics and with the data from the Accra area (Table 1). A number of studies have investigated the crash determinants. According to the National Road Safety commission (statistics 2018), the lead public statutory body responsible for road safety management in Ghana, the main causes of road accidents in the country relate to adverse driver behaviours such as over-speeding; reckless overtaking, drunk and fatigue driving. Dealing with road trauma by severely punishing the driver doesn't solve the problem. There is more to learn from examining how broader system-level factors in the Ghanaian transport sector and society in general affect the behaviour of drivers and overall safety outcomes in the country. Today, driver errors or adverse driver behaviours (such as over-speeding, inattentiveness, and fatigue driving) are considered not as the causes of accidents but as the outcomes of the interactions between and among the wider societal or system-level factors (e.g., government policies, terms and conditions of labour relations and compensation systems) that underlie the sociotechnical road transport system in which drivers operate (Boateng, 2021b). Some of the private transport organizations argue that "the best safety device that one can install in a vehicle or equipment is a trained and educated driver". Another local contributory factor is the limited investment in rail and public bus transport and other infrastructure to support non-motorized transportation systems (such as bicycle lanes). Concentration of investments and localization of industries, services and workplaces to the centre of the big cities makes traffic congestion and its negative effects on environment another cause of fatalities and road trauma in Ghana. Indeed, some empirical evidence has emerged that traffic congestions in the cities incentivize over-speeding — one of the main causes of Road Traffic Crashes in Ghana (Obeng-Odoom, 2009).

An analysis of the vehicle circulating park reveals that the Ghanaian transport system relies on the importation of cars. However, only 8% of the imported cars are brand new, the remaining 92% range between second to fifth hand cars. Only 13% of the imported cars are below 5 years, about 34% are up to 10 years with those up to 15 years and above constituting over 50% (Sulemana, 2012).

2.6. PUBLIC TRANSPORTS

A number of recent studies have focused on the involvement of public transport in crashes, since they represent the second category of offending vehicles. Damsere-Derry (Damsere-Derry et al., 2021) sought to model the injury severity of intercity bus transport via random multinomial logit. The dataset involves 1374 traffic crashes from the 575 km long Accra-Kumasi-Sunyani-Gonokrom highway spanning in the years 2013-2017, obtained from BRRI. The higher probability of sustaining fatal injuries was for pedestrians, unlicensed drivers, and drivers and passengers aged more than 60 years. Also speeding, wrong overtaking, careless driving and inexperienced drivers increase the probability of serious injuries and fatalities on the intercity highway. Vice versa, villages were found to be most prone to crashes causing hospitalized injury. The authors conclude on the usefulness of enforcement of traffic regulations, of the importance about the crashworthiness assessment of intercity public transport buses, as well as the importance that imported vehicles should meet certain minimum safety criteria and should be equipped with advanced technologies, such as driver-assist systems.

Ojo (Ojo et al., 2018) point out as the lived experiences of inter-urban commercial bus drivers involved in RTCs in Ghana remains relatively underreported. Their study involving face-to-face in-depth interviews with 15 interurban commercial bus drivers who survived RTCs and still drive. The analysis revealed environmental factors (such as weather condition, road surface, road curvature) accounted for the RTCs. Survivors received poor pre-hospital trauma care and no welfare package. Measures to RTCs could include road/transport infrastructure improvements, pre-hospital trauma care improvement with more ambulances and qualified personnel (such as paramedics), to implement road safety programs and focused enforcement of traffic regulation and, finally, to provide social welfare package for survivors and their families.

Examining factors that influence bus and minibus crash severity between 2011-2015, Sam (Sam et al., 2018) found that factors are related to the driver, to road and weather conditions and to the vehicle. Additional factors are the time of the accident and the collision type. The study estimates the severity of such traffic crashes by fitting generalised ordered logit models, revealing that weekends, the absence of road median, night-time conditions, bad road terrain (curved, wet and rough roads), hit-pedestrian collisions, and drunk driving are associated with more severe public transport crash outcomes. Conversely, the absence of road shoulder, accidents in intersections, the presence of traffic control and collision types (except hit-pedestrian) are associated with less severe traffic crashes. Basically, descriptive statistics showed like this type of crashes are high and severe, involving about 65% of young drivers (≤35 years) and a five percent (5%) of unlicensed or partially licensed drivers. Most common driver errors were, e.g., inexperience and inattention, improper overtaking, improper turning, over-speeding, fatigued driving and tailgating (responsible for 80% of crashes), mainly when the buses/minibuses were going ahead (84%) on straight and flat roads (89.4%) without median (69.4%) at the time of their crash.

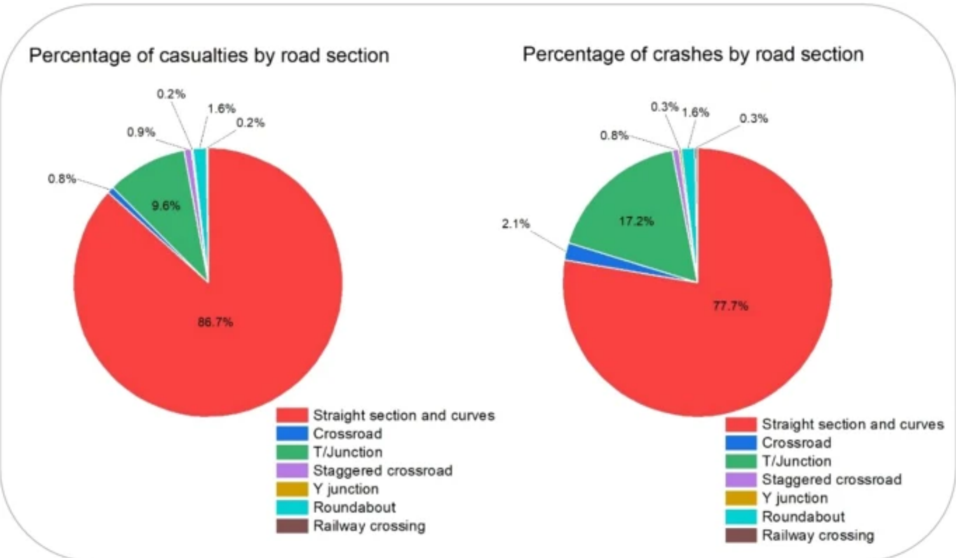
Garcia (Garcia et al., 2021) found like trucks and buses are mainly responsible for pedestrians' death and more in general for all types of victim (death) mode. Data was provided by the Ghanaian Police Service through the Building and Road Research Institute over years 2007 to 2016 (Table 2). The table shows the number of road traffic fatalities by types of victims and impacting road users. The authors concluded that walking, cycling and mass transit trips could be made the safest, cheapest, most pleasant, and convenient options for most everyday trips and that efforts and investments should be shifted towards a more sustainable transport profile that prioritise public transport and active travel.

Table 2: Road traffic fatalities according to victim and impact mode. Accra, Ghana, 2007-2016 (Garcia et al., 2021)

		Impacting mode								
		Pedestrian	Bicycle	Motorcycle	Car, pick-up or van	Bus	Trucks	No other or fixed object	Unknown	TOTAL
Victim mode	**Pedestrian**	0	2	63	434	218	76	1	87	881
	Bicycle	0	0	2	24	11	10	0	3	50
	Motorcycle	6	0	9	56	29	18	20	5	143
	Car	3	0	4	29	25	22	47	5	135
	Pick-up truck or van	0	0	0	3	4	5	8	0	20
	Bus	1	1	1	8	14	13	33	3	74
	Heavy transport	0	0	0	3	4	4	22	0	33
	TOTAL	10	3	79	557	305	148	131	103	

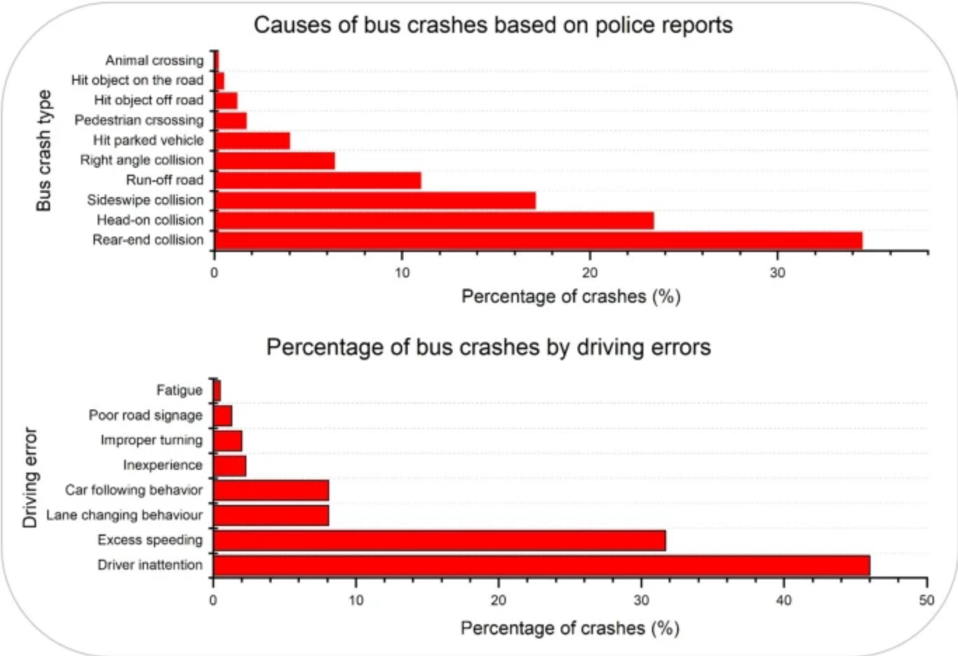
Alimo (Alimo et al., 2023) conducted a geospatial analysis of bus crashes along the Accra-Kumasi highway and obtained from the BRRI over years 2005 to 2019. 53% of crashes involved buses (2236 bus crashes in 363 crash locations along the 243 km highway). The study found like bus crashes occurred mainly (1) at straight road sections and curves (Figure 8), (2) near dense settlements, (3) around vehicle service stations such as mechanic shops and fuel filling stations, and (4) in the afternoon under clear weather conditions. The major causes of bus crashes are transgressive and aggressive driving behaviours such as inattention, excess speeding, lane-changing, and car-following behaviour (Figure 9). The minor causes are driver inexperience, poor road signage, improper turning, and fatigue. Most crashes result from rear-ended and head-on collisions. Their main suggested countermeasures are the expansion of the road lanes, installing bus surveillance technologies, specialised warning signs near crash-prone locations, and increased police monitoring and regulatory enforcement.

Figure 8: Percentage of casualties (left) and crashes (right) by road section (Alimo et al., 2023)



Funded by
the European Union

Figure 9: Percentage of Bus crash by type (top) and percentage of driving error (bottom) (Alimo et al., 2023)



Boateng (Boateng, 2020) attempts a better explanation for the causes of dangerous driving behaviours among "Tro-Tro" (minibus) drivers, trying to take into account for the context of the behaviours and their influences rather than mainly focused on social misbehaviour such as "over-speeding". Boateng underline like "Tro-Tro drivers operate within a precarious work climate marked by problems such as low wages; cut-throat competition; high level of job insecurity; imposition of non-negotiable throat-cutting daily fees by car owners and harassments from bribe-demanding corrupt police officers. The exigencies of meeting these numerous financial and other demands of their work, not moral failure, are what fuel dangerous driving behaviours among the drivers".

2.7. HEAVY GOODS VEHICLES

Limited material was found on HGVs. In the only relevant study (Poku-Boansi et al., 2018) the authors highlighted a serious issue about the population exposure risks associated with the transportation of hazardous materials. Applying the mixed methods approach to the Accra – Kumasi Highway (N6), they found that approximately 1464 inhabitants could at risk of either being killed or injured over less than 300 km stretch of the N6 (risk of a single shipment of a hazardous material was 0.09144 inhabitants per vehicle/km). Moreover, they pointed out that 66.5% of truck operators have a limited driver experience.

2.8. NATIONAL DATABASE

The Ghana National Road Traffic Accident Database is the national crash dataset since 1991. Data are obtained from the Motor Traffic and Transport Department of the Ghana Police Service and managed by the BRRI of the Council for Scientific and Industrial Research, Kumasi, Ghana. BRRI conducts research based on the country's official road traffic crash data, which is collected using an approved standard accident reporting format. The data is stored on computers using the Transport Research Laboratory, UK - developed Microcomputer Accident Analysis Package (MAAP, Windows version) software. Unfortunately, no information about the dataset structure has been found (Accra Metropolitan Assembly, 2021; Amoh-Gyimah et al., 2017; Sam et al., 2018).

The latest Accra road safety report (Accra Metropolitan Assembly, 2023) pointed out the existence of other data sources like the Ghanaian insurance records and the civil registration and vital statistics system while still highlighting how they are not reliable or readily available.

A further relevant source of information on road safety, road users, road management, road crashes and related issues the Global Road Safety Facility provides information on road safety and related thematic in low- and middle-income countries on a global level. The organization is a global multi-donor fund, which is hosted by the World Bank. Its mission is to help governments develop road safety management capacity and scale up road safety delivery in low- and middle-income countries. The organization provides information on all pillars of road safety (management, roads, speed, vehicles, road users and post-crash care). It also provides information on the current status for each country and region along with extensive information on key risk factors, issues and opportunities. For Ghana the organization compiled a profile of the status of roads and road safety.

Funded by
the European Union

3. RWANDA

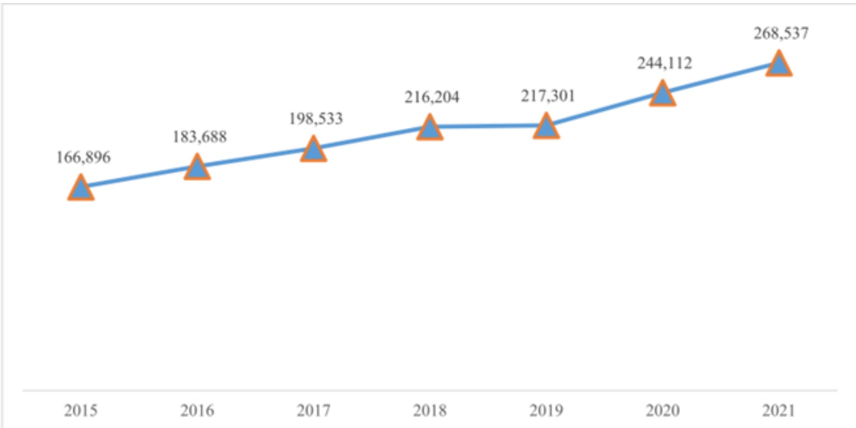
In this chapter the most recent and relevant reports and research papers on the Rwanda crash statistics are analysed to depict the recent safety conditions on the roads. The documents allow the identification of both major trends and the most relevant user groups, which road safety initiatives should focus on.

3.1. GENERAL STATISTICS

Modelled estimates from the Institute for Health Metrics and Evaluation in 2015 reveal that Rwanda has the highest road traffic fatality rate among East African countries, with 22 deaths per 100,000 population (Wang et al., 2020). Additionally, Rwanda bears the highest burden of RTIs, with 1,173 disability-adjusted life years per 100,000 population.

Within this context, data from the National Institute of Statistics of Rwanda reports a growing vehicle registration trend since 2015, with a plus 10 percent per year in the last two years (Figure 10). Regarding the vehicle typology, motorcycles were the most registered vehicle in the last three years (2019-2021), followed by cars (car & jeep), and public or commercial vehicles such as bus, trucks, minibus, etc ().

