TRANS-SAFE

TRANSFORMING ROAD SAFETY IN AFRICA

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Radical improvement of road safety in low- and medium-income countries in Africa

D(3.1): Recommendations for vehicle safety and training material

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Summary Sheet

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LIST OF ABBREVIATIONS

Acronyms	Full meaning
ABS	Antiblock Brake System
ACC	Adaptive Cruise Control
ADAS	Advanced Driver Assistance Systems
AEB	Autonomous Emergency Braking
AfCFTA	African Continental Free Trade Agreement
ALKS	Automated Lane Keeping System
BAS	Brake Assist System
BSD	Blind Spot Detection system
CCW	Cyclist Collision Warning
CFC	Chlorofluorocarbon
CO2	Carbon Dioxide
CRS	Child Restraint System
DDR (ADR)	(Advanced) Driver Distraction Recognition and warning
DVLA	Driver and Vehicle Licensing Authority
DVR	Digital Video Recorder
EAC	East African Community
ECOWAS	Economic Community of West African States
EDR	Event Data Recorder
ESC/EVSC	Electronic Stability Control/Electronic Vehicle Stability Control
EU	European Union
FCDA	Front Car Departure Alert
FCW	Forward Collision Warning
FUPD	Front Underrun Protective Devices

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FVSA	Forward Vehicle Stop Alert
FWF	Frontward Facing
GTR	Global Technical Regulations
HGV	Heavy Goods Vehicle
HMW	Headway Monitoring Warning
ISA	Intelligent Speed Assist
LCV	Light Commercial Vehicle
LDW/LDWS	Lane Departure Warning/Lane Departure Warning System
LKA	Lane Keep Assist
LMI	Low – Medium Income
LPG	Liquified Petroleum Gas
MCW	Motorcycle Collision Warning
MDB	Mobile Deformable Barrier
MKB	Multi-collision Brake (Multikollisionbremse in German)
MPDB	Mobile Progressive Deformable Barrier
MYxx	Model Year (ex: MY18 -> Vehicle from 2018)
NCAP	New Car Assessment Program
NRCS	National Regulator for Compulsory Specifications
ODB	Oblique Deformable Barrier
ODD	Operational Design Domain
OEM	Original Equipment Manufacturer
PCW	Pedestrian Collision Warning
PSV	Public Service Vehicle
PTI/VTI	Periodic Technical Inspection/Vehicle Technical Inspection
PTW	Powered Two-Wheeler
REV	Reverse Collision Warning
RFWS	Run Flat Warning System

RNP	Rwanda National Police
RSC	Roll Stability Control
RUPD	Rear Underrun Protective Device
RWF	Rearward Facing
RWI	Roadworthiness Inspection
SLI	Speed Limit Information
TCS	Traction Control System
TPM	Tyre Pressure Monitoring System
UAE	United Arab Emirates
UFCW	Urban Forward Collision Warning
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
(US) NHTSA	(United States) National Highway Traffic Safety Administration
VAT	Value Added Tax
VIN	Vehicle Identification Number
VIS-DET	Vulnerable Road user detection and warning on front and side of vehicle
VRU	Vulnerable Road Users
WHO	World Health Organization
YSC	Yaw Stability Control
ZCSA	Zambia Compulsory Standards Agency

UN ECE Vehicle Classification – Simplified Overview

Category	Definition
M	Power-driven vehicles having at least four wheels and used for the carriage of passengers.
N	Power-driven vehicles having at least four wheels and used for the carriage of goods
O	Vehicle trailers
L	Motor vehicles with less than four wheels and some lightweight four-wheelers.
T	Motorised, wheeled or tracked agricultural or forestry vehicle having at least two axles and a maximum design speed of not less than 6 km/h, the main function of which lies in its tractive power and which has been especially designed to pull, push, carry and actuate certain interchangeable equipment designed to perform agricultural or forestry work, or to tow agricultural or forestry trailers or equipment;
R	Agricultural trailer: means any agricultural or forestry vehicle intended mainly to be towed by a tractor and intended mainly to carry loads or to process materials and where the ratio of the technically permissible maximum laden mass to the unladen mass of that vehicle is equal to or greater than 3.0.
S	Interchangeable towed equipment: means any vehicle used in agriculture or forestry which is designed to be towed by a tractor, changes or adds to its functions, permanently incorporates an implement or is designed to process materials, which may include a load platform designed and constructed to receive any tools and appliances needed for those purposes and to store temporarily any materials produced or needed during work and where the ratio of the technically permissible maximum laden mass to the unladen mass of that vehicle is less than 3.0.
G	Off-road vehicles

EXECUTIVE SUMMARY

This recommendations for vehicle safety and training material contains a review of the status of current vehicle safety regulations in Africa. Vehicles in this report refer to private individual forms of transport, as well as heavy vehicles used for public transport such as buses, minibuses, motorbikes and shared taxis. It focuses on the situation in Rwanda, Ghana, Zambia, South Africa. The main aim of this recommendations is to adapt different sets of harmonized regulations from the United Nations (WP.29) regarding vehicle safety for new vehicles. This review has identified several gaps in the regulatory environment in different areas of the vehicle. The main focus of the deliverable has laid on the regulations regarding passive and active safety, with the aim of increasing general vehicle safety and thus reducing road fatalities and accident rates.

This study has also served to identify the status of the vehicle fleets in African land. African vehicle fleets have quite old cars and with large symptoms of extensive use. To add to that, vehicles are not properly maintained and are used in unsafe conditions. Also, vehicles are usually heavily modified to be used for other purposes, as an example, vans have seats added in the cargo space to serve as minibuses.

Three main principal causes have been identified to be the root to those problems:

- Periodic Technical Inspections are not being done properly everywhere and are very inconsistent with the tests. Also, while in urban areas is usually enforced by authorities, in rural areas there is not much control over the Road-worthy certificates of vehicles. There is a big portion of the vehicles driving on the roads that are not fit for use and do not have a Roadworthy certificate.

- Official OEM centres for repairs and maintenance are very rare and limited to the main urban areas of the country. Most population rely on local mechanics that most of the time do not have the skills to do the job for more modern vehicles or the required and homologated part to substitute. Aftermarket parts are usually limited, overtaxed and quite expensive, generally unaffordable to the average household.

- A big portion of new vehicles have been on the market for 10-15 years and have not suffered design changes, so they are sold with the same safety equipment as before. A portion of used vehicles is usually imported from Europe and Japan for a second life, when they have been extensively used, after non-repaired accidents or when repairs suppose an over cost to the value of the vehicle. Most of those vehicles imported are not suitable for driving in European and Japanese roads anymore but they are still exported to African countries.

This deliverable contains a series of recommendations to mitigate each of the root causes that have been identified, which each of the pilot countries should test and adopt. Recommendations for new and used vehicles, which contain a series of actions, should be adopted to create a safer environment for drivers and passengers of all kinds of vehicles. These recommendations include adaptations of vehicle safety regulations, actions to take regarding PTIs and other recommendations regarding vehicle maintenance, repair shops/official technical centres and spare parts.

For effective implementation of some of those actions and recommendations, contribution from OEMs and key stakeholders should take part. OEMs can contribute with technical knowledge on

various areas of the vehicle, while key stakeholders can create a strategy to distribute this technical knowledge throughout the specific targets.

This report also expands on aftermarket opportunities to directly intervene in vehicle safety. Research for an aftermarket ADAS device has been made, so older vehicles currently on the road that may be hardly replaceable can be adapted to have better general safety. A protocol to assess the performance of the aftermarket device has been developed, since this device needs to perform as close as possible as if it was already integrated in the manufacturing process of the vehicle.

For the Safe Vehicle Summit, a training performed during Friday, 20th of October 2023 in Kigali, Rwanda, training material was created regarding passive and active safety for vehicles. It was for different topics regarding Vehicle Safety; It started with current and potential impacts of African Vehicle Safety Standards, Safety of vehicle occupants, safety of vulnerable road users (which included VRU protection with crash avoidance, pedestrian passive safety, and PTW passive safety), an overview of Safe and Clean vehicles, and best practise examples and challenges In Rwanda. The training material produced consisted in a series of presentations, which summed up for a total of 3 and a half hours of content.

This deliverable also includes a summary of the content presented in the Safe Vehicles Summit, a training regarding vehicle safety that was performed on October the 20th, 2023 in Kigali. Summaries of the presentations can be found, with also feedback we have been getting from the participants that assisted the training.

This deliverable concludes with…

1. INTRODUCTION

This recommendations for vehicle safety and training materials performs a review of the existing regulatory environment regarding vehicle safety, the issues in the vehicle fleets and the gaps in other areas such as technical inspections in African countries. Its objective is to identify the main areas to work on and the gaps to cover with a series of recommendations to improve vehicle safety, create opportunities for aftermarket vehicle safety interventions and create training material.

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.

1.1 PROJECT BACKGROUND

African road safety challenges are numerous and complex. Globally, only 2% of car fleet is in Africa, yet 16% of road deaths and 44% of global pedestrian and cyclist fatalities occur in this continent. Road safety and socioeconomic development are interconnected. One of the areas where Africa falls behind compared to other areas of the world is its vehicle fleet. In general, it is old and unsafe, which contributes greatly to these numbers.

Despite the safety of new vehicles has increased significantly in recent years, due to technological development of passive (crash protection) and active (crash avoidance) systems, the penetration of such systems in low-income countries is marginal. Furthermore, the imported used vehicles sold in certain countries are in a poor condition and are great threats to the safety of the vehicle fleet.

According to the World Health Organization's Decade of Action for Road Safety 2011-2020 report, in 2015, the African region had the highest estimated road traffic fatality rate, despite having the lowest level of motorization in the world. Today, the region continues to have the highest road traffic injury death rates, let's put the example of Rwanda, compared to Germany; in 2020, Rwanda had 3718 road fatalities, which adjusts for 43,89 fatalities per 100.000 habitants, in the same year, Germany had 2719 road fatalities, which adjusts for 3,3 fatalities per 100.000 habitants. While this number marks quite a big difference, when looking also at motorization levels, differences increase. Germany had 5,7 fatalities per 100.000 registered vehicles (47,72 Million vehicles in total), while Rwanda had 1549,2 fatalities per 100.000 registered vehicles (244.112 vehicles in total). Interventions are necessary across key road user behaviour, road infrastructure, vehicle fleets and institutional factors to improve road safety outcomes. As of 2015, 40 countries in the African continent had a lead agency to coordinate long-term vision and strategy alongside all relevant stakeholders. Furthermore, 29 countries had a national strategy for road traffic safety that was either fully or partly funded.

This deliverable aims to analyse the main problems of the vehicle fleet and the environment around it, where it is lacking action and how can general safety of the fleet be improved in order to reduce road fatalities.

1.2 EXISTING RECOMMENDATIONS WITHIN THE PROJECT

Other deliverables have already been presented and have paved the way for this task. Deliverable 1.2 has performed an assessment of existing road safety policies regarding the defined safety pillars, safe Roads (and streets), Safe Speeds, Safe Road Users, Safe Vehicles, Post-crash care and also regarding

Road Safety Management. Of these, the final recommendations given to improve vehicle safety are the following:

The lack of safe vehicles is being reported to be caused by the importation of used cars from foreign markets which are not going through adequate quality control. This can be attributed to weak enforcement of legislation on imported vehicles. Gaps in enforcement to periodically inspect vehicles is permitting vehicles that are not roadworthy to be on the roads and combat corruption and fraud at vehicle testing centres are two major issues. There is also a need to enhance and set safety manufacturing standards/requirements for neighbouring countries that don't meet local technical requirements, a problem faced by all our implementation countries as observed by the University of Cape Town interviewee.

South Africa has banned the importation of second-hand vehicles to protect their already strong vehicle manufacturing sector. However, this has produced an undesired effect of drivers keeping older vehicles on the road and not substituting them for newer cars. Similarly, in Zambia, there are stiff importation taxes on newer vehicles which incentivises people to opt for cheaper, older, less safe second-hand vehicles from Europe and Asia (Phiri & Chikuba, 2016), as observed by the Zambia Road Safety Trust interviewee. Having safe vehicles on the roads in each country can be achieved by:

- Strict legislation on the fitness of vehicles imported to the country to ensure quality vehicles in good working condition on the roads
- Consistent inspection of vehicles on the road and enhancing the capacity of authorities charged with this for efficiency.
- Quality, standardised crash data – ensure that cars written off during crashes are not refurbished, reregistered back on the roads without being inspected to ensure they are safe to be driven. This can be tasked to the institution established to ensure enforcement and accountability.

While these recommendations are a great start, they need to be expanded on and get more into detail, which is in part what this deliverable will do.

1.3 DELIVERABLE GOAL

The main objective of the project is to analyse and propose processes to reduce the safety issues of all groups of vehicles, such as new, in-operation and used imported, focusing on heavy-duty vehicles and vehicles used for public transport.

Within the deliverable, two additional safety relevant studies will be performed: First, an assessment of aftermarket options for driver assistance systems based on smartphones to warn drivers about accident risk factors and secondly, a safe cargo securing and dimensioning to reduce accident severity.

With inputs coming from WP1 and WP2 along with European partner expertise in vehicle safety development, the specific objectives, and outcomes of this part of the project are:

- Recommendations for vehicle safety in different contexts
- Opportunities for aftermarket vehicle safety interventions
- Training material on safe vehicles

2. VEHICLES IN AFRICA

This section contains more detailed information from the regulatory environment review and vehicle fleet study in Rwanda, Ghana, Zambia, and South Africa, the countries where the demonstration activities will be implemented.

This study of existing regulations contains a preview on existing vehicle regulations in the mentioned African countries regarding new vehicle homologations, used vehicles importation limits and how are they regulated if they are, taxes around new and used vehicles, and manufacturing differences that may be found in new vehicles in comparison to other regions of the world. Also, there is an introduction to the vehicle fleet status: how old is the average vehicle, status of the road-worthy certificate, most common vehicles and OEMs and non-homologated/non-approved vehicle modifications.

Expanding on the imported and used vehicles, the study also contains a review on the regulatory environment of periodic technical inspections (PTI) for each of the countries involved in demonstration activities. This review goes through what is tested and inspected in them, their quality standard if they are based on one, periodicity of inspections for different types of vehicles and their enforcement.

Following on the topic of PTIs, the environment and current status of the network for vehicle maintenance, skilled mechanics and the availability of homologated spare parts has been considered as a key factor in maintaining the condition of safe vehicle and has been looked through. Without a sufficient network of repair centres or qualified mechanics and limited offer of spare parts, it may be an impossible task to increase general safety of the vehicle fleet.

Lastly, the existing consumer information regarding vehicle occupant safety has been looked through. Currently, the campaign #SaferCarsForAfrica from Global NCAP is the only organization that tests new vehicles sold in Africa, with just 20 cars tested. Then, an analysis of the occupant safety for some of those cars will be performed, with also a comparison with their counterparts in other parts of the world.

2.1. RWANDA ROAD VEHICLES ENVIRONMENT

One of the main causes of road crashes in Kigali is the condition of vehicles. A lack of Advanced Driver Assistance Systems (ADAS), vehicle safety standards, and the overall age of vehicles are all contributory factors. There is a lack of regulatory environment for new and used vehicles and most of

the imported vehicles lack modern protective measures. To add to that, Periodic Technical Inspections do not have a proper procedure for inspection and enforcement, since they only have an environment and infrastructure in big urban areas, leaving rural areas with unsafe and uninspected vehicles. In most cases, the environment for maintaining vehicles is not even ideal in urban areas, which limits the ability to have a safe vehicle to a small portion of the population.

2.1.1 Vehicle fleet status

In Rwanda, there were 244.112 registered vehicles in 2020, growing at a rate of 12% yearly approximately. The majority of vehicles have an age of around 15-20 years and have around 200.000km. There is currently a lack of regulatory environment to evaluate the vehicles that are being sold and driven in Rwanda. Regulations that currently exist are very tolerant and allow old and unsafe vehicles to access the country and be sold in the domestic market.

For new vehicles, there is no safety regulation in place that works as a toll to those vehicles, instead, there is an emissions regulation, which is Euro III (Ariadne Baskin, et al., 2020). This regulation, apart from not being able to trace each of the vehicles' safety condition, components, and systems, it is very outdated. It came out in the year 2000 and since then, 3 new regulations for M1 vehicles have been stablished in Europe (Euro IV in 2005, Euro V in 2009 and Euro VI in 2014, and soon Euro VII will be stablished too).

A March 2022 online news piece in the Rwanda Dispatch noted "On his part, Commissioner of Police (CP) John Bosco Kabera, the RNP spokesperson, said that emissions inspection and testing is an obligation to all vehicles in Rwanda to prevent air pollution.

"The contribution of vehicles to the city's ambient air pollution cannot be ignored. All motor-vehicles in Rwanda are required to undergo emissions inspection and testing at the Motor Vehicle Inspection Center. Any vehicle that does not meet applicable emissions standards is not authorized to operate in Rwanda," said CP Kabera.

The Traffic Police, he added, also has mobile hand-held vehicle emissions inspection equipment for on-the-spot emission checks.

In 2019 and 2020, Rwanda Standard Board published standards for air quality and emissions limit for road vehicles as well as automotive fuels equivalent to euro 4."

For used vehicles there is no safety regulation in place, but neither an emissions regulation. Currently, used vehicles suppose the majority of the vehicle market in Rwanda and the majority of African markets. The only limit stablished for used vehicles is a tax applied for old vehicles, which was implemented from the EAC depreciation schedule. This tax increases the older the vehicle is, is applied as the following example:

The 1997 Toyota Carina E was $20.200 when new, now it has depreciated to $4.800. The following Table 1 shows the proportional tax to be applied:

Table 1: Depreciation FOB Rate for used vehicles in Rwanda (EAC, 2014)

PERIOD OF USE	DEPRECIATED FOB RATE
More than 1 year and less than or equal to 2 years	20%
More than 2 years and less than or equal to 3 years	30%
More than 3 years and less than or equal to 4 years	40%
More than 4 years and less than or equal to 5 years	50%
More than 5 years and less than or equal to 6 years	55%
More than 6 years and less than or equal to 7 years	60%
More than 7 years and less than or equal to 8 years	65%
More than 8 years and less than or equal to 9 years	70%
More than 9 years and less than or equal to 10 years	75%
More than 10 years	80%

Since the vehicle is 26 years old, 80% of the depreciated FOB rate is applied and the final price for the vehicle will be $8.640.

This tax increases the prices for older used vehicles and makes these less affordable and levels the price with newer vehicles, so people are moved towards acquiring a vehicle more adequate to current safety standards.

Efforts to improve air quality through promotion of hybrid and electric vehicle imports over internal combustion engines began in 2021 by eliminating VAT and other taxes entirely for these vehicles even when they are imported used. There are other incentives implemented to support development of an electric mobility ecosystem including a charging station network, spare parts and maintenance facilities. Though these incentives do not specifically target vehicles with safety standards, they lower the barrier to purchase of newer vehicles through substantially lower costs on overall vehicles (Rwanda Ministry of Infrastructure, Rwanda Environment Management Authority, 2021).

