DEKRA

ROAD SAFETY REPORT 2020
Mobility on Two Wheels

Steps Toward Making
Vision Zero a Reality.

DEKRA

Accident statistics:
Increase in numbers of two-wheeled vehicles on roads; no drop in numbers of deaths in many countries

The human factor:
Many accidents involving riders of two-wheeled vehicles are caused by a lack of communication, among other things

Technology/infrastructure:
Active and passive safety systems and well-developed roads reduce risk of accidents


Best solutions for bike safety
DEKRA Bicycle Services
When it comes to the safety of bicycles, pedelecs and S-pedelecs, we at DEKRA are the first point of contact for all matters related to testing, expertise, and analyses.
www.dekra.com/ebike-services
DEKRA
On the safe side.
Damage assessment
Assessments
Material and component testing, damage analysis
Product testing
Homologation/ road approvals
Chemical analysis
EMC testing
Battery-/accu testing

More Consideration for our Partners on the Road

One glance at our roads is enough to realize that using two wheels to get around is becoming more and more popular. Manufacturers of motorcycles are recording an increase in sales, and pedelec manufacturers in particular are experiencing a boom in their figures. According to data published by the European Association of Motorcycle Manufacturers (ACEM), the market in the EU grew by eight percent in 2019 compared to the previous year, with a total of almost 1.1 million new motorcycle registrations. At the time of writing, there are no official figures for pedelec sales in 2019 for the EU as a whole. However, the ZIV, an association for the bicycle industry in Germany, recorded growth of almost 39 percent for the year, with sales rising to 1.36 million.

In light of this development, it makes sense that more and more towns and cities are expanding their cycle infrastructure significantly as Germany looks to establish more firmly the kind of culture that has become a long-standing tradition in countries such as the Netherlands and Denmark. This is reflected in the Federal Ministry of Transport and Digital Infrastructure's National Cycling Plan 3.0, which includes measures such as increasing the number of bicycle bridges, tunnels for cyclists, and express bike lanes.

Personal light electric vehicles are also experiencing a real boom all around the world. Before they were approved for use in Germany in May 2019, e-scooters were already cruising around a number of American cities, as well as in Europe in places such as Paris, Vienna, Copenhagen, Stockholm, Lisbon, and Madrid. The huge increase in the popularity of this sector, and particularly of e-scooter rental companies, has led a number of cities – especially those in the USA – to take a more active role in the regulation of their urban infrastructure in order to provide better mobility management overall, improve road safety, and curb the discourteous behavior that can often be seen with regard to the parking of these vehicles, for example.

Dipl.-Ing. Clemens Klinke, Member of the DEKRA SE Management Board

But no matter what type of two-wheeled vehicle people choose, or whether they use them during their free time or for their daily commute, doing so makes them largely unprotected as road users. As such, there is a high risk of these road users "coming off worst" if they are involved in a collision – particularly if it is with a car, van, or truck – and ending up being severely injured or, in the worst-case scenario, even killed. While it is true that the numbers of people killed while riding two-wheeled vehicles have been on the decline in many EU countries for years, we must be careful not to take our eye off the ball. One aspect that should not be overlooked is the consequences of single-vehicle accidents, which can often be disastrous. For example, official statistics for Germany for 2019 show that such accidents accounted for around 30 percent of all the accidents involving motorbike users, as well as 30 percent of the fatal accidents.

This report will detail what action can be taken to counteract this issue. Like DEKRA's previous road safety reports, this publication aims first and foremost to get people thinking and act as a starting point for discussions – among politicians, road traffic experts, manufacturers, scientific institutions, and associations. At the same time, it is intended as a guide for users of two-wheeled vehicles and all other road users, who can help to reduce the number of people involved and killed in road accidents in the long term by cooperating with one another and treating each other with mutual respect, as well as by increasing their awareness of the risks of road use and observing safety standards. Thanks to the good examples set in other countries, we are confident we can make this change.

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Although the number of car and truck drivers killed in road accidents has been on a constant decline for years in many parts of the world, the number of users of two-wheeled vehicles who are killed on the road has remained stable, and in some cases even increased. As such, urgent action is required. Since there is virtually no scope for optimizing the passive safety of a vehicle like a motorcycle – or especially a bicycle – itself, we need to focus on active safety systems.

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What is true for car and truck drivers also applies to users of motorized and non-motorized two-wheeled vehicles: When accidents occur, they are often at least partly the result of a lack of risk awareness, a failure to observe traffic regulations, driving too fast, driving under the influence of alcohol, being distracted, or not exercising sufficient consideration for other road users.

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In order to increase road safety for users of motorized and non-motorized vehicles in the long term, there are a whole series of issues that need to be tackled. In addition to a wide range of measures in areas such as technology and infrastructure, the main onus in this regard is also on the road users themselves.

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The web portal: www.dekra-roadsafety.com

Since 2008, DEKRA has been publishing the annual Road Safety Report in printed form in several languages. The www.dekra-roadsafety.com web portal went live with the publication of the DEKRA Road Safety Report 2016. You can use this portal to access additional content supplementing the printed report (e.g. videos, interactive graphics, etc.). The portal also covers a range of other topics and DEKRA activities concerning road safety. If you have a tablet or smartphone, you can link directly from the printed version to the web portal by scanning the QR codes that can be found throughout the report. Scan the code using an ordinary QR code reader and you will be taken directly to the corresponding content.

LEGAL NOTICE
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Wherever the DEKRA Road Safety Report uses terms such as “road user”, “cyclist”, etc., these terms should always be assumed to apply to all genders unless explicitly stated otherwise.

Road Safety and Sustainable Urban Mobility Policy Need to Come Together

On Europe's roads, 25,000 people died and 135,000 were seriously injured in 2018. These figures need to be repeated to remind ourselves just how unacceptable this situation is.

But what these figures mask is that vulnerable road users (VRU) – those without a protective "shell" such as two wheeler riders and pedestrians – are accounting for an increasing percentage of casualties. Over the last few decades, we have succeeded in making car drivers and passengers much safer, for example through European Union legislation on vehicle safety, but we have not been so successful in making those OUTSIDE the car safer.

The same trend is particularly clear in cities, where 70% of the deaths and serious injuries are now occurring to VRU. We are also seeing new mobility trends, such as e-bikes and e-scooters, which are bringing new types of road users onto our crowded city streets. Unsurprising, therefore, that at the next UN conference in Stockholm in February 2020 we will be looking much more closely at urban road safety.

Road safety and sustainable urban mobility policy need to come together. It is clear that our over-reliance on cars in cities must stop if we are to tackle CO2 emissions, improve our air quality, and reduce both congestion and road casualties. Two wheelers are efficient ways to get around a city, notably in terms of space, but this means a big re-think. We need to make our infrastructure less car-centric – footpaths and bike paths are great value for money, and make active mobility safer.

Matthew Baldwin
European Coordinator for Road Safety and Sustainable Mobility

We also need to reduce speeds – the percentage of drivers exceeding the speed limit in cities ranges from between 35% and 75%. And speed limits are often too high to ensure safety. Where vulnerable road users cannot be kept safely separate from cars, 30 kph should be the maximum default speed – at 30 kph, 90% of VRU survive a collision with a car, but this number drops to around 20% at 50 kph.

The EU has now committed to new 50% reduction targets in deaths and serious injuries for 2020–30. If we are to succeed, improving the safety of two wheeler riders and pedestrians has to play a much bigger role in our future road safety strategies at European, national, and local level.

Getting Mobile on Two Wheels

Whether motorized or not, there can be no doubt that traveling on two wheels is “in” right now. This is due in no small part to the exponential increase in the variety of different bikes and high-tech equipment available, as well as the political trend towards promoting cycling as a mode of transport – especially in towns and cities – in order to help protect the environment. However, getting mobile on two wheels always comes with a higher risk of suffering a severe accident than traveling by car, van, or truck. As road users with little to no protection, riders of two-wheeled vehicles are usually the ones who come off worst in case of a collision.

For years, around 25 percent of all those who have died in road traffic accidents worldwide have been users of motorized and non-motorized two-wheeled vehicles. The figures for the EU are similar: in Germany, for example, around a third of all road users killed in 2019 lost their lives after suffering an accident while riding a bicycle or motorbike. By way of comparison, figures from 2017 – the latest data available – show that users of two-wheeled vehicles accounted for around 16 percent of all the people who lost their lives on the road in the USA. For decades, however, accident rates have been highest in heavily populated developing and newly industrialized countries, where mass mobility on two-wheeled vehicles is a prominent feature of the society.

So how much greater is your risk of dying in a road accident in Germany, for example, if you ride a motorcycle instead of driving a car? We can assess this by comparing the number of deaths to the number of registrations for the vehicle type in question. The number of deaths among motorcyclists was 605; around 4.5 million motorcycles were registered. The number of deaths among car drivers and

Milestones along the Way to Greater Mobility and Road Safety

- Bicycle, general
- Motorcycle, small moped
- Pedelec, speed pedelec, e-bike
- Pedal scooter, electric scooter

1817 Invention of the Draisine (or dandy horse), forerunner of the bicycle and thus all two-wheeled vehicles.

1861 Foot pedal drive on front wheel: Michaudine/velocipede

1865/69 First use of solid rubber tires and spoon brakes

1869 Michaux works with Perreaux to develop the first bicycle with an auxiliary engine.

1800 | 1860 | 1870

passengers was 1,364; around 47.7 million cars were registered. This means that, for every 100,000 vehicles registered, 13 motorcyclists and three car drivers/passengers lost their lives. This disparity becomes even more stark when we take into account the fact that motorcycles have a far lower mileage. The EU Commission was already saying years ago that the chance of being killed on the road was around 18 times higher per kilometer covered for motorcyclists than for those traveling by car. Incidentally, the EU Commission calculated this risk as being seven times higher for cyclists.

These few figures alone show that there is still a drastic need for action when it comes to road safety for users of two-wheeled vehicles, particularly as mobility on two wheels is likely to increase even further in the next few years. This applies to both motorcyclists – be they leisure bikers or commuters – and, in particular, to cyclists and users of electrically assisted bikes. According to data published by the ZIV, an association for the bicycle industry in Germany, bicycles and e-bikes are the perfect modes of transport for short and medium-distance journeys. The ZIV also states that, according to the results of several studies, freight bicycles could account for around 50 percent of all motorized goods transport in cities in the future. However, the more cyclists there are on the roads, the harder it will be to find a suitable way of apportioning the available road space – a division that still heavily favors cars in many areas of the world. Another source of potential conflict is also emerging alongside this familiar "battleground": the increase in

Andreas Scheuer MdB
German Federal Minister of
Transport and Digital Infrastructure

A Holistic Approach

Cyclists and motorcyclists have something in common: they enjoy direct contact with the road and feel the wind as they ride. However, this also makes them vulnerable. There is no vehicle protection. Thus, we all have a duty to be alert and considerate, following the rules on the road in order to save lives.

In general, we are making great progress. In 2019, road fatalities in Germany reached a historic low (3,059). However, we are a long way from "Vision Zero". One of the key factors to bring us closer is protecting users of two-wheeled vehicles. In accident statistics, they are bucking the trend: while fewer and fewer road users are dying overall, there has been no change in the number of fatalities among cyclists: 444 died in road accidents in 2019.

We want to stop and reverse this trend with different measures. The German Federal government has provided € 1.46 bn for bicycle infrastructure which we want to invest e.g. in establishing a network of safe, wide bicycle paths and lanes, kept as separate as possible from the road network. We will be relying on state and municipal governments to implement this initiative.

I want cyclists to feel safe on our roads. Therefore we have made changes to the German Road Traffic Act, e.g. implementing a requirement for drivers to keep a distance of 1.5 meters when overtaking cyclists in built-up areas. We have also laid the groundwork for the establishment of bicycle zones, and introduced a general no-stopping restriction for designated bike lanes. Also, we have introduced a new regulation whereby motor vehicles over 3.5 metric tons must not exceed walking speed when turning right in a built-up area. This is a response to the terrible accidents caused by cyclists being in the blind spot of vehicles. We have launched our "Turning Assistant Campaign" in order to equip thousands of trucks with life-saving technology even before it is required by EU law.

Cyclists can also contribute to improving safety. Our successful helmet campaign, "Looks like shit. But saves my life." is designed to convince specifically young people to wear cycling helmets. After all, helmets save lives!

We also want to improve the safety of motorcyclists. One of the many ways we are doing this is by supporting the German Association for the Motorcycle Industry in their online campaign offering road safety tips for bikers. Alongside this, our own campaigns continue to address the correct conduct for both motorcyclists and other road users. At the EU level, we have played a role in equipping motorcycles with ABS as standard. Finally, we have focused on establishing a safe infrastructure. One example is the information we have published in partnership with federal states, giving concrete recommendations to make motorcycle routes safer – e.g. by using safety barrier posts with rounded edges instead of sharp ones.

Every one of us in this society has a duty to uphold and maintain road safety. DEKRA's contribution to this cause is invaluable.

1885 Daimler Reitwagen (first motorcycle)

1894 First series motorcycle by Hildebrand & Wolfmüller

1895 Ogden Bolton (USA) files first patent for "new and useful improvement in electrical bicycles"

1880 1890 1900

The DEKRA Micro Mobility Standard: Safety for E-Scooters and Similar Vehicles

Current safety standards and regulations for the use of new mobility options differ not just from one country to the next, but often even from city to city. Regulations on the safety of these options play a key role. While many see micro-mobility as one of the pillars of the mobility concepts of the future, the new vehicles also add new risks to traffic situations that are already very complicated.

As a comprehensive approach to safety and sustainability for e-scooters and similar vehicles, DEKRA has drawn up a standard for safe micro-mobility. E-scooter rental company Circ, which has since been taken over by Bird, was an important partner during this process. The standard covers more than 120 individual inspection points, which are split into eight different areas. The system assesses the mobility options from every important perspective. The main target groups for these bundled expert services are "Mobility as a service" providers such as e-scooter rental companies, and towns and cities where such rental services are available.

DEKRA's experts put the following eight areas under the microscope – depending on the local legal requirements, where applicable:

❶ **Technical design of the vehicles:** Frame and wheels, brakes, lights, handling, electrical safety, battery safety, pollution, electromagnetic compatibility, functional safety, wireless connections.

❷ **Production, transport, and assembly of the vehicles, plus placement into circulation based on a general type approval:** Quality management, health and safety at work, environmental protection.

❸ **Authorities, insurance, and infrastructure:** Insurance coverage, marked/permitted parking areas, geo-fencing (e.g. in order to prevent use in pedestrianized areas), age limit for users.

❹ **IT security and data protection:** Data security, network security, data protection.

❺ **Training and user conduct:** User training via app/online, recommendations for safety gear (helmet), information on applicable road use regulations, responsible marketing.

❻ **Vehicle use:** Provision of the vehicles, incorporation into local transport networks, accident reporting and investigation, environmental standards.

❼ **Maintenance and storage:** Maintenance intervals for vehicles and charging infrastructure, damage reporting and repairs, feedback for vehicle development, employee training, safety at work, fire protection.