Figure 10: Annual registration of vehicles; data source: (NISR, 2022)



Funded by
the European Union

Table 3: Annual registration of vehicles by type; data source: (NISR, 2022)

Category	Cumulative MV reg. at 31st Dec 2019	Cumulative MV reg. at 31st Dec 2020	Total Cumulative of Registered Vehicles up to 31st December 2021
Caterpillar	154	167	177
Bus	1,706	1,965	2,084
Trucks	8,273	9,680	11,397
Pick-up	17,026	18,685	19,890
Special Engine	3,504	4,139	5,047
Jeeps	25,771	30,156	34,622
Microbus	1,536	1,937	2,414
Minibus	6,096	6,405	6,327
Cars	34,555	38,938	43,182
Motors	117,199	130,326	141,532
Trailers	1,055	1,166	1,234
Semi-trailers			555
Tricycle	73	73	73
Unknown			3
FORKLIFT	28	41	0
HALF-TRAILER	325	434	
Total	**217,301**	**244,112**	**268,537**

Although an increase in the circulating park of the vehicles, data from Rwanda National Police showed that the total number of crashes in 2020 decreased by 33% compared to 2015, while there was a peak in 2021 where crashes doubled compared to 2020 (Figure 11).

Nonetheless, looking at crash frequencies by the National Institute of Statistics of Rwanda (NISR, 2022), the trends of fatal and serious injury crashes show to be comparable among the years considered (2018-2021), while the number of minor injury crashes and those with PDO are more than doubled (Table 4). Therefore, this might be either due to a grow of 10% in the 2021 vehicle registration compared to the previous year, or it might suggest a real improvement in the crash data collection.

Among the seven years considered, fatal crashes were almost constant with an average of 613 cases per year, while the trend of serious crashes showed a decreasing phase compared with 2019 (-28%, on average; Figure 12).

Figure 11: Annual number of crashes (NISR data)

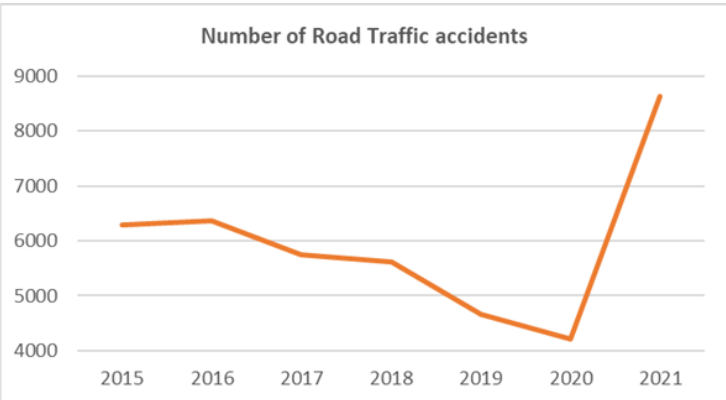
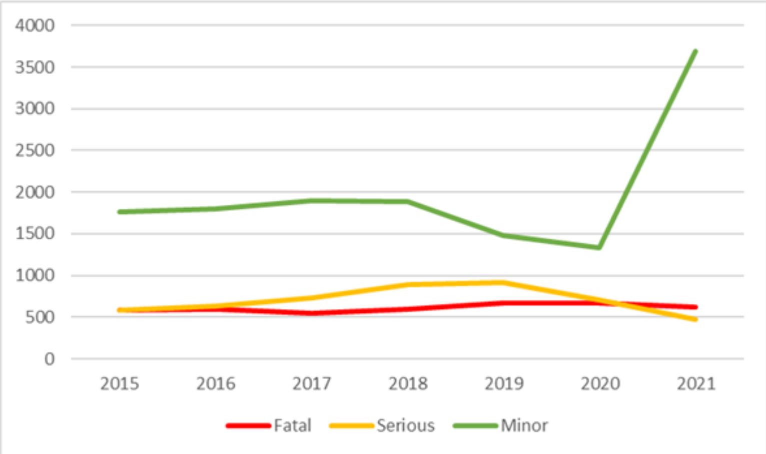


Table 4: Annual number of crashes and repartition by crash type (NISR data)

	Crashes	Fatal	Serious	Minor	PDO
2015	6282	584	583	1767	3348
2016	6363	593	629	1794	3347
2017	5754	549	733	1896	2577
2018	5611	597	885	1887	2242
2019	4653	673	911	1485	1584
2020	4203	675	710	1326	1492
2021	8639	621	471	3688	3859

Figure 12: Annual number of crashes by type (NISR data)

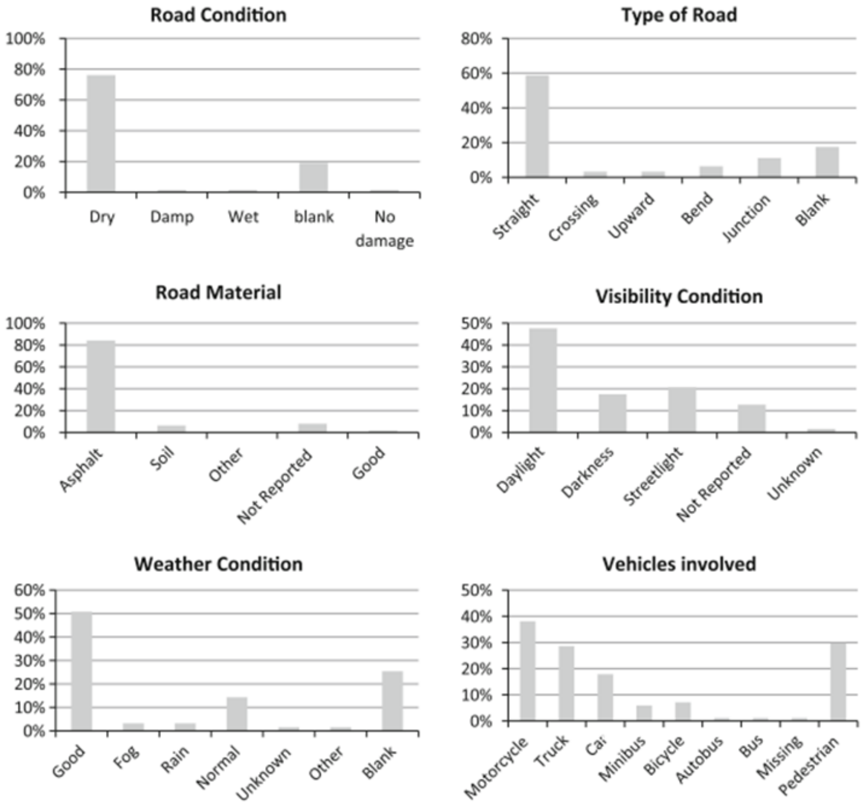


In their study about on-scene fatalities, Kim (Kim & Byiringiro, 2016) showed that road traffic crashes were the leading cause of blunt injury mechanisms. Moreover, the authors found that most crashes occurred on straight (nearly 60%) and dry (nearly 75%) roads, with daylight visibility conditions (about 47%) and good weather conditions (about 50%). While, concerning the collision types, the vehicle to pedestrian crashes were the most frequent ones, followed by single vehicle crashes (Figure 13).

Through a cross-sectional randomized survey, Zafar (Zafar et al., 2018) showed that in Rwanda pedestrians were the most injured road users, followed by PTW and bus/car/truck vehicles. The authors found Face/Head/Neck to be the body region most affected by injuries, with nearly 34% of the total injuries, followed by the abdomen (17%) and extremities (15.5%). Moreover, despite the small number of injuries collected (58 out of 809), the authors found that 33% of them resulted in major disabilities such as not being able to work or needing help with transport and with daily living.

Concerning crash causes, negligence, no-correct manoeuvres, and speeding prevailed over the entire period considered (2016-2020) (Gatesi et al., 2022).

Figure 13: Conditions of road crashes (Kim & Byiringiro, 2016)



Rwanda's urban area, particularly Kigali Province, has a high population density of 2,535 residents per square kilometre, although most of the population resides in rural areas. Kigali also accounts for 70% of the registered vehicles in the country. Furthermore, studies based on hospital records indicate that RTIs comprised 73.4% of all injury cases and 61.2% of fatal injuries in Kigali. Despite some investigations into the epidemiology of RTIs, more knowledge is needed regarding the geographic locations and built environment characteristics of crash hotspots in Kigali.

In recent years, geographic information systems (GIS) have emerged as valuable tools for analysing the spatial and temporal patterns of RTCs. Utilising GIS can provide insights into the physical environment surrounding RTC hotspots in Kigali, enabling more effective road safety initiatives and improvements in the infrastructure of the built environment to reduce the risk of RTIs for vulnerable road users.

3.2. PEDESTRIANS

Pedestrians have the highest proportion of road crashes fatalities in Rwanda; they account for almost 50% of all fatalities (World Bank, 2020) . According to the Department of Traffic and Road Safety of Rwanda, the involvement of pedestrians in road crashes were 255 out of 655 fatalities, 175 out of 684 serious injuries, and 1.262 out of 5.244 minor road accidents (RNP, 2022b). The study by Patel (Patel et al., 2016) found that pedestrians and cyclists have 263 times higher odds of having a serious injury compared to car occupants (Table 5). Kim (Kim & Byiringiro, 2016) found pedestrians to be the second road user most involved in on-scene fatal crashes (about 30%). While, most recently, statistics from the department of Traffic and Road Safety indicate that pedestrians were the majority victims of road accidents in 2021 year with 225 fatalities (RNP, 2022a).

Currently, no up-to-date data on the proportion of involvement and fatalities of road crashes involving school children in Rwanda is available. However, a study on the safe school zone project around Groupe Scolaire Camp Kigali found that there are three main modes of transport that students choose to go to their school: 82.2% of students walked, 13.08% used buses, and 4.71% went by private cars. This data shows that most of the students are pedestrians, which could increase the possibility of getting involved in crashes, since the road safety of the student was considered unsafe, due to the occurrence of road crashes that affect school children at least once a year around this study area (Nzeyimana, 2019). The fact that roads for school children in Rwanda are unsafe is also supported by records from Kigali University Central Teaching Hospital, where 20,5% of 1101 road accidents victims were children in age 0-15 years (Twagirayezu et al., 2008).

A study on crash causation showed that 47% of crashes were caused by high speed, 32% were due to a lack of knowledge of road safety behaviour, 13% were caused by drunk driving, and 8% were because of poor infrastructure conditions (Nkumbuye, 2022). Other factors contributing to the crash are vehicle problems, inability to manoeuvre, weather conditions (e.g., rain), negligence, and cell phone use while driving (Clarisse, 2015).

Table 5: Analysis of year 2013 crashes by type of crash vehicle and by victim vehicle (Patel et al., 2016)

	Total	Grievous	Non-grievous	OR (IC 95 %)
Primary Crash Vehicle, N (%)				
Pedestrians & Cyclists	6 (0.3)	3 (0.2)	–	
Cars	1121 (43.8)	157 (34.1)	948 (46.1)*	Ref
Motorcycles	372 (14.5)	143 (31.0)	219 (10.1)	4.27 (2.54;7.24)**
Buses	374 (14.6)	67 (14.5)	301 (14.6)	2.11 (1.22;3.63)**
Trucks	686 (26.8)	91 (19.7)	583 (28.4)	1.88 (1.19;3.00)**
Primary Victim Vehicle, N (%)				
Cars	1214 (53.9)	37 (8.7)	1156 (64.6)*	Ref
Pedestrians & Cyclists	257 (11.4)	220 (51.8)	34 (1.8)	263.64 (147.02;496.53)**
Motorcycles	346 (15.4)	139 (32.8)	196 (11.0)	23.86 (15.26;38.41)**
Buses	186 (8.3)	10 (2.3)	174 (9.7)	1.20 (0.43;2.81)
Trucks	248 (11.0)	18 (4.2)	228 (12.7)	2.89 (1.49;4.51)**
Paved Roads, N (%)	2364 (95.6)	423 (96.4)	1901 (95.6)	0.41 (0.14;1.16)

(*N* number, *SD* standard deviation) *Significant at $P < 0.05$ in a bivariate association; **Significant at a $P < 0.05$ in the multivariate model; *OR* odds ratio

3.3. CYCLISTS

Between 2010 and 2013, bicycle involvement in accidents was quite low accounting for 1.2% of accidents in Kigali. Bicycles involvement in accidents however decreased between 2011-2013. In the period between 2010- 2013, injuries caused by bicycles stood at 3.9% which was higher than injuries caused by lorries, trailers and for wheel vehicles. In terms of death caused by accidents involving various means of travel between 2010-2013, bicycles involvement contributed about 7.3% of deaths

Funded by
the European Union

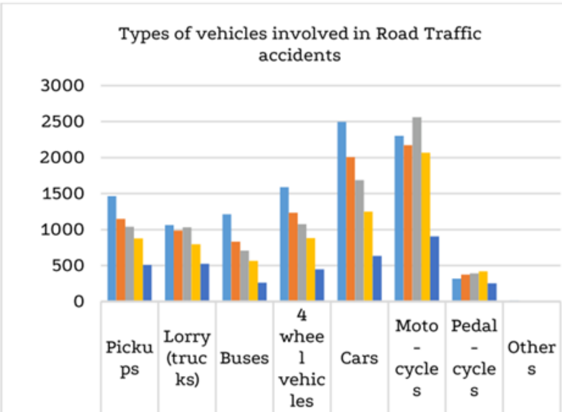
which was higher than deaths involving pickups, lorries, trailers, cars and four wheel vehicles according to statistics from the Rwanda National Police (Clarisse, 2015). In 2022, the RNP recorded 81 bicycle accidents that occurred across the country where 76 people were injured and 7 cyclists were killed (RNP, 2022b).

3.4. POWERED TWO-WHEELERS

Analysing crash data between 2016 and 2020 (five years) from the Rwanda National Police dataset, Gatesi (Gatesi et al., 2022) found PTWs to be the vehicle most involved in road traffic crashes (min 22.0% - max 30.2%). Looking at frequencies, the PTWs involved in a crash ranged from 2069 to 2560 between the 2016 and 2019 years, while in the 2020 the frequency clearly dropped due the impact of Covid-19 pandemic restrictions (905; Figure 14).

Even though crash data were referred to some previous year (2012), Kim (Kim & Byiringiro, 2016) found similarities and pointed out that PTWs were the vehicle most involved (about 38%) followed by cars rated at the third place (about 18%). Vice versa, Patel (Patel et al., 2016), analysing crash data relative to 2013, founded that car predominating (43.8%) compared to PTWs (14.5%). However, this data is only partially in contrast with Gatesi (Gatesi et al., 2022), who shows a similar situation in 2016 (although less prominent) (Figure 14). Focusing on casualties, PTW riders were the most injured road user with a percentage ranging between 41.6% and 47.5% in the years 2016-2019 (Figure 15).

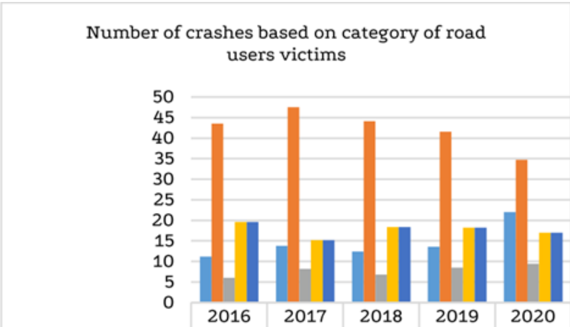
Figure 14: Vehicle types involved in road crashes; years 2016-2020 (Gatesi et al., 2022)



	Pickups	Lorry (trucks)	Buses	4 wheel vehicles	Cars	Moto-cycles	Pedal-cycles	Others
2016	1464	1063	1213	1589	2495	2301	319	10
2017	1150	988	831	1234	2005	2174	374	6
2018	1041	1033	707	1074	1688	2560	393	0
2019	876	798	566	883	1249	2069	421	0
2020	510	524	263	448	634	905	252	0

Funded by the European Union

Figure 15: Number of crashes based on category of road user victims; years 2016-2020 (Gatesi et al., 2022)



	2016	2017	2018	2019	2020
Drivers (%)	11.2	13.8	12.4	13.6	22
Moto-cycle (%)	43.5	47.5	44.1	41.6	34.7
Pedal-cycle (%)	6	8.2	6.8	8.5	9.4
Passengers (%)	19.6	15.2	18.4	18.2	17
Pedestrians (%)	19.6	15.2	18.4	18.2	17

3.5. CARS

Analysing data from the Kigali Traffic Police for the 2013, Patel (Patel et al., 2016) have found cars to be the most frequent vehicle type involved in Rwandan traffic crashes, with 43.8% of cases, producing the vast majority of minor injuries (64.3%). In 2016, cars were still the vehicle most involved in traffic crashes, but since 2017 the numbers show a declining trend (Figure 14). Nonetheless, the cluster made up by cars, 4-Wheels, and pickups still represents the vehicle group mostly involved in crashes (48%; Gatesi et al., 2022).