2.1.2 New and used vehicles

The proportion of new and used vehicles registered each year shows that new vehicles are still very unaffordable to the general public in Rwanda. From 2019 to 2020, the total number of registered vehicles increased by 26.811 (from 217.301 in 2019 to 244.112 in 2020 (National Institute of Statistics of Rwanda, 2020)). In the same year, there were 665 new vehicle sales in Rwanda (Manufacturers, ANDC, JATO Dynamics), which account for 2,4% of the total of registered vehicles in 2020, the other 26.146 were used vehicles, most of those also imported from other countries. Pandemic lowered slightly new vehicle sales, but the previous years were not showing a clear trend in vehicle sales overall, fluctuating always between 600 and 780 units as seen in the Table 2 below (in 2021 there were 714 new vehicle sales and in 2022, 646).

Table 2: New vehicle sales (2015-2020) in Rwanda (Good car bad car, Automotive Sales data, 2021)

YEAR	NUMBER OF NEW VEHICLES	CHANGE TO PREVIOUS YEAR
2015	654	4.81%
2016	685	4.74%
2017	780	13.87%
2018	774	-0.77%
2019	758	-2.07%
2020	665	-12.27%

From the 244.112 total vehicles registered, 130.326 were motorcycles, followed by cars and Jeeps (4x4 cars), with 69.094 combined units.

The Toyota Hilux was in 2020 the best-selling new vehicle, with 179 units sold, also consolidating Toyota as the leader in car sales. Volkswagen and Suzuki followed Toyota in the rankings.

As seen in the previous section, new vehicles are regulated by emissions and by a quite old standard. This has allowed new vehicles to have old designs and features even if they are being sold as new. Obviously, not all of the new vehicle sales are like this, but a portion of those do not have safety devices and systems to today's standards. Apart from this, materials used to build these vehicles are of lower quality and the same model may be different to its counterpart in other parts of the world, making the new vehicles sold in African countries in general, less safe than in other countries.

Used vehicle market is composed by vehicles manufactured in the 1990s and the 2000s, very few cars from the 2010s and even less from the 2020s can be found in the used car market (Rwanda Car Mart, 2024). The majority of those vehicles follow the trend of new cars, most are from Asian manufacturers (Japanese and Korean mainly), and also some German manufacturers.

Used car market can have two main origins the used domestic market and the used import market, which come mainly from Europe and Japan. Each of them have similar types of vehicles, but their conditions have many differences. Usually, local vehicles have a certain degree of maintenance, while imported vehicles, especially European ones (Japan performs an inspection before importing most vehicles to other countries), come in very bad conditions.

2.1.3 Imported vehicles and their regulations

The import of vehicles into Rwanda is a very common practice. The majority of the imported vehicles come from Europe and Japan, and they are used. Of the vehicles imported, just 13% of the total imported vehicles from 2014 to 2019 were new vehicles, the rest of them were used. 59,8% of the used imported vehicles had more than 11 years old and on average, more than 220.000km (as University of Rwanda has analysed for this deliverable).

The condition of those vehicles should not be a problem if they were maintained properly, but as the Used Vehicles Exported to Africa study shows, imported European cars are generally in bad

conditions. The majority do not have a valid Roadworthy certificate and have not gone through a technical inspection in a while. To add to that, there are some examples that have been involved in accidents and have not been properly repaired, plus they lack equipment that was originally mounted from factory (Netherlands Human Environment and Transport Inspectorate, Ministry of Infrastructure and Water Management, 2020).

2.1.4 Vehicle Technical Inspections

Rwanda National Police (RNP) is the organism responsible for road traffic law enforcement, driving license testing, the issuing of driving licenses and vehicle testing. It is responsible for motor vehicle fitness inspection and the issuance of roadworthy certificates. Private vehicle testing stations are not allowed in Rwanda.

Vehicle inspections are performed in accordance with the Rwanda Standard RS 145-1, "Testing of Motor Vehicles", it includes mechanical soundness and roadworthiness and smoke emissions and exhaust system testing standards. Commercial vehicles, all minibuses and buses and driving teaching vehicles are required to technical inspections every 6 months. All other vehicles are required to be tested once a year. New vehicles are required to be tested 18 months after the date of first registration.

Testing equipment in the Motor Vehicle Inspection Centres include the following:

- Brake roller tester
- Axle play detector
- Headlamp beam-aim checking device
- Wheel alignment device
- Suspension tester
- CO2 gas analysis/emissions tester

Also, a visual inspection is carried out, which includes an evaluation of the body of the vehicle, as well as the side rear-view mirrors.

The vehicle inspection equipment is connected to a server room where the vehicle inspection logs are automatically registered and inspection reports that are automatically processed.

The legislation prescribes a minimum qualification of the examiners of vehicles. If a vehicle fails the roadworthiness test, the owner is allowed 14 days to repair any defects or faults for a final inspection. If the vehicle passes the test, a roadworthy certificate is issued, and a secure sticker is attached to the vehicle's number plates for the purpose of law enforcement. The security and integrity of the roadworthy certificates and stickers are a high priority for the Police.

2.1.5 Vehicle maintenance

Most European countries are starting to have an aged vehicle fleet, but since most of those vehicles go through PTIs and scheduled maintenance through official OEM dedicated centres, those old vehicles do not suppose as big of a safety concern as it does in most African countries.

In Rwanda, the OEMs with most vehicles on the roads are Toyota, Volkswagen, Nissan, and Hyundai. Those manufacturers have very few official centres (Toyota has two and Volkswagen, Nissan, and Hyundai one) where they can conduct repairs and maintenances in Kigali respectively, but do not have other centres in other areas of the country. This creates a very unideal situation for those vehicles found in rural and urban areas far from the main capital, which obligates the owners to either make long drive or to take the vehicle to a local mechanic.

This last bit has a problem. Local mechanics most of the time do not have the necessary tools and usually they do not have the necessary spare parts neither; there is a lack of regulation to have control over mechanical interventions outside the official manufacturer centres. The main reason for that is the lack of local manufacturing and the limited availability for new and official spare parts. Local mechanics have an extra difficulty added when getting those new spare parts and consequently, the parts being used for repairs are taken from donor vehicles which have already been through many miles and the parts are not in an optimal condition. They may not be broken but are very worn and can suppose a threat to the vehicle normal functioning.

There are companies in Rwanda which propose a solution to the ageing and unsafe vehicle fleet. Bringing affordable electric vehicles to the country with more flexible financing plans is one of the solutions GoKabisa offer. They also offer a network of garages and shops, along with other retailers, where electric vehicles can be repaired and maintained through well trained and skilled mechanics.

There are also other factors that play a minor role in maintaining a good vehicle condition. One of them is the low quality of fuel, which can reduce the lifetime of a vehicle's engine. In Rwanda, fuel quality has improved a lot recently, REGULATION N° 09/R/GP-EWS/RURA/2023 OF 28/03/2023, has helped in stablishing a regulatory framework for fuel quality control in Rwanda, but still, fuel may contain unsuitable additives and a higher than desirable sulphur levels (high sulphur levels cause corrosive and excessive wear on metal surfaces of the engine, higher degradation of engine oil, catalyst toxicity, and also cause after-treatment systems to be useless).

Also, relevant factors that influence the maintenance of vehicles is the theft of key vehicle components and non-homologated aftermarket modifications. There are vehicles which have suffered aftermarket non-homologated modifications and have been done without considering safety factors, such as transforming cargo areas in vans to be able to have seats and transport people, removing rear seats of cars and transforming them into transport vehicles, etc.

2.2. GHANA ROAD VEHICLES ENVIRONMENT

Similarly, to Rwanda, in Ghana, one of the main causes of road crashes is the condition of vehicles. A lack of Advanced Driver Assistance Systems (ADAS), vehicle safety standards, and the average age of vehicles all contribute to the disproportionate amount of fatalities. There is a lack of regulatory

environment for vehicle safety, but there are regulations that control new and used vehicles being sold in the country. Periodic Technical Inspections have a more stablished network and infrastructure, but still fall behind occidental standards. There is also an extensive network of repair and maintenance centers of the main OEMs and manufacturers in the urban areas of the country, but as in Rwanda, rural areas are left behind in this aspect. Ghana has a total of six car assembly plants (Volkswagen, Toyota, Nissan, Peugeot, Sinotruck and Kantanka automobiles) which helps in reducing the price for new vehicles and also helps with the spare parts problems found in other countries in Africa.

2.2.1 Vehicle fleet status

In Ghana there were approximately 3,2 million vehicles registered approximately as of 2022. Of those vehicles, around 72% were petrol powered, 27% diesel and about 1% Liquified Petroleum Gas (LPG). There is no significant percentage of registered Electric Vehicles or other related technologies. There is an acknowledgement that production should be increased in production plants and there should be an increase in the number of production plants to help in adjusting the price of new vehicles to a more affordable level. The average vehicle is around 14,2 years old as of 2015 and have around 200.000km. In Ghana, vehicle use is more extended than in Rwanda, consequence of being a country with more extension and more population, and since there are no updated studies regarding this topic, there could be a more aged vehicle fleet with more mileage nowadays (Peprah, 2023).

Currently, there is no regulatory environment for new vehicles, but there is a similar situation as in Rwanda regarding imported used vehicles. New vehicles, as in other African countries, is regulated by an emissions regulation, in Ghana's case is Euro II, which came out in 1996, 28 years ago. The same case as in Rwanda is repeated here: a very outdated regulation is in place (since it came out, Euro III, Euro IV, Euro V, Euro VI and soon Euro VII have been established) which only controls emissions and is unable to trace each vehicle safety status and components.

For local used vehicles there is currently no safety standard or regulation in place, but there is one for imported vehicles. Ghana tried to implement a ban on imported used vehicles of 10 years or older but failed to do so after importers pushed back. Since then, additional taxes have been implemented for import of old used vehicles. As of September 2022, the Government announced that it planned to move forward with the import ban planned in 2020 and an increase in import tariffs (Baba Imoro Musah, et al., 2020).

2.2.2 New and used vehicles

Similarly, to what Rwanda's situation is, the proportion of new and used vehicles registered show that new vehicles are still unaffordable to the majority of the population in Ghana. From 2015 to 2022, the number of registered vehicles increased in around 1.247.436 vehicles, from 1.952.564 in 2015 to approximately 3.2 million vehicles in 2022. Of all those registered vehicles, 37.388 where new, as the JATO Dynamic data shows in the following Table 3, divided per each year:

Table 3: New vehicle sales (2015-2022) in Ghana (Good car bad car, Automotive Sales data, 2023)

YEAR	NUMBER OF NEW VEHICLES	CHANGE TO PREVIOUS YEAR
2015	3.600	-47,83%
2016	4.200	16,67%
2017	4.066	-3,19%
2018	4.268	4,97%
2019	3.394	-20,48%
2020	3.710	9,31%
2021	9.150	60,23%
2022	5.000	-44,44%

The top selling manufacturers are Toyota with a 33,8% of the new vehicles market, Nissan (10,6%), KIA (8,4%), Mitsubishi (6,8%) and Suzuki (6,5%). The best-selling model is the Toyota Hilux, followed by the Nissan Hardbody and the Toyota Prado. There are a total of 6 pick-up trucks in the Top 8. Small sized SUVs and compact cars, such as the Volkswagen Gol and the KIA Sonet are also in the Top 12 best-selling cars (Gasnier, 2022).

The dominant manufacturers in the used car market are Japanese, Korean, German and from the United States. From Japan, Toyota and Honda have the biggest presence, followed by Nissan and Suzuki. A notable fraction of the market is also formed by Korean manufacturers Hyundai and Kia. Manufacturers from Germany, such as Mercedes and Volkswagen, can also be found, together with the Americans Ford, Dodge and Jeep. Most of the vehicles on the market were manufactured between 2010 and 2016, but with some exceptions of newer and older vehicles. On average, vehicles from 2 to 5 years old have around 51.000km. Newest cars start at around 35.000km or less, while 5-year-old cars are already at 75.000km (Jiji Ghana , 2024).

2.2.3 Imported vehicles and their regulations

As in Rwanda, vehicle importation is a very common practice. Most of the vehicles, as the new and used vehicle market trend shows, are Japanese and European, with also a slight portion of American cars. Ghana imports about 100.000 vehicles each year, of which 90% are used,

With the aim of changing the dynamic of importing used vehicles, Ghana is seeking investment from leading OEMs to create manufacturing plants in National soil. Toyota, Volkswagen, Nissan, Suzuki, KIA and Mahindra have already set up assembly plants in Ghana. The Government applies 15% VAT to imported vehicles (and imports in general), but exempts domestically manufactured and assembled vehicles from the VAT.

The Government of Ghana has previously shown interest in banning the import of used vehicles older than 10 years, but the importers pressured to not approve this. Retailers of imported used vehicles still conform a big source of income for many and the transition to more sales for locally assembled

new vehicles seems difficult (International Trade Administration - Department of Commerce - United States of America, 2023).

2.2.4 Vehicle technical inspections

Vehicle Technical Inspections are performed and regulated by Driver and Vehicle Licensing Authority (DVLA). BensamAuto, Bivac Automotive and SGS, amongst others, are the businesses the DVLA uses to perform the PTIs through trained professionals.

The periodicity of the PTIs is the following

- 1 year for private cars
- 6 months for commercial vehicles

To determine if a vehicle is roadworthy, the DVLA has set limit values and criteria for determined types of tests. These tests take around 25 minutes, depending on the type of vehicle, and they cover a big range of components and safety elements, including seatbelts, tyres, suspension lights, brakes and emissions (Bensam Auto Service Limited, 2024):

- Above Carriage Check: An inspector carries out visual checks on Vehicle identity (number plate, engine and chassis numbers), Lighting equipment (headlamps, stop lamps, front and rear lamps, direction indicators, etc), Bodywork, Vehicle modification/accessories, Road wheel and tyres, General items (seat belts, horn, windscreen, safety devices, etc)
- Exhaust Emission Test: Checks exhaust emission level of petrol driven vehicles. A probe is inserted into the exhaust pipe to collect gas sample for measurement. Exhaust emissions are potentially dangerous. This test helps to ensure that road vehicles remain properly serviced and have relatively clean and efficient engines.
- Alignment Test: Checks front wheel alignment. The lateral movement of the front wheels is measured as the vehicle is driven over the side-slip tester. Suspension and Shock absorber Test checks the front and rear wheels for suspensions loose or worn-out capacity of your vehicle. The suspension helps your vehicle absorbs the shocks of potholes and bumps.
- Brake Test: Determines efficiency of brakes The brake tester is used to measure brake performance, efficiency and drag force. Test results are automatically registered. Test instructions and results are displayed on the overhead indicator board.
- Under Carriage Check: Checks the condition of car parts and components. Vehicle is driven over an inspection pit for visual checks on: Chassis, Exhaust system, Suspension system, Steering system, Brake system, Leakage, Corrosion.
- Headlight Test: Determines proper alignment and focus of headlamps. The headlight aimer is used to measure the luminous intensity and the horizontal and vertical aim of each headlamp at high beam. Test instructions and results are displayed on the overhead indicator board.

2.2.5 Vehicle maintenance

In Ghana, there is a more extended OEM repair and maintenance centers than in other African countries. The leading vehicle manufacturers in the country have between 8 and 14 locations where customers can bring their cars to be repaired or conduct the necessary programmed maintenance to their cars. Since local manufacturing is more extended, there is a supply for spare parts, although prices are still high for the average household in Ghana. Apart from that, local vehicle importers contact on a periodic basis Commercial Service Ghana to seek for suppliers of specific vehicles, as well as OEM and aftermarket parts to help service and maintenance shops.

There is a problem with these repair shops and maintenance centers. As it happens in Rwanda, rural areas of the country are neglected and most of those repair networks are located in big urban areas. Having a country as big as Ghana means that some of the rural areas may be as 4 to 6 hours away from the nearest official or certified repair center, with local mechanics having limited tools and experience with relatively modern vehicles (Baba Ziblim, et al., 2018).

Also, similar problems like in Rwanda appear regarding fuel quality, theft of key vehicle components and non-homologated aftermarket modifications.

2.3. ZAMBIA ROAD VEHICLES ENVIRONMENT

In Zambia, most motor vehicles on the roads are second hand imports mainly from Europe and Asia, which are usually older than 10 years. Implicitly, it means that the vehicular safety integrities are diminished owing to their age. The stiff importation taxes on newer vehicles also tend to encourage people to opt for cheaper, older and less safe vehicles. Vehicle fitness checks and CO2 Compliance checks do not appear to be stringent.

Around 90 percent of crashes in Zambia involve vehicles that fail to comply with traffic rules. Many vehicles in the country are imported from abroad and are very old, making them more prone to breakdowns and crashes. Additionally, they are often not well maintained and are unroadworthy, with elements such as poor brake systems, poor lighting, worn-out tires, and lack of protective mechanisms like seatbelts and airbags making them especially dangerous to drive. This is especially true of the minibuses used as public transport, where extra seats are often fitted locally, making them carry more people than they are designed for.

2.3.1 Vehicle fleet status

As per a study performed by the IMC Worldwide, in 2020, there were more than 750.000 registered vehicles in Zambia, with an average age of 12,5 years and increasing. Of all the registered vehicles, none of them is electric, despite the governing bodies having made favorable policies in order to boost electric vehicle sales and importations, like imposing a zero-rate excise duty for electric vehicles and halving custom duties.

The only manufacturer that has an assembly plant in Zambia is Tata Motors. Their assembly plant serves to manufacture a series of buses and trucks. There are no cars manufactured in Zambia, which as a consequence and as seen in other regions, increases the prices of new cars. The list of new vehicle distributors is also quite limited, with just Toyota, Nissan, Tata, and Isuzu being registered as official distributors. There is neither a manufacturing plant for spare parts, which as it will be discussed later, makes maintaining a proper vehicle status a difficult chore.

There is currently no safety standard regarding the sale of new and used vehicles, but as in Rwanda and Ghana, there is a tax system to incentivize the import of newer vehicles. Vehicles with an age greater than five years are required to pay a one-off tax called the Motor Vehicle Surtax, which is added to the import duty. To add to that, there is also an annual tax on emissions, called Carbon Emissions Surcharge, which is applied to all vehicles and depends on their engine displacement. These taxes are more focused on emissions, but having as many new vehicles as possible helps in easing the problem of unsafe vehicles (Rugamba, A, 2020).

2.3.2 New and used vehicles

As in Rwanda and Ghana, Zambia's proportion of new and used vehicles registration is quite despair, which also shows an inability from the majority of the population to buy a new car.