❽ **Recycling:** Life cycle, recycling of materials, reuse of parts.

micro-mobility, which is the term used to refer to people using personal light electric vehicles such as e-scooters and self-balancing vehicles such as Segways to get around.

The fact is, as road users with no cabin to protect them, riders of two-wheeled vehicles are always in danger of suffering severe or even fatal injury if they become involved in a single-vehicle accident or a collision with another vehicle. The following chapters of this report will go into detail on what action can be taken to significantly reduce this risk for the various vehicle categories, from e-scooters, bicycles, and pedelecs to small mopeds, mopeds, and motorcycles.

THE LIMITS SET BY DRIVING DYNAMICS

In this context, it seems sensible to take a moment to familiarize ourselves with a few of the physical peculiarities of two-wheeled vehicles as a mode of transport. For example, why do

1907 Construction of the oldest bicycle path in Germany, the Offenbacher Alleenring, begins in 1907; the path features a segregated cycling facility.

1914 Medical officer Dr. Eric Gardner makes the first protective headgear for the motorbike race on the Isle of Man using shellac and canvas.

1915 to 1922 In 1915, the Autoped Company manufactures a pedal scooter powered by a combustion engine or electric motor; Krupp acquires the license and continues producing the model under the name "Krupp-Roller" in Germany from 1919 to 1922 (the first e-scooter).

1935 Launch of the telescopic fork for BMW motorbikes – still the most common design today

1938 DKW introduces the 125 ccm cubic capacity class as standard, followed by the development of larger capacity classes after the Second World War

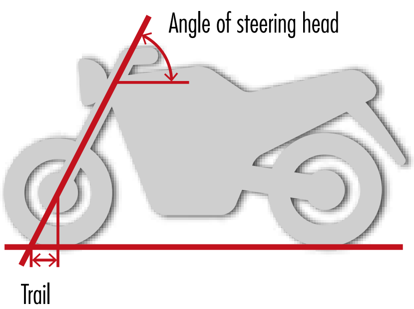
1900 | 1910 | 1920 | 1930 | 1940

motorcycles and bicycles not fall over when traveling in a straight line? After all, they are subject to the laws of gravity, just like everything else in the world. Some motorcycles weigh over 200 kilograms, yet they can still be ridden safely. Some bicycles travel on tires with widths of no more than 20 millimeters, yet they remain safe and stable when in motion and there is no concern about simply tipping over. Both motorcycles and bicycles stabilize themselves when traveling at a suitable speed. This means that the rider does not constantly have to worry about keeping upright.

But how exactly does this work, what factors are required for it to be effective, and what forces are at work in this situation? One factor that affects the inherent stability of both motorcycles and bicycles is speed – both vehicles must be traveling at a certain minimum speed in order to stabilize themselves. The rotation of the wheels generates what are known as gyroscopic forces, which keep the system stable and return it to a stable condition for travel even when it is affected by external factors.

Another effect that helps stabilize two-wheeled vehicles is trail – the distance between the theoretical point at which the steering axis intersects the ground and the actual point at which the front tire touches the ground (see illustration, below). The larger the trail, the more stable the vehicle will be when traveling in a straight line; however, vehicles with large trails such as "chopper"-style motorcycles

The trail and the angle of the steering head play an important role in the stability and agility of a two-wheeled vehicle.



Dr. Walter Eichendorf
President of the German
Road Safety Council (DVR)

We Need to Make it Safer to use Two-Wheeled Vehicles

Riding two-wheeled vehicles is dangerous, and is becoming more dangerous. It makes little difference whether you're traveling by motorcycle, moped, bicycle, or pedelec – the numbers of accidents and deaths have increased for every category. There are many reasons for this, but all these user groups have one thing in common: they all have very little protection when on the road.

Anyone who uses a bicycle to get around, especially in cities, will notice that the infrastructure has often not been designed with their safety in mind. Increasingly crowded roads, cycle paths and lanes that are too narrow, too scarce, or blocked by parked cars, and unsuitable junction designs lead to dicey situations every day.

The approval of e-scooters for use on roads has made the problem worse. E-scooter riders often travel in twos or threes are frequently under the influence of alcohol, and often ride on the sidewalk even though this is illegal. It is obvious that many users do not know the rules, or are simply unwilling to act responsibly.

As a result, we urgently need to introduce a comprehensive traffic monitoring system, including a bicycle squad for police forces in every city. If we are to truly transform how our roads are used, we need to expand our (bicycle) infrastructure in a way that is intelligent and improves road safety. Only when cycling becomes objectively safer – and feels safer – will we start seeing more people opt for this healthy and environmentally friendly mode of transport.

Measures that enable more people to use motorized two-wheelers without sufficient experience on the road or adequate training do not help with this issue. This includes the option that has been forced through in many states allowing 15-year-olds to drive mopeds. We urgently need to introduce measures that will prevent holders of Class B drivers' licenses from driving Class A1 light motorcycles – maximum displacement 125 ccm, max. 15 hp and speeds of over 100 km/h – until they have undergone appropriate training and passed an independent test.

If we want to reduce the number of injuries and deaths on our roads in the long term, the safety of users of two-wheeled vehicles needs to be taken more seriously at every level of the German political system. Having approved Vision Zero in the coalition agreement, we now need to truly commit to implementing it!

1965 Luud Schimmelpennink launches the first attempt at a bicycle sharing system in Amsterdam.

1968 Development of the Trott helmet by Karl-Heinz Trott (first bicycle helmet for mass sports)

1969 First motorcycle with front hydraulic disc brakes (Honda CB750 Four)

1976 Wearing a helmet becomes a legal requirement in Germany for motorcycles > 20 km/h, extended to mopeds and small mopeds in 1978

1979 First hydraulic anti-dive systems for individual motorcycles launched by Kawasaki and Garelli; shortly followed by series production by Suzuki and Yamaha

1960 | 1970 | 1980

Classification of Bicycles and E-Bikes/Pedelecs/Speed Pedelecs/(Light) Motorcycles

	Designation	Legal framework	Legal classification	Key technical classification criteria
Bicycle	Bicycle		Exempt from regulations for motor vehicles Special regulations	• Mode of transport powered by **muscle power** • No (auxiliary) drive
Bicycle	Pedelec (25) *= Bicycle*		**Reg. (EU) 168/2013** In acc. with Article 2, Para. 2: **Exempt from Regulation**	• Bicycle with pedal drive and pedal assistance • Electric **auxiliary motor** with max. continuous rated power/effective power: ≤ 250 W • Assistance is: - Interrupted when the rider stops pedaling - Reduced progressively as the vehicle's speed increases - Interrupted before the vehicle reaches a speed of 25 km/h • Electric motor **assistance for start-up/pushing** that enables acceleration of **up to 6 km/h** even without pedaling
			German Road Traffic Act (StVG) In acc. with Section 1, Para 3: **Not a motor vehicle acc. to StVG**	
Motor vehicle	Speed pedelec (25) *= Light motorcycle*		**Reg. (EU) 168/2013** In acc. with Article 4, Annex I: **Light, two-wheeled motor vehicle** Subclass L1e-A **Bicycle with drive**	• Cycles designed for pedal power and equipped with an **auxiliary drive***, the main purpose of which is to **assist the function of the pedals** • Auxiliary drive power interrupted when vehicle reaches a speed of 25 km/h • Max. continuous rated power/effective power: ≤ 1,000 W
			Small moped – Motorcycle/Bicycle with auxiliary motor In acc. with Section 4, German Driving License Regulation (FeV)	• Small moped: ≤ 25 km/h / ≤ 250 W • Combustion engine: ≤ 50 cm³
			Light small moped (subclass) Light Small Moped Exemption Regulation (Leichtmofa-AusnahmeVO) (for Section 6, Para. 1, StVG)	• Light small moped: ≤ 20 km/h / ≤ 500 W • Combustion engine: ≤ 30 cm³
	Speed pedelec (45) *= Light motorcycle*		**Reg. (EU) 168/2013** In acc. with Article 4, Annex I: Class L1e – **Light, two-wheeled motor vehicle**	• Max. speed by design: ≤ 45 km/h • Max. continuous rated power/effective power: ≤ 4,000 W • Combustion engine: ≤ **50 cm³**
	Light motorcycle		**Reg. (EU) 168/2013** In acc. with Annex I: **Class L3e-A1 – Two-wheeled motorcycle with low power**	• Max. continuous rated power/effective power: ≤ 11 kW • Power-to-weight ratio: ≤ 0.1 kW/kg • Combustion engine: ≤ 125 cm³
	Motorcycle		**Reg. (EU) 168/2013** In acc. with Article 4, Annex I: **Class L3e – Two-wheeled motorcycle**	• Two-wheeled vehicle that cannot be classified as Class L1e

* Not a pedelec if fitted with a combustion engine or hybrid drive

Source: DEKRA

also require a larger steering force. A small trail makes a vehicle more nimble and agile, i.e. easier to steer, but such vehicles are also less stable and more "jittery" in terms of their response when traveling in straight lines at high speeds. When a two-wheeled vehicle tilts on its longitudinal axis, the trail exerts a force against the direction of the tilt at the point where the front tire touches the ground. For example, if a bicycle tilts to the right, a force will be exerted towards the left at the point where its front tire touches the ground, allowing the front wheel to turn to the right on its steering axis (in the direction of travel).

Both the trail and the gyroscopic forces keep bicycles and motorcycles stable when they are traveling in straight lines. In this situation, the two effects overlap. Due to the higher speeds they travel at, motorcycles usually generate greater gyroscopic forces than bicycles. At speeds of 25 to 30 km/h and over, a motorbike will stabilize itself, and would not tip over without a rider. On a bicycle, the trail plays a bigger role. In addition to the two aforementioned effects, however, stability is also affected by the shape of the bike, its overall mass, the distribution of this mass, and the width and shape of its tires. As such, all these factors need to be taken into account by designers and riders alike in order to help improve safety for two-wheeled vehicles – all around the world.

1988 Anti-lock braking system for motorcycles (BMW K 100)

1990 First use of the pedelec principle (Yamaha Power Assist System)

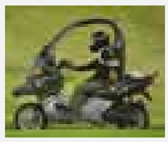
1992 Traction control for motorcycles (Honda Pan European)

1995 The world's first successful bicycle renting system is launched in Copenhagen, with a pool of 300 bikes

1996 First motorcycle to be fitted with a combined braking system, ABS, and traction control (Honda ST 1100)

1997 Cyclists in Germany are permitted to cycle on the road on routes with no bicycle path.

2000 BMW C1, the first two-wheeled vehicle with an enclosed design to protect the driver



1985 | 1990 | 1995 | 2000

Understanding the Physics Involved Also Makes Cornering Safer for Motorcyclists.

Antonio Avenoso
Executive Director, European Transport Safety Council (ETSC)

The Rise of e-Scooter Sharing Schemes Is a Particular Concern for the Road Safety Community

It is still not clear what effect the increasing use and popularity of e-scooters has and will have on road safety. Some of the potential road safety challenges related to e-scooters, which can go at up to 25 km/h, are the conflicts with pedestrians, especially when e-scooters are ridden on sidewalks, possible conflicts with cyclists when using cycling infrastructure, and with motorized vehicle drivers when sharing the road, as these drivers might face difficulties noticing a small but fast-moving e-scooter rider. E-scooter riders might be affected more than other road users by road infrastructure defects such as potholes.

All these issues require data and research. In the meantime, it is important to define traffic regulations on space sharing: whether e-scooters should compete for space on sidewalks with pedestrians, share cycling paths with cyclists, or use roads together with motorized traffic.

At the moment, there is a legislative gap in regulating e-scooters as they are covered by neither EU regulation on type approval, nor national legislation in many European countries.

Currently, there is no reliable data in Europe on collisions involving e-scooters that resulted in road deaths or serious injuries. Data collection is hindered by the fact that e-scooters are mostly not regulated under the traffic code and not even categorized as vehicles. In cases where collisions with e-scooters do not involve a motorized vehicle, police may not be called to the scene and, as a result, such collisions might not be registered in the police database.

Even in cases where the police are called, there is no field in the police report form indicating e-scooters as a vehicle category involved in a collision, which further limits data collection.

ETSC's recommendations to EU Member States:
- Legislate highway code rules for e-scooters;
- Add new field categories in police reports to distinguish collisions involving e-scooters and electrically assisted bicycles;
- Collect data on serious and fatal collisions involving an e-scooter.

ETSC's recommendations to EU institutions:
- Conduct research on the road safety implications of e-scooters and electrically assisted cycles, including infrastructure needs;
- Consider developing guidance on managing safety aspects of personal e-scooters based on existing European best practice.

2005 Lithium batteries reach market maturity, leading to a boom in the sales of e-bikes.

2006/07 Motorcycle airbag (Honda Gold Wing)

2009 First brake-by-wire system (Honda CBR 600/1000)

2014 Electronic Motorcycle Stability Control (MSC), KTM 1190 Adventure in partnership with Bosch

2017 Start of the e-scooter boom in the EU and the USA

2019 E-scooters approved for use on German roads from June 2019. Regulations: Type approval, maximum speed 20 km/h, minimum age 14, no drivers' license required

2005 | 2010 | 2015 | 2020

Users of Two-Wheeled Vehicles at Particularly High Risk of Being Involved in an Accident

Although the number of car and truck drivers killed in road accidents has been on a constant decline for years in many parts of the world, the number of users of two-wheeled vehicles who are killed on the road has remained stable, and in some cases even increased. Given this situation, urgent action is required. Since there is virtually no scope for optimizing the intrinsic safety of a vehicle like a motorcycle – or especially a bicycle – itself, we need to focus on active safety systems.

Motorcycle, moped, bicycle, pedelec, or e-scooter – whenever any kind of two-wheeled vehicle is involved in an accident, the consequences for the users are often devastating. This is because, unlike cars, vans, and trucks, such vehicles do not have a crumple zone. Even if a car – the most common second party in accidents – is driving comparatively slowly, a collision will often result in very severe injury. After colliding against the hard shell of the vehicle, which is usually enough to cause injury on its own, a cyclist's body is still at risk of further injury when it falls to the ground.

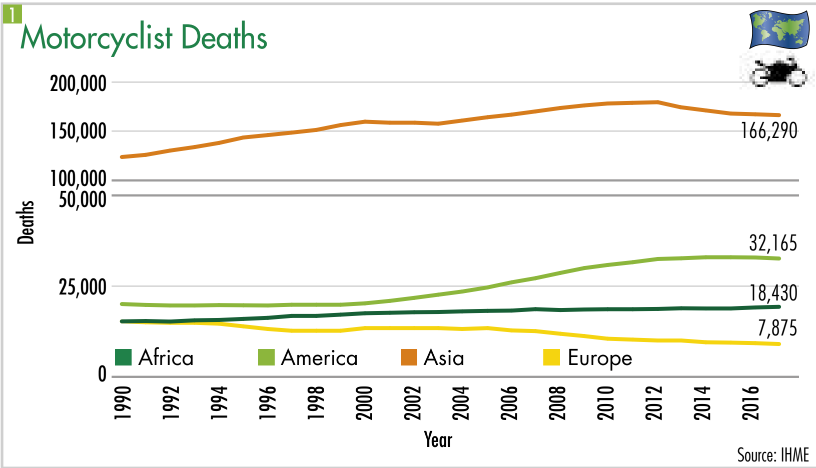
ASIA HAS THE HIGHEST FIGURES IN THE WORLD FOR CYCLISTS AND MOTORCYCLISTS KILLED ON THE ROAD.