3.6. PUBLIC TRANSPORTS

Among the total number of crashes collected by the Kigali Traffic Police in 2013, buses were found to be involved in about 15% of crashes, of which 15% with serious crashes. The 374 crashes involving buses have produced 8% of victims, of which only two percent were seriously injured (fatal and serious injured; Table 5). Nonetheless, Patel (Patel et al., 2016) found buses have in average two times odds to produce a serious crash than cars. Vice versa, Gatesi (Gatesi et al., 2022) found public vehicles, such as buses, have been involved in an average 9% of crashes occurred in the period 2016 - 2020.

3.7. HEAVY GOODS VEHICLES

Patel (Patel et al., 2016) found that HGVs were responsible for about 27% of the total crashes, and being, thus, the second vehicle most involved in traffic crashes. Over a longer time span Gatesi (Gatesi et al., 2022) found that HGVs (trucks or lorries) have been involved in an average 12% of the total cases. Although HGVs cause only four percent of the seriously injured outcomes, their occupants had three times odds to be serious injured compared car occupants. More in general, HGVs have roughly two times odds to produce a serious crash than cars (Patel et al., 2016).

On the other hand, Kim (Kim & Byiringiro, 2016) found HGVs to be roughly involved in one third of the on-scene fatal crashes (about 28%). Additionally, grouping public and heavy goods vehicles, we can observe how this cluster is reaching out for about 47% of the total fatalities and thus they were the leading cause of on-scene road traffic deaths.

3.8. NATIONAL DATABASE

In a still unpublished study by Healthy People Rwanda (HPR et al., n.d.) there are relevant information on the collection and management of crash data procedures, which are summarized and reported in this section. Crash data collection has greatly evolved in the past two decades in Rwanda. RNP oversees the maintenance of the crash database and the collection of the crash information. Data are collected using a form, which includes the following categories:

- general crash information:
    a) date and time
    b) location description
    c) GPS coordinates
- crash type for Multiple vehicle / Single vehicle cases
- infrastructure:
    a) number of lanes (both direction)
    b) speed limits
    c) speed limits (posted)
    d) road surface condition
    e) crash location (i.e. type of road segment)
- environmental conditions:
    a) weather
    b) light
- probable crash cause
- crash outcome:
    a) crash severity
    b) casualties by category
- vehicle information:
    a) vehicle types
    b) vehicle details (for each vehicle involved in crash):
        - driver's name
        - driver's license information
        - direction of travel prior to crash
        - vehicle ownership

- vehicle damage
- insurance information
- vehicle registration no. and model

- driver condition
- victim information
  a) name
  b) age
  c) gender
  d) vehicle registration no.
  e) injuries
  f) role
- information on other vehicles involved in the crash
  a) vehicle registration no.
  b) driver's name
  c) sex
  d) age
  e) driver's license
  f) license first issue
  g) insurance validity

Until 2022 the crash data were collected at local level by trained crash investigation police officers on a paper form and later aggregated data was sent to the central level where they were kept in registers. Since January 2022 the same set of data is collected using tablets and sent directly to the central level where a designated team continuously organize them in a database.

In time some changes occurred at the level of the injury severity:

- until 2014 crashes were only categorized as serious and minor injuries;
- after 2014 the crash category was expanded to include fatal (if there is at least one death), serious, minor injuries, and property damage-only crashes.

The victim category includes both deceased and (seriously and lightly) injured persons. It is worthwhile to deepen the procedure used to assign a specific injury severity, which can be summarized in the following steps:

- all RTIs involving a loss of body part and severely/moderate sick victims are initially counted as serious, and all others are counted as minor injuries;
- thirty days post-crash, the hospital is contacted to find out the outcomes for the victims:
  - if the victim has died, he/she is considered as "killed" and the crash as "fatal";
  - if the victim has a permanent disability, the injury is identified as "serious".

In the same report (HPR et al., n.d.) the authors indicate that the national database can be affected by underreporting. The phenomenon is common in LMICs for road traffic injury and death data (Segui

Gomez et al., 2021). However the introduction of electronic data collection and transfer in 2022 represents a systematic improvement. Linkage among police-reported data, hospital records, a trauma registry, and other sources would further reduce the chance of underreporting, as well as possible erroneous attribution of the injury severity due to missing follow up with the hospitals. The authors (HPR et al., n.d.) also state that the national health system is progressively replacing paper based medical records with digital databases, thus enabling cross-linking of different data sources.

Lastly, the study (HPR et al., n.d.) calls for the creation of high-quality data systems, to adequately support research efforts and refers to the common data structure suggested in (Segui Gomez et al., 2021). For the implementation phase, it suggested the use of the Data for Road Incident Visualization Evaluation and Reporting (DRIVER) open-source system by the GRSF (GRSF, n.d.).

4. SOUTH AFRICA

In this chapter the most recent and relevant reports and research papers on the South Africa crash statistics are analysed to depict the recent safety conditions on the roads. The documents allow the identification of both major trends and the most relevant user groups, which road safety initiatives should focus on.

4.1. GENERAL STATISTICS

The ESRA survey conducted between 2019 and 2020 collected data from 1013 people about road safety culture and road user behaviour in the previous 12 months (Torfs et al., 2021). Data from the self-declared behaviours have been weighted on a total of 12 African countries (Benin, Cameroon, Egypt, Ghana, Ivory Coast, Kenya, Morocco, Nigeria, South Africa, Tunisia, Uganda, and Zambia).

Most responders state to use the following mode of transport: car as a passenger (97.6%), pedestrian (93.4%), car as a driver (88.4%), public transport (81.2%), and only 27% the PTWs. Most of the sample feel safe when using public transport (6.8, Likert scale 0-10), followed by car as driver (6.5) and car as passenger (6.3). On the other side, PTW and cyclist have been considered the most unsafe transport modes, with a mean score of 4.8 and 4.9, respectively.

Most responders declared to drive after drinking alcohol (32.4%) and when they may have been over legal limit for drink-driving (21.3%). Around half sample (47%) declared to talk on a hand-held phone while driving or read a text message or email or checking social media. More than a half of the respondents drive faster than the speed limit inside and outside built-up areas.

South Africa is classified as a Middle-Income Country and falls within Group 1, i.e., Countries/Areas with good death registration data (WHO, 2018). Compared to the other 98 Middle-Income Countries, South Africa ranks 83rd in the fatality rate per 100 000 population and 80th out of 84 Group 1 countries. Only two countries in the African Region are classified as Group 1 countries, Mauritius and South Africa, with fatality rates per 100 000 population of 13.7 and 25.9, respectively. South Africa is considered one of the two leading countries in the African Region regarding road safety traffic data, given that other African Region countries are not classified as having good death registration data or falling outside Group 1 (Vanderschuren & Roux, 2019).

South Africa has a fatality rate per 100 000 population or relative risk of dying due to road crashes of 25.9, ranking it 136 out of 175 countries (WHO, 2018). Out of the 44 participating African Region countries, South Africa ranks 15th in the fatality rate per 100 000 population. South African road safety rates per 100 000 population or relative risk of dying due to road crashes have decreased from 31.9 fatalities per 100 000 in 2010. in 2010.

Data obtained between 2015 and 2017 shows that Gauteng and KwaZulu-Natal have the highest road fatalities, increasing from 2,472 to 2,800 and 2,411 to 2,734 deaths, respectively. On the other hand, Gauteng and Western Cape have lower fatality rates, less than 20 fatalities per 100,000 population, making them comparatively safer. KwaZulu-Natal and Eastern Cape followed with less than 25 fatalities per 100,000 population. However, all other provinces had higher fatality rates, with fatalities exceeding 25 per 100,000 population.

Regarding the relative risk of dying due to road crashes, defined as fatalities per 100,000 population, the Northern Cape has the highest risk of dying in a crash, with 35.7 fatalities in 2017. In contrast, the Western Cape is considered the safest province, with only 19.0 fatalities in 2017.

In 2017, road crashes cost the South African economy R162.045 billion, adjusted for the annual CPI and relevant annual crash and fatality rates. This amount increased from an estimated R142.9 billion in 2015. The costs between provinces differ by quite a margin, with the Northern Cape having the lowest average annual cost burden of R4.6 billion. In contrast, Gauteng and KwaZulu-Natal have the highest cost burden, exceeding R30 billion. These costs are primarily related to population size, with Gauteng housing almost 25% of the South African population and being responsible for just over 20% of the road crash costs. However, the contribution of other provinces to the overall road crash costs is less significant. Fatalities and fatal crashes seemed to decline between 2017 and 2018 (ITF, 2019).

An analysis of the circulating park vs the involvement in fatal crashes shows relevant information for possible actions of safety improvement. Private-type vehicles were found to be responsible for over 50% of fatal crashes. Light Delivery Vehicle Double/Cab (LDV D/C Type) vehicles, which are mainly used for private purposes, accounted for 18.6% of all fatal crashes, followed by an alarming 10.5% of public transport type vehicles; Hazardous Substance Vehicles were overrepresented in fatal crashes with 1.7%. Additionally, 195 EMS-type vehicles were involved in fatal crashes, which was a significant concern.

Figure 16 illustrates the over/under-representation of each clustered vehicle description for fatal crashes and SIs vs. TVP, respectively. Private-type cars were underrepresented in fatal crashes overall by 15.9%, while they were overrepresented on SIs by 11.3%. The high percentages (7.7% and 4.2%) of overrepresentation for public transport type vehicles and Heavy vehicles, respectively, in fatal crashes were a significant cause for concern.

Figure 16: Vehicle population vs involvement in fatal crashes by vehicle type (RTMC, 2021a)

% Self-propelled Vehicles, Fatal Crashes and AARTO Speed Infringements per Vehicle DESCRIPTION

#	Vehicle DESCRIPTION	VehPop	% Of Total	Fatal Crashes	% Of Total	AARTO SI	% Of Total
	Total:	11 546 383		32 333		32 333	
	% Of Total:	86,6%		100,0%		100,1%	
	Subtotal:	9 993 866		32 333		12 130 488	
1	PRIVATE TYPE	6 818 300	68,2%	16 906	52,3%	9 649 189	79,5%
2	LDV TYPE	1 699 642	17,0%	6 006	18,6%	1 133 097	9,3%
3	PUBLIC TRANSPORT	275 127	2,8%	3 384	10,5%	431 887	3,6%
4	HEAVY VEHICLE	269 504	2,7%	2 231	6,9%	60 377	0,5%
5	LDV D/C TYPE	744 310	7,4%	2 033	6,3%	799 081	6,6%
6	MOTORCYCLE	105 555	1,1%	659	2,0%	26 609	0,2%
7	HAZ_SUBST_VEH	38 317	0,4%	558	1,7%	12 994	0,1%
8	EQUIPMENT TYPE	22 359	0,2%	357	1,1%	3 490	0,0%
9	EMS TYPE	19 548	0,2%	195	0,6%	13 128	0,1%
10	HEARSE	1 204	0,0%	4	0,0%	636	0,0%

The investigation of fatalities by age group shows that citizens aged 20 to 40 account for 38.7% of all traffic fatalities. The age category between 40 and 65 is next, accounting for 21.8% of fatalities (Vanderschuren & Roux, 2019). These age groups also reflect the economically active population. The distribution of road fatality victims' ages across different provinces in South Africa does not vary significantly. However, there is a discrepancy in the number of road fatalities where the victim's age has not been recorded. This discrepancy varies between the nine provinces, with Gauteng province having the highest number of unknown ages at 20%, followed by the North West province with 13.1%. Age records were not recorded for 24.7% of all road fatalities in South Africa. SAPS send a quick response form to the RTMC within 1-3 days of a fatal crash to document fatalities. However, there is poor follow-up by SAPS in establishing and submitting the victims' ages, which were unknown when submitting the quick response forms to the RTMC. Due to this lack of information, micro-analysis of road fatalities versus age is severely limited, as only 75.3% of the ages of the deceased are known.

Vanderschuren (Vanderschuren & Roux, 2019) also analysed the gender distribution in road fatalities. South African data show a significant gender disparity, with only 21.7% of victims being female between 2015 and 2017. In contrast, 76.2% of fatalities were male, while 2.2% of cases could not be identified. This indicates at least three male fatalities for every female fatality. Other researchers have reported similar findings. The gender breakdown of fatalities differs between provinces. Gauteng has the lowest female fatality rate at 18.3%, while the Eastern Cape has the highest at 25%. For male fatalities, the range is 72.5% to 79.5% across provinces, with female fatalities ranging from 18.3% to 25%.

In the research by Vanderschuren (Vanderschuren & Roux, 2019) the fatality distribution was also studied according to period of the year, weekday and time. The findings showed that fatalities for ages between 0 and 65 peaks during school holiday periods, specifically in April (8.8%), July (10.2%), September (9.5%), and December (10.7%). The majority fatalities occurred in December and July, while February records the least at 5.6%. In December, the highest fatalities (5.6%) were recorded for the age group 20 to 39; in July, fatalities (5.4%) in the age group 35 to 39 peaked. The age groups 40 to 65 and 0-19 years showed the same trend, with a slightly lower percentage of fatalities for the two age groups in the respective months. For the age group older than 65 years, the percentage of fatalities per month did not vary considerably throughout the study. The study also discovered that Saturdays and Sundays have the highest road fatalities, accounting for almost half (47.6%) of all fatalities. Saturdays accounted for the highest percentage of fatalities—25.6%—across all age categories. On these two days, the death rates were highest for all age groups, with victims aged between 20 and 39 years having a death rate of 26.4% and victims aged between 40 and 65 years having a death rate of 13%. Conversely, the lowest number of fatalities occurred on Tuesdays, with an average of 9.2% fatalities from Monday to Thursday and 25.5% of all fatalities occurring on Fridays.

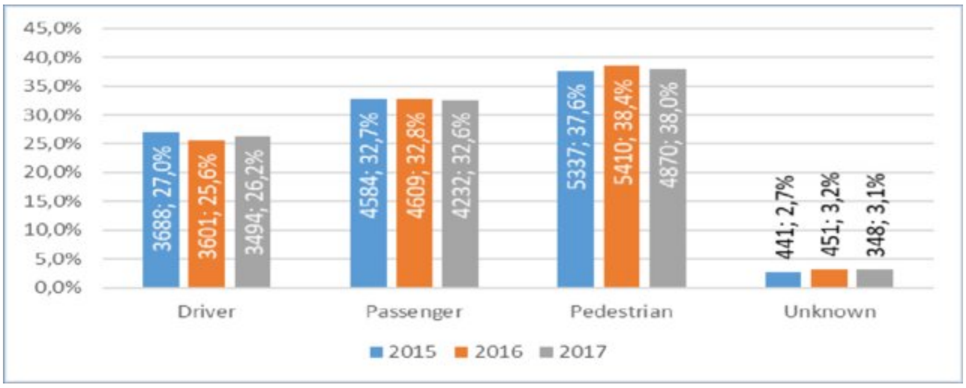
The distribution per time of the day showed that more people aged 20 to 39 died during the 4 hours of 5 pm to 9 pm (14.6%) than any other time of day. The eight-hour timeframe from 8 am to 5 pm saw the lowest percentage of fatalities for this age group (11.8%). The age group 40 to 65 years had a similar trend. "*The peak fatality periods for these age groups coincide with travel times to and from work between 06:00 to 08:00. A sharp increase during leisure hours (from 17:00). The high number of fatalities from 18:00 to 23:00 for the combined age group 40 to 65 is most likely due to after-hour activities, including alcohol consumption by both drivers and pedestrians, especially over weekends [...]. Reduced traffic congestion after-hours also increase speeds and fatality risk. Enforcement levels may also decrease during this time.*" (Vanderschuren & Roux, 2019)

4.2. PEDESTRIANS

The paper by Vanderschuren (Vanderschuren & Roux, 2019) revealed significant annual trends regarding fatalities among road user types. The highest fatalities occurred among pedestrians, ranging from 37.6% to 38.4%, followed closely by passenger cars at 32.6% to 32.8%. However, notable disparities in fatalities per road user type exist among the provinces. Pedestrians accounted for more than 46% of deaths in Gauteng and KwaZulu-Natal, with the Western Cape close behind at 44.3%. On the other hand, the Northern Cape had the lowest pedestrian fatality rate at 24.9%, and the Free State province had slightly more at 25.9%, which could be attributed to lower pedestrian activity due to low population densities.