In the Table 4 below, the registered new vehicles per year in Zambia, from 2015 to 2020, can be found:

Table 4: New vehicle sales (2015-2020) in Zambia (Good car bad car, Automobile sales data, 2021)

YEAR	NUMBER OF NEW VEHICLES	CHANGE TO PREVIOUS YEAR
2015	1.700	-15,00%
2016	2.300	35,29%
2017	848	-63,13%
2018	1.118	31,84%
2019	1.094	-2,15%
2020	1.908	74,41%

As a comparison between new vehicles and the total amount of registered vehicles per year, the latter data can be found in the Table 5 below:

Table 5: Number of registered vehicles per year (2015-2020) in Zambia (CEIC Data, 2022)

YEAR	NUMBER OF REGISTERED VEHICLES
2015	56.574
2016	32.944
2017	41.197
2018	44.465
2019	40.746
2020	31.027

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the European Union

As it can be seen, the number of registered vehicles compared to new registered vehicles shows a clear advantage in number for registered used vehicles. From 2015 to 2020, 246.953 vehicles were registered, of which just 8.968 were new, being just a 3,63% of all the registered vehicles in those years.

Best-selling manufacturers as per the most recent sales data in 2022, Toyota was at the top spot of the ranking, with a 47,5% of the market share, followed by Tata, with a 9,8% of market share and Isuzu, with a 9,2% market share (Focus2move, 2023).

As for the used car market, the leading brands are Japanese, having Toyota as the preferred brand for second hand vehicles. The Toyota Auris (Corolla in Europe), the Toyota Vitz (Aygo) and the Toyota Vanguard (RAV4) are the most popular models from the Japanese manufacturer. Nissan is also a very common manufacturer to be found within used cars. The Nissan Note and the Nissan Dualis (Qashqai in Europe) are the most popular models.

2.3.3 Imported vehicles and their regulations

Explained previously, for used imported vehicles there is no safety standard, but there is a tax system that incentivises importing newer vehicles. For vehicles older than 5 years, a tax exists where there is a one-off payment at the moment of import, this is the Motor Vehicle Surtax. There is also a tax called the Carbon Emissions Surcharge, which depending on the engine displacement, there is a bigger payment. Newer vehicles have less displacement, since they are turbocharged and can achieve similar performance with smaller engines (Africa Regional Centre (CUTS ARC), 2018).

Also, since December 2006, the Zambian Standard ZS560 is in place, which states that imported vehicles must go through a pre-shipment inspection scheme. Vehicles go through a roadworthiness inspection in origin countries, which are appointed by Zambia Compulsory Standards Agency (ZCSA), through agents in Japan, South Africa, Singapore, United Kingdom, United States of America and United Arab Emirates. All used motor vehicles destined for Zambia must meet the requirements imposed by this pre-export inspection. If any vehicle exported to Zambia from any of those countries arrives without having gone through the inspection, the agents incur a penalty which will depend on the vehicle size (ZCSA, 2021).

This inspection was initiated after the recognition of Zambia as a nation which imports a lot of used motor vehicles by the Minister of Commerce, and with the aim to minimize the risk of unsafe and substandard motor vehicles entering the Zambian market.

2.3.4 Vehicle technical inspections

The Zambian government stablishes the following periods for registered vehicles to undergo roadworthiness tests (Road Transport and Safety Agency - Zambia, 2024):

- Personal motor vehicles or trailers – 12 months
- Public Service Vehicles (PSV), Cargo - 12 months
- Public Service Vehicles (PSV), Passengers (long-term licence) - 4 months
- Public Service Vehicles (PSV), Passengers (short-term licence) - 3 months

For the Inspection of Pre-import used vehicles, the designated agent is ATJ (AutoTerminal Japan), which conducts Roadworthiness Inspections (RWI) for Accredited Inspections companies in Japan, Singapore, U.A.E., United Kingdom, South Africa and United States of America in compliance with both the Zambian Standards ZS560.

There are conformity assessment procedures shall be used to verify that all used motor vehicles (including motorbikes, cars, vans, buses and trucks of all sizes) exported to Zambia are in compliance with ZS560:2004 before shipment from the supply country. ATJ adheres to the following critical parameters in the standard.

- Road Worthiness shall be determined by the compliance of requirements specified in the standard.
- The vehicle should be free of CFC (R12) gas.

Pre-import inspections and Roadworthiness tests in Zambia for used vehicles are quite similar and include the inspection of several key components and parts from the vehicle inspected.

The inspection criteria include the following (AutoTerminal Japan, s.f.):

- Visual inspection
- Engine check
- Braking systems and components check
- Steering wheel check
- Suspension and underside check
- Exhaust system check
- Doors check
- Interior check
- Wheel hubs/stub axles/tires check
- Instrumentation check
- Electrical wiring and equipment check
- Lightning system check
- Obligatory reflectors check
- Mirrors and wipers check
- Windscreen glass check
- Accessory check
- Speed meter check
- Brake check
- Headlight check

- Side slip check
- Exhaust/smoke check
- Drive and idle test
- Radioactive contamination inspection (only in Japan and UAE)

2.3.5 Vehicle maintenance

In a similar situation as in Ghana and Rwanda, Zambia has very limited official centres for repairs and maintenance. Manufacturers are only located in big urban areas with just 2-3 repair centres, located in Lusaka, the capital, and Kitwe/Ndola, Solwezi or Kasama.

Zambia is quite large, and having manufacturers concentrated just on 5 or 6 urban areas for a country which compared to European countries would be ranked 2nd in land area size (just behind Russia), supposes a problem to the population not located near those centres, having to do trips of over 9-10 hours in the most extreme cases if they wanted to have official technicians work on their cars.

There is the possibility of repairing and maintaining vehicles in local mechanics, but most of the time, they rely on experience with old vehicles with simple mechanics and do not have modernized tools to work with new vehicles and in most cases, and neither have spare parts available and in a proper condition.

2.4. SOUTH AFRICA ROAD VEHICLES ENVIRONMENT

South Africa's vehicle fleet is considerably larger and in a better general condition than that of other African countries. New vehicle sales represent a huge part of the registered vehicles in South Africa and those new vehicles are close in safety systems and components to what there is in Europe. The main problem seen in South Africa is the lack of roadworthy vehicles in the roads, despite having a big portion of new vehicle sales, as explained below.

Vehicle Technical Inspections have a very well stablished system and network, but the fact that those are not mandatory to be passed periodically but when a vehicle is sold or bought, makes the South African vehicle fleet unsafe. There is also a well stablished network of official repair and maintenance centers all over the country and by most manufacturers, which makes repairs easy to make and affordable in case a vehicle is required to be repaired.

South Africa is the leader in automotive manufacturing in the African continent, with several manufacturing plants all over the country, from BMW (1), Ford (2), Mahindra (1), MAN (2), Mercedes (1), Nissan (1), STELLANTIS (1 future plant for 2026), Toyota (1), Volkswagen (1) and Volvo Trucks (1). Having these manufacturing plants nationally helps in reducing the problem of spare parts availability that other countries may encounter. Also, the government has many programs that support the automotive industry, defining it as a key growth sector.

2.4.1 Vehicle fleet status

There are approximately 12 million registered vehicles in South Africa, with an average age of 10 years and 6 months. On average, those vehicles travel 15.000 to 20.000 km per year, but there are not precise figures on the average total mileage of the vehicle fleet. Despite having the biggest vehicle fleet in Africa, there are only 1.000 electric vehicles registered, which shows the low penetration of the technology in the continent.

There is a technical framework for component type approval of motor vehicles in South Africa, it was established on 1st of September 2008 by the National Regulator for Compulsory Specifications (NRCS), based on UNECE regulations, which requires a series of systems and components of a vehicle to be certified under an E-mark. All new vehicle models, built up vehicles, modified vehicles and individual vehicle modifications must ensure compliance with the requirements of the compulsory specifications and technical regulations of their class (M1 vehicles, M2, etc.). Those mandatory requirements for South African motor vehicle parts can be found in the Table 6 below:

Table 6: South Africa mandatory requirements for motor vehicles parts (Shui, 2020)

No.	*Items*	*Standard*
1	Hydraulic brake and clutch fluid	VC8013
2	safety helmets for motor cyclists	VC8016
3	Child restraints for use in motor vehicles	VC8033
4	Replacement incandescent lamps for motor vehicles	VC8048
5	Replacement headlights for motor vehicles	VC8049
6	Replacement secondary lights (position lights, stop lights, direction-indicator lights, parking lights, reversing) for motor vehicles	VC8050
7	Replacement safety glass for use in road vehicles	VC8051
8	Replacement brake lining assemblies for road vehicles	VC8053
9	Pneumatic tyres for passenger cars and trailers	VC8056
10	Pneumatic tyres for commercial vehicles and their trailers	VC8059
11	Ball type couplings and towing brackets for towing caravans and light trailers	VC8065
12	Replacement elastomeric cups and seals for hydraulic brake actuating cylinders for use in motor vehicles using non-petroleum base hydraulic brake fluid	VC8080

The NRCS is the organism that inspects vehicles and reviews those inspections. Once the vehicle has obtained the certificates after the approval, there is post-market surveillance of those vehicles.

Used vehicles do not have an established framework, but they need to pass a Vehicle Technical Inspection and obtain a roadworthiness certificate before being sold. There are no special taxes applied for used vehicles, but for new locally manufactured vehicles and components have a lower tax than imported ones. There is also a sale tax depending on the CO2 emissions on passenger cars, which

for vehicles that emit more than 95g of CO2 per kilometer equals to R132/g/km or R176/gCO2/km for double cabs (pick-up trucks) (naamsa, 2024).

2.4.2 New and used vehicles

The majority of the registered vehicles in South Africa are new and re-registers of old vehicles coming from the local used vehicle market. In the Table 7 below, the number of new vehicles sold in South Africa for the period 2015-2022 can be seen:

Table 7: New vehicle sales (2015-2022) in South Africa (Good car bad car, Automotive sales data, 2023)

YEAR	NUMBER OF NEW VEHICLES	CHANGE TO PREVIOUS YEAR
2015	412.670	-6.05%
2016	361.289	-12.45%
2017	361.289	0.00%
2018	365.242	1.09%
2019	355.378	-2.70%
2020	247.571	-30.34%
2021	304.340	22.93%
2022	363.696	19.50%

The best-selling manufacturers in South Africa are Toyota (28,5%), Volkswagen (13,5%), Suzuki (10,8%), Ford and Nissan. Trends for new vehicles are similar to other countries, but with the addition of Volkswagen. As seen in the previous table, there were 363.696 cars sold in 2022, with also 135.666 Light Commercial Vehicles (LCV).

Most of the models those manufacturers sell come from local factories and assembly plants. This is due to the government supporting the automotive industry through a series of programs. The most recent one, the Automotive Production and Development Programme (APDP), implemented in 2013, aimed to stimulate the expansion of local production and increase the local content, with the goal of reaching 1.2 million vehicles manufactured per year. This program works through four main pillars, which are an Import duty; to freeze import duties on imported vehicles depending on where they come from, the Vehicle Assembly Allowance (VAA) BP; to support duty-free imports to vehicle assemblers, the Production Incentive (PI); to increase the Value Added by the manufacturer, and the Automotive Investment Scheme (AIS); to incentivise the public sector and support investments by OEMs (NAACAM, 2015).

The used vehicle market has similar trends to the rest of the continent, Japanese, German, Korean and American manufacturers dominate the market, but there is a notable presence of Italian and French manufacturers. Toyota, Kia, Volkswagen, Jeep, Opel, Renault, and Citroen have a big presence in the market, and, in a bigger proportion than in Ghana, semi-premium and premium brands like Mazda,

Mercedes, Audi, BMW and others is bigger and takes a notable part of the used car market. Vehicles in the secondhand market are also newer and have less mileage compared to the rest of African countries. Most of them are from 2014 onwards, with some exceptions, and the mileage can be very varied, with some cars with a few thousand kilometers up to more than 250.000km. The average used vehicle sold had around 79.000km in 2023, with an average age of 5 years. For the first half of 2023 (Jan-Jun), 168.897 used vehicles were sold in South Africa, while in the same period of time there were 174.229 new vehicle sales (without counting LCV), which represents how much bigger the new car market is in South Africa (Automotive Industry Portal - MarkLines, 2023).

2.4.3 Imported vehicles and their regulations

Import of used vehicles is banned in South Africa, their economy is significantly stronger than in other countries and the average household can buy a new car if needed. Under exceptions, it is possible to import second-hand vehicles into south Africa if a permit has been granted. Importing used vehicles is specially restricted to protect the local automotive manufacturing industry and permits are only issued under very specific circumstances.

Those exceptions are usually for returning South African nationals and immigrants with permanent residence and bring vehicles registered to their names. Other exceptions include import or racing cars, vintage passenger vehicles, specially designed vehicles, and inherited vehicles.

2.4.4 Vehicle technical inspections

Depending on the use and purpose of each vehicle, different periods of time are stablished to have the vehicle tested, as defined in the following bullet points:

- When registering a vehicle or when it changes ownership, not mandatory periodically, takes about 3-4 hours and checks extensively most of the car's components, it is defined as the owner's responsibility to go through them periodically when owning and maintaining a vehicle.
- If the vehicle is used for public transport or is a heavy-load vehicle (excluding buses), roadworthy certificates must be passed every year before renewing the motor vehicle licence.
- Buses are tested every six months

Inspections are carried and regulated by the government, most of the time, they are done through specialised companies like DEKRA and SGS.

Inspection requirements

- Identification: The engine and VIN must match those on the registration document. There must be no tampering of any vehicle identifiers. In the case of an engine change, all associated requirements must be in place (and logged on eNaTIS), including police clearance and data dotting.

- Body: There must be no damage or rust present that compromises the integrity of the body or chassis. There must be no damage that can cause an injury to pedestrians or cyclists. Doors should be easy to open from the inside and outside and be firmly attached at the hinges.
- Interior: The odometer and speedometer must be in working order. Seats must be secure without damage. All seatbelts must be operational.
- Lights and safety: All lights and indicators must be in good working order. All lights should be securely fitted and have no water ingress. The low and high beam functionality is tested, as well as the level of the beams. The hooter must be operational.
- Windows and windscreen: There should be no cracks on the windscreen. All windows designed to open should be able to open and close. Windscreen wipers should be in good order and operational.
- Wheels, tyres and brakes: Tyre and wheels must be the correct size and fall within manufacturer specifications. All tyres (included the spare if applicable) must have a tread depth of at least 1, 6 mm. Wheel bearings should run smoothly, with no play. Brakes on all wheels must be in good working order (likewise the parking brake). Brake discs should be in good working order and there should be no leaks from the hydraulic system.
- Suspension: Shock absorbers should be in good working order with no leaks present. Kingpins, control arms and anti-roll bars should be secure; any play must be within specification. Steering system must be in good working order. Wheel alignment should be within specification.
- Powertrain: The engine compartment should be free from damage and leaks. Engine and transmission mountings must be intact. The battery should be secured and have no cracks or leaks. No loose or damaged wiring should be present. No excessive smoke from the exhaust. Transmission should be in good working order.

2.4.5 Vehicle maintenance

There is a very well stablished network of dealerships and maintenance/repair centres in South Africa. Big urban areas are very well covered by all the manufacturers that sell new vehicles in the country, but also smaller urban areas and the rural areas close to them also have repair and maintenance shops available nearby. The majority of the population is covered by official centres, and to add to that, there are networks of well trained and skilled mechanics that also have more availability of spare parts and advanced tools in case there are no official centres nearby.

The problems of fuel quality and non-homologated modifications to vehicles are not as big of a problem as in Rwanda, Ghana, or Zambia, but some vehicles are still affected by the latter and the theft of valuable components.

2.5. CONSUMER INFORMATION AND NEW CAR ASSESSMENT PROGRAMS IN AFRICA

Consumer information provides potential car buyers and owners with information regarding safety performance of cars in crashes and encourages manufacturers to introduce designs based on safety beyond what the regulations require as a minimum.

Those designs have been evolving through the years with a wide variety of technologies, and the most common found methodology for ratings of those are the predictive rating systems. These aim to assess a vehicle crash safety performance before it is sold on the market and used on the roads. Controlled crash tests are performed for individual models, components of cars are also tested and even visual inspections and ratings of the interior of the cars are part of those predictive ratings. Programs like Euro NCAP have contributed to improvements in crash protective design to ensure vehicle occupants are safer with crash tests, which generally represent the most common crash scenarios found in each region, in this case in Europe. The European Commission believes that Euro NCAP is the nowadays the most important mechanism for achieving advances in vehicle safety, thanks to creating a competitive environment in which even manufacturers use good results from those tests as part of their advertising campaigns.

2.5.1 Global NCAP #SaferCarsForAfrica

#SaferCarsForAfrica was launched in November 2017 by Global NCAP and AA South Africa. The objective was to perform the first crash test assessments of some of the most popular compact and small cars sold in South Africa. There were 5 vehicles tested then, the Volkswagen Polo Vivo, Datsun Go+, Toyota Etios, Renault Sandero and Chery QQ3. The vehicles chosen were the entry-level version of each car model, which resulted in one of those models not being fitted with airbags as a standard.

Global NCAP awarded separately child safety rating and adult occupant rating in order to highlight the different levels of protections the cars provide to passengers on the rear seats. The assessment of child safety also checks the compatibility of the car to the child restraint system/seat each manufacturer recommends, as well as the level of protection it provides during the crash test.

In the recent years, more cars have been tested. Models which are more widely sold in other regions of Africa and have more representative results for more countries in the continent. All the models tested have to go through a crash test. It consists in a Frontal crash test against a deformable barrier at 64 km/h and with an overlap of 40%. It simulates a head on collision between 2 cars and follows the protocol described in Euro NCAP – ODB Frontal Impact Testing Protocol v7.0.1 Apr 2015.

Since July 2022, a Side Impact is also performed, but of all the vehicles that will be analysed in the following part, none of them went through it. This side impact follows the protocol described in Euro NCAP - MDB Side Impact Testing Protocol v6.0 Aug 2012.

2.5.2 Analysis of occupant safety for new cars sold in Africa

Within the #SaferCarsForAfrica campaign, 20 cars have been tested in the last 7 years. These are rated from 0 to 5 stars (0 to 17 points) in adult occupant safety and 0 to 5 stars (0 to 49 points) in child occupant safety. Criteria for awarding points can be found in the same Global NCAP official site,

Assessment Protocol July 2022 - 2025: Child Occupant Protection; Assessment Protocol July 2022 - 2025: Adult Occupant Protection.

In this section, an analysis of the ratings for 5 models can be found, with the objective of highlighting the previous problem mentioned of unsafe new vehicles in the African continent. One model has been selected as a reference, the Mahindra XUV300, since it was the first car to achieve 5 stars on adult occupant protection for Global NCAP #SaferCarsForAfrica. The remaining 4 models are amongst the most popular vehicles in the continent in different countries, the Toyota Yaris 2018, the Volkswagen Polo Vivo, the Chery QQ3 and the Nissan NP300 Hardbody. For the Nissan NP300, arguably the most popular model on the list, an analysis on a test from Global NCAP, can be found in this part too. This test consisted in a car-to-car crash between the variant sold as new in Africa and one sold in Europe as a secondhand vehicle. All the data and figures used in this section are from the Global NCAP database (Global NCAP, 2024).