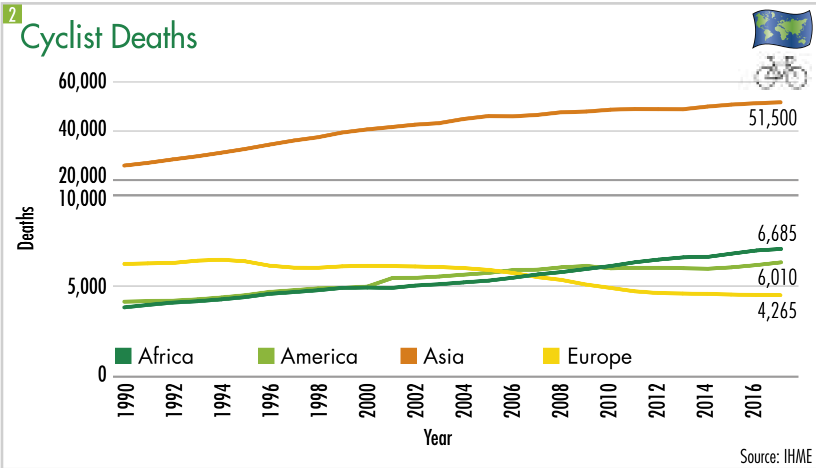
Likewise, in collisions that involve a car and a motorcyclist, the force of the impact acts directly upon the motorcyclist. Due to the significant difference in mass, users of two-wheeled vehicles are also subject to significant deceleration or acceleration. In addition to this, motorcycles generally reach the limits of their stability in terms of their driving dynamics much faster than a vehicle like a car.

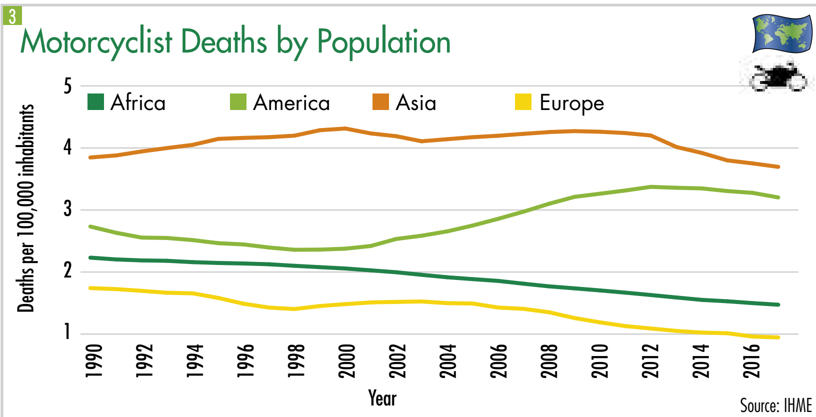
This "mismatch" between riders of two-wheeled vehicles and other users of motorized vehicles is reflected markedly in the international accident statistics, alongside many other factors. According to data published by the Insti-

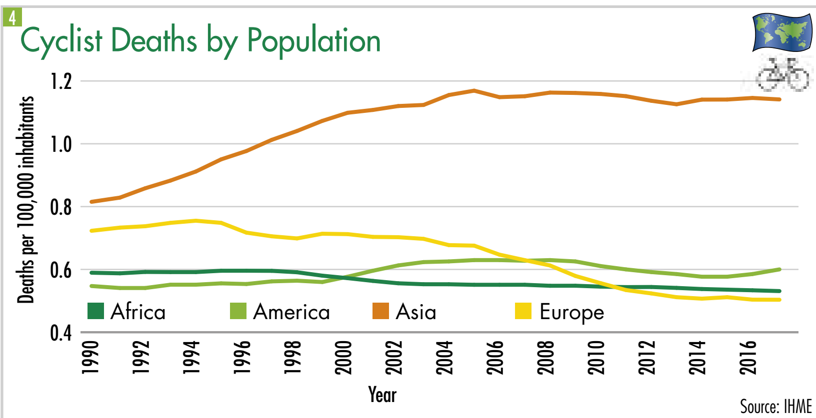
tute for Health Metrics and Evaluation (IHME) at the University of Washington in Seattle, approximately 225,000 motorcyclists and around 69,000 cyclists worldwide lost their lives in road accidents in 2017. Combined, these figures account for around a quarter of all the 1.25 million road fatalities. In terms of both motorcyclists and cyclists, Asia recorded the highest number of deaths by far: around 166,000 and 51,500 respectively. These numbers have been on an upward trend for years, especially for cyclists – though thankfully the number of motorcyclist deaths has been dropping again since 2012 (Figures 1 and 2). In terms of percentages, the biggest increase globally has been among cyclists aged between 50 and 69. The number of people in this demographic who were killed on the road rose from 9,400 to 23,900 between the years 1990 and 2017, increasing almost two and a half times. The figures for motorcyclists are similar.

The extent of the risk of being killed while riding a two-wheeled vehicle – motorized or otherwise – in Asia becomes even clearer when evaluated in terms of deaths per 100,000 inhabitants (Figures 3 and 4). Almost four motorcyclists and 1.14 cyclists per 100,000 inhabitants are killed on the roads in Asia – two figures that

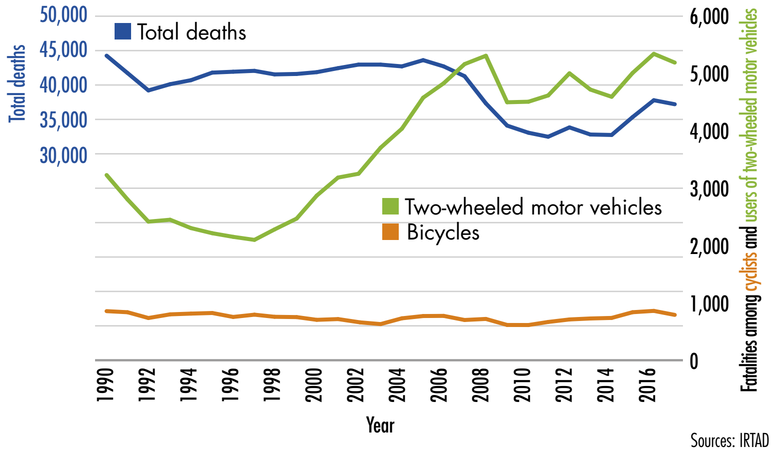






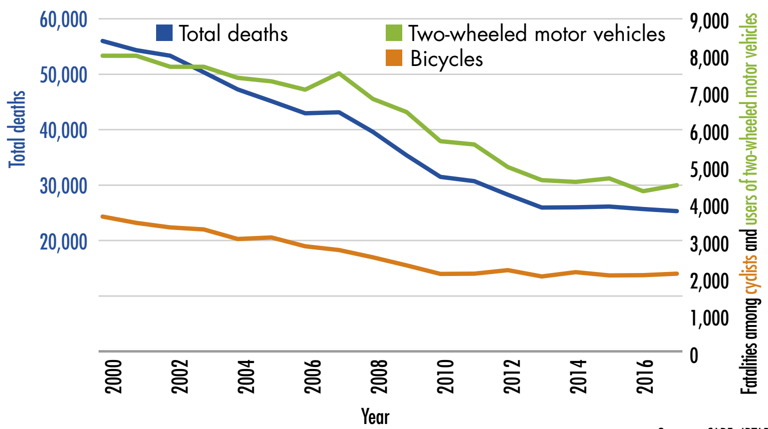


5 Deaths in Road Accidents in the USA



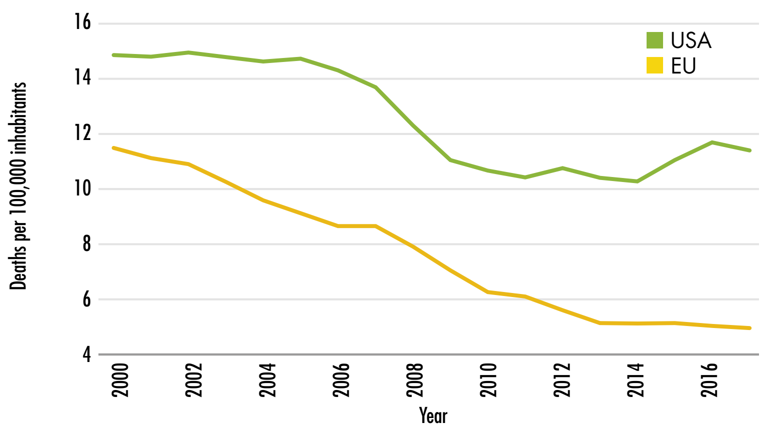
Sources: IRTAD

6 Deaths in Road Accidents in the EU



Sources: CARE, IRTAD

7 Comparison of Deaths in Road Accidents



Sources: CARE, IRTAD

are far above the global average (2.95 and 0.9 respectively).

ACCIDENT STATISTICS WORLDWIDE: COMPARING THE USA AND THE EU

In terms of fatalities among road users, a comparison between trends in the USA and the EU makes for interesting reading. Generally speaking, the number of cyclists killed on the road in the USA remains at the same level as 30 years ago while there has been a significant change in the number of people killed in road accidents as a whole. This applies especially to motorcyclists, for whom there was a dramatic rise in the number of fatal road accidents in the early 2000s (Figure 5). At first glance, the situation in the EU seems to be positive. A small rise in 2008 aside, the number of deaths among both road users in general and specifically for cyclists and users of two-wheeled motor vehicles have been decreasing constantly for years. Since 2013, however, the number of deaths in all three classes has stagnated (Figure 6).

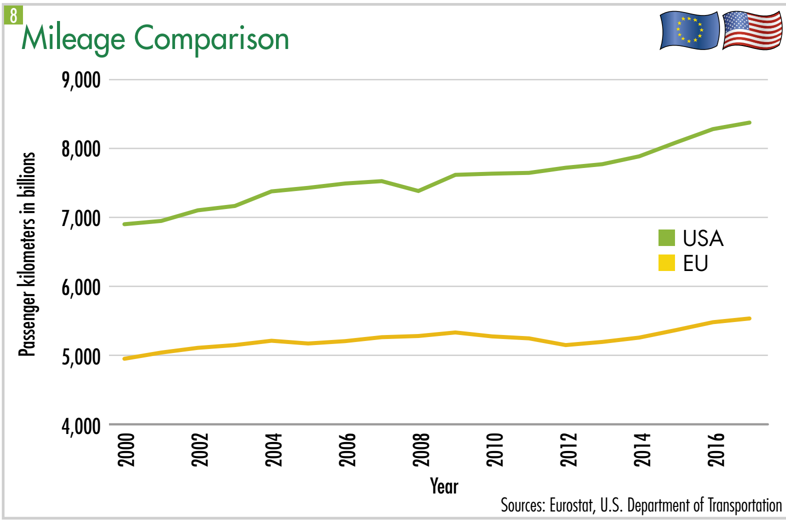
USA'S POPULATION SMALLER, BUT TRAFFIC LEVELS AND DEATHS ON THE ROAD HIGHER

In terms of population, the 28 states that make up the EU were home to a total of around 511 million people in 2017; the USA's population the same year was 326 million. Yet despite having the smaller population of the two, more people have died on the road in the USA than in the EU since 2010. This wasn't always the case. As recently as the year 2000 there were around 56,000 road fatalities in the EU, compared to just under 42,000 in the USA. By 2017, the EU had managed to reduce this figure by almost 55 percent to 25,300. The USA only recorded a drop in road fatalities of just under twelve percent over the same period, to 37,100. As a result, the USA now suffers many more deaths in road accidents per 100,000 inhabitants than the EU. However, this number is still well below the global figure published by the WHO for 2016, which was 18.2 road fatalities per 100,000 inhabitants. Following an increase in 2016, the USA recorded a figure of 11.4 deaths in road traffic accidents per 100,000 inhabitants in 2017, while the EU registered a record low of 4.9 (Figure 7).

IN 2017, AROUND 18 PERCENT OF PEOPLE KILLED ON THE ROAD IN THE EU WERE USERS OF TWO-WHEELED MOTOR VEHICLES.

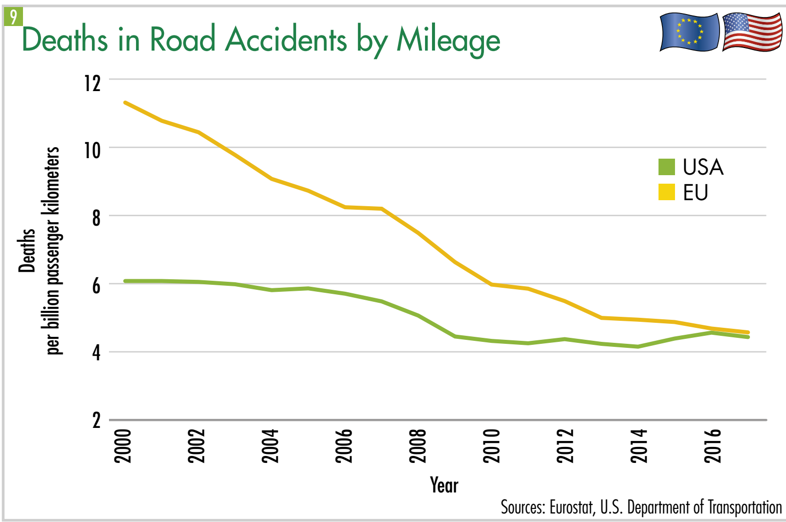
The number of motorcyclists killed on the road in the USA has risen in recent years.

In order to create a reference to vehicle usage, we need to compare these figures with the respective traffic volumes. The official figures for the main types of personal transport – car, bus, and motorcycle – were published by Eurostat for the EU and the U.S. Department of Transportation for the USA, and are illustrated in the graph in Figure 8. The traffic volume for these modes of transport was much higher in the USA than in EU countries, reaching a peak of almost 8.4 billion passenger kilometers in 2017. In the same year, the EU recorded over 5.5 billion passenger kilometers. As a result, Figure 9 shows a surprising trend: In terms of road fatalities in relation to actual number of kilometers traveled, the USA's numbers for the last 17 years are better than those of the EU countries; however, they have been stagnating since 2009, remaining at an almost constant level and even rising occasionally during this period. On average, 4.4 people per billion passenger kilometers died on roads across the USA in 2017 while using one of the aforementioned modes of transport. Despite a slight increase in the number of kilometers traveled, the same figure has been on a constant decrease in the EU since the year 2000, reaching a record low of 4.6 road fatalities per billion passenger kilometers in 2017. So the EU and the USA are on roughly equal footing in terms of this statistic.