Overall, one or more pedestrians were killed in almost half of all recorded fatal crashes from 2015 to 2017 in South Africa (45.8% in 2017). In KwaZulu-Natal and Gauteng provinces, one or more pedestrians were killed in 55.3% and 52.4% of fatal crashes, respectively, with the percentage increasing from 2015 to 2017 in both provinces. The Western Cape province had a similar percentage of pedestrian fatalities at 51.5%. The Free State and Northern Cape provinces had the lowest number of fatal crashes, with pedestrians killed at 33.8% and 31.5%, respectively, but this percentage increased in both provinces from 2015 to 2017.

Figure 17: Road Fatalities per Road User Type between 2015 and 2017 (Vanderschuren & Roux, 2019)



Approximately 17.5 million children live in South Africa, and most walk home (43%) or to school (40%) daily. The average travel time for children to walk to the educational institution is more than 16 minutes. Hence, children in South Africa spend a significant amount of time on roads, which increases the likelihood of their involvement in crashes (Janmohammed et al., 2019).

From 2015 to 2017, around 1300 children (under the age of 17 years) were killed in road crashes every year, indicating that child road safety is a challenge in South Africa (Janmohammed, 2023). Isaac (Isaac et al., 2015) found that nearly 50% (2.201 out of 4.690) cases of sustained injuries due to road crashes were children between five and nine years old, with a proportion of 1.7 males for every female. Data from the Red Cross War Memorial Children's Hospital in South Africa indicates that 75% of children aged 0–12 years injured in road traffic were pedestrians, and some others were injured in minibus taxis or passenger seats without restraints (UNICEF, 2022). According to the State of Road Safety in South Africa Report, the highest percentages of fatalities for pedestrians aged between 0 and 14 happened in December 2021 (31%) and June 2021 (30%), with an average proportion of 18% fatalities throughout the year (RTMC, 2021b).

Most child road fatalities occur in KwaZulu-Natal, Gauteng, and the Eastern Cape, with 828, 580, and 519 fatalities, respectively. Since 56% of South African children live in these provinces, this finding shows that areas with higher child populations are likely to have more child road fatalities and injuries. The high occurrence of child pedestrian crashes in this area is affected by a lack of supervision from adults since the children live with single parents or no parent at all (Janmohammed et al., 2019). Other factors contributing to road crashes and injuries are human factors, road and environmental factors, and vehicle factors, accounting for 85% - 86%, 9% - 11%, and 4-5%, respectively (RTMC, 2021b). The human factors mostly found in road crashes consist of speeding and drunk driving in areas where pedestrian movement is high, inappropriate overtaking, hit and run, and jaywalking. Regarding road and environmental factors, poor road surface conditions (e.g., slippery and potholes), lack or absence of street lighting and road equipment, limited pedestrian infrastructure, and settlement or high trip production land use near high-speed roads. Meanwhile, two main concerns for vehicle factors are worn-out or burst tires and ageing vehicles (Janmohammed, 2023; RTMC, 2021b).

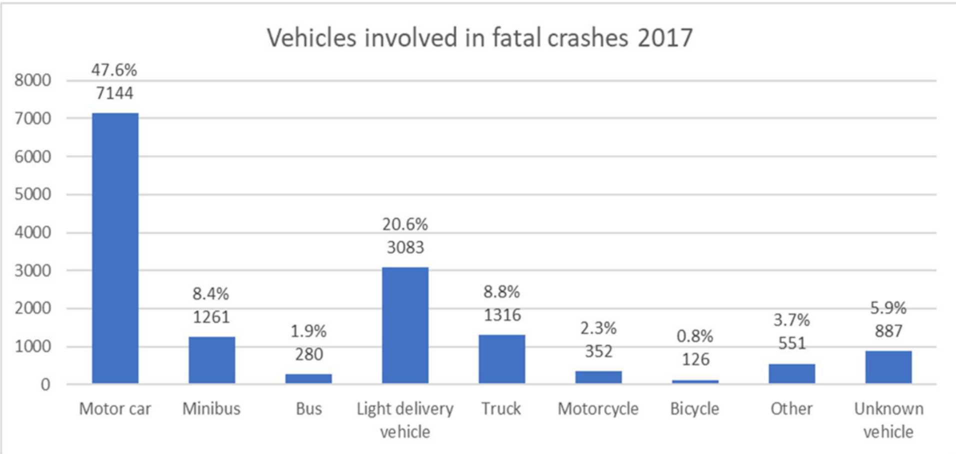
Funded by the European Union

An in-depth study by Mhlanga (Mhlanga, 2018) in Ethekwini found that most road crashes involving school children occurred when the children crossed the road away from the intersection (58%). Human behaviours that cause road crashes are children's reckless behaviour at 69%, unsafe driver performance at 13%, the child was playing or fighting on the road at 8%, lack of visibility to recognise pedestrians at 6%, and speeding at 4%. Most crashes happen during daylight under clear and dry weather, from 13.00 to 15.30, when all children return from school.

4.3. CYCLISTS

Cycling safety has become a significant concern on South African roads due to the rising number of fatal crashes and accidents involving cyclists (Arrive Alive, n.d.-a). In 2016, there were 451 cyclist deaths, up from 320 in 2015, as the Road Traffic Management Corporation reported. A 2017 report noted that bicycles contributed towards the least number of fatal crashes at 0.8%.

Figure 18: Fatal crashes by vehicle type in South Africa in 2017 (Schermers et al., 2019)



Raising awareness about cycling safety is crucial and should be emphasized in schools and across various platforms. Although the beautiful South African scenery and the increasing number of competitive cyclists are enjoyable, cyclists face numerous challenges during training, including dangerous road conditions, harsh weather, and the risks associated with other motorists. While competitions have strict safety measures in place, training rides require the same level of attention and caution.

In October 2004, a law was enacted in South Africa mandating that all cyclists must wear helmets. The rule states that cyclists and passengers must wear securely fastened and properly fitted protective helmets while riding a bicycle. However, the enforcement of this law is not practiced, and fines are not issued.

The Global Road Safety Facility by the World Bank, states that a decrease of 30km/h on the current speed limits on urban, rural and metro roads will lead to a definite decrease in fatal road incidents. Road design and infrastructure in South Africa remains focused on improving mobility for the private car, whereas if major speed calming measures, that improve mobility for non-motorised transport as a mode, were implemented, road crash incidents relating to bicycles would occur less (GRSF, 2023a).

4.4. POWERED TWO-WHEELERS

South Africa is the largest 2-wheeler market in Africa, along with Nigeria, Tanzania, Kenya, Algeria, Uganda, Egypt, Morocco, Angola, and Ethiopia (Addo-Ashong, 2021). The fatality of powered 2-3 wheelers in South Africa is less than 1% (WHO, 2018). This number is lower than other road user groups because the use of PTW is lower than other modes of transport. In 2019, only 0.6% of inhabitants chose to go to work by PTW. Most inhabitants used private cars or other types of passenger cars and walked, as much as 59.4 % and 21.5%, respectively (Cowling, 2023). This finding is also supported by the data from the World Bank (World Bank, 2020) that out of 9,909,923 registered vehicles in South Africa, motorcycles or PTW only accounted for 3.7% of the total registered vehicles. In 2019, the Motorcycle Safety Institute of South Africa recorded 437 motorcycle crashes, with 357 people injured and 125 dead. 450 of the victims were male, and 33 of them were female (Jonker, 2019).

However, the safety of powered two-wheelers still needs to be considered to improve the overall road safety situation and save people's lives in South Africa. Currently, there is no safe vehicle standard for motorcycles, there are laws related to helmet usage, but the standard of safe helmets is not regulated under specific laws (WHO, 2018). The majority of road crashes involving motorcycles (75%) happened between Motorcycle and Another Vehicle. This type of crash mainly occurred in junction and urban traffic during peak hours, with a 24% fatality rate and 73% injured. People aged 20-39 were found to be the highest group, 55%, to get injured, and male was found to have higher involvement in the event of road crashes. Although crashes often occur on high-speed roads, the trend shows an increase in urban roads since the movement is higher than on high-speed roads that are identic with rural roads (Jonker, 2019).

In a single crash event, vehicle failure contributes to less than 3%, while human error was about two-thirds of the cases, the typical errors are sliding out and fall due to sudden braking or running wide on a curve due to high speed or under-cornering. Roadway defects, such as poor pavement and potholes, contribute to 2% of the crashes, and stray/wild animal involvement was 1% of all road crashes involving motorcycles. In multiple vehicle crashes, the other motorised vehicle users found to be violated the motorcycle right-of-way caused two-thirds of road crashes. Another factor is that the low conspicuity of motorcycle users tends to make them less visible to other road users until they cannot avoid the collision. Violations against traffic rules, lack of attention while executing driving tasks, driving under the influence, and incompetent riders were also found in most cases (Arrive Alive, n.d.-b).

4.5. CARS

Private vehicles were involved in almost 50% of all fatal crashes (Vanderschuren & Roux, 2019). Gauteng and Mpumalanga provinces had more than half of their fatal crashes involving one or more private vehicles. Light delivery vehicles and panel vans also significantly affected fatal crashes. More than a quarter of fatal crashes in the Northern Cape and Northwest provinces involved LDVs, while Gauteng had the lowest involvement at 12.4%. Notably, a large proportion of the LDV population may fall under the "Private Vehicle" category, including double cabs and single cab "bakkies" that are popular among private vehicle owners. Unfortunately, this cannot be determined from the available data and requires further research. The national percentage of fatal crashes involving one or more LDVs was 19.2%.

A Road Traffic Management Corporation report aimed to provide input for road safety programs on the types of vehicles involved in fatal crashes. Additionally, the report examined the potential over- or under-representation of vehicle types in fatal crashes and speed violations. Safe vehicles, safe speeds, and safe road use were critical components of the Safe System approach, to which the report provided relevant analysis. The research aimed to establish any over or under representation of various NaTIS defined vehicle parameters for vehicles involved in fatal crashes compared to the total registered vehicle population in South Africa (RTMC, 2021b).

According to the vehicle category classification used by NaTIS, the study period showed that 53.8% of fatal crashes involved light passenger motor vehicles (with a capacity of less than 12 persons), followed by light load vehicles (with a Gross Vehicle Mass of 3500Kg or less) accounting for 25.1% of fatal crashes. Together, these two categories of vehicles were involved in nearly 78.9% of all fatal crashes. In addition, light passenger vehicles and light load vehicles accounted for 95.5% of all AARTO speed infringements (SIs) issued between January 2019 and June 2021, and comprised 90.8% of the total NaTIS self-propelled vehicle population. Light passenger vehicles were overrepresented by 12.0% for SIs, while fatal crashes were underrepresented by 13.7% when compared to TVP. However, compared to TVP, light load cars were slightly overrepresented for fatal crashes while being 7.4% underrepresented for SIs.

4.6. PUBLIC TRANSPORTS

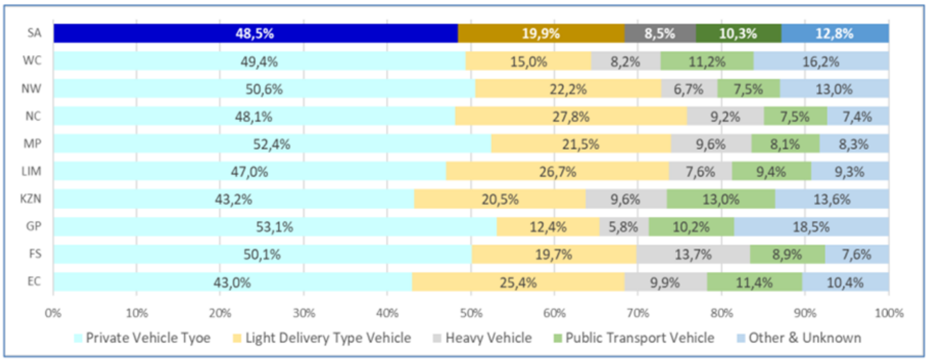
RTCs of public transports, as well as of HGVs strongly depend on local factors, such as the availability of the service and the presence of specific road infrastructure. As per data collected by RTMC from 2015 to 2017, public transportation vehicles were engaged in 10.3% of all fatal collisions in South Africa (Vanderschuren & Roux, 2019). However, in rural provinces such as the Northern Cape, Northwest, Mpumalanga, and Free State, the involvement of public transport vehicles in fatal crashes was relatively lower. The Northwest and Northern Cape provinces had the lowest involvement, with 7.5%, most likely due to limited public transport availability. The highest involvement of public transport vehicles in fatal crashes was observed in KwaZulu-Natal, with 13.0%.

Heavy passenger vehicles and heavy load vehicles equipped to draw were overrepresented by 6.9% and 5.4%, respectively for fatal crashes (RTMC, 2021b). Considering that heavy passenger vehicles (mainly public transport vehicles) and heavy load vehicles travel more vehicle kilometres compared to other vehicle classes, they are more likely to be exposed to on-road conflicts or driver fatigue, which could explain the higher incidence of fatal crashes in these classes.

4.7. HEAVY GOODS VEHICLES

Heavy vehicles were engaged in 8.5% of all fatal crashes during the study time (Vanderschuren & Roux, 2019). The percentage of fatal accidents involving these vehicles differed considerably between the provinces, with the Free State having a percentage of 13.7% compared to Gauteng's 5.8% and the North West's 6.7% (Figure 19). Traditional heavy vehicle routes such as the N3, N1, and N5, which pass through the Free State province, had the highest involvement of heavy vehicles.

Figure 19: Fatal road crashes per mode of transport, data RTMC 2015-2017 (Vanderschuren & Roux, 2019)



4.8. NATIONAL DATABASE

The International Transport Forum nicely summarized the data collection process in South Africa (ITF, 2017). The police and traffic authorities in South Africa gather information on motor vehicle crashes. The Road Traffic Management Corporation, legally obligated to disclose this information, is represented in this data collection procedure. The RTMC creates, consolidates, interprets, conducts analyses of, and produces the State of Road Safety reports using the data that has been collected. Quick response forms are used to report fatal crashes within 24 hours, and South Africa adheres to the worldwide practice of registering fatalities within 30 days. Culpable Homicide Crash Observation Report forms collect data on fatal crashes daily. The South African Police Service is the primary source of this information. A list of all fatal collisions that have been reported, as well as CHoCOR forms from various police stations, are provided to RTMC by the SAPS. The data is then collected, processed, and verified by RTMC to create a thorough report. Ongoing dialogues with the provinces are done to guarantee the accuracy and authenticity of the given information. However, it is necessary to manage road traffic data more efficiently among municipal, provincial, and national agencies. For analysing the nature, consequences, significant injuries, and other crash risk factors, it is frequently necessary to rely solely on police data. Initiatives are being implemented to improve cooperation among the agencies involved in collecting statistics on road traffic in response to this difficulty. In order to establish a more integrated approach to road traffic information management, the Council for Scientific and Industrial Research and Statistics South Africa are working together to develop a new database. Efforts are underway to expand the data sources by obtaining road crash information from other stakeholders.