Mahindra XUV300

Figure 1: Mahindra XUV300 Safety rating (Global NCAP, 2021)

The first model to be analyzed is the Mahindra XUV300. It is the only car to accomplish the maximum score of 5 stars in adult occupant protection for the #SaferCarsForAfrica campaign, with 16,42 out of 17,00 available points. For child occupant protection it achieved 4 out of 5 stars, with 37,44 points out of 49,00.

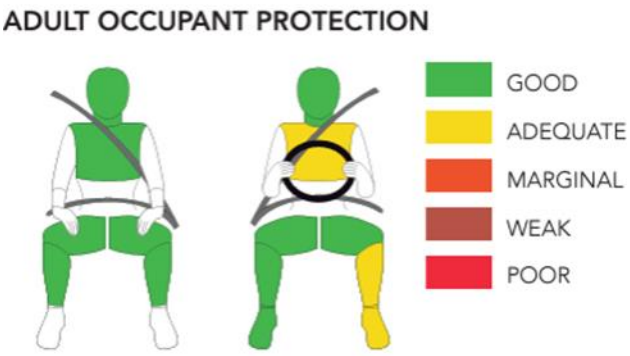

Figure 2: Mahindra XUV300 adult occupant protection diagram (Global NCAP, 2021)

To know why the vehicle has scored that well in the adult occupant protection score, a look at Figure 2 with each body-part assessment makes it clear. The protection offered to the driver and passenger's neck and head was good. Passenger's tibia and knee were also good. For the driver, the knees had good protection, but this time the left tibia, left foot and chest show adequate protection. The vehicle's bodyshell was rated as stable and capable of withstanding further loadings.

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The child seat used for the 3-year-old dummy was installed FWF with ISOFIX. A top tether was available to avoid excessive forward movement during the impact. The Child Restraint System (CRS) used for the 18-month-old dummy was also installed RWF with ISOFIX and support leg, protection offered to the 18-month-old dummy was good. CRS did not show incompatibility. The car offers ISOFIX and top tether anchorages in the 2 outboard rear seats and offers passenger airbag disconnection switch in case of a CRS needing to be installed in the front passenger seat.

Child restraints performance and safety equipment available can be found in the following Table 8:

Table 8: Child Restraints and Safety Equipment (Mahindra XUV300) (Global NCAP, 2021)

CHILD RESTRAINTS

	CHILD RESTRAINT	HEAD / CHEST	CRS TYPE	ADJUST	POSITION
18 MONTH OLD CHILD	BRITAX BABYSAFE W/BASE	PROTECTED/ GOOD	0+	ISOFIX /LEG	RWF
3 YEAR OLD CHILD	BRITAX DUO PLUS	PROTECTEED / FAIR	1	ISOFIX/TT	FWF

SAFETY EQUIPMENT

FRONT SEATBELT PRETENSIONERS	YES	SIDE BODY AIRBAGS	NO	SBR	YES
DRIVER FRONTAL AIRBAG	YES	SIDE HEAD AIRBAGS	NO	ISOFIX ANCHORAGES	YES
PASSENGER FRONTAL AIRBAG	YES	DRIVER KNEE AIRBAG	NO	ABS (4 CHANNEL)	YES

Toyota Yaris 2018

Figure 3: Toyota Yaris Safety rating (Global NCAP, 2018)

The next vehicle to be analyzed is the Toyota Yaris 2018 model. It obtained 3 stars in adult occupant protection (10,77 points out of 17,00) and 3 stars in Child occupant protection (29,09 out of 49,00 points).

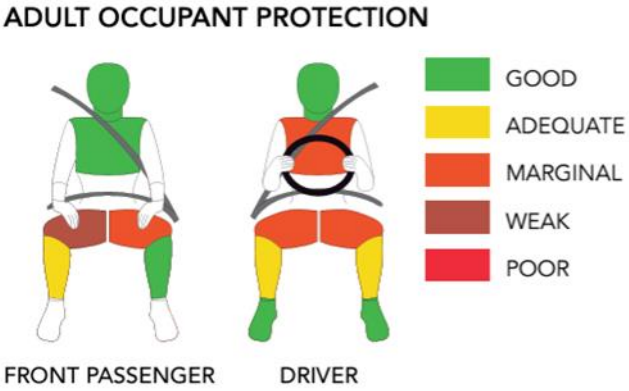

Figure 4: Toyota Taris adult occupant protection diagram (Global NCAP, 2018)

Looking at Figure 4: Toyota Taris adult occupant protection diagram, we can see why it scored the way it has. Protection to the Driver's head, neck and foot was good, also to the passenger's head, neck, chest and left tibia. Protection was adequate in driver's tibias and passenger right tibia. It was marginal for the driver's chest and knees and passenger left tibia, while it was weak on the passenger right tibia.

The child seat used for the 3-year-old was installed FWF with ISOFIX and the CRS used for the 18-month-old was installed RWF using ISOFIX and support leg, the latter offered good protection to head and chest. The 3-year-old dummy was prevented excessive forward movement during impact. The car offers 3-point belts in all seating positions and ISOFIX and top tether anchorages in the 2 outboard rear seats as standard. Child restraints performance and safety equipment available can be found in the following Table 9:

Funded by
the European Union

Table 9: Child Restraints and Safety Equipment (Toyota Yaris) (Global NCAP, 2018)

CHILD RESTRAINTS

	CHILD RESTRAINT	HEAD / CHEST	CRS TYPE	ADJUST	POSITION
18 MONTH OLD CHILD	MAXI COSI CABRIOFIX / FFIX	PROTECTED / PROTECTED	0+	ISOFIX /LEG	RWF
3 YEAR OLD CHILD	MAXI COSI PEARL / FFIX	PROTECTED / FAIR	1	ISOFIX /LEG	FWF

SAFETY EQUIPMENT

FRONT SEATBELT PRETENSIONERS	YES	SIDE BODY AIRBAGS	NO	SBR	YES
DRIVER FRONTAL AIRBAG	YES	SIDE HEAD AIRBAGS	NO	ISOFIX ANCHORAGES	YES
FRONT PASSENGER FRONTAL AIRBAG	YES	DRIVER KNEE AIRBAG	NO	ABS (4 CHANNEL)	YES

Volkswagen Polo Vivo

Figure 5: Volkswagen Polo Vivo Safety rating (Global NCAP, 2017)

The Volkswagen POLO VIVO analyzed is the 2017 model. It obtained 3 stars in adult occupant protection (10,81/17,00) and 3 stars in child occupant protection (30,52/49,00).

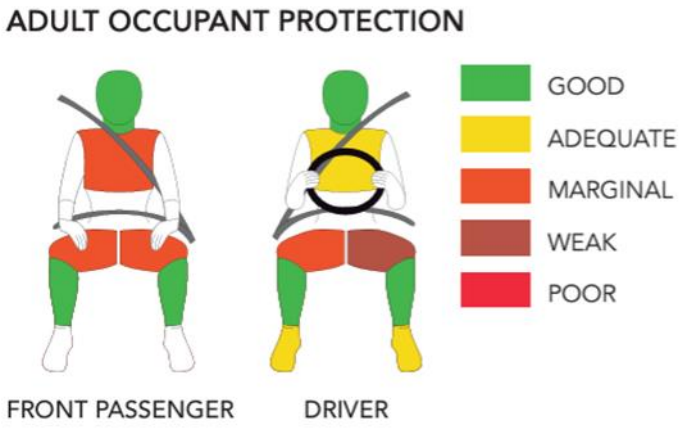

Figure 6: Volkswagen Polo Vivo adult occupant protection diagram (Global NCAP, 2017)

As seen in Figure 6: Volkswagen Polo Vivo adult occupant protection diagram, the protection offered to the driver and passenger's head and neck was good, also to both driver and passenger's tibias. Protection to driver's chest and foot was adequate and protection to driver's right knee and passenger's chest and knees was marginal. Lastly, protection offered to the driver's left knee was weak. There were dangerous structures behind the dashboard that the knees could impact with.

The 18-month-old dummy used a CRS, which was installed RWF using ISOFIX and support leg, offered good protection to head and chest.

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The seat used for the 3-year-old was installed FWF with ISOFIX and support leg, which was able to prevent excessive forward movement during the impact while also offering good protection to head and chest. 3-point belts are available in all seating positions and ISOFIX with top tether anchorages in the 2 outboard rear seats as standard. Child restraints performance and safety equipment available can be found in the following Table 10:

Table 10: Child Restraints and Safety Equipment (Volkswagen POLO VIVO) (Global NCAP, 2017)

CHILD RESTRAINTS

	CHILD RESTRAINT	HEAD / CHEST	CRS TYPE	ADJUST	POSITION
18 MONTH OLD CHILD	MAXI COSI CABRIOFIX / FFIX	PROTECTED / PROTECTED	0+	ISOFIX /LEG	RWF
3 YEAR OLD CHILD	MAXI COSI PEARL / FFIX	PROTECTED / FAIR	1	ISOFIX /LEG	FWF

SAFETY EQUIPMENT

FRONT SEATBELT PRETENSIONERS	YES	SIDE BODY AIRBAGS	NO	SBR	YES
DRIVER FRONTAL AIRBAG	YES	SIDE HEAD AIRBAGS	NO	ISOFIX ANCHORAGES	YES
FRONT PASSENGER FRONTAL AIRBAG	YES	DRIVER KNEE AIRBAG	NO	ABS (4 CHANNEL)	YES

Chery QQ3

Figure 7: Chery QQ3 Safety rating (Global NCAP, 2017)

The Chery QQ3 analyzed is a 2017 model. It obtained 0 stars in both adult and child occupant protection, with 0,06 and 2 points respectively. It is a vehicle being sold as new in some African countries and due to its low price has its popularity.

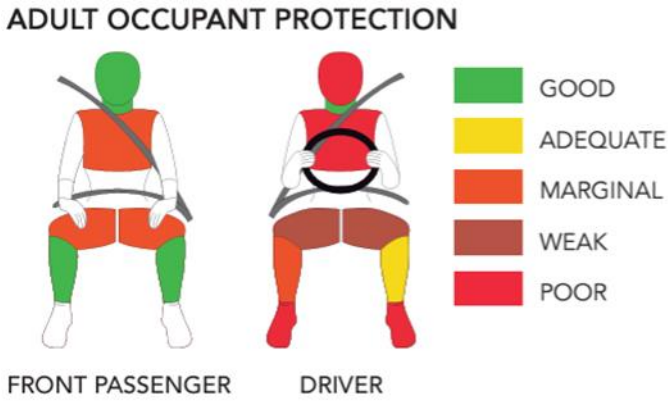

Figure 8: Chery QQ3 adult occupant protection diagram (Global NCAP, 2017)

As seen in Figure 8: Chery QQ3 adult occupant protection diagram, the protection offered to the driver's head, foot and chest was poor. Front passenger and driver knees could impact with dangerous structures behind the dashboard, offering marginal and weak protection. The passenger chest also offered marginal protection, and the only parts to get good protection were the driver's neck and the passenger's knees, head, and neck.

The car manufacturer did not recommend available CRSs for the test. The Q1.5 (18-month-old) showed good protection while the Q3 (3-year-old) offered marginal protection since the head was exposed during the impact. The CRS also showed incompatibility with the car restraint systems. In the figure below, the Child restraints performance and safety equipment can be found in the Table 11 below:

Table 11: Child Restraints and Safety Equipment (Chery QQ3) (Global NCAP, 2017)

CHILD RESTRAINTS

	CHILD RESTRAINT	HEAD / CHEST	CRS TYPE	ADJUST	POSITION
18 MONTH OLD CHILD	CHICCO KEYFIT	PROTECTED / GOOD	0+	BELTED	RWF
3 YEAR OLD CHILD	CHICCO ELETTA COMFORT	VULNERABLE / GOOD	1	BELTED	FWF

SAFETY EQUIPMENT

FRONT SEATBELT PRETENSIONERS	NO	SIDE BODY AIRBAGS	NO	SBR	NO
DRIVER FRONTAL AIRBAG	NO	SIDE HEAD AIRBAGS	NO	ISOFIX ANCHORAGES	NO
FRONT PASSENGER FRONTAL AIRBAG	NO	DRIVER KNEE AIRBAG	NO	ABS (4 CHANNEL)	NO

Nissan NP300 HARDBODY

Funded by the European Union

Figure 9: Nissan NP300 Hardbody Safety rating (Global NCAP, 2018)

The last car to be analyzed is also one of the most popular models in the continent. The Nissan NP300 HARDBODY (MY 2018) is an affordable Pick-up truck which tested to 0 stars for adult occupant protection (0/17,00) and 2 stars for child occupant protection (14,00/49,00).

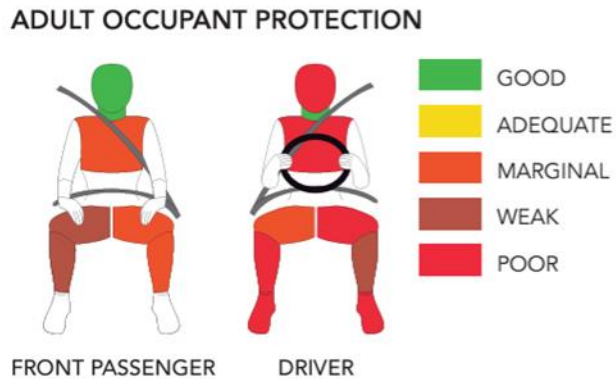

Figure 10: Nissan NP300 Hardbody adult occupant protection diagram (Global NCAP, 2018)

As seen in Figure 10: Nissan NP300 Hardbody adult occupant protection diagram, the protection offered to the driver's head, chest, left knee, right tibia, and foot was poor. The rest of the parts were between weak and marginal, except the neck, which offered good protection. Passenger chest and left knee and tibia offered marginal protection, while the right knee and tibia offered weak protection. There were dangerous structures behind the dashboard where knees and legs could impact.

For child occupant protection, the Q1.5 CRS was installed RWF using the adult seatbelt and offered good protection to head and chest. The seat for the Q3 was installed RWF with the adult seatbelt, although the CRS manufacturer does not recommend it. The car neither has a 3-point seatbelt or ISOFIX as standard.

Child restraints performance and safety equipment available can be found in the following Table 12:

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Table 12: Child Restraints and Safety Equipment (Nissan NP300 Hardbody) (Global NCAP, 2018)

CHILD RESTRAINTS

	CHILD RESTRAINT	HEAD / CHEST	CRS TYPE	ADJUST	POSITION
18 MONTH OLD CHILD	CHICCO KEYFIT	PROTECTED / PROTECTED	0+	BELT	RWF
3 YEAR OLD CHILD	CHICCO ELETTA	EXPOSED / POOR	1	BELT	FWF*

SAFETY EQUIPMENT

FRONT SEATBELT PRETENSIONERS	NO	SIDE BODY AIRBAGS	NO	SBR	NO
DRIVER FRONTAL AIRBAG	YES	SIDE HEAD AIRBAGS	NO	ISOFIX ANCHORAGES	NO
FRONT PASSENGER FRONTAL AIRBAG	YES	DRIVER KNEE AIRBAG	NO	ABS (4 CHANNEL)	YES

Nissan NP300 HARDBODY car-to-car crash comparison

Global NCAP performed a car-to-car crash for one of the best-selling pick up models in Africa, the Nissan NP300 HARDBODY. The test performed was against a second-hand Nissan Navara NP300 MY2015, which is manufactured in Europe. This car-to-car crash aimed at graphically demonstrating the double standard applied by some car manufacturers to vehicle safety in Africa (Global NCAP, 2020).

Figure 11: Car-to-car crash; Nissan NP300 Hardbody (L) and Nissan Navara NP300 MY15 (R) (Global NCAP, 2020)

This first test showed a massive difference between the two models. The European model was able to absorb most of the energy of the crash with the frontal structures through controlled deformation and energy dissipation, while the African model was not able to absorb the energy or dissipate it through and it ended up severely deforming the survival cell of the vehicle. The intrusion inside the cabin is excessive and the energy reaches the dummy, as it can be seen in Figure 11 on the left, which is the frame at the moment of impact between both the NP300 Hardbody and the Navara NP300.

The vehicle structure collapsed and resulted to be very unstable. Also, the high amount of stress and forces that went into the driver dummy during the test, added to the instability of the bodyshell made the airbags ineffective to dissipate any energy.

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Figure 12: Diagram and safety rating comparison between Nissan NP300 Hardbody and Nissan Navara NP300 (Global NCAP, 2020)

The differences in the respective assessments are shown in the diagram on the left, the Nissan NP300 HARDBODY shows the results from Global NCAP campaign #SaferCarsForAfrica in 2018, while the Nissan Navara NP300 shows the results from the Euro NCAP test performed in 2015. The diagram on Figure 12, the side of the NP300 HARBODY (left), shows that the vehicle offers between marginal and Poor protection for the driver, and similarly, the passenger has poor protection in the head section, while the NP300 Navara (right), shows good protection for driver and passenger minus the tibias for the driver, which show an adequate protection.

The dummies in the African model would have most likely sustained fatal injuries, while the dummy from the European model would most certainly have walked away from the accident with superficial injuries or none at all. Also, the European version of the car is fitted with many safety systems that could act before the accident, like an anti-skid system or Electronic Stability Control (ESC), while the African version does not equip any of those.

3. REGULATORY ENVIRONMENT IN EUROPE

European vehicles are fitted with a wide range of safety features to reduce the risk of dangerous situations and eventual crash consequences. In order for a vehicle to be sold within the European regions, they have to meet the demands of vehicle safety type of approval (active to passive safety, protection of vulnerable road users, post-crash rescue and general safety), environmental factors and conformity of production.

These requirements are part of global technical regulations for wheeled vehicles, equipment and parts which are managed by the UN ECE world forum for harmonization of vehicle regulation (WP.29). Among international regulations, the 1958 United Nations Agreements on regulations contains the legal framework to establish regulatory instruments for motor vehicles and their equipment and type of approval. Due to the extensive nature of the current vehicle technology, there are more than 150 regulations appended into the 1958 agreement with most covering single vehicle component or technology (UNECE - Inland Transport Committee, Walter Nissler, 2019).

Funded by the European Union

In addition to these regulations, vehicles in Europe must pass a technical inspection test under a legal time frame. The intervals at which vehicles need to be inspected vary from one European country to another. Overall, the results of these safety elements do not only affect the vehicle design, but it translated well into the reduction of injury risk of occupant and vehicle's crashworthiness.

In relation to the condition of vehicle fleet in the African continent, the UN Environmental Programme (UNEP) in collaboration with various international partners aims to aid Africa's sustainable transport development by providing safer and cleaner vehicle through the project "Safer and Cleaner Used Vehicles for Africa". This opportunity also brought a discussion with various African stakeholders such as The East African Community (EAC), Economic Community of West African States (ECOWAS), major vehicle exporters and African vehicle importers.