8 Mileage Comparison

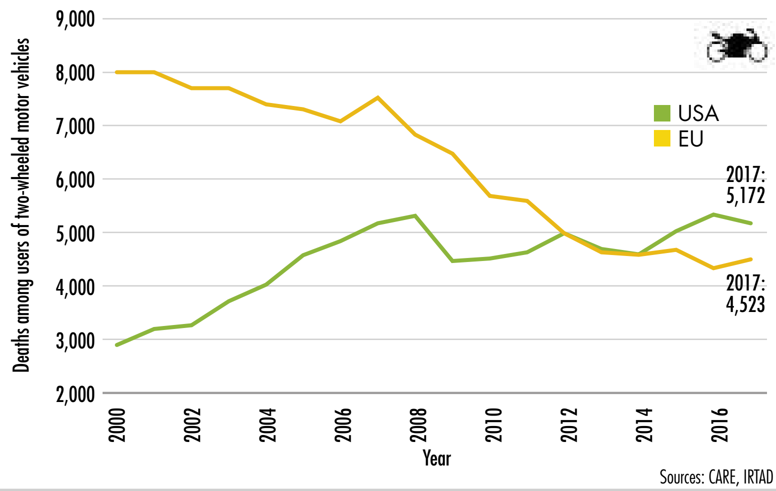
Sources: Eurostat, U.S. Department of Transportation



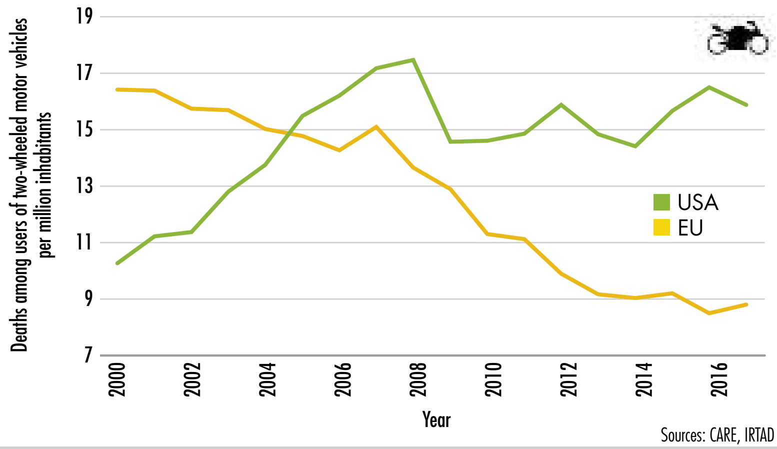
9 Deaths in Road Accidents by Mileage

Sources: Eurostat, U.S. Department of Transportation

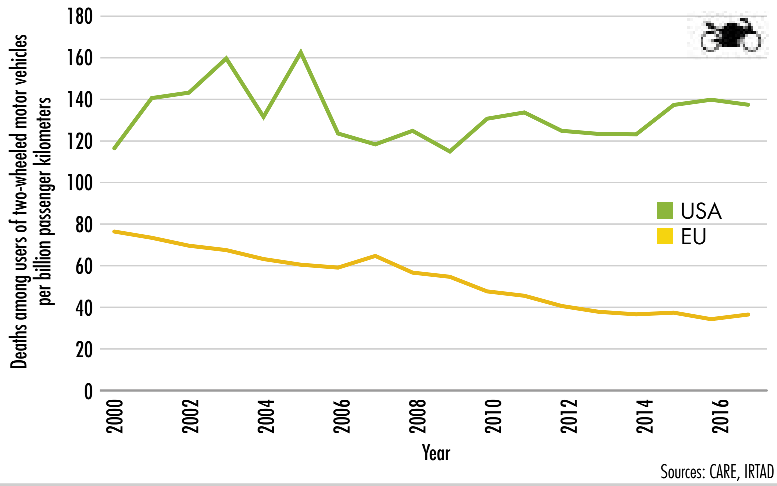
10 Deaths Among Users of Two-Wheeled Motor Vehicles



11 Deaths by Population



12 Deaths by Mileage



FAR HIGHER MORTALITY RATE FOR USERS OF TWO-WHEELED MOTOR VEHICLES IN THE USA THAN IN THE EU

If we look at the figures for motorcyclists, we can see that there was a significant increase in fatal road accidents for this group in the USA between 2000 and 2007, followed by a slight upward trend since. Since 2007, this number has fluctuated between 4,500 and 5,500 per year (Figure 10). In terms of total road accidents in the USA, users of two-wheeled motor vehicles account for around 14 percent of all fatalities. While it is true that most of those who die in road accidents in the country are traveling by car, the increase in the number of deaths among users of two-wheeled motor vehicles is still extremely concerning.

If we compare the USA to the EU (Figure 10), we can see that the number of users of two-wheeled vehicles who died on the road in the EU fell at a relatively constant rate up until 2013; the figure almost halved between 2000 and 2017, dropping from around 8,000 to 4,500. Here too, however, the number of road accident fatalities among motorcyclists and moped users has stagnated since 2013. Around 18 percent of all traffic fatalities in 2017 were users of two-wheeled vehicles. Most of these were in Italy, France, and Germany. Southern European countries such as Spain and Greece where two-wheeled vehicles are traditionally more common on the roads should also be highlighted. When we take population size into account, the following pattern emerges: In the USA, the number of motorcyclists killed on the road per million inhabitants rose from 10 to 17 between 2000 and 2008, and has fluctuated between 14 and 16 ever since. Over the same period, EU countries have recorded a relatively constant decline from more than 16 motorcyclists killed on the road per million inhabitants to 9 in 2013. Since this point, the number has stagnated at this level (Figure 11).

The high number of motorcyclists killed on the road in the USA is especially shocking if we take a closer look at mileage: Motorcycle usage is three times higher in the EU than the USA, yet the number of motorcyclists killed on the roads is currently higher in the USA. However, the USA also saw usage of two-wheeled motor vehicles on its roads almost double between 2000 and 2008, which explains the increase in fatalities over this period. The numbers of deaths differ accordingly based on the traffic volume. In the USA, around 137 people per billion kilometers traveled by motorcycle died in 2017, while the EU's number for the same period was just 36. This makes the fatality rate for the USA three and a half times higher than that of the EU. Furthermore, the number of deaths in relation to traffic volume has declined continuously between 2000 and 2017 in the EU, while stagnating and even rising slightly in the USA over the same period (Figure 12).

One reason for this trend in the USA is undoubtedly the fact that many states have been relaxing legislation requiring riders to wear helmets ever since the late 1970s. There are currently only 19 states that require all riders to wear helmets by law. In 29 states, this requirement only applies to a certain demographic (18 to 21-year-olds), and in some cases also to newly licensed drivers. In Iowa and Illinois, riders of two-wheeled motor vehicles are not required to wear a helmet at all. According to data published by the National Highway Traffic Safety Administration (NHTSA), 5,172 motorcyclists lost their lives on the road in the USA in 2017. 39 percent of these people were not wearing a helmet at the time of the accident. Driving under the influence of alcohol is also a serious problem. 28 percent of the fatalities had a blood-alcohol level of at least 0.08 percent at the time of the accident. For single-vehicle accidents, this figure was even higher at 42 percent.

The increasing popularity of motorcycles, particularly among "older" road users, has undoubtedly also left its mark. Where motorcyclists aged 30 and under were at particularly high risk of suffering a fatal accident in the 1970s, accounting for 80 percent of all motorcycle fatalities, this pattern has changed dramatically in recent years. Today, the over-50s are the most at-risk demographic, accounting for around 36 percent of all motorcycle fatalities. The under-30s are in second place, with 28 percent. Experts in the USA estimate that the reasons for this increase among older motorcyclists (whose fatalities – 91 percent of over-50s and 97 percent of over-70s – are overwhelmingly male) stem from overconfidence. A person who used to ride a motorcycle a lot in their youth before taking a long break, perhaps due to having a family, may enjoy the same sense of freedom when rediscovering the vehicle later in life, but will no longer possess the same experience, reaction speed, or general fitness level. The risk may also be compounded by the ability to afford a large, powerful motorcycle.

Accidents involving a car and a cyclist often occur at junctions.

THE RISK OF BEING KILLED ON THE ROAD IS MUCH HIGHER FOR MOTORCYCLISTS THAN FOR CAR USERS.

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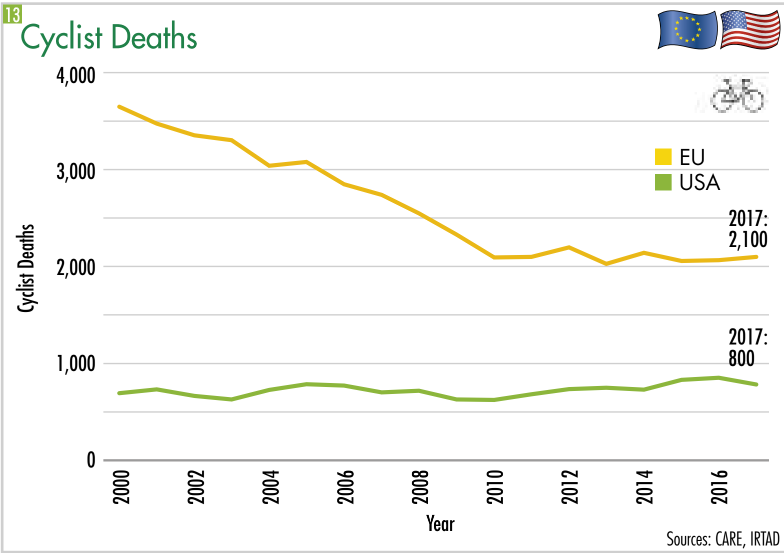

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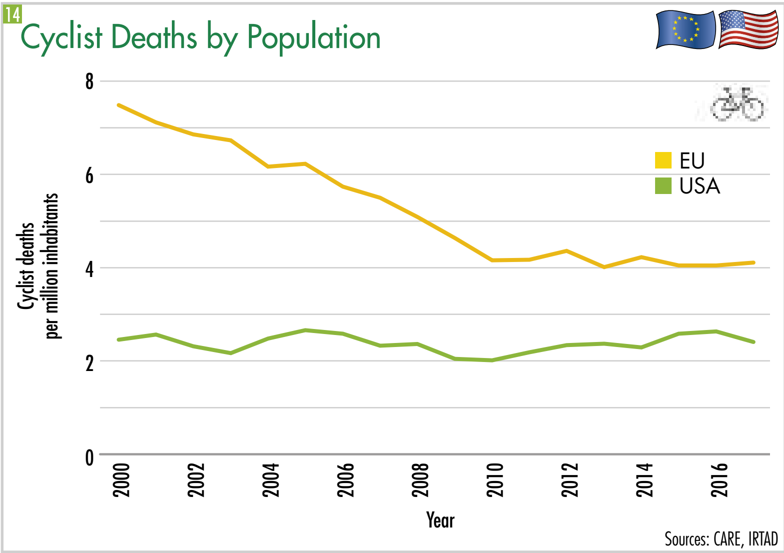

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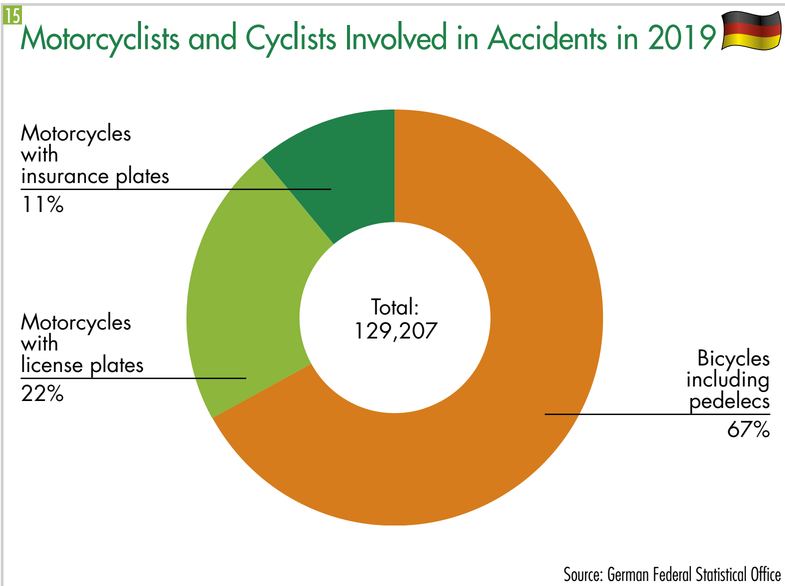


SIGNIFICANTLY MORE CYCLISTS KILLED ON THE ROAD IN THE EU THAN IN THE USA

The number of road users killed while riding a bicycle has always been higher in the EU than in the USA. The main reason for this is that the use of bicycles as a means of transport has thus far been much less widespread in the USA. As with the overall figures, there has been a constant decrease in the number of cyclists who have suffered a fatal accident in the EU in terms of the long-term statistics. However, this figure has remained stagnant at almost 2,100 since as far back as 2010. Estimates also place the number of cyclists killed on the road in 2017 at 2,100. Germany accounts for the largest number of the EU's bicycle fatalities by some distance, followed by Italy, Poland, Romania, France, and the Netherlands. The number of cyclists killed in road accidents in the USA was around 800 in 2017, with the trend rising slightly. This figure has remained almost constant since 2000 (Figure 13). Accordingly, the cyclist fatality rate for 2000 was 2.4 per million inhabitants. This level will be reached again in 2017. In the EU, the rate fell from 7.5 in 2000 to 4.1 in 2017 (Figure 14).