5. ZAMBIA

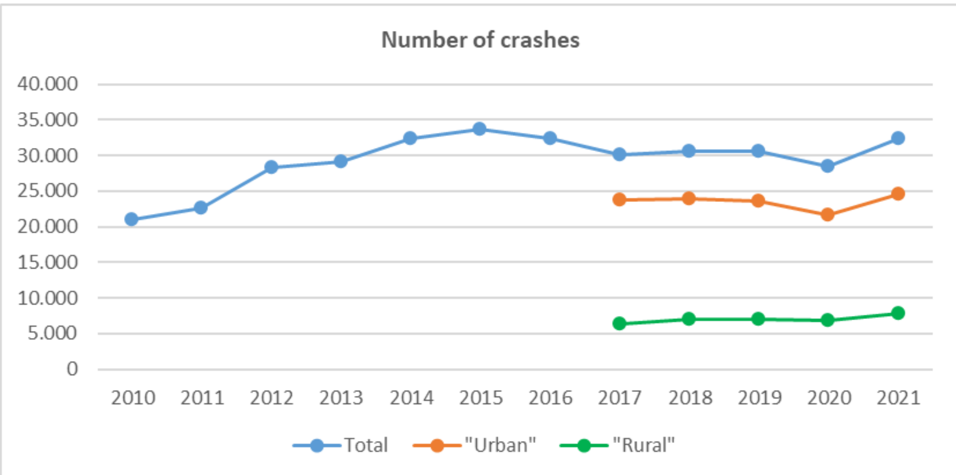
In this chapter the most recent and relevant reports and research papers on Zambia crash statistics are analysed to depict the recent safety conditions on the roads. The documents allow the identification of both major trends and the most relevant user groups, which road safety initiatives should focus on.

5.1. GENERAL STATISTICS

Most of the Zambian people who took part in a survey on road safety culture and road user behaviour conducted by ESRA between 2019 and 2020, state to use the following mode of transport: public transport (98%), pedestrian (98%) and car as a passenger (96%), followed by car as a driver (63%) and PTWs (34%). However, remarkable is the fact that a lot of people self-declared to drive in unsafe conditions: after drunk alcohol (25%) and after having probably exceeded the legal limit for drink-driving (13.4%), faster than the speed limit outside build-up area as well as to travel without seatbelt (70%) (Vias Institute, 2020).

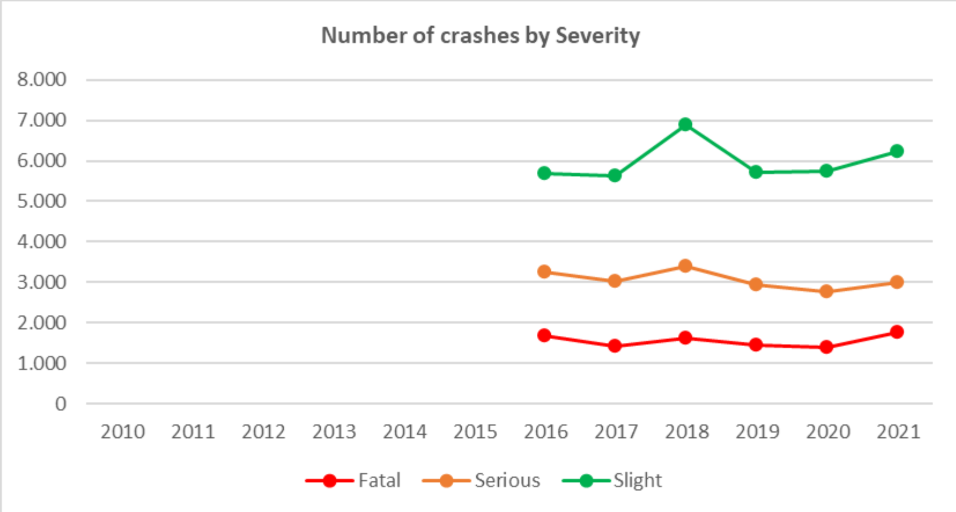
In the Road Transport and Safety Agency annual report 2021 (RTSA, 2021) an approximately constant growth in the number of accidents was reported on 2010 basis. In the same way, the urban areas were more prone to accidents than rural areas (Figure 20). In terms of the severity of road traffic crashes, a 2019 report recorded that fatal crashes accounted for 5%, 9% were serious, 19% were slight and 67% were only damages (Figure 21). The 2020 and 2021 records indicating the severity of road traffic crashes remained at similar levels. As for the crash outcome, fatal and serious crashes showed a near constant trend, with a proportion of slight and serious crashes three and two times of the fatal crashes, respectively (data only available between 2016 and 2021). In 2019 and 2021, Lusaka recorded the highest number of fatalities at 54% and 60% respectively.

Figure 20: Number of crashes in Zambia by area in the period 2010-2021 (RTSA data)



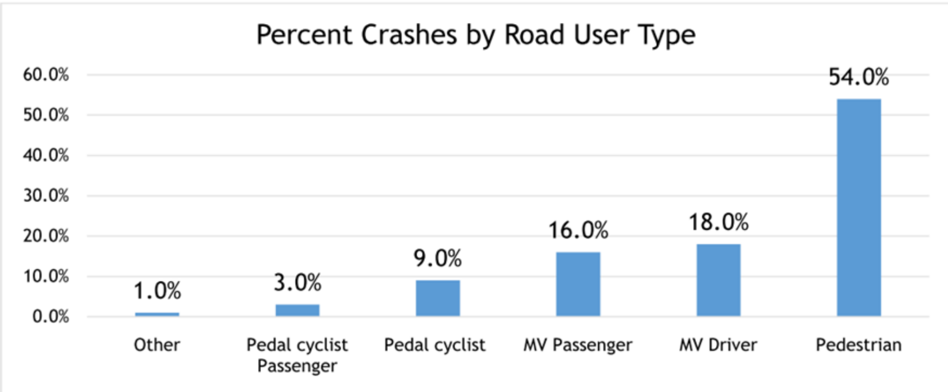
Funded by
the European Union

Figure 21: Number of crashes by severity in Zambia in the period 2016-2021 (RTSA data)



An analysis by road users (Figure 22) revealed that over half of people involved in a crash were pedestrians (54%), followed by motor vehicle occupants (34%) (RTSA, 2021). Unfortunately, in the national statistics released by RTSA, the specification for cars, public transport and heavy goods vehicles is not always available, which are generally included under the MV label.

Figure 22: Percent Crashes by Road User Type (RTSA data 2018-2020; RTSA, 2021)



In the period 2017-2021, RTCs involved more than 40000 vehicles per year (Figure 23). The repartition per vehicle type didn't change significantly in time, with private cars and vans representing approximately 0% of the involved vehicles. PTW vehicles, here referred to as motorcycles, and bicycles account each for not more than 3% of the total vehicles involved in crashes.

Figure 23: Type of Motor Vehicle in RTC in the period 2017-2021 (RTSA data)

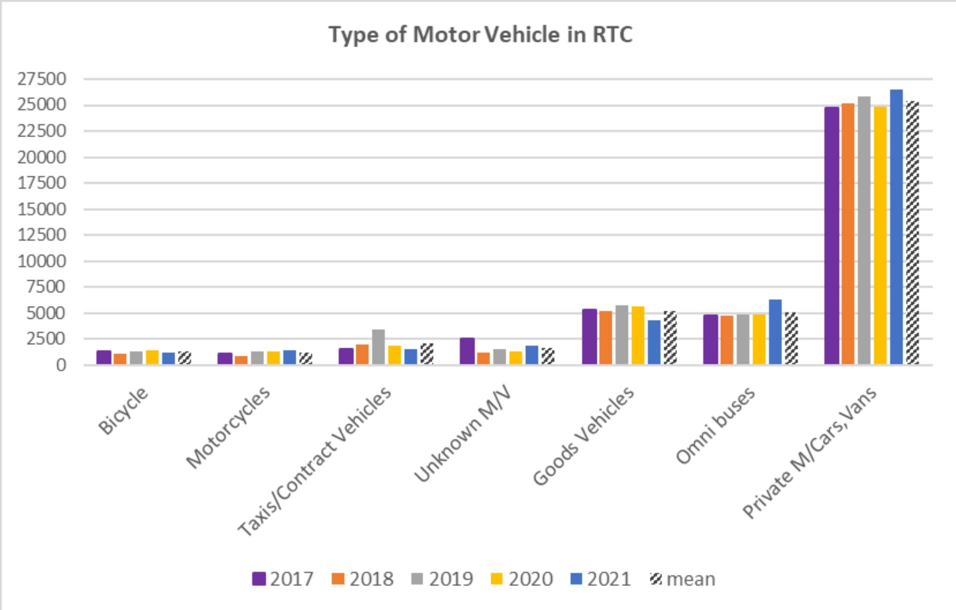


Table 6: Type of Motor Vehicle in RTC in the period 2017-2021 (RTSA data)

Type of Motor Vehicle in RTC							
	2017	**2018**	**2019**	**2020**	**2021**	***mean***	**%**
Carts	29	20	217	35	49	70	0.2%
Tractor	280	50	49	118	78	115	0.3%
Bicycle	1340	1091	1335	1422	1191	1276	3%
Motorcycles	1101	898	1328	1316	1428	1214	3%
Taxis/Contract Vehicles	1533	1975	3470	1857	1486	2064	5%
Unknown M/V	2553	1249	1486	1318	1821	1685	4%
Goods Vehicles	5368	5238	5736	5592	4313	5249	12%
Omni buses	4790	4712	4923	4895	6341	5132	12%
Private M/Cars,Vans	24679	25170	25866	24824	26471	25402	60%
Total	**41673**	**40403**	**44410**	**41377**	**43178**	**42208.2**	**100%**

The frequencies of casualty severity showed a small fluctuation between 2011 and 2021, with a minimum in 2020. Notably, it is important to highlight that the frequency of serious injured is at least double that of the fatalities. Vice versa, the number of slight injured seems quite low compared to the literature, suggesting a possible underreporting (Figure 24).

Differences in rural and urban areas show how rural roads are more dangerous than the urban roads with a frequency of fatal and serious injured people slightly higher than in the urban area (Figure 25). This data demonstrate that rural crashes involve a higher number of road users on average, since the number of crashes is lower than in urban areas (Figure 20).

Figure 24: Number of casualties by type (RTSA data)

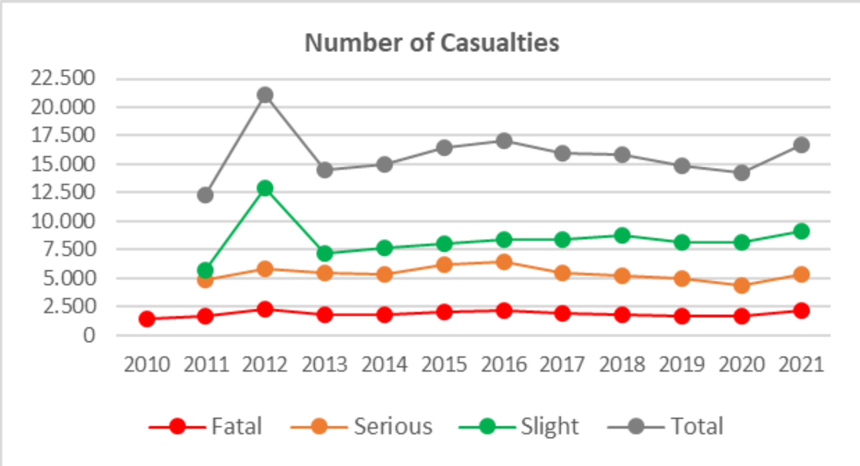
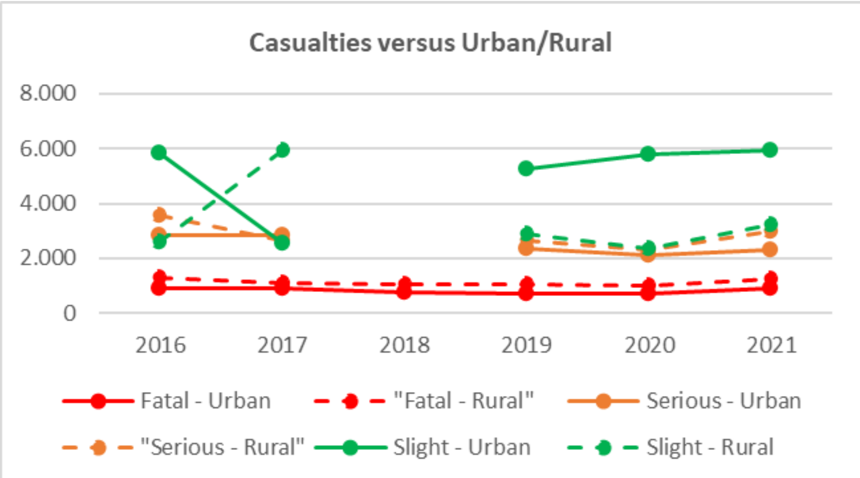


Figure 25: Number of casualties by area and type (RTSA data)



A joint analysis of the number of casualties by road user and type (Figure 26, Table 7) and of the vehicles involved in RTCs (Figure 23) shows an overrepresentation of the cyclists and of PTW riders in all type of casualties. Although pedestrians represent a serious road safety concern, both bicycles and PTWs should be the next priority in the agenda.

Figure 26: Number of casualties by road user and type (RTSA data)

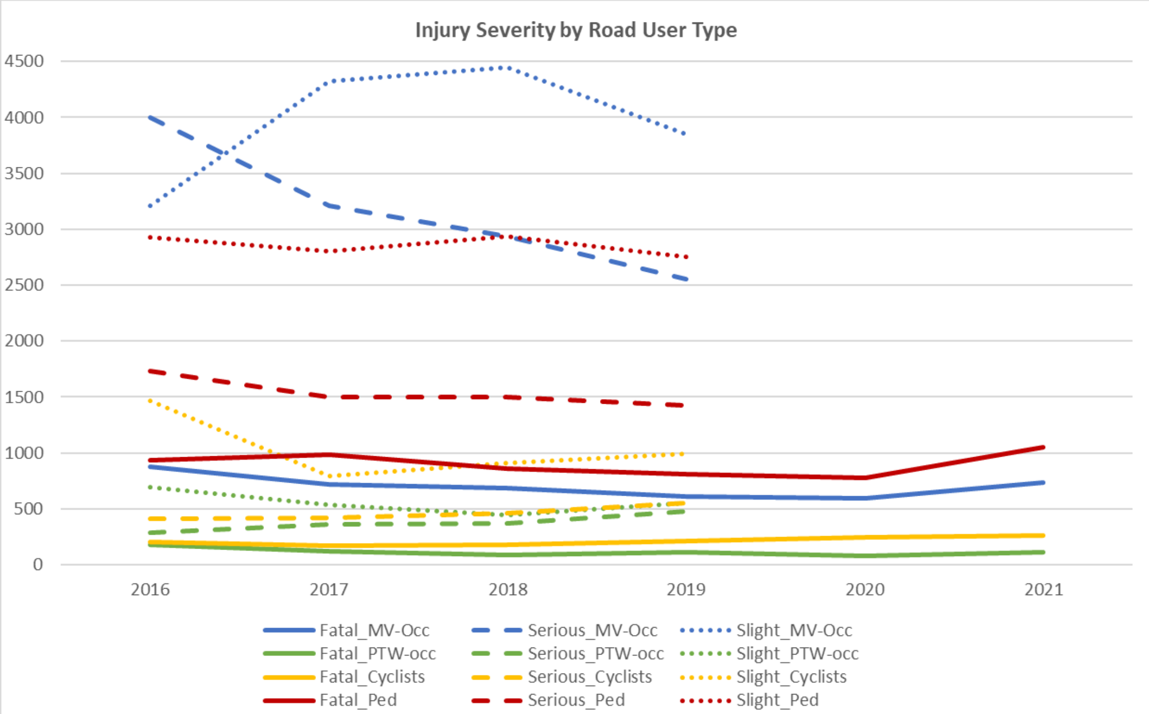


Table 7: Number of casualties by road user and type (RTSA data)

Fatalities by Road User Type						
	2016	2017	2018	2019	2020	2021
Pedestrians	937	980	856	813	773	1052
MV occupants	880	718	689	609	596	738
PTW occupants	182	120	90	112	80	112
Cyclists	207	171	182	212	241	261
Total	2206	1989	1817	1746	1690	2163

Seriously Injured by Road User Type						
	2016	2017	2018	2019	2020	2021
Pedestrian	1734	1501	1497	1427	n.a.	n.a.
MV occupants	4001	3214	2937	2550	n.a.	n.a.
PTW occupants	285	364	373	481	n.a.	n.a.
Cyclists	412	421	459	554	n.a.	n.a.
Total	6432	5500	5266	5012	n.a.	n.a.