Following numerous discussion and considerations among stakeholders, the principal standards for used vehicles in Africa have been established as one of the key project outcomes. The minimum vehicle safety requirements are based on the 1958 UN Regulations which ensures the presence of safety elements to protect vehicle occupants and pedestrians from accidents (**Error! Reference source not found.**).

Table 13: Safety requirements for global and intra-African trade of new or used vehicles

Topic	Passenger cars	PTWs	Commercial vehicles
	UN Regulation	UN Regulation	UN Regulation
Active safety			
Brakes	R 13 H (incl. ABS)	R 78 (incl. ABS) GTR 3	R 13 (incl. EVSC)
Electronic Stability Control	R 140 / GTR 8		
Steering	R 79		R 79
Tyres	R 30/ GTR 16	R75	R 54
Mechanical couplings			R 55
Passive safety			
Helmets		R22	
Safety belts anchorages	R 14		R 14
Safety belts	R 16		R 16
Seats/ head restraints	R 17, R 25/ GTR 7		
Frontal collision	R 94		
Lateral collision/Pole side impact	R 95, R 135/GTR 14		
Pedestrian Safety	R 127/ GTR 9		
Child restraints	R 44		
Electric Vehicle safety	R 100/ GTR 20	R 136	
Cabs strength			R 29
General safety			
Buses and coaches			R 107
Safety glazing	R 43/ GTR 6		R 43
Devices for indirect vision			R 46
Underrun protection			R 58, R 93
Lighting and light installation			
Installation of lighting	R 48	R 53, R 74	R 48

This concept encourages global and intra-African transfer of new or used vehicles and their components, provided they fulfill the necessary conditions at the point of export from the registered

country of vehicle or parts registration and quantifiable definition of “used quality vehicle” (WP.29 - UNECE, 2022), (CITA International Motor Vehicle Inspection Committee, 2022).

The section 3.1 will highlight all of the recommended regulations as well as our recommended UN Regulation that can positively contributes to road safety. Some regulations directed towards safety of commercial vehicles will also be highlighted. The subsection 3.2 will supplements the information regarding the current vehicle regulation from the East African Community (EAC) regarding the use of commercial vehicle.

3.1. UN VEHICLE REGULATIONS

Active Safety counts as safety measures to prevent any kind of crash and to reduce the crash energy (by lowering vehicle speed). As the majority crash causes can be traced back to human errors, these active systems can react faster than human and intervene in a critical situation by sending acoustical / haptic warning or applying breaks and corrective steering measures to avoid crash.

☐ = *Recommended Regulation by the ECE for covering “basic safety aspect” of a vehicle* (CITA International Motor Vehicle Inspection Committee, 2022)

Table 14: Active Safety UN Regulations

UN-Regulation	Safety Feature	Description
R 13 / R 13H	Braking system (incl. ABS)	**Scope:** Vehicle in M1 and N1 categories **Aim:** Universal provision of braking system control, braking test, its performance and response time. Heavy Duty Vehicle is applied to UN R. 13 with additional requirement to air brake systems, braking compatibility for towing trailers, Endurance of braking systems.
R 78 GTR 3	Braking system (incl. ABS)	**Scope:** Vehicle in L categories (PTW, 3-wheelers and quadricycles) wit max. speed of 25 km/h. **Aim:** Universal provision of general operation of braking systems, braking test, parking brake systems and ABS test.
R 30/GTR 16; R 75; R 54	Tyres	**Scope:** Air tires for vehicle M1, O1 and O2 categories **Aim:** Universal provision of tires dimension, tire performance test under maximum normal load, tread wear indicator and markings.
R 55	Mechanical Coupling	**Scope:** device and components for motor vehicles and trailers **Aim:** This regulation establishes international requirements compatibility for mechanical coupling devices and its components
R 79	Steering system	**Scope:** Steering System for vehicle M, N, O categories **Aim:** Universal provision to establish minimum requirements for the layout and performance of steering systems fitted to vehicles used on the road. Additionally, autonomous steering system is address in this regulation as well.

R 140 / GTR 8	Electronic Stability Control (ESC)	**Scope:** Vehicle in M1 and N1 categories **Aim:** Universal provision of ESC-system's design, functional requirements, performance in slippery and unstable condition and robustness of ESC-systems in normal use (i.e. corrosion)
R 64	Temporary tyre spare unit & Run-Flat Warning Systems (RFWS)	**Scope:** Spare tyres and tyre pressure loss warning system for vehicles of category M and N **Aim:** Universal provision of dynamic performance test of temporary tyre unit (braking and deviation) and Run-Flat warning systems under possible loss of tyre pressure scenarios.
R 130	Lane Departure Warning System (LDWS)	**Scope:** LDW of vehicle in categories M2, N2, M3 and N3 **Aim:** Universal provision of general requirements, mechanical, dynamic and environmental test as well as warning provided by the system. LDWS alerts the driver when the vehicle unintentionally veers away from its designated travel lane.
R 131 / R 152	Advance Emergency Braking Systems (AEB)	**Scope:** AEBS of vehicle in categories M2, M3, N2 and N3 (R 131) and of vehicle categories M1 and N1 (R 152) **Aim:** AEBS operates by recognizing a potential collision ahead and issue visual and acoustical warning to the vehicle driver. If there are no response from the driver, AEBS initiates the braking system to slow down to prevent collision.
R 139	Brake Assist System (BAS)	**Scope:** BAS of vehicle in categories M1 and N1 **Aim:** BAS assists the driver in applying appropriate brake pressure to decelerate the vehicle and reduce the severity of a collision. It activates when the vehicle sensors detect a potential collision and detect either insufficient brake pressure or no response from the driver to mitigate the critical event.
R 157	Automated Lane Keeping System (ALKS)	**Scope:** ALKS of vehicle in category M1 **Aim:** When activated by the driver, ALKS takes over the lateral and longitudinal control of a vehicle and keeps the vehicle within its current lane. R 157 limits the operational speed of ALKS up to 60 km/h.

Passive Safety counts as safety measures to reduce the consequences of accident (property damage and personal injuries). These systems are built in as the vehicle structure or deployed if a crash is imminent and cannot be avoided.

Table 15: Passive Safety UN Regulations

UN-Regulation	Test Methods	Description
R 14	Safety Belt Anchorages	**Scope:** Safety / Seat Belt Anchorages for all types of vehicles **Aim:** Universal provision of requirements of the safety belt anchorages in regard to their minimum numbers, their locations, static strength to reduce the possibility of their failure during crashes for effective occupant restraint and the test procedures.
R 16	Safety Belts	**Scope:** Safety Belts for all types of vehicles

		Aim: Universal provision of tests for assembled safety-belts and their additional safety features to ensure their robustness and optimal occupant restraint during crashes.
R 17	Seats	**Scope:** All vehicles category M and N (forward facing only) **Aim:** Universal provision of vehicle seats, their anchorages and any head restraints
R 22	Helmet and visors	**Scope:** Protective helmets for drivers and passengers of PTW and (if any) sun visors of the helmet **Aim:** Universal provision of helmet structure, impact absorption test and helmet straps.
R 25 / GTR 7	Head restraint	**Scope:** Vehicles category M and N (forward facing only) **Aim:** Universal provision of head restraint general requirements, establishment of reference points and static test.
R 29	Cabs Strength of commercial vehicle	**Scope:** Driver's cab of vehicle category N1 **Aim:** Universal provision of occupant protection by ensuring sufficient structural safety for the cab of a commercial vehicle, necessitating controlled deformation that doesn't excessively intrude into the occupant's survival space.
R 44 / R 129	Child Restraint System (CRS)	**Scope:** CRS design for vehicles with 3 or more wheels **Aim:** Universal provision to establish CRS category, general requirements, various test (durability, dynamic crash, etc.), CRS placement on a vehicle seat and its installation direction. The newer regulation R 129 improve CRS safety by adding requirements to side crash test, overhaul of CRS category based on child's height and new instruction for direction of CRS installation.
R 94	Offset Frontal	**Scope:** Vehicle category M1 and N1 **Aim:** Universal provision of occupant protection for frontal crash against a 40% offset deformable barrier at 56 km/h crash speed, evaluating energy dissipation throughout the car structure to avoid intrusion into the deformed side of passenger compartment.
R 95	Side Barrier	**Scope:** Vehicle category M1 and N1 **Aim:** Universal provision of occupant protection for side crash against a moving deformable barrier at 50 km/h crash speed. This test simulates a perpendicular side crash with another dynamic vehicle and ensures adequate occupant side protection.
R 127 / GTR 9	Pedestrian Protection	**Scope:** Vehicle category M1 and N1 **Aim:** Universal provision of vehicle's pedestrian protection on the front structure. Test methods for pedestrian protection range from head impact for adult & child on vehicle bonnet and upper and lower leg impact on the front bumper
R 135 / GTR 14	Side Pole	**Scope:** Vehicle category M1 and N1 **Aim:** Universal provision of occupant protection for side crash against a rigid pole at 32 km/h crash speed. In Addition to R 95 side crash test, this regulated test stressed the side impact

		protection of drivers head and simulates crashes into rigid roadside objects such as trees or poles.
R 34	Fuel tank safety – fire risk	**Scope:** Tank(s) for liquid fuel of vehicle category M, N and O **Aim:** Universal provision to prevent fire risk in case of collision (frontal / lateral and rear). This regulation assesses the leakage of liquid fuel and potential occurrence of fire due to the fuel leakage after the required impact test.
R 114	Replacement Airbag	**Scope:** Airbag modules replacement for all vehicle category, replacement steering wheel equipped with an airbag module of M1 and N1 vehicle category, replacement airbag outside of steering wheel **Aim:** Universal provision to aftermarket airbag module to ensure their functional integrity due to varying degree of product characteristics.
R 124	Replacement wheels	**Scope:** non-manufacturer replacement wheels for vehicles in categories M1, G, O1 and O2 **Aim:** Universal provision of general requirements for replacement wheels categorized as identical / replica outside of the original wheels authorized by the vehicle manufacturer.
R 125	Forward field of vision	**Scope:** 180° forward field of view of driver's category M1 **Aim:** Universal provision to ensure adequate field of vision provided by the windscreen for the driver.
R 137	Full Frontal Rigid Barrier	**Scope:** Vehicle Category M1 and N1 **Aim:** Universal provision of occupant protection for frontal crash against a full width rigid barrier at 50 km/h crash speed. This test places high demands on the restraint systems in front and rear seating position

General Safety:

Table 16: General Safety UN Regulations

UN-Regulation	Safety Feature	Description
R 43/ GTR 6	Safety Glazing	**Scope:** all vehicles equipped having glass material **Aim:** Universal provision of safety glazing materials, installation on vehicles, testing of safety aspect and general requirements intended to reduce the possibility of injury.
R 46	Devices for indirect vision	**Scope:** all devices for direct and indirect vision (conventional mirrors, vehicle camera systems and other devices giving indirect field of view to the driver. **Aim:** Universal provision of three classes and general requirement for these devices.

R 58 (Rear)	Rear Underrun Protective Devices (RUPD)	**Scope:** RUPD devices for vehicle categories N, O **Aim:** Universal provision of general requirements for RUPD device to protect the whole rear width against rear crashing of vehicles of category M and N. RUPD ensures the crash compatibilities between larger and smaller vehicles.
R 93 (front)	Front Underrun Protective Devices (FUPD)	**Scope:** FUPD devices for vehicle categories N **Aim:** Universal provision of general requirements for FUPD device to protect the whole front width against front crashing of vehicles of category M1 and N1. FUPD ensures the crash compatibilities between larger and smaller vehicles.
R 100 / GTR 20	Electrical safety for vehicles with 4 or more wheels	**Scope:** Electrical vehicles of category M and N with Rechargeable Energy Storage System (REES) & electric light-duty vehicle with a top speed exceeding 25 km/h **Aim:** Universal provision of testing safety requirements for lithium batteries under regular vehicle use (vibration test, thermal shock and cycling, electric shock, etc.)
R 136	Electrical safety for PTW	**Scope:** Electrical vehicle of category L for its power train and REES **Aim:** Universal provision of testing safety requirements for lithium batteries under regular vehicle use (vibration test, thermal shock and cycling, etc.). R 136 does not cover for post-crash requirements in comparison to R 100.
R 107	General Construction of Buses and Coaches	**Scope:** vehicle of category M2 or M3 **Aim:** Universal provision of general requirements, vehicle stability test, fire suppression system and protection against fire risk (batteries, fire extinguishers, fire detection, etc.)
R 105	Vehicle for transportation of dangerous goods	**Scope:** Vehicle category N and O intended for carrying dangerous goods by road **Aim:** Universal provision of various requirements to ensure safe transportation of materials classified as dangerous goods.
R 160	Event Data Recorder (EDR)	**Scope:** EDR for vehicle category M and N **Aim:** Universal provision of minimum data collection, storage and crash survivability of EDR. Data elements in the EDR recordings offers a comprehensive understanding of crash occurrence and an efficient crash investigation.

Lighting and light installation:

Table 17: Lighting and light installation UN Regulations

UN-Regulation	Safety Feature	Description
R 48	Installation of lightning and light-signaling devices	**Scope:** Vehicles of categories M, N and O **Aim:** Universal provision of headlights, taillights, stop lamps, turn signals, and hazard lights of a vehicle or trailers. The regulation specifies the size, shape, color, and location of these device and methods to verify conformity of the regulation.

		Additionally, this regulation builds upon the technical requirements for signaling of Emergency lane-keeping systems.

3.2. EAST AFRICAN COMMUNITY VEHICLE REGULATIONS

The East African Community (EAC) is an intergovernmental organization consisting of seven States: Burundi, Democratic Republic of the Congo, Kenya, Rwanda, South Sudan, Uganda, and Tanzania, with its headquarters in Tanzania. The EAC focuses on promoting cooperation in political, economic, and social sectors among its members, and has made significant progress in regional integration, including the establishment of a customs union and a common market. The community has successfully implemented the EAC Vehicle Load Control Act (2016) which intend to establish legal framework to control vehicle loads, enforcing harmony, institutionalizing arrangements for the regional trunk road network within the community, and addressing related issues. This led to establishment of related regulations further describing requirements for commercial transport within the community road network (see Table 18 below) (East African Comunity, 2018)

Table 18: East African Community vehicle load control regulations

Regulation Name	Regulated Measures	Description
East African Community (EAC) - Vehicle Load Control Regulations, 2018	Vehicle Dimension & Axle Configurations	**Aim:** Conformity of vehicle dimension and their axle configuration when operating within regional trunk network. Further, this regulation specifies the gross vehicle weight, axle loads limit and max. volume capacity for vehicle transporting liquid cargo in bulk
	Enforcement Measures	**Aim:** Enforcement of weighbridges or truck scale to ensure truck loads are not overweight in accordance with EAC road regulation. In case of overloading, this regulation also specifies the procedure to initiate penalties in form of fees and demerit points.
	Special Loads	**Aim:** Special permit for commercial vehicle to carry loads categorized special load which further divided into *abnormal, awkward, hazardous, unstable and super loads*. This regulation also specifies compliance to the condition of transport for the specified goods covering the general safety measures and precautions.

4. RECOMMENDATIONS FOR VEHICLE SAFETY

In this section, the objective of the deliverable is developed. A series of recommendations and training material have been worked on. These recommendations focus on the regulatory environment regarding vehicle safety on their first part, from Periodical Technical Inspections to Technical Regulations and requirements for the approval of new vehicles.

The second part contains an aftermarket opportunity that has been worked on too. It consists in retrofitting new devices into the existing vehicle fleet of the selected African countries.

Lastly, this section also contains a summary of the content presented in the Safe Vehicles Summit, a training regarding vehicle safety that was performed on October the 20th, 2023 in Kigali. Summaries of the presentations can be found, with also feedback we have been getting from the participants that assisted the training.

4.1. GENERAL RECOMMENDATIONS AND PROGRESSIVE REGULATIONS

In an effort to make a significant change, a set of progressive regulations, which are an adaptation of existing ones in other parts of the world (UNECE regulations), should be adopted by the selected countries in this project (Rwanda, Ghana, Zambia, and South Africa). Those are mainly based around passive safety of vehicles, which is probably one of the biggest areas of impact on avoiding and reducing the severity of road accidents, but also include other regulations as countries start adapting to them. The prohibition of importing used vehicles is not contemplated, since buying new vehicles is still far from affordable to most of the population and they rely on the used vehicle market. Furthermore, in 5-10 years, the vehicles that will be imported to Africa will be compliant with current safety standards if adequate measures are taken. The aim of these progressive regulations is to allow each of the countries to adapt to modern standards for new vehicle sales at an assumable progress rate without having to redirect investment and resources from other sectors into this vehicle fleet renewal.

The regulations that will be adapted are mainly UNECE vehicle regulations for new vehicles sold in African countries. Created and managed by the WP.29 of the Inland Transport Committee of the United Nations Economic Commission for Europe, these are a uniform system of regulations for the design, construction, and approval of wheeled vehicles to facilitate their international commercialization (UNECE Vehicle Regulations). Most of those regulations cover a single component of the vehicle or technology and the equipment and parts which can be fitted or used.

In Africa, there are a lot of inequalities between countries, and imposing a standardized set of regulations on every one of them at the same time would not be fair and possible. Lots of countries may not even have enough resources to make that adaptation and could create more differences between them. This can be mitigated by following a path of regulations which go from less restrictive to adding themselves to the UNECE regulations and adapting a New Car Assessment Program (NCAP). Having these progressive regulations allows us to create a path to a Standard regulation without leaving any country behind; every one of them can start the path at the most convenient stage for them. These regulations have the aim to properly help in renewing the vehicle fleet in order to lessen fatalities in African roads.