ACCIDENT STATISTICS IN GERMANY

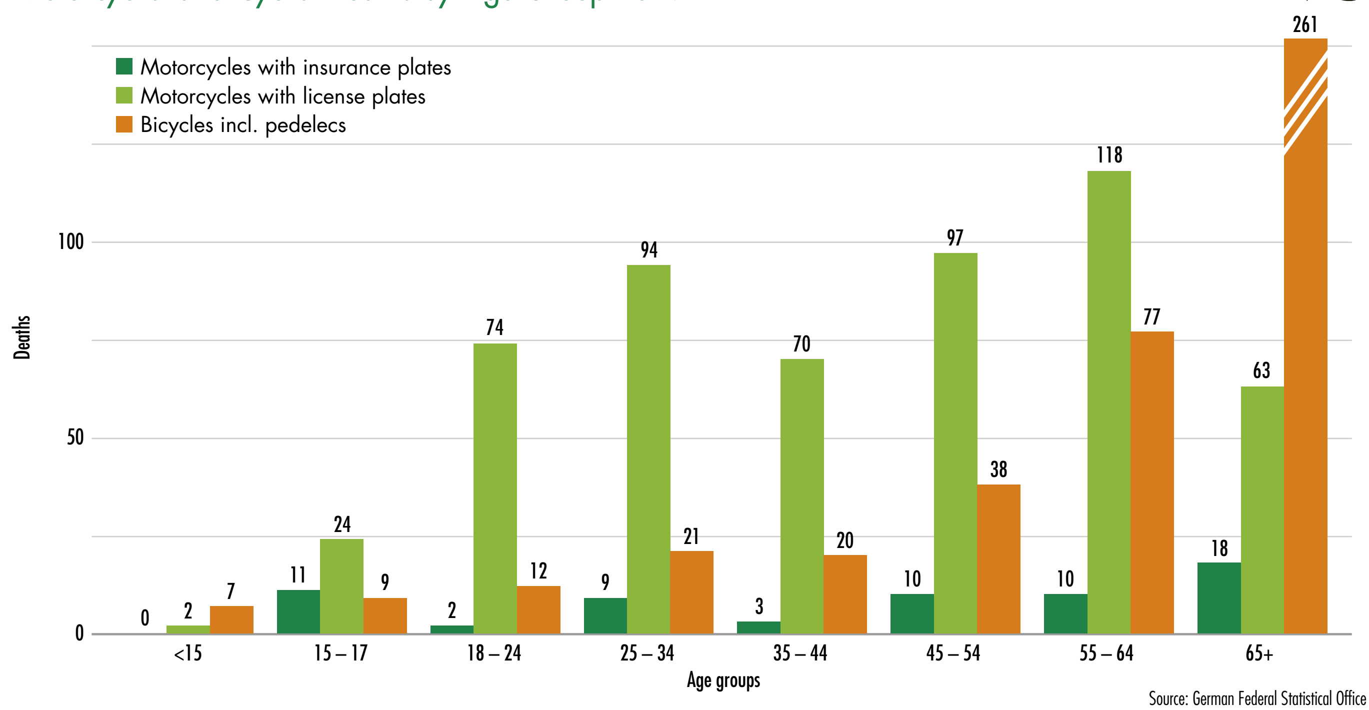
With regard to accident statistics for two-wheeled vehicles in Germany (Figure 15), a welcome downward trend can be seen, at least when comparing 2019 to 2018. In total, 129,207 users of two-wheeled vehicles were involved in accidents on German roads – 4.5 percent fewer than in 2018, when the number was 135,103. The number of motorcyclists involved in accidents fell almost nine percent from 31,419 to 27,927, with the number of fatalities dropping from 619 to 542. A total of 13,925 users of two-wheeled motor vehicles with an insurance plate were involved in road accidents in 2019. One year earlier, the figure was 14,792. 63 users of two-wheeled motor vehicles with insurance plates lost their lives – 15 fewer than in 2018. The number of cyclists involved in road accidents in 2019 fell around one percent compared to the previous year, from 88,880 to 87,342. The number of deaths in this group remained the same, at 445. 118 of these cases were pedelec users, compared to only 89 in 2018. This means that the number of pedelec users who died on German roads increased by a whopping 32 percent.

As the German Federal Statistical Office wrote in its 2019 annual report on motorcycle and bicycle road accidents, the comparative risk of being involved in a road accident is higher for users of motorcycles than of other motor vehicles. In 2019, six motorcyclists per 1,000 officially registered motorcycles with license plates were involved in an accident, as opposed to five car users per 1,000 cars. The risk of being killed in a road accident was also significantly higher for users of motorcycles with license plates than for occupants of cars, at 12 fatalities per 100,000 motorcycles compared to three fatalities per 100,000 cars. These figures underline the fact that motorcycles come with a higher overall risk of injury than cars, and also that the consequences of accidents are more severe for users of motorcycles with a license plate than for occupants of cars. In 2019, the comparative risk of being killed while riding a motorcycle that requires a license plate was actually more than four times higher than for occupants of cars – despite the fact that the mileage covered by motorcyclists was much lower.

Motorcyclists are also at a much higher risk when newly licensed: 35.4 percent of motorcycle users involved in an accident and over 18 percent of those killed in an accident in 2019 were between 15 and 24 years old. The reason for this is obvious: Young motorcyclists often have little experience on the road, and also tend not to know their own limits. Aside from young people, the elderly were the most likely to suffer an accident on a light motorcycle: 28.6 percent of fatally injured users of light motorcycles were aged 65 or older. This figure was even higher among cyclists, with this age group accounting for more than half of all fatalities (Figure 16).

As stated by the German Federal Statistical Office in its annual report on road accidents in Germany for 2019, 31 percent of those involved in accidents and almost 27.5 of motorcycle users killed in accidents suffered their injuries in single-vehicle accidents. In collisions involving a motorcyclist and another road user, the second party was a car in almost 81 percent of cases. In more than 26,200 collisions of this type, 1,653 occupants of cars and 22,036 motorcycle users were injured. This means that around 93 percent of the victims of these accidents were motorcyclists or their passengers, even though 68 percent of these accidents were caused by car drivers.

16 Motorcyclist and Cyclist Deaths by Age Group 2019



Source: German Federal Statistical Office

OVERCONFIDENCE IS A HUGE DANGER FOR MOTORCYCLISTS.

With regard to accidents that resulted in motorcyclist fatalities (Figure 17), single-vehicle accidents accounted for almost 28 percent of accidents in built-up areas and almost 27 percent in non-built-up areas. In total, this means that around 27 percent of all the motorcyclists killed on the road lost their lives in accidents that did not involve other road users. In accidents involving two parties, the data shows that cars played the largest role as the second party. Taking into account all road classes, almost 50 percent of these accidents were caused by the driver of the car. In total, almost a third of the accidents that resulted in motorcyclist fatalities were caused by the motorcyclist themselves.

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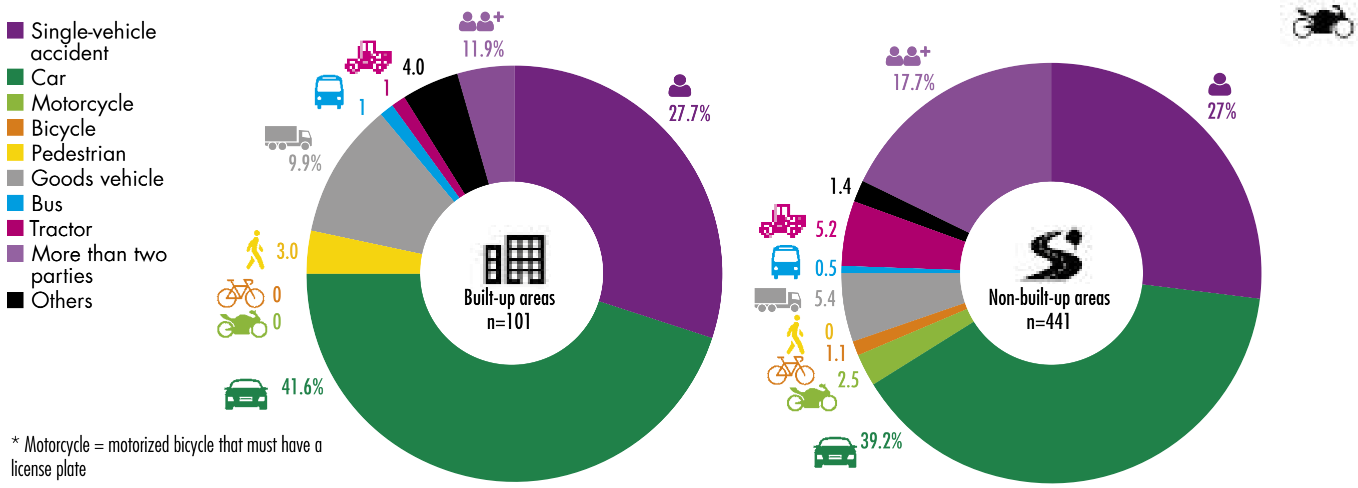
Parties Involved in Accidents with Motorcyclists* in 2019



* Motorcycle = motorized bicycle that must have a license plate

In accidents involving more than two parties, 90 motorcycle users lost their lives (built-up areas: 12, non-built-up areas: 78)

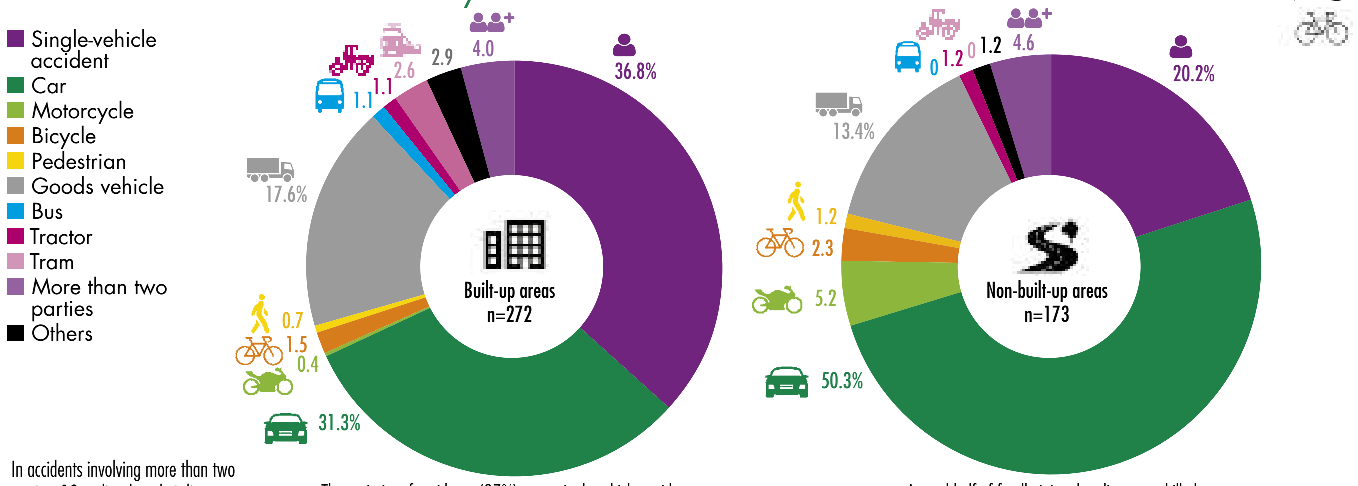
70% of deaths caused by single-vehicle accident or collision with a car.

66% of deaths caused by single-vehicle accident or collision with a car.

Source: German Federal Statistical Office

18

Parties Involved in Accidents with Cyclists in 2019



In accidents involving more than two parties, 19 cyclists lost their lives (built-up areas: 11, non-built-up areas: 8)

The majority of accidents (37%) were single-vehicle accidents, 31% were collisions with cars, almost 18% were collisions with goods vehicles

Around half of fatally injured cyclists were killed in collisions with cars.

Source: German Federal Statistical Office

Of the 87,253 bicycle accidents resulting in personal injury that were reported to the police, almost 22.5 percent were single-vehicle accidents. The most common second party in bicycle accidents was a car, accounting for around 64 percent of such accidents, and in such cases the driver of the car was the main cause of the accident 75 percent of the time. If we look at the bicycle accidents that resulted in cyclist fatalities (Figure 18), we can see the following pattern: Of the 173 cyclists who lost their lives on roads in non-built-up areas, 35 died in single-vehicle accidents. 87 died in accidents involving a car. 51 of these accidents were caused by the cyclist themselves. Particular note should also be taken of the single-vehicle accidents that occurred in built-up areas. Of the 272 cyclists who lost their lives in such areas, 100 died in accidents that did not involve any other party. Cars were the most common second party; the driver of the car was deemed to be the main cause of the accident in 45 cases, and the cyclist in 40 cases. The analysis shows that much more emphasis needs to be placed on preventing single-vehicle accidents. The main objectives here are to improve the infrastructure, massively increase the number of cyclists who wear helmets, and provide training for pedelec use, especially for senior citizens.

Generally speaking, it should be noted that there is a high number of unreported cases. Someone who falls off their bike and injures themselves will rarely call the police, and will usually opt to go to a doctor under their own steam, even if severely injured. Even when an ambulance is called, the police are not always notified. As a result, these single-vehicle accidents do not appear in the official statistics.

RAPID INCREASE IN ACCIDENTS INVOLVING PEDELEC RIDERS

The pedelec (pedal electric cycle) has presented road users with a new form of mobility. The pedelec boom is well underway, and the number of these vehicles on our roads is rising continuously. In Germany, for example, a total of 5.4 million pedelecs were in use

Most Common Types of Motorcycle Accidents Resulting in Personal Injury

In order to describe the sequence of events for an accident, we need to look not only at information such as "cause of accident" (mistake on the part of the road user or other contributing circumstances) and "nature of accident" (collision or running off the road), but also at data on the "type of accident" in question. This refers to the traffic event or conflict situation from which the accident arose.

An assessment of the GIDAS (German In-Depth Accident Study) accident database conducted by DEKRA Accident Research for multiple years between 2002 and 2018 produced the results shown in the graph below for motorcycle accidents resulting in personal injury that involved vehicles with a displacement of more than 125 ccm:

Accident type 1 = Driving accident: Driver loses control of the vehicle as a result of not selecting the correct speed for the course, cross-section, incline, or condition of the road, or because they did not notice a change in the course or cross-section of the road soon enough.

Accident type 2 = Turning accident: Accident triggered by conflict between a vehicle that is turning and a road user approaching from the same or opposite direction.

Accident type 3 = Joining/crossing accident: Accident triggered by conflict between a road user who should be waiting before joining or crossing a road and a vehicle with the right of way on said road.

Accident type 4 = Pedestrian crossing accident: Accident triggered by conflict between a pedestrian cutting across a road and a vehicle on said road.

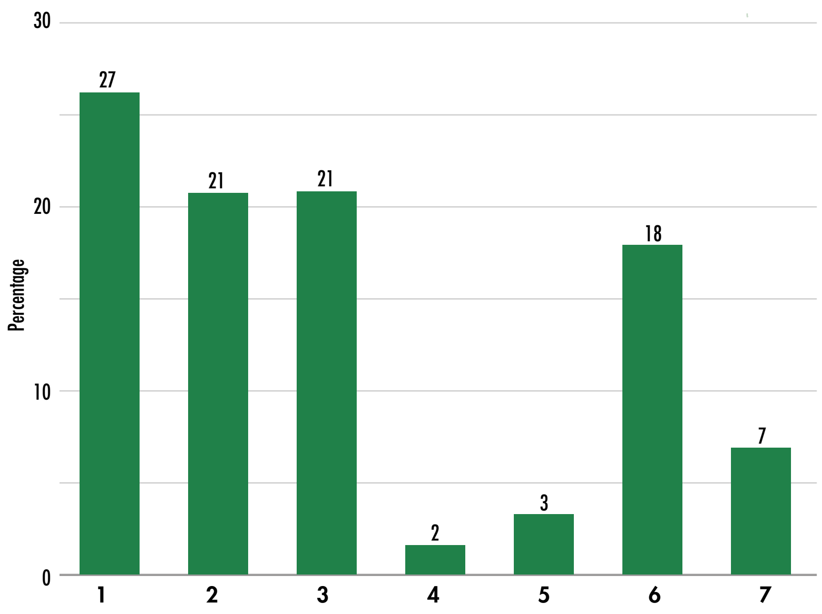
Accident type 5 = Accident due to stationary traffic: Accident triggered by conflict between a vehicle in moving traffic and a vehicle that is stationary on the road, i.e. one that is parked or waiting.

Accident type 6 = Accident in parallel traffic: Accident triggered by conflict between road users traveling in the same or opposite directions.

Accident type 7 = Other accident

Across all accident types, motorcyclists are particularly susceptible to injuries to the upper and lower extremities; however, injuries to the spine and thorax were also relatively common.

Distribution by Accident Type



(n=1,105 cases)

Source: DEKRA Accident Research/GIDAS

Burkhard Stork
Federal Chair of the
General German Bicycle Club (ADFC)

We Need Safe Roads for Everyone!