Slight Injured by Road User Type						
	2016	2017	2018	2019	2020	2021
Pedestrian	2928	2806	2937	2754	n.a.	n.a.
MV Occupants	3210	4323	4451	3851	n.a.	n.a.
Cyclists	1466	794	911	989	n.a.	n.a.
PTW occupants	690	539	440	555	n.a.	n.a.
Total	8294	8462	8739	8149	n.a.	n.a.

RTSA reports also included the analysis of potential contributory factors: 2019 and 2021 data (RTSA, 2019, 2021) showed that road conditions contributed 0.28% and 0.32% respectively to RTCs. Road category conditions included poor road surface in need of repair as well as other road defects such as obstructed view and dusty roads.

An analysis of the RTC occurrence by time of the day on 2020 and 2021 data (RTSA, 2021) showed that the peak of crashes is at 18:00-20:00, and more widely in the 16:00-midnight time range. In terms of crashes by day of the week, the 2020 and 2021 stats highlight that majority of crashes took place on Saturday (RTSA, 2021). This is a shift from 2019 statistics that recorded Friday as the day where majority of RTCs were recorded (RTSA, 2019).

5.2. PEDESTRIANS

ESRA2 survey reported the high proportion oz Zambian citizens, who travel by walking (Vias Institute, 2020). Although this very popular choice pedestrians are the most vulnerable road user in Zambia, having the highest number of fatalities with an average of 902 deaths per year (2016-2021). After a decreasing phase in the period 2017-2020, 2021 data show a sharp increase in fatalities, in line with the overall increase of crashes and casualties. Conversely there is a decreasing trend of seriously injured pedestrians over the period the period 2016-2019 (Figure 26).

Zambia has a very high proportion of the young population; around 46% of its inhabitants are children under 15. The enrolment rate for primary schools in Zambia is 88%, and most pupils, about 70% of school children (WHO, 2021), attend school on foot. However, due to the limited availability of dedicated pedestrian infrastructure, school trips become dangerous for children (Robinson, 2023).

In 2021, 32.373 road crashes happened in Zambia; the number increased by 14% from the previous year. The fatality went up 28%, where 2163 people get killed in road crashes, and 5.307 were seriously injured in road crashes. 10% of the fatalities were children under 16 years, and 3 out of 4 (29% female and 71% male) were male. Pedestrians were 49% of the total road fatalities being pedestrians, up from 2020 in absolute terms (+279 fatalities) and as road user share (+3%) . The data shows that pedestrians were the most vulnerable to road traffic crashes among all road users and accounted for a total of 4,246 road traffic crashes between 2018 and 2020, which resulted in 540 fatalities, 927 serious injuries, and 2779 slight injuries (RTSA, 2021).

Child pedestrians are among vulnerable road users who tend to act recklessly and are less attentive to their surroundings. The crash risk is even higher for them when they move to and from school without adult supervision. According to Zambia Road Transport and Safety Status Report (RTSA, 2021), the total number of casualties of children in road crashes is 1.457, with 49% slightly injured, 36% getting severe injuries, and 15% getting killed in the involvement of road crashes. The fatality for child pedestrians is 72.8%, the highest compared to children in motorised vehicles and cyclists or children as passengers.

Human errors are found to be a leading contributor to road traffic crashes, accounting for 87.9%. This result is supported by a previous study by Biemba (Biemba et al., 2015), which had human error as the highest-ranking contributing factor to road crashes in Zambia. Other contributing factors are weather conditions, obstruction, road conditions, wandering animals, and vehicle defects. Most of the accidents related to human error are recorded as the result of excessive speed of 14.9%, misjudging clearance distance of 14.5%, failing to keep a near side of 14.3%, overtaking of 8.2%, and reversing negligent of 6.3% (Zambia Police, 2022). Aside from the human factor, in Lusaka, for instance, lack of dedicated infrastructure for vulnerable road users, poor drainage system, inadequate lighting, and poor road design also contribute to road crashes (Robinson, 2023; WHO, 2021). Therefore, the government has started programs to address this issue, such as improving road design and reducing the speed limit around school areas (WHO, 2021).

5.3. CYCLISTS

Information on road safety of cyclists can be derived from the analysis of RTSA reports, although data is only available for the period 2016-2021. According to the four-road user categories considered by the RTSA reports, cyclists' fatalities were at the third rank, showing a roughly constant number of fatalities with an average of 212 deaths per year (2016-2021). Vice versa, the trend of seriously injured cyclists was slightly increasing with a peak in 2019. In terms of contribution to RTCs, cyclist errors contributed the lowest in 2019 and 2021 at 0.05% and 0.36% in 2021 which were attributed to human error. In 2019, 15 cases were caused by cyclists holding onto other motor vehicles (RTSA, 2019).

A 2015 study in the Chipata district in Zambia, identified the following factors that were responsible for bicycle accidents in the district: defective bicycles such as poor brakes, no bells, unlicensed cyclists and cases where cyclists were not trained to share public roads with motor vehicles. Additionally, there were issues of inadequate law enforcement where authorities did not undertake bicycle inspection, lack of adequate infrastructure such as tracks, signage, helmets and adequate reflectors for cyclists as well as influence of drugs and alcohol abuse by cyclists who would use the roadway (Mulenga, 2015).

5.4. POWERED TWO-WHEELERS

Low usage of PTWs is reflected also in their involvement in crashes, as evidenced in the RTSA reports where data is only available for the period 2016-2021 (Table 7). In fact, PTW riders and pillion riders show the lowest number of fatalities and a slightly downward trend over the period under consideration, with an average value of 116 fatalities per year (2016-2021). On the other hand, the data of seriously injured riders show an increasing trend with an approximately doubling value if comparing 2019 with 2016 (Figure 26).

5.5. CARS

The analysis of the car data needs to consider that RTSA reports do not always make a distinction between cars, public transport vehicles and heavy goods vehicles and thus it is impossible to get specific trends. Nonetheless, looking at private vehicles such as cars and vans (Figure 23), they showed the highest percentage of vehicles involved in a crash over the five years considered (2017-2021), with an average percentage of 60%.

Funded by
the European Union

Further information on crash of MV and related contributory factors are available in section 5.8.

5.6. PUBLIC TRANSPORTS

A focus on crash analysis of public transport cannot be developed, since RTSA reports do not always make a distinction between cars, public transport vehicles and heavy goods vehicles. The only retrieved information referred to omnibuses, which accounted for 12% of the total vehicles involved in crashes over the 2017-2021 period.

5.7. HEAVY GOODS VEHICLES

Since RTSA reports do not always make a distinction between cars, public transport vehicles and heavy goods vehicles, it is impossible to get specific trends.

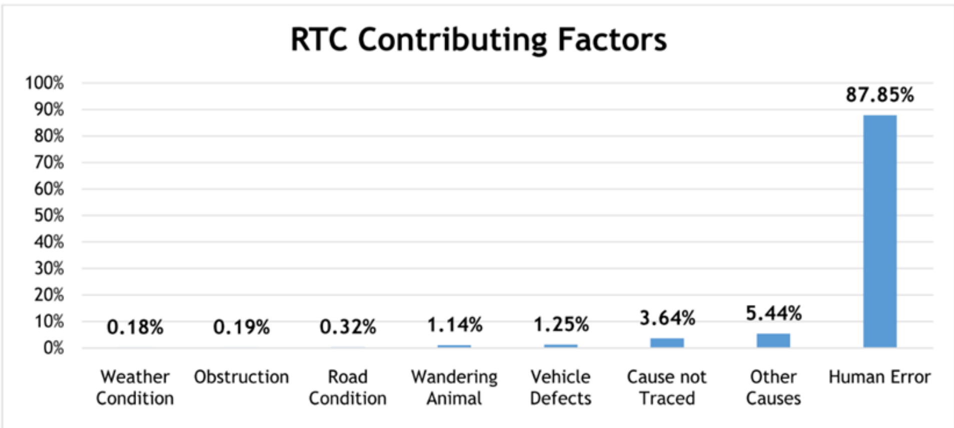
Concerning heavy goods vehicles (goods vehicles), account for 12% of the total vehicles involved in crashes in the period 2017-2021 (Table 6).

5.8. CONTRIBUTORY FACTORS

RTSA reports also perform an analysis of the contributory factors in RTCs. The results (Figure 27) shows that human errors were leading contribution to road crashes accounting for about 88% of case. The data identifies a slightly increasing trend with 2020 and 2019 data (86.5% and 81.5%, respectively). Vehicle defects accounted for only 1.3% followed by wandering animals (1.1%), while road condition and obstruction cumulatively accounted for 0.51%.

In the following paragraphs a focus will be dedicated to the three main causes of contributing factors, which are clearly identifiable.

Figure 27: RTC contributing factors (RTSA, 2021)

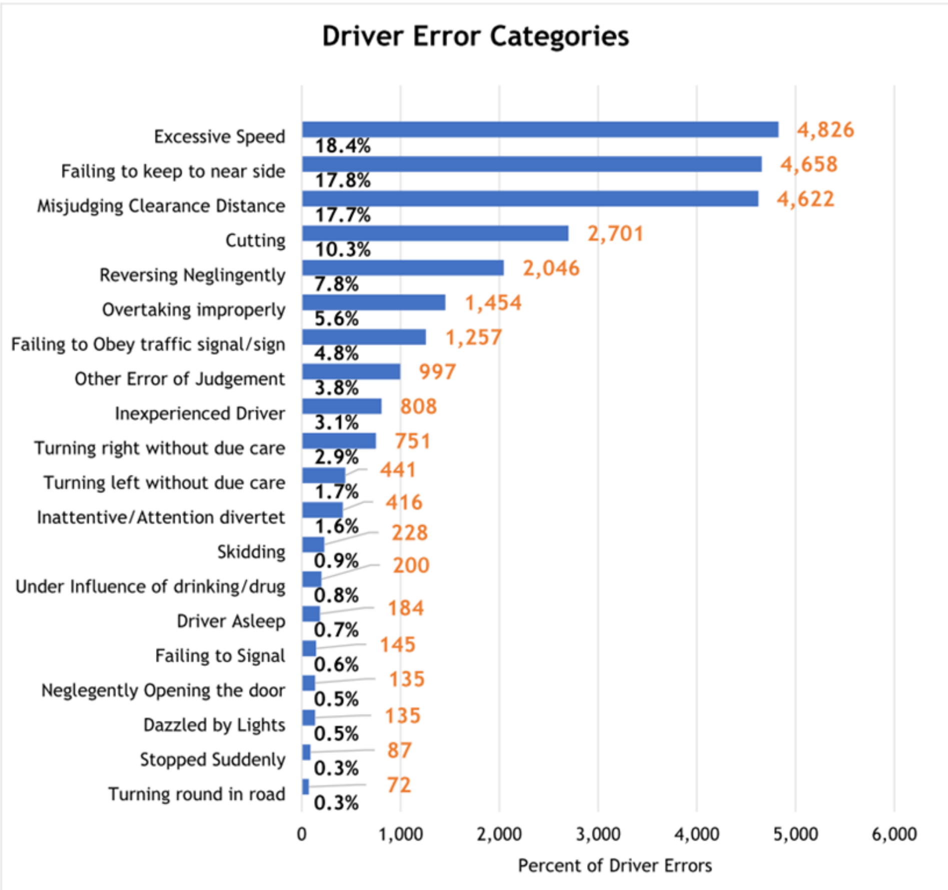


Funded by the European Union

5.8.1 Human errors

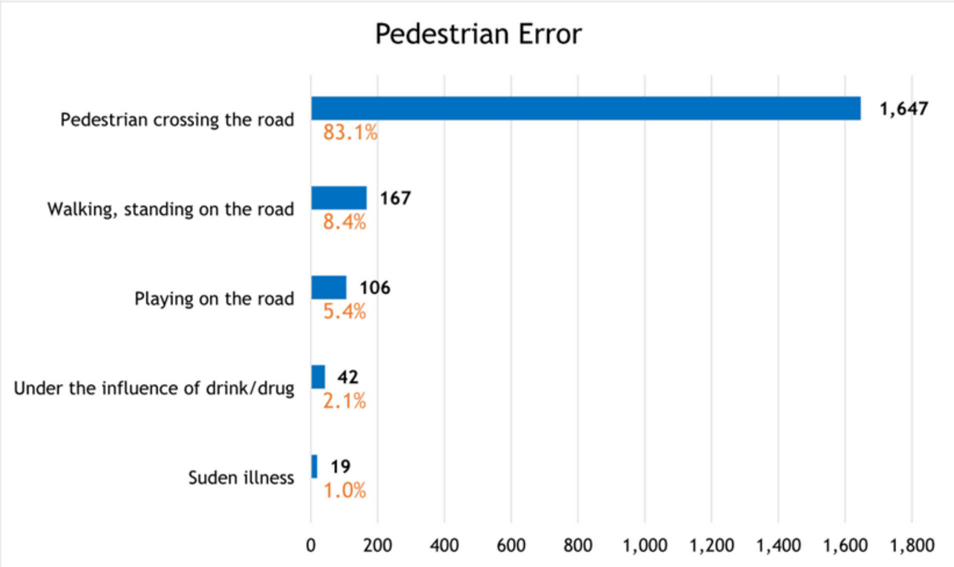
Within human errors, driver errors were the most (92%), followed by pedestrian errors (7%). Categorising by driver errors modalities, excessive speed was the most common (18.4%), followed by failing to keep near side and misjudging clearing distance had 17.8% and 17.7%, respectively, and the cut of the other vehicle trajectory/path (10.3%) (RTSA, 2021). In 2019 driver errors were lower by approximately 12% (81.5% vs. 92%), but the top five driver error modalities were consistent (RTSA, 2019). Among pedestrians, the majority of their errors were due to a misjudgement while crossing the road (83%). Similar trend was also registered for the previous year (2020) both for human errors and driver error modalities (RTSA, 2020).

Figure 28: Categories of driver errors (RTSA, 2021)



Funded by the European Union

Figure 29: Categories of driver errors (RTSA, 2021)



5.8.2 Motor Vehicle defects

Motor vehicle defects had a secondary influence on the total number of road traffic crashes in 2021, as it was relevant only in 1.25% of cases (Table 8). Problems to motor vehicle tyres was the most frequent cause with 34.9% immediately followed by brakes, which also recorded a high number of defects (31.4%). A similar trend was also registered for the previous year (2020) (RTSA, 2020, 2021)

Table 8: Categories of MV defects and respective contribution in RTCs (RTSA, 2021)

No.	Motor Vehicle Defects	Number of RTCs caused	% MV Defects	%of Total Number of RTCs
1	Brakes	139	34.41%	0.43%
2	Tyres	141	34.90%	0.44%
3	Steering	20	4.95%	0.06%
4	Springs	13	3.22%	0.04%
5	No front light	1	0.25%	0.00%
6	No rear light/reflector	9	2.23%	0.03%
7	Unattended vehicle running away	43	10.64%	0.13%
8	Smashed windscreen	4	0.99%	0.01%
9	Vehicle overloaded	34	8.42%	0.11%
	TOTAL	**404**	**100%**	**1.25%**

5.8.3 Wandering animals

Wandering animals also contribute to the occurrence of road traffic crashes. Statistics show that dogs on the road accounts for 13% of crashes due to animals on the road. Other domestic animals represent overall 82% of cases, while other animals had contributed about 5% (Table 9). Although there is an increase of about 31% compared to the previous year, the trend is similar to 2020. Nonetheless, animals are a very minor issue for Zambia. The number of crashes caused by animals is about 1% of the total amount (RTSA, 2020, 2021).

Funded by
the European Union

Table 9: Contributory factors in the category of wandering animals (RTSA, 2021)

No.	Wandering Animal	Number of RTCs caused	%Passenger Errors	% of Total Number of RTCs
1	Dog on the road	48	13.01%	0.15%
2	Other domestic animal on the road	303	82.11%	0.94%
3	Other animals on the road	18	4.88%	0.06%
	TOTAL	**369**	**100%**	1.14%

5.9. NATIONAL DATABASE

The Road Transport Safety Authority is the Zambian Government Agency deputy to analyse and release the annual road transport and safety status report, while the crash data collection is in charge of Zambia Police across the country.