The first steps/phases of the path, only consider the most basic factors involved in how the current African vehicle environment is developed. Those first regulations and standards should be to make sure the most basic things are made properly, such as PTIs, their enforcement, creation of certified repair centers, training of professionals to carry over mechanical interventions and ease of taxes to spare parts adapted to incomes of each country. These first **phases (1-2)** should include the next action items and regulations:

- Standardized PTIs: set of Check points to go over and enforcement in urban and rural areas. This last point could be achieved by creating a database with numberplates and associated data regarding PTIs and vehicle roadworthiness, then adapting cameras to recognize numberplates and cross-reference with the data and check if vehicles are roadworthy and apply the corresponding sanctions if they are not.
- As a reference, PTIs should follow a similar set of checks for cars and other types of vehicles of greater mass as follows (inspections based on ISO 17020 and checks as done in Spain):
    - VIN on the car same as papers
    - Number plates well fixed and readable
    - Corrosion and oxidation in the body/underbody
    - Bumpers in place and well fixed, without any damages potentially dangerous for pedestrians
    - Interior of the car without parts that might be dangerous
    - Seats fixed properly and belts lock when they have to
    - Doors must close properly
    - Windows must go up and down easily
    - Claxon must work, steering wheel must have anti-theft block
    - Speedometer must be working properly
    - Windshield wipers must have liquid and the blades must be ok
    - Danger/engine/airbag lights turn off when starting the car
    - All lights must be working, long beam, dipped and position lights, braking lights, reverse and blinkers
    - Windshield nor any window must have any cracks or be broken
    - Side mirrors must be in place and without damage
    - Tire's drawing deep is checked, size, speed code and load index too
    - The vehicle's power, brake balance and suspensions are checked

- Possible leakages anywhere in the underbody; fuel tank, exhaust, catalytic converter, direction rods, overalls, silent-blocks and springs
- Emissions are checked at the end of the inspection

- For powered two wheelers and motorcycles (also based on ISO 17020):
  - The VIN must be in a good state and without modifications, it should be the same as on the motorcycle documentation.
  - Front lights, brake lights, number plate light, blinkers and catadioptric lights must be working.
  - Side mirrors must be fixed as stated by the manufacturer, must be in a good state and if they are not OEM's, they must be homologated.
  - The handlebar must work as intended and so it must not be broken or faulty.
  - All direction systems, including direction block as an anti-theft measure must work.
  - Numberplate must be properly fixed so it doesn't move around, and it complies with the minimum slope angle so it can be read properly. If it's a metallic numberplate, it must be mounted on a license plate holder, so it doesn't present dangerous edges.
  - Tyres, apart from having to coincide with the ones stated in the data sheet, must be in good condition and have the right pressure.
  - The side stand must do its job and stop the engine when it is taken out. When the motorcycle is put up again, it must fold back to its original position.
  - The effectiveness of the braking is checked, front and rear.
  - Suspension must work as intended.
  - Check for possible liquid drains, such as oil, gas... Also, the condition of the gearbox is checked.
  - Tests for polluting emissions are made, those being noise and carbon monoxide emissions, according to the legal limits or the limits stated by the motorcycle manufacturer.
  - If the vehicle has any modification or notable repairs, they will be checked to be in the motorcycle's datasheet.

PTIs/VTIs should be passed periodically, so the condition of vehicles never goes below a desired safety standard. Depending on vehicle use and purpose, different periods are stablished to pass those inspections, and the recommended would be the following, as the Spanish regulation states (count starts at the moment the vehicle leaves the dealership when first new):

- Motorcycles, 3-wheeled vehicles, quadricycles, light quadricycles, quads and three wheeled mopeds: exempt for the first 4 years, after that, every 2 years
- 2-wheeled mopeds: exempt for the first 3 years, after that, every 2 years
- Private use vehicles dedicated to people transportation (cars), excluding the previous 2 categories, with up to 9 seats, including the driver. Includes motorhomes and home vehicles: exempt for the first 4 years, between 4 and 10 years, every 2 years, and for vehicles older than 10 years, every year

- Ambulances and public service vehicles dedicated to people transport, including school transportation, with or without taximeter with up to 9 seats, including the driver: for the first 5 years, once per year, after that, twice per year
- Rental vehicles, with or without driver and driver's school, dedicated to people transportation, with up to 9 seats including the driver. Also including motorcycles, 3-wheeled vehicles, quadricycles quads, mopeds and light quadricycles: exempt for the first 2 years, between 2 and 5 years old, once a year, after 5 years, twice a year
- Vehicles dedicated to people transportation, including school transportation and underage people, with seating capacity for 10 or more, including the driver: for the first 5 years, once a year, after that, twice a year
- Vehicles or set of vehicles dedicated to goods transportation, with a Maximum Authorized Mass lower or equal to 3,5 tons: exempt for the first 2 years, between 2 and 6 years, every 2 years, between 6 and 10 years, yearly and more than 10 years twice a year
- Vehicles dedicated to goods transportation with a Maximum Authorized Mass over 3,5 tons: once a year until 10 years, after that, twice a year
- Towed caravans with a Maximum Authorized Mass over 750 kg: exempt for the first 6 years, every 2 years after that
- Agricultural tractors, self-propelled agricultural machinery, agricultural trailers and other special agricultural vehicles, except walking tractors or similar machines: exempt for the first 8 years, from 8 to 16 years, every 2 years, after that, once a year
- Vehicles dedicated to construction and services and self-propelled machinery, with the exemption of those whose original max. speed is lower than 25 km/h: exempt for the first 4 years, between 4 and 10 years, every 2 years, after that, once a year
- Mobile transformer stations and vehicles adapted for circus machinery or traveling recreational fairs: exempt for the first 4 years, between 4 and 6 years, every two years and after that, once a year

To add to this, to ease the problem of vehicle maintenance, manufacturers should give support to repair shops (more access to spare parts and modern tools, including diagnosis tools, online trainings for modern vehicles, or online live repairs with on-site mechanics) and create franchises with well-trained mechanics and technicians (smaller centers with capabilities for areas with limited access to centers located in urban areas). Optimally, an already existing quality standard should be adopted to support this environment that wants to be created with trained technicians and mechanics.

These first 2 phases should make mandatory Traction Control Systems (TCS), ABS, ESC, seatbelts in all seating positions and at least a Driver and front passenger airbag. They should also adapt the regulations proposed in the East African Community meeting that took place in September 2022 that involved several stakeholders. The regulations included are the following:

- For passenger cars:
  - Active safety: Brakes (R13 H, including ABS), ESC (R140 GTR 8), Steering (R79), Tyres (R30/GTR16)
  - Passive Safety: Safety belts and anchorages (R14), Safety belts (R16), Seats/head restraints (R17, R25/GTR 7), Frontal collision (R94), Lateral

collision, pole side impact (R95, R135/GTR 14), Pedestrian safety (R127), Child restraint systems (R44), Electric Safety (R100)
        - General safety: Safety Glazing (R43)
        - Lighting and light installation: Installation of lighting (R48)
- For PTWs
    - Active Safety: Brakes (R78, including ABS/GTR 3), Tyres (R75)
    - Passive safety: Helmets (R22), Electric PTW safety (R136)
    - Lighting and light installation: Installation of lighting (R53, R74)
- For commercial vehicles and trucks:
    - Active safety: Brakes and EVSC (R13), Steering (R79), Tyres (R54), Mechanical couplings (R55)
    - Passive Safety: Safety belts anchorages (R14), Safety belts (R16), Cabs strength (R29)
    - General safety: Buses and coaches (R107), Safety glazing (R43), Devices for indirect vision (R46), Underrun Protection (R58, R93)
    - Lighting and light installation: Installation of lighting (R48)

Also, starting from these first 2 phases and onwards, the import of used vehicles should be limited to vehicles with an age of 6 to 8 years at most and have a valid roadworthy certificate, that is not to expire in the following 2-4 months.

The following **phases (3-4**) should start adapting the remaining Passive and General Safety regulations: Fuel tanks safety and prevention of fire risks (R34), Lateral Protection of goods vehicles (R73), Seats of Large passenger vehicles (R80), Replacement brake lining assemblies and drum brake linings for power-driven vehicles and their trailers (R90), Retro-reflective markings (heavy and long vehicles) (R104), Vehicles for the carriage of dangerous goods (R105), Replacement airbag (R114), Replacement wheels (R124), Frontal Full-width impact (R137), Child restraint anchorages (R145), etc.

In the last **phases (5-6)**, the remaining regulations for Advanced Driver Assistance Systems (ADAS) and other monitoring devices (Lane Departure Warning (R130), Advanced Emergency Braking (R131), Brake Assist (R139) …), and other assistance and monitoring systems (tyre pressure monitoring system, blind spot monitoring system, etc.) will be adopted. Also, ADAS for commercial vehicles, trucks and buses like Intelligent Speed Assist, Driver Drowsiness and Alertness Warning, Brake Assist, Autonomous Emergency Braking, Pedestrian Detection, Lane Keep Assist, Lane Departure Warning, and Automatic High Beams should be made mandatory for all new vehicles.

After this last phase, the adoption of the full UNECE vehicle regulations will be made. At the same time, a New Car Assessment Program should be adapted or created for all the countries in the African region. As seen before, Global NCAP already has the #SaferCarsForAfrica campaign, but the number of cars being tested is insignificant compared to the variety of new cars that can be bought. Furthermore, the Global NCAP only consists of a frontal crash and a lateral crash, which does not provide enough information on occupant safety and does not provide any information on Vulnerable Road Users or Safety Assists, and the information regarding Child Occupant Protection is also quite

limited. The best options would be to evolve the existing protocols for Global NCAP or adapt one that already exists and has this information for consumers.

Other measures should be taken to control the used vehicles that enter the continent. Not every person will be able to buy a new car in the following years, that is why having established PTI centers and OEM maintenance centers is a key point. The used and the imported used vehicle market is something that will not disappear and will still play an important role in developing a safer vehicle fleet if the correct measures are taken.

One way to assure that a vehicle is imported and sold in a good status is through a Vehicle Technical Inspection (VTI). Nowadays, vehicles are imported to Africa in a bad status or very deteriorated and even after being involved in accidents without being repaired. Some countries already perform pre-import vehicle inspections, like Japan, but in order to have certain control over the safety of the vehicle fleet, there should be technical inspections before a vehicle is sold. This way, the used and imported vehicle market could be used to heal the vehicle fleet by selling vehicles in optimum condition. Used and imported vehicles should go through extensive Technical Inspection before being sold to have them in a correct status. It should be compulsory from the first phase that every vehicle sold goes through an inspection.

Lowering taxes on imported parts is a key aspect to make a change and make it possible to maintain an optimum vehicle status. Average African incomes can't afford repairs and maintenances because of high spare part costs and their low availability. By lowering the taxes, repairs and maintenance would be more affordable and consequently, demand for those parts would rise and compensate for the lower taxes.

There is another way, but a very complex one, to ease the problem of high prices, low quality and the bad status of used vehicles and it is to create a chain of local manufacturing. By doing this, new cars are sold directly in the country where they are manufactured and thus, prices are significantly lower, narrowing down the gap with used and imported vehicles and new vehicle demand could be covered. The main problem is that to begin with this, a huge industry should be developed in some of these countries. From creating Tier 3 (supply of raw materials), Tier 2 (supply of subcomponents) and Tier 1 (supply of major components) manufacturers, to creating or bringing Original Equipment Manufacturers (OEM) to build their vehicles on African soil. There are enough resources to extract material from the soil and to sustain themselves, but there is a lack of investment and qualified personnel to do so.

To add to this, the African Continental Free Trade Agreement should be boosted so countries in the group can codevelop themselves. It is currently ratified by Republic of Burundi, Democratic Republic of Congo, Republic of Kenya, Republic of Rwanda, Republic of Uganda, and the United Republic of Tanzania, with Republic of South Sudan in the process too. The idea behind the AfCFTA is to create the largest free trade area bringing together the 55 countries of the African Union (AU) to create a single market for the continent and to enable the free flow of goods and services across the continent and boost the trading position of Africa in the global market. It wants to eliminate trade barriers to

help in creating and establishing regional value-added production across all service sectors, with potential to foster industrialization, job creation and investment (East African Community, 2022).

4.2. ADAS RETROFIT DEVICES

4.2.1 Rationale

The review of road crashes in Rwanda, Ghana, South Africa and Zambia, performed in task 1.1 and reported in the deliverable "D1.1: Results of accident analysis and SoA review" has evidenced that 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 ADAS. Sections 2.1 and 2.2 of this document called for the introduction of ADAS in vehicles as a valuable contribution to increase road safety.

At the same time the circulating park of cars in Africa is largely comprised of secondhand vehicles, which are not equipped with up-to-date assistance systems and the substitution with brand new vehicles is still marginal. In addition, the replacement of HGVs with new ones, prompted by the necessity to introduce ADAS, is not viable because of costs. These considerations have supported a review of available ADAS retrofit systems as a tradeoff and cost-effective solution, which could revamp the current HGV fleet and produce tangible results in the short/medium period (Kuehn, 2011), (J. Scholliers, 2020).

4.2.2 Review of available retrofit systems

ADAS encompass different technologies ranging from "simple" warnings to the driver to a direct actuation of the vehicle (e.g. ACC, AEB, ESC, ISA, LKA, RSC and YSC). The latter category offers enhanced functionalities as it overcomes the behavioral limits of the driver due to inattention or failure inappropriately judging the scenario or performing the appropriate evasive maneuver in terms of response time and intensity. Nonetheless they required a deep integration into the vehicle and cannot be installed as aftermarket products.

In the study the focus concentrated on those ADAS functions, which are available in aftermarket products to retrofit vehicles in the circulating park. These systems have an inherent limitation: they provide a warning, and more generally information to the driver, who is still in charge of implementing the most appropriate maneuver to eliminate the risk. As such they cannot provide support in all those conditions where an accident occurs due to the "failure to act" of the driver. Nonetheless, these systems could be cost-effective solutions to steepen the curve of ADAS introduction in the circulating park and still enhance road safety. As a side effect, they stimulate the adoption of a safer driving style and thus the driver is actively involved in an improvement process. In addition, some systems record and make available driving data and thus they enable the possibility of a review of safety relevant driving conditions with a *more expert driver* in the typical process of peer-to-peer training.

In the review of the aftermarket products the following technologies were identified:

- FCW: Forward Collision Warning
- BSD: Blind Spot Detection system
- LDW: Lane Departure Warning
- SLI: Speed Limit Information
- DDR (ADR): (Advanced) Driver Distraction Recognition and warning
- REV: Reverse Collision Warning
- TPM: Tyre Pressure Monitoring System
- VIS-DET: Vulnerable Road user detection and warning on front and side of vehicle
- HMW: Headway Monitoring Warning
- FCDA: Front Car Departure Alert
- PCW: Pedestrian Collision Warning
- CCW: Cyclist Collision Warning
- MCW: Motorcycle Collision Warning
- UFCW: Urban Forward Collision Warning
- VIRTUAL BUMPER
- DVR: Digital Video Recorder
- FVSA: Forward Vehicle Stop Alert
- DVR (DASH CAM)

As is evident from the above list, different manufacturers use overlapping and different definitions for their systems (e.g. VIS-DET includes PCW, CCW and MCW). However, we decided not to modify the manufacturers' acronyms to facilitate the comparison of the information in this deliverable with the official websites.

The review allowed us to identify 18 manufacturers and 30 models as shown in Table 20 and Table 21. The set of products is much diversified both in terms of product functions and prices, which range from 40€ to 2,800€. Although the market seems highly dynamic, the major manufacturers were identified, while a similar statement is not possible for low-cost manufacturers. The latter group offers products with no information on the operative range and response time for the identification of the threats. They usually sell online, with no possibility of technical support on-site. The business approach conveys the idea of companies ready to take advantage of an expanding market, and more focused on a "technology enthusiast" customer, potentially interested to try a functionality, attracted by a low price but also with limited expectations. On the web several low-cost products are available and only a few of them were included in this review because of a possible interest for the LMI countries, after technical assessment of their ODD.

ADAS functions implemented on mobiles are also available, but they were not reported in this review since:

1. the mobile has limited battery capacity if employed in heavy load processing tasks as continuous image processing to implement ADAS;
2. since the mobile needs to be removed at the end of the travel, it is real the possibility of re-positioning errors that would affect the app functionalities.

3. the app needs an explicit activation by the driver, while several systems automatically turn on as the engine starts.

All these considerations are linked to the decreased reliability of the system and thus they should not be present in a safety system.

The manufacturers, with the examined devices and their ADAS functions, are reported in Table 20. An analysis of the available functions reveals that 18 devices offer both FCW and LDW support, 14 the dash cam functionality, 12 PCW, 10 SLI or REV functions. Other functionalities are available on a more limited number of systems and specifically (in brackets the number of systems): HMW (7), DDR (ADR) and CCW (5), BSD, VIS-DET and VIRTUAL BUMPER (4), FVSA and TPM (2), MCW (0). Navigation is available in 1 product and Wi-Fi connection is available in 8. The components, features, price and the company website are reported in Table 21 Both table Table 20 and table Table 21 can be found in 7.1 Annex 1 – Database of the ADAS retrofit devices.

More expensive systems (e.g. Camos-Primitech, Mobileye, PLK) offer solutions with more functionalities, and provide more technical documentation to support the choice, but at a minimum price of approximately 1,000€. Nonetheless CareDrive and Xiaomi offer economic devices with both FCW and PCW. The wide implementation of these devices could potentially generate a robust impact on road safety, contributing to the protection of pedestrians and also to decrease the vehicle-to-vehicle crashes (e.g. in Ghana 17.8% of annual deaths are pedestrian involved in a crash with a minibus, bus or HGV (Accra Metropolitan Assembly, 2021).

At present it is impossible to perform a robust evaluation of the impact since key information are missing:

- the definition of the ODD for some of these systems.
- the scenario characterization of the crashes with involvement of pedestrians.
- the relevance of the FCW scenario.

4.2.3 Retrofit ADAS testing

To overcome the limitations evidenced in section 4.2.2 and to characterize the ODD of a specific low-cost ADAS retrofit system, there is the necessity to design and implement a field test protocol. The protocol will be implemented in two phases:

1) Reconstruction of predefined operational traffic scenarios in a restricted area to characterize the system triggering conditions (e.g. ego vehicle minimum and maximum speed, minimum and maximum distance of the target) and validate them.
2) Testing of the ADAS system under real traffic conditions to determine the number of false positive/false negative activations

Phase 1: tests for system characterization in a restricted area

- Materials and Instruments:
  - Ego Vehicle: van (e.g. IVECO Daily)
  - Opponent: car and pedestrian targets

- Low-cost ADAS retrofit system with ADAS functions (FCW, PCW, and optionally LDW)
- 2 GoPro cameras
- (optional) high-end retrofit ADAS system for comparative validation

- Input parameters:
  - Ego vehicle speed
  - Opponent initial position
  - Opponent trajectory
  - Opponent speed
- Output:
  - ODD of the ADAS functionalities of the system

Phase 2: Field Operational Test in real traffic conditions

- Materials and Instruments:
  - Ego Vehicle: IVECO Daily – VAN
  - Low-cost ADAS retrofit system
  - 2 GoPro cameras
  - (optional) high-end retrofit ADAS system for comparative validation
- Input parameters:
  - real world traffic conditions
- Output:
  - estimation of the false positive/false negative activations
  - user acceptance of the system

In parallel a characterization of the scenarios relevant for the FCW and PCW functionalities will be started in cooperation with local partners of the demos, to extrapolate the validation performed in a European context to the African one and to take a decision on a further validation step in one of the four countries involved in the project (i.e. Ghana, Rwanda, South Africa, and Zambia).