Turning trucks are a potential death trap for cyclists. Every year, situations such as this lead to 30 to 40 deaths in Germany, as well as thousands of serious injuries. Women, senior citizens, and children are particularly likely to be the victims of such accidents. We have been appealing to politicians and industrial players for years to come up with solutions to this problem. We truly appreciate the pioneering work of Mercedes in the development of turning assistants for trucks, which has resulted in many other manufacturers following suit. However, these systems still need to be developed further – in order to truly help, they need to be able to execute an emergency braking maneuver. They also need to be made a legal requirement as soon as possible. We want politicians and administrators to provide safe junctions and separate traffic light sequences so that motor vehicles and bicycles do not get in each other's way as much. Last but not least, we need everyone to be as considerate as possible of unprotected road users. As goods traffic in our towns and cities increases, we need safe roads for everyone!

in 2019, compared to just 2.1 million in 2014 (Figure 19). Pedelec sales are also booming in other countries. This should come as no surprise – after all, many towns and cities are promoting cycling heavily. However, both in Germany and in other countries, the number of pedelec users involved in accidents has risen dramatically (Figure 20).

It is no coincidence that pedelecs are popular among senior citizens. The assistance offered by the built-in electric motor enables them to cycle further without over-exerting themselves. This is reflected clearly in the accident statistics for this user group. 60 percent of the pedelec users killed in Germany in 2019 were over 70 years old. Those over 75 alone accounted for almost 51 percent of pedelec fatalities in 2019 (Figure 21).

Setting our Sights on the Blind Spot

When an unprotected road user collides with a truck, it truly is a case of David vs. Goliath. However, there is one major difference between this situation and the famous Bible story – on the road, Goliath always wins. After all, cyclists and pedestrians have no chance when faced with the sheer mass of a truck. In 2018, for example, a total of 34 cyclists in Germany lost their lives in accidents involving trucks that were turning right.

New technological developments in vehicles – such as the factory installation or retrofitting of turning assistant systems – are an important factor in preventing such scenarios from occurring. However, a resolution issued by the EU Commission has declared that turning assistants will not become a legal requirement until 2022 for new truck vehicle types, and it will be 2024 before the requirement applies to all new trucks. In accordance with the 9th Amendment to the Long Truck Field Test (Feldversuch Lang-Lkw), turning assistants became a legal requirement for new long trucks on July 1, 2020, and the same requirement will come into effect for all long trucks – and thus for all existing vehicles – on July 1, 2022.

Back in 2016, Mercedes-Benz became the first manufacturer in the world to put this type of personal detection system on the market. The system works on several levels. For example, if there is a cyclist in the warning zone, a triangle of yellow LEDs will light up in the A column on the co-driver's side. If the system senses a risk of collision, the LEDs will flash red and light up more intensely, and the radio speaker to the driver's right will issue a warning sound. In addition to this, the sensors can detect stationary obstacles such as traffic lights and street lights in the turning circle of the truck when it is turning. This prevents collisions not only on public roads, but also when the truck is maneuvering on a parking lot, for example. The comprehensive assistance this system offers the driver is provided at all speeds – from when the truck is stationary (e.g. when waiting at a traffic light) up to the maximum speed limit.

In addition to such systems, however, it is equally important to teach road users about the dangers of the "blind spot" – something DEKRA has been doing for decades. On top of this, DEKRA has been addressing cyclists directly since fall 2018 with large stickers for trucks bearing the words, "Never overtake on the right!" This applies all the more at junctions when trucks are using their turn signals to indicate when they are about to turn.

There are now a wide range of products that can be used to retrofit turning assistants. These systems, which are based on a variety of different technologies, can be fitted to trucks cheaply and thus help to drastically reduce the risk of an accident. The huge demand for such systems among truck drivers was made clear by a promotional program that was launched in Germany, during which the entirety of the promotional stock was used up remarkably quickly. We cannot recommend highly enough that other governments seek to repeat and replicate this initiative.

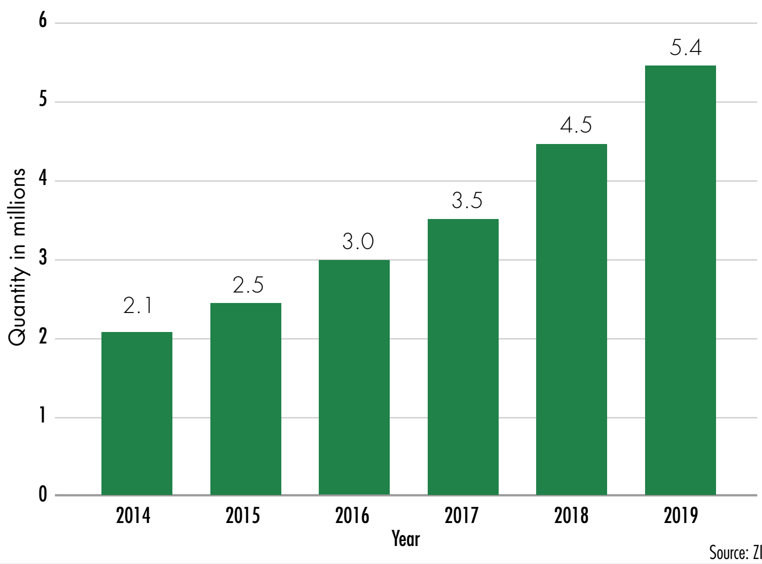
Section 5, Clause 8 of the German Road Traffic Act (StVO) remains a large problem. According to this regulation, cyclists and small moped users are permitted to overtake vehicles such as trucks that are waiting in the right-hand lane on the right, providing they do so at moderate speed and with the utmost care, and that there is sufficient space for them to do so. It is the unreserved opinion of DEKRA that this regulation must be abolished, as the space to the right of a waiting truck can quickly become a death trap, as experience has sadly demonstrated far too often. This is because the sufficient space required on the right to overtake a truck only opens up when the truck wants to turn right and has thus positioned itself slightly further to the left than usual.

UNDERESTIMATION OF THE ENORMOUS ACCELERATION AND BRAKING POWER OF PEDELECS IS ESPECIALLY COMMON AMONG SENIOR CITIZENS.

But why is riding a pedelec so dangerous, especially for senior citizens? There are a myriad of reasons for this phenomenon. One of the main problems is the fact that other road users often drastically underestimate how fast a pedelec can move. In addition to this, older people are often out of practice, as a lot of time has elapsed between when they were last on a conventional bicycle and their venture into the world of the pedelec. As a result, they often underestimate the fast acceleration and high braking power, as they are not used to these features. On top of this, reaction speed diminishes with age (due to problems with sight or balance), as do the general physical abilities required for cycling. Likewise, older bodies are less capable of withstanding falls. Older people can be injured more easily – and, more importantly, more severely – than young cyclists if they fall, so even the smallest of tumbles can have fatal consequences.

In light of the age distribution of the German population, this is likely to remain a challenge for many years to come. In particular, those born during the baby boom years of 1975 and earlier are gradually reaching the age where the likelihood of being severely or fatally injured when riding a pedelec or a bicycle increases dramatically. In 2018, pedelec users aged 45 and over made up 93.2 percent of deaths on German roads. This age group also accounted for a large portion of the bicycle fatalities for that year – 79.5 percent. The percentage of pedelec users who suffered severe injuries on the road in 2018 that were aged 45 and over was similarly high, at 87.2 percent. For severely injured cyclists, the figure was 58.6 percent. As such, urgent action is required if we are to put a stop to this trend.

19 Growing Numbers of Pedelecs on the Road



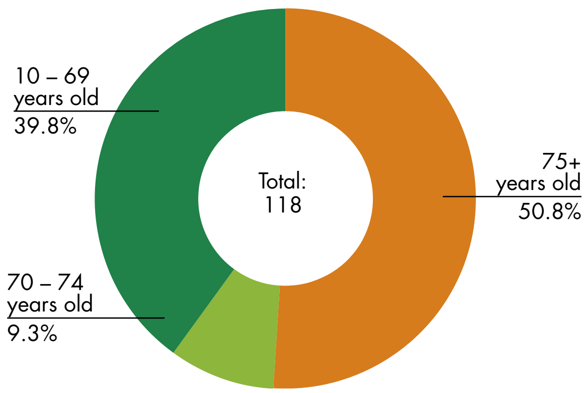
Source: ZIV

20 Accidents involving bicycle, pedelec, and speed pedelec users

	2017	2018	2019		2017	2018	2019
Bicycle & pedelec				*Bicycle* only			
Deaths	382	445	445	Deaths	314	356	327
Severe injuries	14,124	15,530	15,176	Severe injuries	12,750	13,523	12,580
Minor injuries	65,222	72,905	71,721	Minor injuries	61,549	67,249	63,812
Total involved in accidents	79,728	88,880	87,342	Total involved in accidents	74,613	81,057	76,719
Pedelec only				*Speed pedelec* only			
Deaths	68	89	118	Deaths	0	4	4
Severe injuries	1,374	2,077	2,596	Severe injuries	144	145	81
Minor injuries	3,673	5,657	7,909	Minor injuries	371	422	281
Total involved in accidents	5,115	7,823	10,623	Total involved in accidents	515	571	366

Source: German Federal Statistical Office

21 Ages of Pedelec Users Killed in 2019



Source: German Federal Statistical Office

Dr. Jörg Kubitzki
Allianz Center for Technology (AZT),
Safety Research

Innovative Urban Mobility? Cyclists and Pedestrians are Still Losing Out.

The number of bicycles on our roads has been increasing exponentially for years. In light of this, an increase in the number of cyclists who are the main causes of accidents is inevitable. Our calculations at the AZT show that, in terms of absolute figures, there has been a 17 percent increase over the last ten years – as opposed to a five percent decrease for car drivers and a 15 percent decrease for pedestrians. It is true that traffic volume has increased by 29 percent for cyclists and three percent for pedestrians and cars over the same period. However, the number of cyclists per 1,000 people involved in accidents involving personal injury who were the main cause of said accidents has been rising markedly for several years. Between 2012 and 2018, this number for cyclists increased from 415 to 442, while the figure for car drivers over the same period dropped slightly from 562 to 558, and for pedestrians from 268 to 261.

However, such comparative calculations allow very little consideration for the sheer number of variables affecting these figures, such as the quality of the road networks and traffic density. As such, we should be cautious when using the aforementioned accident figures to point the finger of blame. The real problem goes much deeper.

If we take a closer look at the trend for accidents according to the parties involved, it becomes clear that the promotion of CO_2-neutral mobility stands little chance of success if we do not adjust our strategic focus. Collisions between cars are on the decline, while those between two-wheeled vehicles and between a two-wheeled vehicle and a pedestrian are on the rise. For users of non-motorized vehicles, our roads are starting to become more and more crowded. Keeping these road users apart from motorized traffic and thinking in terms of categories – fast/slow traffic, outgoing/incoming/transit traffic, cars, two-wheeled vehicles, pedestrians, and all from the perspective of wanting to prevent accidents involving motor vehicles – has improved safety over the course of several decades.

But mobility is now more complex and variable. People are more spontaneous, mixing conventional and innovative modes of transport at short notice. And all the time, the volume of traffic on our roads is increasing. Our infrastructure and safety technology can no longer keep up with this trend. The German Environment Agency, transport associations, safety committees, and even the Deutsche Gesellschaft für Verkehrspsychologie (German Society for Traffic Psychology) are pushing for a more systematic approach that will help us to think holistically across all types of road user. An integrated national plan for bicycle and pedestrian traffic would be a good start. The AZT's most recent study shows that environmentally friendly pedestrian traffic is decreasing overall, not least due to the increase in the number of vehicles on our roads. Many people are simply giving up, especially senior citizens. As a society, we must aspire to be better than this.

In accidents involving bicycles and e-scooters, a quick response from the emergency services is often the difference between life and death.

HIGH RISK OF INJURY IN E-SCOOTER ACCIDENTS.

ACCIDENTS INVOLVING E-SCOOTERS ON THE RISE

As of mid-June 2019, the use of "e-scooters" is now permitted on German roads with no license required. These vehicles still play a relatively minor role in terms of the country's accident statistics. According to the German Federal Statistical Office, 251 accidents involving personal light electric vehicles occurred in the first quarter of 2020. As a result of these accidents, one e-scooter user was killed, 39 were severely injured, and 182 suffered minor injuries. By way of comparison, police recorded more than 12,700 accidents that resulted in injuries to cyclists across Germany in the first three months of 2020. In figures, this broke down into 52 deaths, 2,052 severe injuries, and 10,431 minor injuries. The use of e-scooters has been permitted for some time in many other EU member states, as well as other countries such as the USA. As the number of these vehicles on the roads has increased, so too have the accident figures in some areas.

For example, a study published by the University of California in San Francisco showed that the number of scooter-related injuries recorded in the USA rose 222 percent between 2014 and 2018, to more than 39,000. Even more worryingly, the number of hospitalizations over this period increased 365 percent to 3,300. The most common victims were aged between 18 and 34. The study was based on accident statistics provided by the National Electronic Injury Surveillance System.

Ana Tomaz
Vice President, Portuguese National Road Safety Authority

The Volume of Traffic on our Roads is Increasing – What Does This Mean for Road Safety?

Traffic accidents are a global problem. The World Health Organization (WHO) has declared them a danger to public health: They are the most common cause of death among young people, the third most common for under-40s, and the eighth most common for other age groups. More people currently die in road accidents than from HIV infections, tuberculosis, or other illnesses. 1.35 million people lose their lives in traffic accidents every year. This is equivalent to around 3,700 deaths per day, or one every 24 seconds. And that figure does not account for those who survive but suffer injuries or severe injuries with permanent damage. 54 percent of those who die on the road are unprotected road users. This includes users of two-wheeled vehicles, who account for 31 percent. This number is an unacceptable and needless price to pay for our mobility. We would not put up with such high figures for any other mode of transport.

In Portugal, the number of traffic accidents involving two-wheeled motor vehicles is above the European average. Over the last five years, users of two-wheeled vehicles accounted for a quarter of the fatalities on average (155) – 5 percent cyclists and 20 percent users of motorcycles or light motorcycles. Most users of two-wheeled vehicles were killed in built-up areas, on country or municipal roads, or in city traffic. This accounts for two thirds of all the motorcyclists and cyclists involved in accidents. As a result, cities and transport infrastructure are of particular importance when investigating the causes of accidents.

What we need is a new model of mobility – one that protects people and makes road safety our top priority, thus solving the problems traffic is currently causing: congestion, air pollution, and accidents. This new model of mobility needs to include all road users. It also needs to be self-explanatory and tolerant of the most vulnerable road users. It needs to be built on the basic premise that human error is unavoidable – but deaths and severe injuries due to traffic accidents are not.

When developing this new model, we need to consider measures such as improving vehicle design and road infrastructure, separating different types of traffic, and applying speed regulations, all of which have a huge impact on reducing accidents, especially in terms of their consequences. When put together, these measures need to guarantee a level of safety that enables the road infrastructure and/or the vehicle itself to "intervene" when a component of the vehicle system – especially the driver – fails, thus preventing deaths and severe injuries due to accidents. Preventing the loss of human life must be the motivation behind all our decisions. The only acceptable number of deaths on the road is zero.