Although a clear assignment of the tasks, national statistics seems affected by enormous underreporting. In their recent work, Mwale (Mwale et al., 2023) assessed the level of under-reporting of road traffic crash fatality data in the province of Lusaka and tried to extend to the whole country. The authors estimated that the actual number of people who died as a result of road traffic crashes in Lusaka Province in the year 2020 was approximately 1,786 (95% CI [1,448 – 2,274]). This data corresponds to an estimated mortality rate of around 53 deaths per 100,000 population. Indeed, comparing these data with the national ones for the same 2020, we can see that the number of people who died in a road crash at national level is less than the number of fatalities estimated for the only Lusaka province.

The Road Transport and Safety Agency was established under the Road Traffic Act No. 11 of 2002 and began operational activities in 2006. The RTSA mandate encompasses various essential functions. Firstly, it is responsible for effectively implementing transport, traffic management, and road safety policies. Additionally, the RTSA is tasked with efficiently and accurately registering motor vehicles and trailers in compliance with the provisions outlined in the road traffic act. The RTSA also plays a crucial role in issuing licenses and permits.

Furthermore, the RTSA is entrusted with efficiently implementing international protocols and treaties concerning road transport. It ensures transparent and accountable collection of funds for the road fund, allocating the appropriate percentages from the revenues collected. The agency also actively conducts effective road safety education programs to raise awareness and enhance safety knowledge among the public. Moreover, it coordinates various road safety initiatives and programs to ensure their effectiveness and impact. Lastly, the agency is responsible for approving and monitoring the implementation of road safety programs, ensuring they meet the required standards.

The road transport and safety status report, compiled by the RTSA, is based on road traffic crash data collected from Zambia Police stations nationwide (RTSA, 2021). The main objective of this report is to provide an overview of the current road safety situation, identify risk factors, assess the impact of road traffic injuries on society, and propose potential measures to reduce the number of crashes, fatalities, and injuries. Additionally, this report serves as a valuable tool for decision-making in road safety, offering valuable insights and information for informed actions and strategies.

Based on the findings of the Road Transport and Safety statistics for 2021, recommendations have been made regarding the establishment of a database. The foremost advice is implementing an injury surveillance system to generate reliable data on road traffic crashes and injuries. This system should focus on capturing data on fatal outcomes and include indicators for non-fatal outcomes, allowing for comprehensive analysis and comparisons with international standards. By developing such a surveillance system, policymakers and relevant stakeholders can access accurate and up-to-date information, enabling them to make informed decisions and formulate effective road safety policies.

The GRSF does have a database profile on Zambia; however, most of the fields are not populated with data (GRSF, 2023b).

6. CRASH DATABASES

A robust and widespread data collection system is not yet established in Africa, although the data availability is recognized as a prerequisite to develop safety solutions. In this chapter are reported information from projects aimed to facilitate the adoption of a data collection system.

A joint effort of the African Transport Policy Program and of the GRSF produced a report with a generally applicable procedure for the African context to establish a crash database system, which is summarized below (Segui Gomez et al., 2021):

1) **Get Started:**
    a) Assess data requirements, particularly related to crash-related information.
    b) Evaluate the crash report form used by police officers attending the crash.
    c) Assess staff capacity for data collection, storage, management, and analysis.
    d) Collect information on final and intermediate outcomes, especially high-risk routes, to identify safety problems and measures.
2) **Make Progress:**
    a) Develop a relevant data collection strategy to ensure essential information is collected.
    b) Regularly check the crash data system for accuracy and completeness, comparing police and hospital data.
    c) Include basic features in the database for comprehensive analysis of crash problem types.
    d) Collect information on the availability and condition of road assets relevant to safety outcomes.
    e) Encourage data aggregation at the national level.
    f) Collect other data relevant to setting and monitoring road safety targets and trends.
3) **Consolidate Activity:**
    a) Implement a comprehensive data collection strategy and regularly monitor its effectiveness.
    b) Fully implement a crash database containing all crash data, ensuring spatial coding and quality control checks.
    c) Establish a roadway inventory database containing information on road assets and their relation to safety outcomes.
    d) Establish linkages between critical data sources, such as police, hospitals, crash data, and road asset data.
    e) Define data collection needs for crash-related and other safety outcomes, aiming for a minimum set of data elements for international comparison.

Funded by the European Union

The report also includes a set of *Good practice system design recommendations* for efficient crash-data systems, that include:

1) Data collection: utilise innovative technology to improve data quality, reduce staff intervention, and expedite data availability.
2) Data storage: store data electronically with linkages to other enterprise systems for advanced analysis and cost-effective data sharing.
3) Analysis and reporting: use GIS and customised reporting tools to visualise trends and query information at various geographic levels.
4) Accessibility: ensure adequate access to tools and data through internet/intranet solutions, reducing the need for data export or specialised software installations.
5) Overall efficiency: improve efficiency in collecting, storing, maintaining, and analysing crash data to allocate resources effectively and decrease response time for critical safety issues.

PIARC, the World Road Association, included a *Safety Data* section in its *Road Safey Manual* (PIARC, n.d.). A primary indication is the necessity of integration of different data sources (e.g. crashes, injuries, and health sector) to achieve a better comprehension of the safety problem. Over 70% of nations use police data as their primary source when determining national crash statistics. These data are entered into crash database systems for simple analysis and reporting. In certain instances, hospitals or both sources of information are used to obtain data. Police data must be supplemented with data from the health sector in order to characterise significant injuries fully. It assists in identifying under-reporting levels and addressing data quality issues. Comprehensive crash injury research data is also required to infer collision and injury causation correctly. In the manual the different data sources are analysed and for each of them the most important keypoints are outlined:

1) **Police-reported crash data:**
    a) The police are well-positioned to collect crash information as they are often present at the scene.
    b) A crash report form is typically completed, capturing detailed information such as crash location, time, user details, road and environmental conditions, crash details, and vehicle factors.
    c) Examples of crash report forms can be found in WHO, and countries may have their criteria, such as the US Model Minimum Uniform Crash Criteria.
    d) It is vital to balance collecting necessary information and the burden placed on the police. Police involvement and collaboration throughout the process are crucial as they are critical stakeholders in establishing and collecting crash data.

Funded by the European Union

2) **Hospital data:**

   a) Hospital data helps identify under-reporting and provides better injury information when police data is insufficient.

   b) International recording systems like the International Classification of Diseases (ICD) and Abbreviated Injury Scale (AIS) coding systems are widely used.

   c) An internationally agreed definition of "serious" injury is recommended, using the Maximum Abbreviated Injury Scale (MAIS) with a score of 3 or greater for one or more body regions (MAIS3+) as the threshold.

3) **Registration systems:**

   a) Vital registration data from death certificates can be used to monitor road deaths.

   b) Around 40% of WHO member countries collect vital registration data with the required level of detail for monitoring road traffic deaths.

4) **Other crash data sources:**

   a) Data from emergency services, tow truck drivers, the public, and insurance companies can provide additional crash information.

   b) However, the quality and extent of this information may be limited compared to police and hospital-reported data.

7. CONCLUSION

The deliverable has investigated the crash statistics of the four countries involved in the Living Labs of the TRANS-SAFE project (i.e. Ghana, Rwanda, South Africa and Zambia), to make available a summary of the road safety context. Whenever possible, the analysis concentrated specifically on recent years as they are the most significative for an informed decision on the actions likely to produce an improvement of road safety with a high benefit/cost ratio. In the next paragraph are summarized the results for the most relevant user groups in each country.

Ghana. Country wide statistics (2018 and 2019) indicate that the most vulnerable road users were *pedestrians*, *motorcycle riders*, *and bus occupants*, respectively in decreasing order of importance, being car, walking and public transport the preferred modes of transport of the population. Both crashes and fatalities increased in 2019 over 2018. A previous study correlated the increase of RTCs to the general increase of Ghana population, although data from Accra region indicated that is possible to have decreasing trend of crashes, fatalities and injuries even with a larger circulating park of vehicles.

Past studies revealed that *pedestrians* have a three times higher likelihood of getting killed in road crashes compared to drivers, and six times higher if the pedestrian is a child. Several factors were identified as potential contributors to crashes involving pedestrians: high-speed roads in settlement areas, reckless and undisciplined driving behaviour, low pedestrian safety knowledge and inexperience due to young age, and lack of pedestrian facilities. These factors should be considered for implementation of safety solutions and monitoring actions.

Use of *motorcycles* for commercial and private transportation of people and goods is rising, and consequently the occurrence of PTW road crashes. A recent study has identified a parallel increase of urban and extra-urban crashes. The two categories differ for the most frequent configuration (at intersection vs head-on impacts), but common traits were identified like low awareness of helmet-wearing and reckless behaviour and disobeying traffic safety regulations. Possible safety enhancements include improvement of the efficiency of the licensing system, of law enforcement and vehicle standards policies (e.g., adopting appropriate state-of-the-art vehicle standards such as motorcycle anti-lock braking systems), adoption of red-light cameras at intersections.

Cars are more offending vehicles than victims, but they are the most appreciated transportation mode. Nonetheless the circulating park is old, and most imported cars are second-hand. While is desirable to replace cars with more up-to-date ones, incorporating more recent safety devices, improvements can be obtained on the side of the human factors, reducing the cases of over-speeding, reckless overtaking, drunk and fatigue driving.

Public transport represents the second category of offending vehicles, and the occupants are the third most important group for fatalities. Inappropriate driver behaviour (e.g. speeding, wrong overtaking, and careless driving) contributes to crashes. Possible solutions should act on the re-training of drivers and on a more widespread use of driver-assistance systems (e.g. after-market ones to reduce the cost of vehicle renewal).

Rwanda. The country has the highest road traffic fatality rate and number of RTIs among East African countries, with a steadily increasing volume of the vehicle circulating park. Nonetheless the most recent statistics evidence a decreasing trend in fatalities and serious injuries. Crashes experienced a peak in 2021, due to an increase of the minor crashes (the amplitude of the variation suggests a possible change in the data collection procedure, although the only reported one was implemented in 2022). Pedestrians and PTW riders were the most injured road users.

Pedestrians represent almost 50% of road fatalities, and they are a relevant category also for injuries. There are no official figures on the involvement of children in pedestrian fatalities, but more than 80% of them walk to school. The most frequent crash causes are high speed, lack of knowledge of road safety behaviour, and drunk driving.

Motorcycles are the vehicle type with the highest percentage of victims in RTCs since 2016. Since 2017 motorcycles are also the vehicle most involved in crashes. These results, associated to an annual registration rate triple compared to cars, clearly evidence the relevance of the problem. No specific suggestions were found in dedicated research papers and reports, but training of riders for a shared safety responsibility (PTW have a four times higher likelihood to be the primary crash vehicle and 24 times to be the primary victim vehicle compared to cars) and improved use of personal protective equipment will enhance riders' safety.

HGVs, together with *public transport* represent the leading cause of on-scene road traffic deaths (48%).

Rwanda has recently (2022) implemented an upgrade of the crash data collection system that will produce beneficial effects, in terms of data availability to monitor more efficiently the evolution of road crashes. The possible future linkage of the national database with hospital databases will enable more in-depth studies on crash outcomes and causations.

South Africa. Most used transport modes are cars (both as passenger and driver), walking, and public transport. PTWs represent less than 30% of the people choices. This repartition is reflected also in the results of RTCs, with cars involved in 52% of fatal crashes (but still underrepresented since cars are associated to a large share of 68% of the circulating park), followed by LDVs (slightly overrepresented 19% of fatal crashes and 17% in circulating park) and public transport (overrepresented in fatal crashes 10% vs 2.8% in the circulating park).

Pedestrians represent the user group with the highest fatality rate, but values vary greatly in different areas of the country, linked to specific urbanization structure. Pedestrian safety is a challenge since 75% of children aged 0–12 years injured in road traffic were pedestrians. The majority of crashes happened when the children crossed the road away from the intersection. The main crash cause was children's reckless behaviour (almost 70%), followed, in decreasing order of relevance, by unsafe driver performance, the child was playing or fighting on the road, lack of visibility to recognise pedestrians, and speeding.

Car passengers and drivers are the second and the third user group by fatality, respectively. Fatalities of other user groups represent 3% on average.

HGVs and *public transport* are overrepresented in traffic crashes. In its annual report RTMC links this data to the higher exposure of these vehicles to traffic, because of longer distance travelled, which may in turn generate more events of driver fatigue. If the case, driver assistance systems may support the driver and avoid possible crashes.

South Africa has a structured data collection system, which includes also the registration of fatalities occurred up to 30 days after the crash. Contacts are ongoing to strengthen the collaboration among RTMC and the local agencies and authorities, to involve them in the data collection process for the analysis of consequences, significant injuries, and other crash risk factors. In addition, the Council for Scientific and Industrial Research and Statistics South Africa are working together to develop a new database, and they are aiming also to expand the possible data sources.

Zambia. General country statistics showed that crashes have increased since 2010 until 2015, then decreased until 2020 before increasing again in 2021. It is not clear if the latter variation is the start of a new trend, or just a time limited phenomenon. Since 2016 also information on crash severity is available and the related trends are in line with the number of crashes at national level. Pedestrians are involved in the majority of road crashes, followed by motor vehicle drivers and passengers, and by pedal cyclists. The involvement of other road users is marginal. Vehicles most represented in RTCs are cars/vans, omni buses and goods vehicles.

RTCs in rural areas are less frequent but they result in more casualties and more fatalities per event. This result should be considered to elaborate solutions to reduce the severity of these crashes.

Pedestrians' safety is deteriorating based on 2021 data over the previous year. In this category most school children are included, since 70% of them attend school on foot. The absence of adequate infrastructure exposes children to risk of RTCs, whose human errors are the leading contributor (e.g. excessive speed, misjudging clearance distance, failing to keep a near side, and overtaking).

MV passengers and drivers are the second category of road users in RTCs, although private cars/vans are the vehicle primarily involved. Driver human error is the contributing factor in 88% of RTCs. Thus an action on this vehicle category and its drivers, would produce the dual benefit of decreasing the offending potential of these vehicles and also to reduce casualties of its occupants.

Cyclists are the third vulnerable road user category, and its statistics show no improvement in fatalities in the period 2016-2021 and a slightly increasing trend for seriously injured cases.

Data for national statistics is collected by Zambia Police and then analysed by the Road Transport Safety Authority. A recent study has assessed that data are affected by underreporting. RTSA itself, in a document published in 2021, has made recommendations to improve the data quality and start the data collection of the injury outcome.

Databases. Several sources have identified the improvement of data collection and the availability of high-quality databases as a priority to improve road safety. An easier access to national data for research purposes would further facilitate studies and the development of solutions.

8. REFERENCES

Ablin Consult. (2010). *Consultancy service for a study on the use of motorcycles for transporting passengers for hire and reward in Ghana*. Ghana Ministry of Transport.

Accra Metropolitan Assembly. (2021). *Road Safety Annual Report 2019-2020*.

Accra Metropolitan Assembly. (2023). *Road Safety Annual Report 2021*.

Acheampong, R. A. (2016). Cycling for Sustainable Transportation in Urban Ghana: Exploring Attitudes and Perceptions among Adults with Different Cycling Experience. *Journal of Sustainable Development*, *9*(1).

Ackaah, W. (2010). Road traffic fatalities among children in Ghana. *Injury Prevention*, *16*.

Adanu, E. K., Agyemang, W., Lidbe, A., Adarkwa, O., & Jones, S. (2023). An in-depth analysis of head-on crash severity and fatalities in Ghana. *Heliyon*, *9*(8), e18937. https://doi.org/10.1016/j.heliyon.2023.e18937

Addo-Ashong, T. (2021). Power-Two-Wheelers in AFRICA - Motorcyclists Safety Workshop: Riding in a Safe System. *Africa Region: SSATP/WorldBank*.

Adom-Asamoah, G., Okyere, S., & Senayah, E. (2015). Factors influencing school travel mode choice in Kumasi, Ghana. *International Journal of Development and Sustainability*, *4*(1), 1–17.