4.3. SAFE VEHICLES TRAINING

As part of the planned activities for this Task 3.1, a training was held in Kigali on the 20th of October 2023. This training, called the Safe Vehicles Summit, had the objective of gathering local stakeholders from the government, academia, and industry to educate on opportunities and gaps related to vehicle safety. The main program was designed to transfer knowledge on innovative vehicle safety standards used worldwide, with emphasis on European New Car Assessment Programs as the meeting's central topic. The meeting lasted for about 4 hours and the agenda was the following:

9:00 **Welcome**

Oliver Lah (Urban Living Lab Center, Germany)

9:15 **The Current and Potential Impacts of African Vehicle Safety Standards**

Alphonse Nkurunziza & Elizabeth Krebs (University of Rwanda, Healthy People Rwanda)

9:30 **Safety of vehicle occupants**

Victor Garcia (Applus-IDIADA, Spain)

10:30 **Tea break**

10:50 **Safety of vulnerable road users**

VRU protection with crash avoidance

Ondřej Vaculín (Technische Hochschule Ingolstadt, Germany)

Pedestrian passive safety

Aditya Haryanto (Technische Hochschule Ingolstadt, Germany)

PTW passive safety

Tomasz Bońkowski (University of West Bohemia, Czech Republic)

11:50 **Safe and Clean Vehicles**

Janene Tuniz (UN Environment Programme)

12:20 **Best prac2ce examples and challenges in Rwanda**

Classio Joao Mendiate (University of Rwanda)

12:50 **Closing**

Oliver Lah (Urban Living Lab Center, Germany)

Presentations were done in a hybrid model; some of the presenters were not able to attend the meeting and thus pre-recorded their session to avoid any problems with internet connection and to have a fixed timeslot and duration.

The presentation contents, as written in the agenda above, were the following:

- Current and potential impacts of African Vehicle Safety Standards
- Safety of vehicle occupants
- Safety of vulnerable road users
- Safe and clean vehicles
- Best practice examples and challenges in Rwanda

To get a better look at those contents, presentations have been summarized and they can be found below:

Current and potential impacts of African Vehicle Safety Standards

The first of the presentations of the day explained the current and potential impacts of African Vehicle Standards, as the title says. The objective of the presentation was to give an insight on the current African landscape, why there should be standards and what is the way forward. At the start, the standards currently in place in Africa and the existing roadmap was shown. As an example, it was also shown the evolution of road death rates in France in regards with the introduction of different standards and mandatory safety systems and devices.

In the following slides, data regarding the effectiveness of ABS, ESC, Front airbag, seatbelt, Side airbag, side door beam, side padding and pedestrian protection is shown with the objective of showing the reduction in road traffic deaths, injuries, and health burden in the Latin American region.

A similar estimation with Southeast Asian nations was also showed, concluding that in both cases the most effective devices were the ABS and the ESC. It was also shown how many of those devices work and the existing background Europe has in crashworthiness. It ended showing the African Union Road Safety Charter and vehicle safety standards currently in place, focusing later in the EAC safety standards, Rwanda's safety standards and its harmonization with international standards.

Safety of vehicle occupants

To start with the Euro NCAP related presentations, this one introduced Occupant safety, Active and Passive safety. It also presented the requirements vehicles must comply with and the different levels in those hierarchies. It then gave a short history on where it all started, with the first Frontal Crash test at 56 km/h, performed by the US NHTSA in 1979 with a Mitsubishi Mirage/Dodge Colt/Plymouth Champ. Since this first crash test, programs have improved and have made it easier for consumers to access and understand this information. After this, the presentation proceeds and introduces the different organizations that currently exist and perform NCAPs, and specifically shows which cars are tested in Euro NCAP and how they are selected.

To make the learning more dynamic, a vehicle model was selected to follow the tests and the explanations for the different scores (Adult Occupant, Child Occupant and Safety Assist; Vulnerable Road Users would be explained in a later presentation on its own) it obtained. The selected model was the CUPRA Formentor, one of the best-selling small SUVs in Europe. The first tests analyzed were related to the Safety Assist score. First, an introduction of the Assistance systems involved in these tests was given; ADAS, electronic driving aids and occupant status monitoring devices were the main focus of these slides to explain the score and the tests, which to better understand, a video of both tests was shown (AEB Car-to-car and LSS).

Following these slides, an introduction to passive safety was given; airbags, safety belts and deformable elements were introduced, altogether with a short explanation to those. Once this section was introduced, the different tests and scores for adult occupant protection was explained. The dummies used (the THOR-50th Percentile male, Hybrid III 50th Percentile male and 5th Percentile female, WorldSID 50th Percentile male and BioRID UN 50th Percentile male), what do those dummies represented and the different tests they go through (Front MPDB, Front full width rigid barrier, Side MDB, Side Pole, Far-side Impact and Whiplash low-speed test). For each of the tests, a slide where

they were explained, why they are done and how they are represented was presented, with a final video to better understand the tests themselves and their set ups.

After Adult occupant protection, the same was done with child occupant protection, explaining the dummies (the Q10 (10-year-old child) and the Q6 (6-year-old child)), the tests, and the different safety features (ISOFIX, Child Presence Detection).

Once scores were presented, the slides went into detail to what they meant; injury criteria, what the scores represented in terms of chances of suffering severe or fatal injuries, different injuries in different body parts possible from those accidents, etc.

In the last stages of the presentation, post-crash protection technologies and methods were explained; MKB, E-call and Rescue sheets.

To finalize the presentation, a resume of the scores with visual diagrams and a resume of all the systems and devices involved was given in order to summarize all the topics learned during the training.

Safety of vulnerable road users

- **VRU Protection with Crash avoidance**

  This presentation primarily discusses ADAS functionalities that are often utilized to prevent potential collisions with VRU. The role of ADAS is to lessen the risk of accidents involving less protected road users. For instance, the system can detect VRUs at an earlier stage, automatically brake to avert potential conflicts, or decrease the impact velocity, thereby reducing the risk of serious injuries. The ADAS functions we discuss in this section include Front Assist, which applies automatic brakes before obstacles; Side Assist, which alerts about blind spot dangers; Door Opening Warning, which signals the approach of a cyclist or vehicle; and Rear Maneuver Assist, which engages automatic brakes if an imminent obstacle is detected behind the vehicle. Attendees are given insights to ADAS system design by diving into different intervention types and key functions like perception, decision-making, and action, along with a typical ADAS vehicle sensor setup. Concluding the presentation, European ADAS requirements that specifically concern UN ECE Regulations 152 and the Euro NCAP ratings to Vulnerable Road Users are covered. A typical Euro NCAP AEB pedestrian test video was displayed for illustrative purposes. The presentation concludes by demonstrating nonstandard test examples, showing the limitations of ADAS technologies, particularly in unconventional crash scenarios.

- **Pedestrian passive safety**

  Following the presentation to active system for pedestrian protection, attendees are given insight into measures to mitigate risk of serious injuries if pedestrian crash occur especially showcasing technologies applied in the front part of the vehicle. The presentation holds a significant purpose given the 2018 WHO global status of road safety showed a high proportion of pedestrian fatality in the African region. Initially, attendees are briefed with the

relationship between impact speed and risk of fatalities for pedestrian citing lowering speed will result in less risk of fatality. Then pedestrian crash mechanics are explained through videos to illustrate most common point of contact and injuries occurrence according to the human body regions. A simplified overview of EU vehicle regulations 127 and Euro NCAP requirements are presented to which are followed by showing most common methods to test vehicle performance in reducing pedestrian injury risk. Additionally, typical impactors used in these pedestrian tests are shown. To close the presentation technological innovation in the automotive industry for pedestrian protection such as active bonnet and pedestrian airbag is shown. The main points to take away from both Vulnerable Road User (VRU) protection presentations are: 1st the adoption of international vehicle safety standards is essential to create a baseline of vehicle design across all countries and 2nd safety testing motivates manufacturers to improve vehicle safety and comply to these prescribed safety standards.

- **PTW passive safety**

  This presentation aims to bring focus to one of the most common vehicle types in Africa, while concurrently highlighting on main passive safety strategies designed to mitigate PTW-related injuries. The discussion starts with an overview of the criteria to define a vehicle as PTW and outlining the differences between L-category vehicles. We then presented the crash mechanics of PTW and compared them to car collisions. This exercise underscores the different strategy required for personal protection of the PTW driver. Main strategy presented to reduce risk of injury for PTW-driver were Personal Protective Equipment (PPE), Helmets and Road-Side Barriers. The presentation also explains the current standards and regulations in place for the design, testing, and standard protocol of these safety measures. To support the illustration, several videos of standard testing methods such as UNE 135900, EN 1621-2:2003 and special focus on ECE R22.05 on helmet safety standards were shown. Furthermore, we provided examples of ISO 13232 standard test to specify the minimum requirements for research into the practicality of protective devices on motorcycles intended to protect the rider in the event of a collision. These examples are supported through a corresponding ISO 13232 test crash test video from ADAC. Lastly, the presentation includes cases of non-standard test scenarios, illustrated via video to demonstrate examples of crash probabilities that are not encompassed by standard testing methods.

Safe and clean vehicles

The closing segment of the presentation centered around a project initiated by UNEP focusing on road safety and emission reduction. This project aims to transform the trade of used vehicles, introducing a set of guidelines and regulations governing their export and import. Named as the "Safer and Cleaner Used Vehicles" project, its primary goal is to accelerate the adoption of standards and procedures ensuring trades of good quality used vehicles. This transition is expected to yield substantial benefits in terms of road safety for drivers and pedestrians alike, while also yielding favorable environmental and economic results. The presentation started by highlighting how the growth of Africa's vehicle fleet is fueled by the surge of aging used vehicles from leading exporters like the EU, Japan, and the USA. However, due to inadequate regulations both at the point of export

and import, these vehicles often lack the roadworthiness, crashworthiness, and emissions standards in comparison to newer vehicle models. A practical consequence example from the Inventory of Sources of Air Pollution in Rwanda illustrated how emissions from these vehicles contribute significantly to air pollution, particularly in urban centers. The presentation also outlined the project's planned measures and action phases for the upcoming years. Progress so far has been met with a good result from the Africa continent citing as of September 2022, 22 countries members of ECOWAS and EAC adopting regional harmonized vehicle standards.

Best practice examples and challenges in Rwanda

This last presentation of the training had the objective of presenting the best practice examples and the challenges that currently exist in Rwanda. The first slides serve to introduce and continue with previous explanations of the safety standards that currently are in place in Rwanda, it starts with explaining the Save LIVES road safety package, launched by the WHO and based on some UN Safety regulations. It continued with an explanation of the Safer Vehicle standards stated in the African Road Safety Charter and the Vehicle Safety Profile of Rwanda through what standards are Rwandan vehicles in compliance with.

The presentation then moved to the best practice examples in Rwanda, with a close look at Vehicle Technical Inspections and the regulations regarding those. Other best practice examples are the regulations regarding seat belts (compulsory for drivers and all passengers), and CRS (all children younger the 6 years who weigh less than 30kg must be secured in a CRS of appropriate size). The last two best practice examples given are the incentives to promote electric vehicles (through fiscal and non-fiscal incentives) and the compulsory use of helmet while using motorcycles.

The 3 main challenges presented were the differences of vehicles with countries close to Rwanda that drive on the opposite side of the road (Rwanda drives on the Right, Kenya, Tanzania and Uganda drive on the left), the quality of the helmets used (they are not required to be certified to any standard of protection, no quality control is enforced under construction and in some cases, they are repaired after being severely damaged) and the lack of import age limits for imported used vehicles. At the end, some conclusions were drawn from all the presented contents.

The recorded presentations can be found in the following link: https://www.youtube.com/playlist?list=PLE40Jx10WnTNrOoAn2Ii1p1SCEkbUMf29, which is a dedicated E-Learning module for the project presentations.

The remaining presentations will be uploaded in the due date in the same link, since at the time of the training they were not recorded.

As part of the dissemination activities, these training courses are also being shared through the project channels.

Feedback from the meeting

People who attended the training were participative and gave lots of feedback. In total, there were 50 attendants, including presenters, able to attend on-site. There was a great variety of organizations represented in the meeting, including technical divisions of different areas of some of those institutions, After the meeting, to get more detailed feedback from the attendants, a questionnaire was sent to participants.

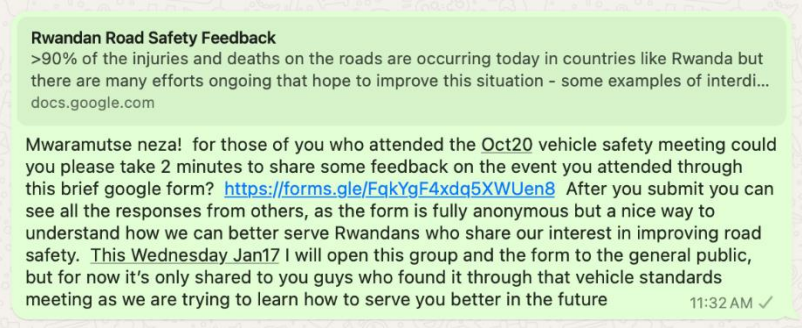


Figure 13: Message sent to all meeting participants asking for feedback

Emails were sent to 30 attendees and 13 of them accepted the invitation to join a WhatsApp road safety communication group where only admins could post but it would serve as a place to share opportunities and information, potentially becoming a discussion space as topics demanded and to facilitate collaboration development. Since issuing the above message and link to the feedback form where participants could anonymously share feedback the following 10 responses were registered, which can be read anonymously in Table 19 below.

Table 19: Safe Vehicles Summit participants' feedback

What was done well at the meeting that you would like to see more of?	What could be done better at a similar session that would make it more valuable to you?	Are there particular topics related to Rwandan road safety you would be interested to learn more about?	What is your preferred way to learn about road safety and collaborate with Rwandan and international colleagues? How can we optimize the resources that we offer to make them the most useful?
The discussion on road safety using helmets	Site visit to the established testing laboratory of helmet at RSB (Rwanda Standards Board)	The standards related with Road safety	The awareness on road safety could help and resources can be optimized through implementation of project related to road safety and funding the university students project related to Road safety
All topics were interesting, and session was interacting	To make it more than one day	Post-crash care and emergency support	Online pos and school programs
good presentation of animation in accident	i may talk to my friends who cars to check daily their airbags connections	about utilization of airbags in cars found in Rwanda	publication in bus parks, radio and tv publicities, meetings .....
Involvement of variety of stakeholders.	More focused discussion and higher quality presentations.	NA	Learning: publications; collaboration: online; optimization: assign "owners" of resources.
Good presentation and sharing of experience from different expert.	The best way is to invite more expert to explain by proving more evidence for what happened like	The influence of built environment factors on pedestrian safety.	By visiting Google scholar to read papers about road safety and collaborating with international organization relating to road safety

	road injuries and accident with clear power point presentation.		
I really enjoyed the presentation about pedestrian Passive Safety	Presentation of statistics about road safety concern country by country or regions would be very helpful.	I think if have another opportunity I would like to express my concern about VRU Protection	I prefer Learning by workshops and Labs.
The cars with airbags at the front of it this technology is highly appreciated.	To give a practical technology knowledge to improve safety and less theoretical	Public transport and autonomous vehicles	To increase the meeting which related to road safety and to evaluate the perception of road users.
Foster more interactive discussions, encouraging participants to share their experiences and well-prepared presentations	Practical Case Studies and Create dedicated networking sessions to foster connections among participants	Topics could include road safety regulations in Rwanda, initiatives to improve road safety, statistics on accidents and fatalities, infrastructure development, and any recent advancements or changes in the road safety landscape in Rwanda.	Organize workshops and webinars that provide practical insights into road safety. Interactive sessions can facilitate discussions and knowledge sharing among participants. Participate in or organize conferences that bring together professionals and experts in the field of road safety. These events offer opportunities for networking, learning, and exchanging ideas on a global scale. Invest in public awareness campaigns to educate the community about road safety. Utilize multimedia resources, social media, and community events to disseminate information effectively.
the session of asking questions, the participants feel confident and linked to the topic.	similar session like the last one, coordinator teams have to send presentation file to participants in order to increase understanding about topic.	Traffic Planning and mobility of pedestrians in urban areas	Providing resources to road users such as publication, reports according to the articles regarding to traffic and read safety.

5. CONCLUSION AND RECOMMENDATIONS

This review on the context of vehicle fleets around selected African countries has isolated the main problems that cause vehicles around those countries to be unsafe. An aged vehicle fleet, with expensive new vehicles that make renewing cars very complicated due to the cost of those vehicles, and a very limited budget to make a purchase of that magnitude, ineffective regulations of Vehicle Technical Inspections (each country with its own causes and problems), the difficult task of maintaining the optimal condition of a vehicle during its lifecycle due to the lack of skilled mechanics, availability of modern tools and spare parts and proper regulations regarding repair centres and their

technicians, and last but not least, the lack of regulatory environment for new, used and imported used vehicles. These problems can be quite complex, since most of them do not have a single root cause, and altogether, cause the main problem of unsafe vehicles driving around African roads.

This deliverable has also analysed current Safety Assessments and consumer information available for some of the most common new vehicles sold in selected African countries, to emphasise in the existing problems in new cars, such as the lack of effective safety equipment in most cases and poor material quality. Also, the regulatory environment found in Europe was reviewed in order to and has deepened in the East African Community regulations.

A set of recommendations that may be able to counter some of the encountered problems from the root has been proposed and compiled in this deliverable, although more action and involvement from institutions and organizations with more influence is required to address the real problems. Those recommendations can be found in section "4.1. General recommendations and progressive regulations", in section "4.2. ADAS retrofit device", in section "4.3. Safe vehicles training" and below in the form of an infographic.

General Recommendation for vehicle Safety

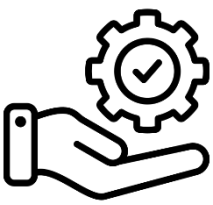
Adoption of Progressive Standardized Regulations

Having established regulations in place for new vehicles is a key aspect to ensure that all cars, trucks, buses, PTWs and commercial vehicles sold as new are safe and comply with all component level requirements. A set of progressive regulations, adapted from the existing UNECE Vehicle Regulations, would allow countries to implement these regulations by steps and without it being a counterproductive process.

Stablished Vehicle Technical Inspections Environment and Methodology

In most countries, there is a VTI methodology and system in place, but in most of them, there is a part of it incomplete, being enforcement, requirements for periodicity, inspection processes, etc., which are one of the causes vehicles are not maintained in the optimal condition. Having a stablished VTI environment and methodology as a standard would allow having safer vehicles on the road, even if those are old. This environment could also be used to inspect imported vehicles and be more selective with the ones that enter the country.

Support from manufacturers to local mechanics



Direct collaboration between manufacturers and local repair shops is vital for the enrichment of the existing mechanics and repair shop network. Manufacturers should provide those with modern tools, knowledge on modern vehicles or live support/online trainings to adapt as many technicians as possible to the new technologies recent vehicles have been equipped with.

Change in import tax approach

A change in the import methodology should be contemplated. As seen, taxes are applied to protect local industries, but at the same time, those industries are not offering the spare parts and other products that need to be imported. Selective taxes on these products would make them more affordable and improve the global chain of aftermarket vehicle components. Also, a change in the taxes applied to imported vehicles could boost the sales of newer imported vehicles.