Cary B. Bearn
Chief Bicycle Officer, Office of Mobility Planning, Department of City Planning, City of Atlanta

Our Roads Need to Be Safer

In 2018, scooters began to appear in cities across the US with varying degrees of permission and coordination. Throughout that year, cities evaluated the devices, the companies, the operations, and began regulating the industry. In Atlanta we passed legislation regulating these shareable dockless mobility devices in early 2019. In that year, there were over 4,600,000 trips taken across eight companies. Based on a survey conducted by the City in November 2019, approximately 40% of those trips replaced driving trips (combination of rideshare and driving). As Atlanta works to reduce our dependence on driving as a transportation mode, the inclusion of scooters as a new option is well aligned with our goals. Our priority has been to make this new option as safe as possible. Tragically, four people have died while riding scooters on our streets.

Even more tragically, those four fatalities are dwarfed by the 23 pedestrian fatalities within the City of Atlanta during the same time period. The newness of scooters often focuses attention to the new challenges of that specific device. For the City of Atlanta, it also underscores the pressing challenges of our current transportation system at large: our roads need to be safer, our sidewalks are often inadequate, and curb space in our cities is increasingly in demand.

In mid-2019, Atlanta passed three major regulations to address safety concerns. First, on a very popular shared use path, a reduced speed zone was implemented during highly congested periods. Before the speed reduction, people walking on the path felt threatened by people riding scooters too close and too fast and there were several collisions with injuries reported. Reducing the speed of scooters from 15mph to 8mph in this zone has greatly reduced the number and severity of these conflicts.

Towards the end of summer, after the fourth fatality in as many months, the City implemented a city-wide no-ride zone daily from 9PM to 4AM. This was a somewhat controversial move as the regulation limits mobility options for people during the night. However, based on crash reports, rider behavior, and the evidence of nighttime fatalities, similar restrictions are becoming increasingly common in cities across the US. Moving forward, the City plans to enact higher standards for scooter lighting and incentivize companies to make further improvements for nighttime safety.

Our third effort to improve safety is ongoing and focused action to keep the sidewalk safe and free of obstructions created by scooters. We have worked to streamline our monitoring and complaint processes around scooters so that companies can be quickly directed to areas most in need of their attention. The City has also begun creating designated parking areas in heavily traveled districts. Although most parking areas are optional, several along one of the busiest scooter corridors are required for riders and company deployments alike. The companies work with the City to continuously re-balance scooters along this corridor and ensure that the scooter supply does not exceed capacity in the designated parking zones.

As 2020 begins, we continue to prioritize safety and are working to adopt a formal Vision Zero policy with data-driven approaches to make our streets safer for everyone – whether they are scooting, walking, rolling, riding, driving, or whatever is next.

A study on e-scooters conducted in Austin, Texas between September 5 and November 30, 2018, has also attracted attention. Over the course of this 87-day period, the study recorded 192 injuries requiring treatment – a little over two per day. Over 60 percent of those injured stated that they had ridden an e-scooter less than ten times before the accident occurred. Fewer than one percent of the e-scooter users injured in the study were wearing a helmet at the time, and almost 50 percent of them suffered head injuries.

In light of the increasing number of e-scooter accidents, Berlin's Charité hospital has also conducted a study into the causes of these accidents and the resulting injuries. For this study, the team around Prof. Martin Möckel, Head of Emergency Medicine and Acute Care at the Charité Mitte and Virchow-Klinikum campuses, examined a total of 24 patients aged between 12 and 62 during July 2019. These experts noted that the injuries typically suffered by people using these vehicles included lacerations to the upper ankle, fractures to the upper extremities, and head injuries. In fact, head in-

Difficulties with the Reconstruction of Accidents Involving E-Scooters

As with any conventional traffic accident, in the aftermath of an accident involving an e-scooter we need to be able to reconstruct the sequence of events that led to it. During this process, an accident analysis expert is enlisted by the court, the district attorney, or the insurance company to reconstruct how the accident happened. By assessing tire tracks and other marks, the final positions of the parties involved, and the damage to the vehicles, this expert can usually draw conclusions with regard to the collision speed, the exact site of the accident, the conduct of the parties involved as they approached one another, and the extent to which the accident could have been prevented.

But if we picture a collision between a cyclist and an e-scooter user on a bicycle path, or between a pedestrian and an e-scooter user on a mixed sidewalk/bicycle path, it quickly becomes clear that the usual procedure cannot usually be applied in such situations. It is often impossible to determine the exact site of the collision, as the parties involved have often cleared the area by the time the police arrive. No conclusive photos showing the final positions of the parties are taken, and there are no marks on the bicycle path or sidewalk surface to document the exact site of the collision and the relative positions of the parties involved.

Since there are no separate lanes on a bicycle path, it is often almost impossible to reconstruct the exact course of the vehicles as they approached the site of the accident. This is also made more difficult by quick lane changes often made without signaling and the resulting evasive maneuvers of other road users, which are likewise almost impossible to determine after the fact and incorporate into the reconstruction. Another reconstruction tool used for collisions between motor vehicles is the calculation of the collision speed based on the damage to the vehicles. This is often impossible to do for collisions involving e-scooters and bicycles, especially due to the relatively low speeds they travel at. This could make the legal processing of such accidents much harder in the future.

juries were suffered by more than half of the patients in the study. Most of these injuries were minor contusions with abrasions. Four of the 24 patients showed signs of minor traumatic brain injury. The large number of soft-tissue injuries to the lower extremities in the vicinity of the upper ankle were caused by accidents where the user was not careful enough when setting off on the e-scooter. The main causes of the accidents were carelessness, a failure to observe the traffic regulations, and impaired driving ability due to the user having consumed drugs or alcohol prior to embarking on the journey. These results show that, as an additional form of mobility, e-scooters pose a risk to their users that is not to be underestimated. At the same time, they also represent a challenge for the existing traffic system.

Many users of e-scooters underestimate the speed of their vehicle.

The Facts at a Glance

- **Across the EU, the number of users of motorized and non-motorized two-wheeled vehicles involved in accidents has more or less stagnated.**
- **In terms of percentages, the 50 – 69 age group has seen the biggest increase with regard to users of two-wheeled vehicles killed in road accidents at the global level.**
- **Overconfidence is often one of the causes of an accident, especially among older motorcyclists.**
- **Pedelec users often underestimate the high acceleration and braking power of their vehicle, as they are not used to it.**
- **Reaction speed diminishes with age, as do the general physical abilities required for cycling. The body's ability to withstand a fall also lessens, so even the smallest of tumbles can have fatal consequences.**
- **It is strongly recommended that cyclists and users of pedelecs and e-scooters wear a helmet. They should also ensure that they are easily visible and wear retroreflective clothing at dusk and night.**
- **In many cases, accidents involving cyclists and right-turning trucks can be prevented by suitable assistance systems, and also by being aware of the risks involved and acting accordingly.**

Compelling Examples of Accidents in Detail

Collision with oncoming traffic

ERROR WHEN JOINING A ROAD

Sequence of events:

On a section of bridge, a motorcyclist lost control of his vehicle when joining a federal highway, veering out of his lane and into oncoming traffic. A group of three motorcycles were coming toward him from the opposite direction. The left side of the motorcycle that was on the wrong side of the road grazed against the first oncoming motorcycle. Following this contact, both motorcycles and their riders fell to the ground. The second motorcyclist in the group collided with the motorcycle sliding toward him on the ground, and also fell off. The last motorcyclist in the group braked his vehicle hard. As a result of this, the front wheel locked and this motorcyclist also fell to the ground.

Persons involved in the accident:

Four motorcyclists

Consequences/injuries:

The rider of the motorcycle that veered into the oncoming traffic and the first motorcyclist in the group traveling in the opposite direction were severely injured in the grazing collision and their subsequent fall to the ground. The two other motorcyclists in the group suffered minor injuries when falling to the ground.

Cause/problem:

The accident was caused by a driving error on the part of the motorcyclist who left his lane. This motorcyclist accelerated too strongly when joining the federal highway, which resulted in him losing control of his vehicle and no longer being able to maintain his course, and thus ultimately veering into oncoming traffic.

Avoidance measures, mitigation of consequences/ strategy for road safety measures:

The accident could have been prevented if the motorcyclist had accelerated much less when joining the federal highway, which would have enabled him to retain control of his motorcycle. Due to their high power and low weight, motorcycles often possess a very high acceleration capability. A lot of experience and a good feel for the correct amount to open the throttle is required. Electronic driving assistants and motorcycle safety training may have been able to prevent the motorcyclist from losing control of his vehicle and causing the accident.

1 Scene of the accident

2 On-ramp onto federal highway

3 Final position of the vehicles

4 Sketch of the collision position

Collision with oncoming traffic

INCORRECT ANGLE

Sequence of events:

While driving round a long bend to the right, a motorcyclist veered onto the wrong side of the road and collided with the front left-hand corner of an oncoming car while in an upright position. The impact of the crash threw the motorcyclist off her vehicle, causing her to bang her head against the left-hand A-column of the car and the adjoining section of the windshield.

Persons involved in the accident:

One motorcyclist and one car driver

Consequences/injuries:

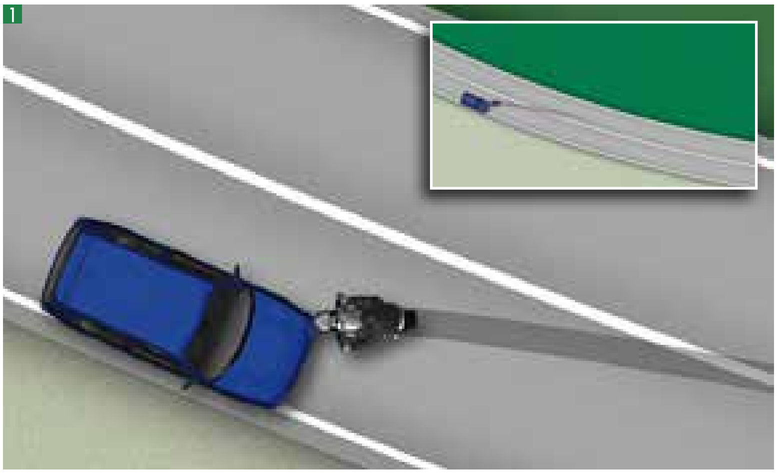
The motorcyclist died at the scene of the accident due to the severe head injuries she had suffered. The car driver suffered minor injuries.

Cause/problem:

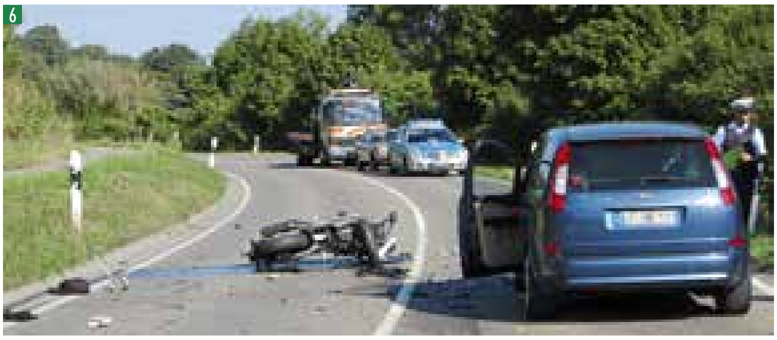
The cause of the accident was the incorrect angle the motorcyclist had adopted in order to take the corner. Due to natural inhibitions, some motorcyclists do not lean far enough into the angle required to corner safely, especially when they are inexperienced and traveling at high speeds. As it did here, this can even occur when a motorcyclist is not breaking the speed limit.

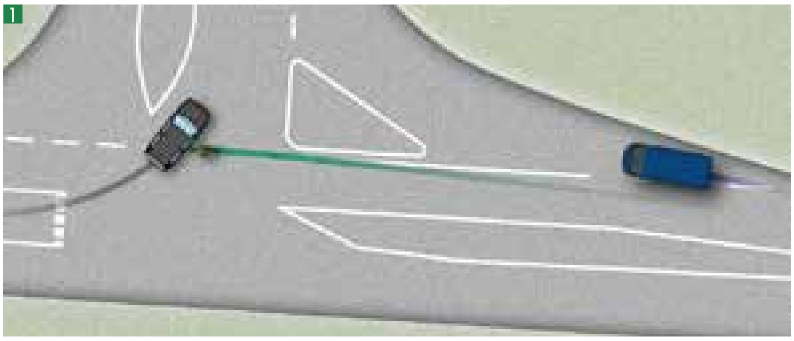
Avoidance measures, mitigation of consequences/ strategy for road safety measures:

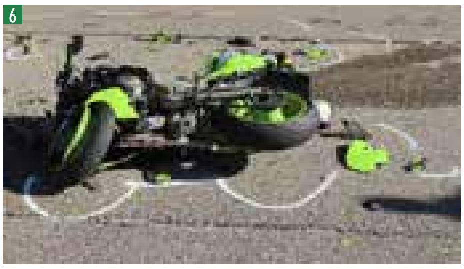
This accident could have been prevented if the motorcyclist had adopted a less vertical angle or taken the corner at a lower speed, which would have enabled her to stay in her lane. The driver of the car had a maximum of 2.1 seconds to respond to the critical situation before the collision. He steered toward the outside edge of the road to his right and started braking, but this was not enough to prevent the accident. Inexperienced motorcyclists often do not lean into corners as far as they could. Motorcycle safety training or specialized cornering training can help many motorcyclists to find the correct balance between speed and angle and learn their own limits.



1 Sketch of the collision position
2 Point of impact on A-column
3 Damage to helmet
4 Damage to motorcycle
5 Damage to car
6 Final position of the vehicles







1 Sketch of the collision position
2 Scene of the accident
3 Final position of the vehicles
4 Damage to car
5 Point of impact on edge of roof
6 Damage to motorcycle
7 Damage to helmet

Turning left into oncoming traffic

CAR HITS MOTORCYCLE

Sequence of events:

On a bypass and under the influence of alcohol, the driver of a car turned left at a junction. A motorcyclist with a pillion passenger was oncoming in the opposite lane. The motorcyclist was behind a van which was also driving along the bypass. The van turned right at the junction, while the motorcycle behind it kept driving straight on. At the junction, a collision occurred between the motorcycle and the car that was turning left. The front of the motorcycle crashed against the right-hand side of the car. This impact threw the motorcyclist against the car, causing him to hit his head against the edge of the car roof.

Persons involved in the accident:

One motorcyclist with pillion passenger
plus one car driver

Consequences/injuries:

The motorcyclist was killed by the impact; the pillion passenger suffered severe injuries.

Cause/problem:

The accident was caused by a number of factors. Firstly, the motorcycle was approaching the junction and the van in front of it at too high a speed (at least 90 km/h in a 70 km/h zone), causing it to be temporarily obscured from view. Secondly, the motorcycle was only briefly visible to the car driver due to a combination of the bend and the slope of the road. However, the car driver's blood alcohol level of 0.09 percent may also have contributed to causing the accident.