Afukaar, F. K., & Ackaah, W. (2006). *Fatal Road Traffic Accidents Involving Children, Consultancy Report on Transport Sector Programme Support, Phase II (TSPS)*.

Afukaar, F. K., Antwi, P., & Ofosu-Amaah, S. (2003). Pattern of road traffic injuries in Ghana: Implications for control. *International Injury Control and Safety Promotion*, *10*(1–2), 69–76. https://doi.org/10.1076/icsp.10.1.69.14107

Agyemang, W., Adanu, E. K., & Jones, S. (2021). Understanding the Factors That Are Associated with Motorcycle Crash Severity in Rural and Urban Areas of Ghana. *Journal of Advanced Transportation*, *2021*, 1–11. https://doi.org/10.1155/2021/6336517

Akaateba, M. A., Amoh-Gyimah, R., & Amponsah, O. (2015). Traffic safety violations in relation to drivers' educational attainment, training and experience in Kumasi, Ghana. *Safety Science*, *75*, 156–162.

Alimo, P. K., Asmelash, A., Agyeman, S., & Lartey-Young, G. (2023). Towards Safer Bus Transport in Developing Countries: Geospatial Analysis of Bus Crashes on an Intercity Highway in Ghana. *Transportation in Developing Economies*, *9*(2), 17.

Amo, T., & Meirmanov, S. (2014). The epidemiology of road traffic accident (RTA) in Ghana from 2001-2011. *Life Science Journal*, *11*(9), 269–275. www.lifesciencesite.com/lsj/life110914_269_275.pdf

Funded by the European Union

Amoh-Gyimah, R., Aidoo, E. N., Akaateba, M. A., & Appiah, S. K. (2017). The effect of natural and built environmental characteristics on pedestrian-vehicle crash severity in Ghana. *International Journal of Injury Control and Safety Promotion*, *24*(4), 459–468. https://doi.org/10.1080/17457300.2016.1232274

Arrive Alive. (n.d.-a). *Cycling Safety*. Retrieved 20 November 2023, from https://www.arrivealive.mobi/cycling-safety

Arrive Alive. (n.d.-b). *Motorcycle Accident Cause Factors*. Retrieved 20 November 2023, from https://www.arrivealive.co.za/motorcycle-accident-cause-factors

Biemba, G., Kanyenda, E., Metitiri, M., & Nkandu, E. (2015). Epidemiology and Factors Associated with Road Traffic Crashes in Zambia. *Open Access J Epid Prev Med Journal of Epidemiology and Preventive Medicine*, *2*(1), 1–9.

Boateng, F. G. (2020). 'Indiscipline' in context: a political-economic grounding for dangerous driving behaviors among Tro-Tro drivers in Ghana. *Humanities and Social Sciences Communications*, *7*(1).

Boateng, F. G. (2021a). Poor Policies, not Drivers, Are to Blame for Ghana's Road Transport Miseries. *SSRN Electronic Journal*. https://www.academia.edu/56490149/Poor_policies_not_drivers_are_to_blame_for_Ghanas_road_transport_miseries

Boateng, F. G. (2021b). Why Africa cannot prosecute (or even educate) its way out of road accidents: insights from Ghana. *Humanities and Social Sciences Communications*, *8*(1), 13. https://doi.org/10.1057/s41599-020-00695-5

Clarisse, M. C. S. (2015). *Factors contributing to road traffic accidents in Kigali City, Rwanda 2010-2013*. Mount Kenya University.

Coleman, A. (2014). Road Traffic Accidents in Ghana: A Public Health Concern, and a Call for Action in Ghana. *Open Journal of Preventive Medicine*, *4*, 822–828.

Cowling, N. (2023, April). *Distribution of modes of transport used to get to work in South Africa in 2019*. https://www.statista.com/statistics/1116074/distribution-of-transportation-used-to-get-to-work-in-south-africa/

Damsere-Derry, J., Adanu, E. K., Ojo, T. K., & Sam, E. F. (2021). Injury-severity analysis of intercity bus crashes in Ghana: A random parameters multinomial logit with heterogeneity in means and variances approach. *Accident Analysis & Prevention*, *160*, 106323. https://doi.org/10.1016/j.aap.2021.106323

Damsere-Derry, J., & Bawa, S. (2018). Bicyclists' accident pattern in Northern Ghana. *IATSS Research*, *42*(3), 138–142. https://doi.org/10.1016/j.iatssr.2017.10.002

Damsere-Derry, J., Palk, G., & King, M. (2017). Road accident fatality risks for 'vulnerable' versus 'protected' road users in northern Ghana. *Traffic Inj. Prev.*, *18*(7), 77–84.

TRANS SAFE
TRANSFORMING ROAD SAFETY IN AFRICA

Dapilah, F., Guba, B., & Owusu-Sekyere, E. (2017). Motorcyclist characteristics and traffic behaviour in urban Northern Ghana: Implications for road traffic accidents. *Journal of Transport & Health*, *4*, 237–245.

Garcia, L., Johnson, R., Johnson, A., Abbas, A., Goel, R., Tatah, L., Damsere-Derry, J., Kyere-Gyeabour, E., Tainio, M., de Sá, T. H., & Woodcock, J. (2021). Health impacts of changes in travel patterns in Greater Accra Metropolitan Area, Ghana. *Environment International*, *155*, 106680. https://doi.org/10.1016/j.envint.2021.106680

Gatesi, J. D., Shuai, B., Mukamana, R., & Mutabaruka, J. D. (2022). Study on the Impact of 'Gerayo Amahoro Policy' on Road Traffic Accidents Reduction in Rwanda. *Journal of Brilliant Engineering*. https://doi.org/10.36937/ben.2022

GRSF. (n.d.). *DRIVER: Global Road Crash Data Management | GRSF*. Retrieved 29 November 2023, from https://www.roadsafetyfacility.org/programs/DRIVER

GRSF. (2023a). *South Africa's Road Safety Country Profile*. https://www.roadsafetyfacility.org/country/south-africa

GRSF. (2023b, January). *Zambia's Road Safety Country Profile*. https://www.roadsafetyfacility.org/country/zambia

Hesse, C. A., & Ofosu, J. B. (2014). Epidemiology of road traffic accidents in Ghana. *European Scientific Journal*, *10*(9), 370–381.

HPR, TIRF, & World Bank. (n.d.). *Research on the Impacts of Automated Speed Enforcement in Rwanda to Develop Recommendations for African Countries: Self- Published Compiled Reports*.

Isaac, K. N., Van Niekerk, A., & Van As, A. B. (2015). Child Road Traffic Crash Injuries at the Red Cross War Memorial Children's Hospital in Cape Town, South Africa in 1992, 2002 and 2012. *Int. J. Inj. Contr. Saf. Promot.*, *22*(4), 352–358. https://doi.org/10.1080/17457300.2014.912236

ITF. (2017). *Road Safety Annual Report 2017*. https://doi.org/10.1787/irtad-2017-en

ITF. (2019). *Road Safety Annual Report 2019*. https://www.itf-oecd.org/road-safety-annual-report-2019

Janmohammed, A. (2023). *Road Safety in the South African Context*. https://www.saferspaces.org.za/understand/entry/road-safety-in-the-south-african-context

Janmohammed, A., Vanderschuren, M., & Clay, C. (2019). *Analysis of Current Child Road Injury and Fatality Data*.

Jonker, H. (2019). *Motorcycle Safety Analysis for South Africa: 2018*. Motorcycle Safety Institute. https://www.msi.org.za/motorcycle-safety-analysis-for-south-africa-2018/

Kim, W. C., & Byiringiro, J. C. (2016). Vital Statistics: Estimating Injury Mortality in Kigali, Rwanda. *World Journal of Surgery*, *40*(1), 6–13.

Mhlanga, M. (2018). *Investigation of the road safety measures around schools in Ethekwini*.

Mulenga, F. (2015). Risky Factors Influencing Bicycle Accidents among Cyclists of Chipata District, Zambia. *International Journal of Science and Research Vol*, *4*(6).

Mwale, M., Mwangilwa, K., Kakoma, E., & Laych, K. (2023). Estimation of the Completeness of Road Traffic Mortality Data in Zambia Using a Three-Source Capture-Recapture Method. *Accident Analysis & Prevention*, *186*, 107048. https://doi.org/10.1016/j.aap.2023.107048

NISR. (2022). *Rwanda Statistical Yearbook 2022*. https://www.statistics.gov.rw/file/13831/download?token=clK0b8mh

Nkumbuye, A. (2022). Cause of road crashes among students in Huye and Kigali city. *Injury Prevention*, *28*, A32.

Nyamuame, G. Y., Aglina, M. K., Akple, M. S., Philip, A. G. D., & Klomegah, W. (2015). Analysis of road traffic accidents trend in Ghana: causing factors and preventive measures. *IJESMR Journal*.

Nzeyimana, I. (2019). *Safe School Zone Project Africa*. Healthy People Rwanda.

Obeng-Odoom, F. (2009). Drive left, look right: the political economy of urban transport in Ghana. *International Journal of Urban Sustainable Development*, *1*(1–2), 33–48. https://doi.org/10.1080/19463130903561475

Ojo, T., Agyemang, W., & Afukaar, F. (2018). Lived experiences of inter-urban commercial bus drivers involved in road traffic crashes in Central Region, Ghana. *Urban, Planning and Transport Research*, *6*(1), 81–94. https://doi.org/10.1080/21650020.2018.1545601

Oppong, S. (2015). Risk chain process model: Linking risk perception to occupational accidents. *Sigurnost*, *57*(1), 25–34. https://hrcak.srce.hr/137603

Patel, A., Krebs, E., Andrade, L., & et al. (2016). The Epidemiology of Road Traffic Injury Hotspots in Kigali, Rwanda from Police Data. *BMC Public Health*, *16*(697). https://doi.org/10.1186/s12889-016-3359-4

PIARC. (n.d.). *Safety Data | Road Safety Manual - World Road Association (PIARC)*. Retrieved 23 November 2023, from https://roadsafety.piarc.org/en/road-safety-management/safety-data

Poku-Boansi, M., Tornyeviadzi, P., & Adarkwa, K. K. (2018). Next to suffer: Population exposure risk to hazardous material transportation in Ghana. *Journal of Transport & Health*, *10*, 203–212. https://doi.org/10.1016/j.jth.2018.06.009

Quarshie, M. (2004). *CYCLING IN GHANA: AN INDEPTH STUDY OF ACCRA*. https://docplayer.net/22448139-Cycling-in-ghana-an-indepth-study-of-accra-october-2004.html

RNP. (2022a). *Police in fresh campaign to prevent road accidents*. https://police.gov.rw/media/news-detail/news/police-in-fresh-campaign-to-prevent-road-accidents/

RNP. (2022b). *Police out to curb bicycle accidents*. https://police.gov.rw/media/news-detail/news/police-out-to-curb-bicycle-accidents/

Robinson, B. (2023). *TUMI INITIATIVE'S TRANSFORMATIVE STORIES*. https://transformative-mobility.org/wp-content/uploads/2023/03/6.-TUMI-City-profile-and-story-Lusaka-d8Ctrk.pdf

RTMC. (2021a). *South African Fatal Crashes in Context*.

RTMC. (2021b). *State of Road Safety in South Africa 'January 2021 to December 2021'*. Road Traffic Management Corporation.

RTSA. (2019). *2019 Road Transport and Safety Status Report*. https://www.rtsa.org.zm/wp-content/uploads/2020/06/2019-Annual-Crash-Statistics-Report-v2-Final-Print.pdf

RTSA. (2020). *2020 Road Transport and Safety Status Report*. https://www.rtsa.org.zm/wp-content/uploads/2021/09/RTSA-2020-Annual-Road-Transport-and-Safety-Status-Report-v3-23.03.2021-Printed-1.pdf

RTSA. (2021). *2021 Road Transport and Safety Status Report*. Road Transport and Safety Agency. https://www.rtsa.org.zm/wp-content/uploads/2022/11/2021-Road-Transport-and-Safety-Status-Report.pdf

Sam, E. F., Daniels, S., Brijs, K., Brijs, T., & Wets, G. (2018). Modelling public bus/minibus transport accident severity in Ghana. *Accident Analysis & Prevention*, *119*, 114–121. https://doi.org/10.1016/j.aap.2018.07.008

Schermers, G., Small, M., & Niekerk, E. V. (2019). *Road Safety Management in South Africa* (Issue WP5/D5.10).

Segui Gomez, M., Addo-Ashong, T., Raffo, V. I., & Venter, P. (2021). *Road Safety Data in Africa: A Proposed Minimum Set of Road Safety Indicators for Data Collection, Analysis, and Reporting*. https://openknowledge.worldbank.org/handle/10986/37235

Setorwofia, A., Otoo, J., Arko, E., Adjakloe, Y., & Ojo, T. (2020). Self reported pedestrian knowledge of safety by school children in cape coast metropolis. *Urban, Planning and Transport Research*, *8*(1), 158–170.

Sulemana, I. (2012). Assessing over-aged car legislation as an environmental policy law in Ghana. *International Journal of Business and Social Science*, *3*(20).

Funded by the European Union

Tamakloe, R., Das, S., Nimako Aidoo, E., & Park, D. (2022). Factors affecting motorcycle crash casualty severity at signalized and non-signalized intersections in Ghana: Insights from a data mining and binary logit regression approach. *Accident Analysis & Prevention*, *165*, 106517. https://doi.org/10.1016/j.aap.2021.106517

Torfs, K., Delannoy, Sh., Schinckus, L., Willocq, B., den Berghe, W., & Meesmann, U. (2021). Road Safety Culture in Africa: Results from the ESRA2 survey in 12 African countries. *ESRA Project (E-Survey of Road Users' Attitudes)*.

Twagirayezu, E., Teteli, R., Bonane, A., & Rugwizangoga, E. (2008). Road Traffic Injuries at Kigali University Central Teaching Hospital. *East and Central African Journal of Surgery*, *13*(1), 73–76.

UNICEF. (2022). *Technical Guidance for Child and Adolescent Road Safety*. United Nations Children's Fund (UNICEF).

Vanderschuren, M., & Roux, D. (2019, July). Road Safety Comparison in South Africa - How Do the Different Provinces Compare? *Southern African Transport Conference*.

Vias Institute. (2019). *Ghana – ESRA2 Country Fact Sheet*.

Vias Institute. (2020). *Zambia – ESRA2 Country Fact Sheet*.

Wang, D., Krebs, E., Nickenig Vissoci, J. R., de Andrade, L., Rulisa, S., & Staton, C. A. (2020). Built Environment Analysis for Road Traffic Crash Hotspots in Kigali, Rwanda. *Frontiers in Sustainable Cities*, *2*, 518171. https://doi.org/10.3389/FRSC.2020.00017/BIBTEX

WHO. (2018). *Global status report on road safety 2018*. World Health Organization. https://iris.who.int/bitstream/handle/10665/276462/9789241565684-eng.pdf?sequence=1

WHO. (2021, October). *Lusaka: Reducing speeding near schools*. https://www.who.int/news-room/feature-stories/detail/lusaka-reducing-speeding-near-schools

World Bank. (2020). Guide for Road Safety Opportunities and Challenges. In *Guide for Road Safety Opportunities and Challenges*. World Bank, Washington, DC. https://doi.org/10.1596/33363

Yankson, I., Nsiah-Achampong, N., & Yeboah-Sarpong, A. (2020). Road Use Behaviour of Urban Primary School Children in Ghana: Case Study of Ablekuma South Education Circuit of Metropolitan Accra. *Ghana Journal of Science*, *61*(1), 88–95.

Zafar, S. N., Canner, J. K., Nagarajan, N., & Kushner, A. L. (2018). Road Traffic Injuries: Cross-sectional Cluster Randomized Countrywide Population Data from 4 Low-income Countries. *International Journal of Surgery*, *52*, 237–242. https://doi.org/10.1016/j.ijsu.2018.02.034

Zambia Police. (2022). *2021 Road Traffic Accidents Annual Statistics*. http://www.zambiapolice.gov.zm/index.php/112-news/388-annual-rta-statistics-for-2021

Funded by the European Union