ADAS retrofit device

As a more immediate solution, adapting vehicle fleets of commercial, public transportation or private transport dedicated vehicles with modern technologies would help in preventing and reducing the number of accidents. Equipping old vehicles with Advanced Driving Assistance Systems would help drivers being more aware of their surroundings and could help in anticipating potentially dangerous situations

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7. ANNEXES

7.1 ANNEX 1 – DATABASE OF THE ADAS RETROFIT DEVICES

To see Annex 1 content, go to the following page. It includes Table 20 and Table 21, from section 4.2.2.

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Table 20: ADAS retrofit devices and associated functions (in yellow the main functions; in grey the availability of a direct connection to the device)

Brand	Model	Vehicle class	BSD	CCW	DDR (ADR)	FCW	LDW	PCW	SLI	DVR (DASH CAM)	FCDA	FVSA	HMW	NAVIGATOR	REV	TPM	UFCW	VIRTUAL BUMPER	VIS-DET	WI-FI
Auto-Vox	- CS2 - Solar1 - W7 - T1400U	M1, M2, N1, N2	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗
Brigade	- BE - 900C + other ones (customizations from the catalogue according to requirements and vehicle)	M2, M3, N1, N2, N3, T1, T2, T3, T4	✓	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✗
Camos - Primitech	PTAI-C6D	M1, M2, M3, N1, N2, N3	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✓
CareDrive	DSM + ADAS MR800	M2, M3, N2, N3	✗	✗	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✓	✗	✓
	MR688	M1, M2, M3, N1, N2, N3	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	AWS650	M1, M2, M3, N1, N2, N3	✗	✗	✗	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✓	✗	✗

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Brand	Model	Vehicle class	BSD	CCW	DDR (ADR)	FCW	LDW	PCW	SLI	DVR (DASH CAM)	FCDA	FVSA	HMW	NAVIGATOR	REV	TPM	UFCW	VIRTUAL BUMPER	VIS-DET	WI-FI
Dolphin Automotive	- DPS400 - DOLC318 - DOLC208 - DOLC118	M1, M2, N1, N2	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗
Garmin	RV 785	M1, M2, M3, N1, N2, N3	✗	✗	✗	✓	✓	✗	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓
Gocomma	Gocomma M20 (4-wheel vehicles)	M1, M2, M3, N1, N2, N3	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗
LUIS Technology	- LUIS R7-S - LUIS RV-8 -LUIS Twin System - LUIS T5 (also Wi-Fi) - BMVI (blind spots) - LUIS 360	M1, M2, M3, N1, N2, N3, T1, T2, T3, T4	✓	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✗
MEKRA	- Radar and/or - Camera system (Vision 4.0)	M2, M3, N1, N2, N3, T1, T2, T3, T4	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✗
Mobileye	8 Connect	M1, M2, M3, N1, N2, N3	✗	✓	✗	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	✗	✓	✗	✗	✗
	Shield+	M2, M3, N1, N2, N3	✓	✓	✗	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	✗	✓	✗	✗	✗

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Brand	Model	Vehicle class	BSD	CCW	DDR (ADR)	FCW	LDW	PCW	SLI	DVR (DASH CAM)	FCDA	FVSA	HMW	NAVIGATOR	REV	TPM	UFCW	VIRTUAL BUMPER	VIS-DET	WI-FI
Movon	MDAS-9	M1, M2, M3, N1, N2, N3	✗	✗	✗	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
	MDAS-5P	M1, M2, M3, N1, N2, N3	✗	✗	✗	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
	MDAS-3LF	M1, M2, M3, N1, N2, N3	✗	✗	✗	✓	✓	✗	✗	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
	MDSM-7	M1, M2, M3, N1, N2, N3	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
PLK	R series	M1, M2, M3, N1, N2, N3	✗	✓	✗	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✗	✓	✗	✓
	O series	M1, M2, M3, N1, N2, N3	✗	✓	✗	✓	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✗	✓	✗	✓
Power Acoustik	DVALT	M1, M2, M3, N1, N2, N3	✗	✗	✗	✓	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
	BUC-1	M1, M2, M3, N1, N2, N3	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗
	WRVC-2	M1, M2, M3, N1, N2, N3	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗
	LP-4CS	M1, M2, M3, N1, N2, N3	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗

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Brand	Model	Vehicle class	BSD	CCW	DDR (ADR)	FCW	LDW	PCW	SLI	DVR (DASH CAM)	FCDA	FVSA	HMW	NAVIGATOR	REV	TPM	UFCW	VIRTUAL BUMPER	VIS-DET	WI-FI
RVS	- RVS - 770718 - RVS - 091406 - RVS - 2CAM - RVS - 4CAM - RVS - 01 -360 (360°)	M1, M2, M3, N1, N2, N3	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗
Snooper	Snooper Dash-Cam	M1, M2, M3, N1, N2, N3	✗	✗	✗	✓	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗
Thinkware	Thinkware X700	M1, M2, M3, N1, N2, N3	✗	✗	✗	✓	✓	✗	✗	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗
Vuemate	- DL550A - DL330A	M1, M2, M3, N1, N2, N3	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Xiaomi	70mai Pro Plus+	not specified	✗	✗	✗	✓	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	70mai Omni Dash Cam	not specified	✗	✗	✗	✓	✓	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓
	70mai Dash Cam M500	not specified	✗	✗	✗	✓	✓	✓	✗	✓	✗	✗	✗	✗	✗	(✓)	✗	✗	✗	✓

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Table 21: Additional information of the identified ADAS retrofit devices

Brand	Model	Components	Features	Price	Official website	Retailers	Country
Auto-Vox	- CS2 - Solar1 - W7 - T1400U	- Rear view camera / License plate holder with integrated camera / Solar license plate holder - Wi-Fi display'	- 110° camera angle - Reverse light connection - Digital/analogue signal - Cameras supported by monitors: 1 - Dashboard or rear-view mirror monitor - Signal amplification antenna designed on the power cable to always ensure maximum signal. - High-performance solar rechargeable battery (Solar 1). - Choice of 6 different reversing guidelines. - Solar 1 license plate holder not suitable for CE plates.	from 77€ to 261€	https://www.auto-vox.com/	X	China

Brand	Model	Components	Features	Price	Official website	Retailers	Country
Brigade	- BE - 900C + other ones (customizations from the catalogue according to requirements and vehicle)	- OSD Radar ECU - BS-9000 Radar Sensor - Wiring + integrations: - Camera and monitor systems - Lateral Ultrasonic Devices	Cameras: - 110° to 153° viewing angle depending on cam model. - 5 infrared LEDs with twilight sensor - Integrated microphone - Sony CMOS sensor Monitor: - Support 2 to 8 camera inputs depending on model. Ultrasound system: - Module for on-screen display of audio and video data by overlaying data from cameras and ultrasonic sensors. - Side sensor package comprising 4 sensors with a detection radius of 1.5m and two sensitivity levels - Wiring for articulated trucks not included. - Rear sensor package comprising 4 sensors with a detection radius of up to 2.5m. Radar: - Obstacle detection up to 30m with a minimum of 3m adjustable.	from 470€ to 1870€	https://brigade-electronics.com/it/	https://brigade-electronics.com/it/dove-acquistare/	United Kingdom
Camos - Primitech	PTAI-C6D	- Frontal video camera - Mini display - Support for: a rear video camera; a dedicated camera for driver	- A facial smart camera for the driver (PT-DSA01) to detect fatigue (closing eyes), sleep, phone use, smoke, and eye distraction from the road. - Integrated 4G module and GPS - Video recording on SD card	from 900€ to 2300€	http://www.primitec.eu	https://camositalia.it/contattaci/	Italy

Brand	Model	Components	Features	Price	Official website	Retailers	Country
CareDrive	DSM + ADAS MR800	- Exterior camera - interior camera towards the Driver - On-board hardware - Speaker	- FCW warning up to 2.7 seconds in advance. - Lane detection accuracy of 30mm at speeds between 0 and 150km/h. - Easy installation on all types of vehicles - Partnerships with automotive, fleet, insurance, public transport. - Interface customization.	from 410€ to 740€	http://www.care-drive.com/	X	China
	MR688	- Driver-facing interior camera with integrated display	- Provides an early warning for driver fatigue and distraction. - Patented pupil detection technology. - Distinguishes between real sleep and fake sleep (open-eye sleep), effectively reducing false warnings. This system can be connected to a vibrating pillow in order to wake up the driver - Also works with the use of sunglasses. - Works all day and in all weather conditions - The power supply can work with a wide voltage range: from 9V to 36V. Good protection against voltage peaks. - Can be integrated with the fleet management system.	from 150€ to 200€			

Brand	Model	Components	Features	Price	Official website	Retailers	Country
	AWS650	- Front camera - Display - On-board hardware	- FCW warning up to 2.7 seconds in advance. - LDW warning from 200mm from road mark. - Can be integrated with other CareDrive products and GPS system - Adaptive control algorithm - Accurate tracking pattern from 30km/h.	from 134€			
Dolphin Automotive	- DPS400 - DOLC318 - DOLC208 - DOLC118	- Rear view camera - Reversing sensors (opt) - Brainbox - Wiring harness - 18.5mm drill bit for bumper hole	- Small camera size (24mm -DOLC118) - 170° camera angle - Waterproofing according to IP68 - Power cable for direct connection to reversing lights - Can be integrated with satellite navigation system - No maintenance required other than manual cleaning of the lens.	from 58€ to 77€	http://dolphin-automotive.co.uk/	http://dolphin-automotive.co.uk/dealers.php	United Kingdom

Brand	Model	Components	Features	Price	Official website	Retailers	Country
Garmin	RV 785	- Front camera with integrated display	- FCWS: The device detects the speed of the vehicle using GPS and calculates the expected safety distance based on this. It is activated at speeds > 50 km/h (30 mph). May not detect vehicles more than 40 m (130 ft) or less than 5 m (16 ft) away. - LDW: Activates at speeds > 65 km/h (40 mph). - SLI: The device beeps and displays a red border on the speed limit icon when exceeding the speed limit set for the current road. - DASHCAM HD: During a recording, the dash cam records continuously, overwriting the oldest unsaved video. - NAVIGATOR: in addition to acting as a navigator, the system alerts the driver if a dangerous situation arises based on where we are. It warns the driver if we are near a school, a level crossing, an animal crossing area, dangerous curves, a narrow road, a steep descent - WIFI: ADAS data can be transmitted via a Wi-Fi connection.	590€	https://www.garmin.com/en-US/	https://www.garmin.com/it-IT/dealerlocator/	United States of America

Brand	Model	Components	Features	Price	Official website	Retailers	Country
Gocomma	Gocomma M20 (4-wheel vehicles)	- Front window solar display - Wi-Fi tyre sensors'	- Solar powered with color LCD display - Supports USB charging (cable not included). - Real-time pressure and temperature monitoring - Alarm for rapid air leakage. - Alarm for anomaly, high and low pressure. - Ensures stable signal and accurate data - Temperature accuracy: ± 3°C. - Pressure accuracy: ± 1.5 PSI.	from 59€	Official store https://it.gearbest.com/top-brands/brand/gocomma.html	X	China
LUIS Technology	- LUIS R7-S - LUIS RV-8 -LUIS Twin System - LUIS T5 (also Wi-Fi) - BMVI (blind spots) - LUIS 360	- Rear cameras - Side cameras - Displays - Wiring (if not Wi-Fi) - Speaker - GPS module	Radar/Display Radar: - Obstacle detection up to 30m with a minimum of 3m adjustable. - Proximity display via 5 led - Integrated buzzer + volume control. Cameras: - Visual angles from 70° to 180° depending on the model chosen. - IP69K class certified.	from 199€ (base package) to 2793€ (included package LUIS 360 HEAVY DUTY)	https://luis.technology/	X	Germany

Brand	Model	Components	Features	Price	Official website	Retailers	Country
MEKRA	- Radar and/or - Camera system (Vision 4.0)	- Radar Sensor - Radar Display and/or - Cameras - Displays and/or - Digital rearview mirrors'	Radar/Display Radar: - Obstacle detection up to 30m with a minimum of 3m settable. - Proximity display via 5 LEDs - Built-in buzzer + volume control. Cameras: - Field of view from 70° to 180° depending on the model chosen. - IP69K class certified.	not available	https://www.mekra.de/	https://www.mekra.de/en/service/handlersuche	Germany
Mobileye	8 Connect	- Front camera - Visual warning display - GPS unit	- FCW warning based on Time to Collision (TTC) calculation up to 2.7s before a collision. - PCW warning up to 2s at collision. - HMW warning from a distance (in seconds) of 2.5s. - Over-the-air software updates - Mobileye Connect platform: provides fleet managers with information on driver safety behavior indicating who would benefit from additional training. - Dedicated app - Data collection to identify the most critical urban areas in order to make cities "smart" and safe.	from 900€ to 1050€	https://www.mobileye.com/	https://www.mobileye.com/us/fleets/find-a-retailer/	Israel
	Shield+	- Front camera - 2 blind spot cameras - Central display - 2 side displays					

Brand	Model	Components	Features	Price	Official website	Retailers	Country
Movon	MDAS-9	- Front camera - Display - Rear camera (optional)	- FCW up to 2.8 seconds in advance. - Two-way wiring. - Supports integration with FMS via RS-232 and CAN communications. - Records over 24 hours with 64GB microSD card. - Supports various accessories including vibrating devices	from 830€ to 970€	https://www.movon-eu.com/	X	Israel (manufacturer South Korea)
	MDAS-5P	- Front camera - Display	- 130° wide-angle Full HD dashcam. - Cabin recorder. - Automatic calibration function. - Transmission of alerts to FMS systems. - Database and statistics available to fleet managers for analysis to improve performance and productivity.				
	MDAS-3LF	- Front camera - Display	- Basic solution - Supports microSD from 4 to 32 GB				

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Brand	Model	Components	Features	Price	Official website	Retailers	Country
	MDSM-7	- Driver-facing interior camera with integrated display	- Provides alarms when the driver's eyes remain closed for longer than a certain time - Provides alarms when the driver looks away - Detects yawning and monitors its frequency by providing an alarm. - Supports 3 different recording modes: normal, G-sensor event, DMS event. Real-time video transmission and/or stores in microSD of max. 128GB. - Detects if the driver smokes. - Stores up to 20 IDs identifying the driver on board. - Provides alarm if driver uses mobile phone. - Live video streaming.	from 189€			
PLK	R series	- Front camera - Display - Vibrating device	- FCW and LDW warning up to 3.0 seconds in advance - Dedicated data collection and download app (also for fleet monitoring by a manager) - Possibility of data sharing with insurance services in order to model insurance premiums according to driving habits. - V2V ready	from 500€ to 950€	https://www.plkglobal.com/main	https://www.plkglobal.com/company/location	South Korea

Brand	Model	Components	Features	Price	Official website	Retailers	Country
	O series	- Front camera with integrated display - Rear camera'	- ACF algorithm improves pedestrian and vehicle recognition performance with advanced intermittent LED sign recognition. - Video recording even when the vehicle is stationary/parked (video surveillance). - FCW and LDW warning up to 3.0 seconds ahead - Dedicated app for data collection and download (also for fleet control by a manager) - Possibility of data sharing with insurance services in order to model insurance premiums according to driving habits. - V2V ready				
Power Acoustik	DVALT	- Front camera with integrated display	- Automatic calibration - G-force's integrated black box function records video and audio even if the vehicle is not running and isolates these recordings for quick recall. - Requires a microSD not included in the package.	from 63€	https://poweracoustik.com/	https://poweracoustik.com/where-to-buy/	United States of America
	BUC-1	- Rear view camera - Wiring	- Sensitivity of 0.01 LUX - 170° camera angle	from 45€			

Brand	Model	Components	Features	Price	Official website	Retailers	Country
	WRVC-2	- Wi-Fi Rear camera	- Easy pairing with Android and Apple devices - Optional connection to car radio or LCD dashboard display - Sensitivity of 0.01 LUX - 170° camera angle	from 70€			
	LP-4CS	- Number plate holder including camera + 3 proximity sensors	- Ultrasonic sensor coverage angle of approx. 180°. - Optional acoustic signals - Interfaceable with any afetrmarket stereo model with an LCD or dashboard monitor via RCA connector. (not suitable for CE plates)	from 40,78€			
RVS	- RVS - 770718 - RVS - 091406 - RVS - 2CAM - RVS - 4CAM - RVS - 01 -360 (360°)	- Rear view camera infrared + others - LCD rearview mirror or display - Wi-Fi wiring/connection	- 130° camera angle - Rear camera with 18 infrared lights - Sharp 2.5 mm lens - Sunlight controller for optimal shooting - Certified weatherproof with IP69K rating	from 299€ to 738€	https://www.rearviewsafety.com/	X	United States of America
Snooper	Snooper Dash-Cam	- Front camera with display and integrated GPS - Rear camera (op)	- Built-in speakers - Night mode - GPS with precise display on Google Maps - 16GB microSD included - HD 1080p - 152° front camera angle - 130° rear camera angle	from 136€ to 328€	https://gb.snooper.eu/	https://gb.snooper.eu/european-distributors	United Kingdom

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Brand	Model	Components	Features	Price	Official website	Retailers	Country
Thinkware	Thinkware X700	- Rear window camera with or without infrared or - External rear infrared camera'	- Designed primarily for use on large commercial vehicles. - 125° camera angle - Automatic calibration. - HD resolution, 1.0 Pixelplus camera with 30 frames per second - Motion detector	from 99€ to 311€	https://www.thinkware.com/	https://www.thinkware.com/Support/WhereToBuy	South Korea
Vuemate	- DL550A - DL330A	- Internal camera with integrated display - Optional GPS module	- Infrared lights allow the driver's state of fatigue to be monitored even in poor visibility conditions - Drowsiness warning: if the driver closes his eyes for more than one second or lowers his head more than 8 degrees for more than 1-2 seconds - Drowsiness warning: when driver moves head out (left/right) of drowsiness detection range for more than 6 seconds or lowers head more than 8 degrees for more than 3 seconds - Intelligent algorithm with early warning functions - Removal of uneven reflections from sunlight by means of special filters - 3-level sensitivity adjustment - Supports various USB accessories (LED indicators and vibrating devices) - Interfaceable with external devices such as navigators etc.	from 167€ to 251€	X	X	South Korea

Brand	Model	Components	Features	Price	Official website	Retailers	Country
Xiaomi	70mai Pro Plus+	- Frontal camera - Driver camera	- Built-in GPS - 130° lens FOV - Local data recording - 2 Inch IPS Screen - 1944P Resolution & 5-Megapixel Camera - Dual-Channel Recording - Loop recording - Night vision - Infrared night vision	100 €	https://70mai.store	X	China
	70mai Omni Dash Cam	- All-in-one system - Integrated mini display	- Built-in GPS - 140° lens FOV - 360° camera FOV - Emergency recording - Night vision - Voice control	200 €			
	70mai Dash Cam M500	- All-in-one system with frontal camera - No display	- Built-In GPS & GLONASS - 170° lens FOV - Night vision - eMMC Built-in Storage - optional TPM - Voice control	140 €			

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