Avoidance measures, mitigation of consequences/ strategy for road safety measures:

The motorcyclist could have prevented the accident by keeping to the 70 km/h speed limit and reacting to the turning car by executing emergency braking and evasive maneuvers. Without a medical assessment, it is not possible to determine the exact extent to which the car driver's blood alcohol level impacted the sequence of events. However, if all the parties involved in the accident had been exercising due attention and consideration for others when using the road, it would have been possible to prevent the accident.

MOTORCYCLE COLLIDES WITH LEFT-TURNING CAR

Sequence of events:

On a town road, a motorcyclist overtook several vehicles that were waiting in front of him, driving through a marked no-passing zone to do so. Due to the high volume of traffic and a traffic light system, a tailback had built up. However, the exit from a local discount store on the right-hand side of the road had been kept clear, which enabled a car driver to turn left out of the exit. Upon seeing the turning car, the overtaking motorcyclist initiated emergency braking. Overbraking caused the motorcycle to fall onto its right-hand side, crashing into the front left-hand corner of the car. The impact threw the motorcyclist from his vehicle, coming to a stop lying on his back in front of the vehicle.

Persons involved in the accident:

One motorcyclist and one car driver

Consequences/injuries:

The motorcyclist was severely injured during the accident and taken to hospital with life-threatening injuries to his internal organs.

Cause/problem:

The cause of the accident was a combination of the motorcyclist failing to adjust his speed and attempting to overtake illegally using the marked no-passing zone. Due to the waiting vehicles, the motorcyclist did not see the turning car until very late. The car driver could not see the motorcyclist. An additional problem was the lack of an ABS system on the motorcycle. When the motorcyclist initiated emergency braking, this resulted in the front wheel overbraking, causing it to slip to the left and the motorcycle to fall onto its right-hand side. As a result of this, the motorcyclist was no longer able to swerve out of the way of the car or keep on braking the motorcycle.

Avoidance measures, mitigation of consequences/ strategy for road safety measures:

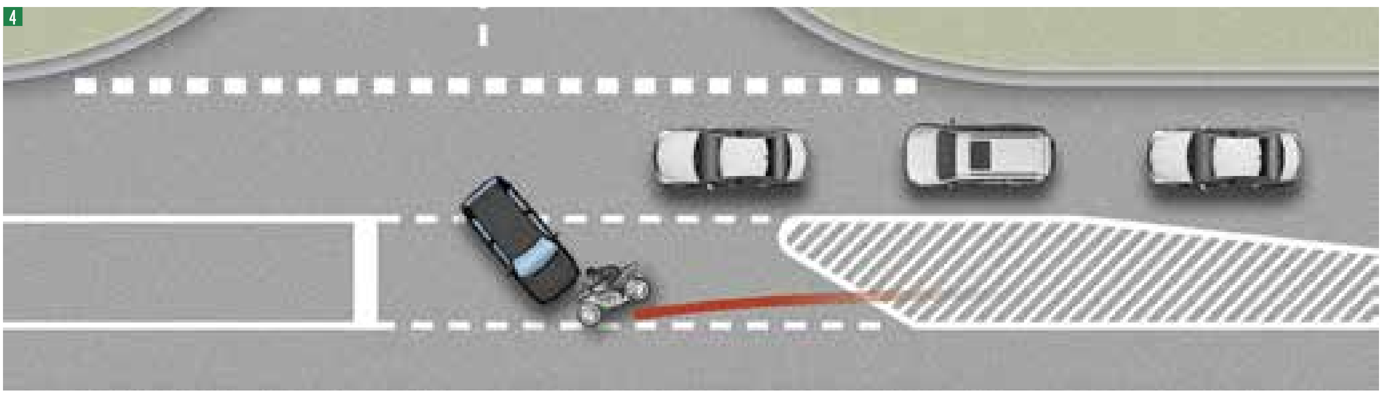
The accident could have been prevented if the motorcyclist had not overtaken the waiting cars on the left by driving through the no-passing zone. If its emergency braking had been stable, the motorcycle would have been able to brake to a stop just in front of where the collision occurred. If there had been an ABS system built into the motorcycle, the emergency braking attempt would most probably have been stable and successful and it would have been possible to prevent the accident.

1 Scene of the accident

2 Perspective from turning car (without tailback)

3 Final position of the motorcycle

4 Sketch of the collision position



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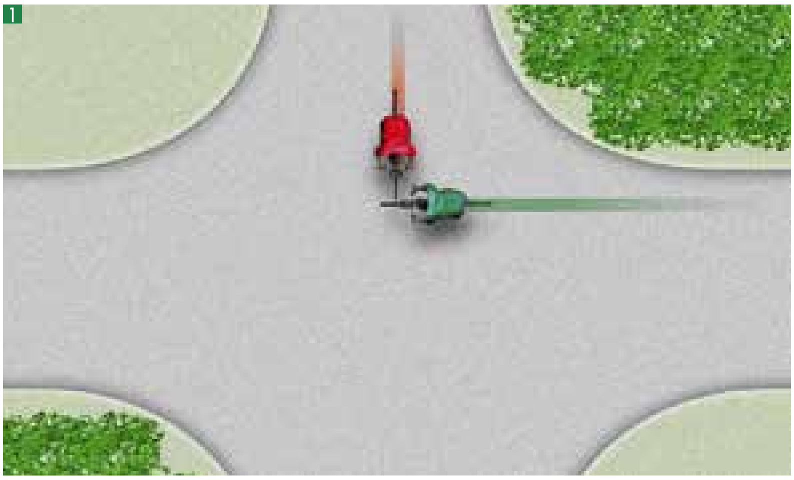

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1 Sketch of the collision position
2 Cyclist's perspective
3 Pedelec rider's perspective
4 Final position of the pedelec
5 Damaged brake disc on the pedelec

Collision at a junction

COLLISION BETWEEN PEDELEC AND BICYCLE

Sequence of events:

At a crossroads of two country lanes, a collision occurred between a pedelec rider and a cyclist. The front of the pedelec collided with the right-hand side of the bicycle. From the pedelec rider's perspective, the cyclist was approaching from the left. During the collision, the pedelec became entangled with the bicycle, and the two riders collided into one another with a great amount force before falling to the ground.

Persons involved in the accident:

One pedelec rider and one cyclist

Consequences/injuries:

Both the pedelec rider and the cyclist were severely injured in the collision.

Cause/problem:

Due to a cornfield (plant height approx. 2 meters), the two parties had no direct view of each other. The pedelec rider approached the crossroads at around 35 km/h; the cyclist at around 20 km/h. In light of the restricted sight lines in all directions, both riders were traveling far too quickly as they approached the crossroads.

Avoidance measures, mitigation of consequences/ strategy for road safety measures:

In consideration of the speeds of both of the parties involved in the accident and the significantly restricted sight lines, the accident was unavoidable. In principle, the accident could have been avoided if both the cyclist and the pedelec rider had adjusted the way they were riding to account for the limited visibility at the crossroads and significantly reduced their approach speeds. In addition to this, users of two-wheeled vehicles always need to be aware that the general rules of the road – especially the "right before left" rule for right of way at junctions – still apply on country and woodland roads, and that anticipation and consideration of others are essential to road safety.

Truck turning right

TRUCK HITS PEDELEC RIDER

Sequence of events:

A truck driver turned right at a junction and, in doing so, hit a 70-year-old pedelec rider. The pedelec rider was traveling in the same direction as the truck and intended to keep going straight on. When she collided with the right-hand side of the truck, both she and her pedelec fell to the ground and she was run over by the rear right-hand dual tires of the truck.

Persons involved in the accident:

One pedelec rider and one truck driver

Consequences/injuries:

The pedelec rider suffered fatal injuries as a result of the accident.

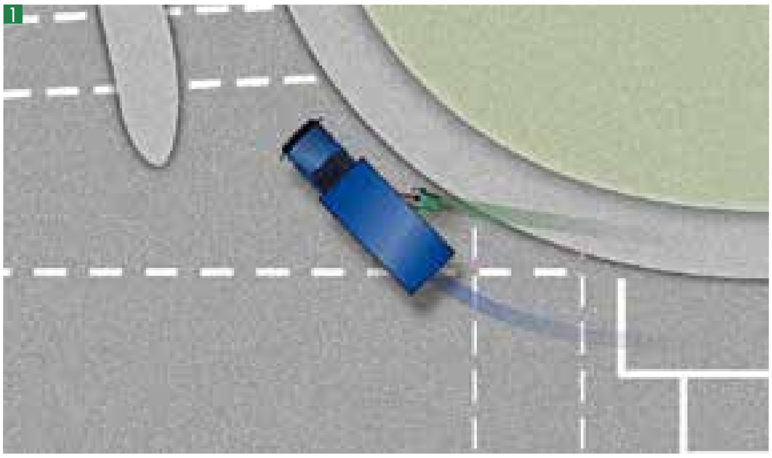
Cause/problem:

Although the truck is equipped with all the legally required mirrors, there are still areas that the driver cannot see either directly or indirectly via the mirrors (blind spots). In the unfortunate event that the pedelec and the truck are traveling at the same speed and the pedelec rider maintains a constant distance from the side of the truck, the pedelec may remain in the truck driver's blind spot for a prolonged period of time. The pedelec rider, who was using the combined bicycle path and footpath, rode straight on at the junction instead of following the path provided as it turned off slightly and crossed the junction via the central island.

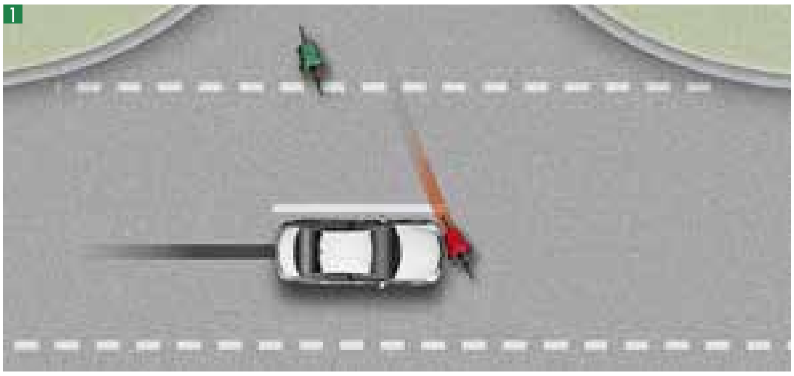
Avoidance measures, mitigation of consequences/ strategy for road safety measures:

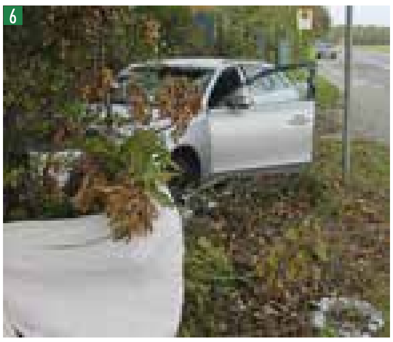
The accident could very probably have been prevented by a turning assistant in the truck. Camera and radar systems detect pedelec riders, cyclists, and pedestrians on the right-hand side of the vehicle and warn the truck driver in real time if they are in an immediate danger zone. Even though truck turning assistants will not be a legal requirement for all new vehicle types until 2022, retrofit systems currently available can also help. Cyclists should be aware of the problem of truck drivers having limited visibility. Extra care must always be exercised in the vicinity of trucks that are signaling right or maneuvering. If the pedelec rider had followed the path provided, the collision would not have occurred.

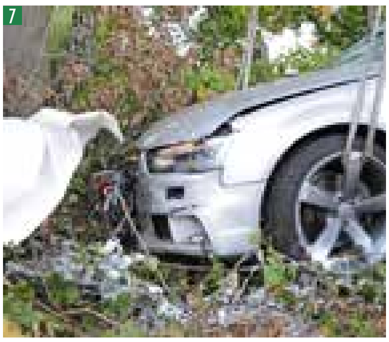
In the wake of the accident, the local council improved the design of the road; these improvements are described on page 73 of this report, in the section on infrastructure.



1 Sketch of the collision position
2 Scene of the accident
3 Footprint
4 Collision position
5 Perspective from the driver's cab







1 Sketch of the collision position
2 Pedelec rider's perspective
3 Car driver's perspective
4 Damage to pedelec
5 Damage to windshield
6–7 Final position of the car

Crossing a country road

CAR HITS PEDELEC RIDER

Sequence of events:

A 78-year-old pedelec rider and her husband, who was also on a pedelec, wanted to cross a country road. Having reached the road, they initially stopped to check for traffic. While her husband waited, the pedelec rider rode on and was hit by a car coming from the right at high speed, which had right of way. The pedelec rider was landed on the hood of the car, and her shoulder and head broke through the car's windshield. The pedelec became entangled with the front of the car and was dragged along with it. As the incident continued, the car veered off the right-hand side of the road and crashed into a tree trunk. This impact threw the pedelec rider off the car, whereupon she flew forward and landed in her final position.

Persons involved in the accident:

One pedelec rider and one car driver

Consequences/injuries:

The pedelec rider suffered fatal injuries and died at the scene of the accident. The car driver was severely injured.

Cause/problem:

The cause of the accident was a miscalculation of the traffic situation on the part of the pedelec rider. The pedelec rider rode into the danger zone – the lane in which the car was driving – approximately one second before the collision. The investigation also revealed that the car driver was traveling at a speed of between 75 and 85 km/h instead of the local 70 km/h speed limit.

Avoidance measures, mitigation of consequences/ strategy for road safety measures:

The accident could have been prevented if the pedelec rider had reacted to the car coming from her right and waited accordingly. The car driver would not have been able to prevent the collision by keeping to the local speed limit. However, observing the speed limit would have enabled him to completely prevent the subsequent collision with the tree. Accordingly, this would also have significantly reduced the risk of injury to the car driver.

DEKRA crash test

CAR COLLIDES WITH BICYCLE

Crash setup:

In this crash test, a car was accelerated to 40 km/h before colliding into the left-hand side of a bicycle crossing its path. From the perspective of the car driver, the bicycle was approaching the point of the collision from the right at an angle of less than 110 degrees and a speed of 20 km/h. The "Hybrid III" crash test dummy (50 percent) used to represent the cyclist was wearing an airbag helmet, which was worn around the neck like a scarf. In case of a collision, this is designed to trigger an airbag that envelops the head in order to protect the whole head area.

Sequence of events during crash:

After the initial contact between the car and the bicycle, the dummy was thrown from the bicycle, it then hit the hood of the car, and its head broke through the windshield. After the car braked, the dummy was thrown off to the side, where it fell against the floor of the crash facility. The airbag helmet did not trigger at any point during the crash sequence.

Vehicles involved:

One bicycle, one car

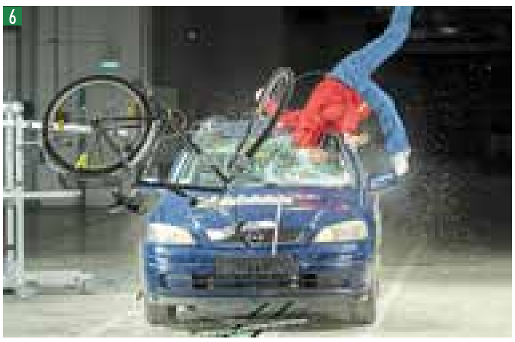
Crash test results:

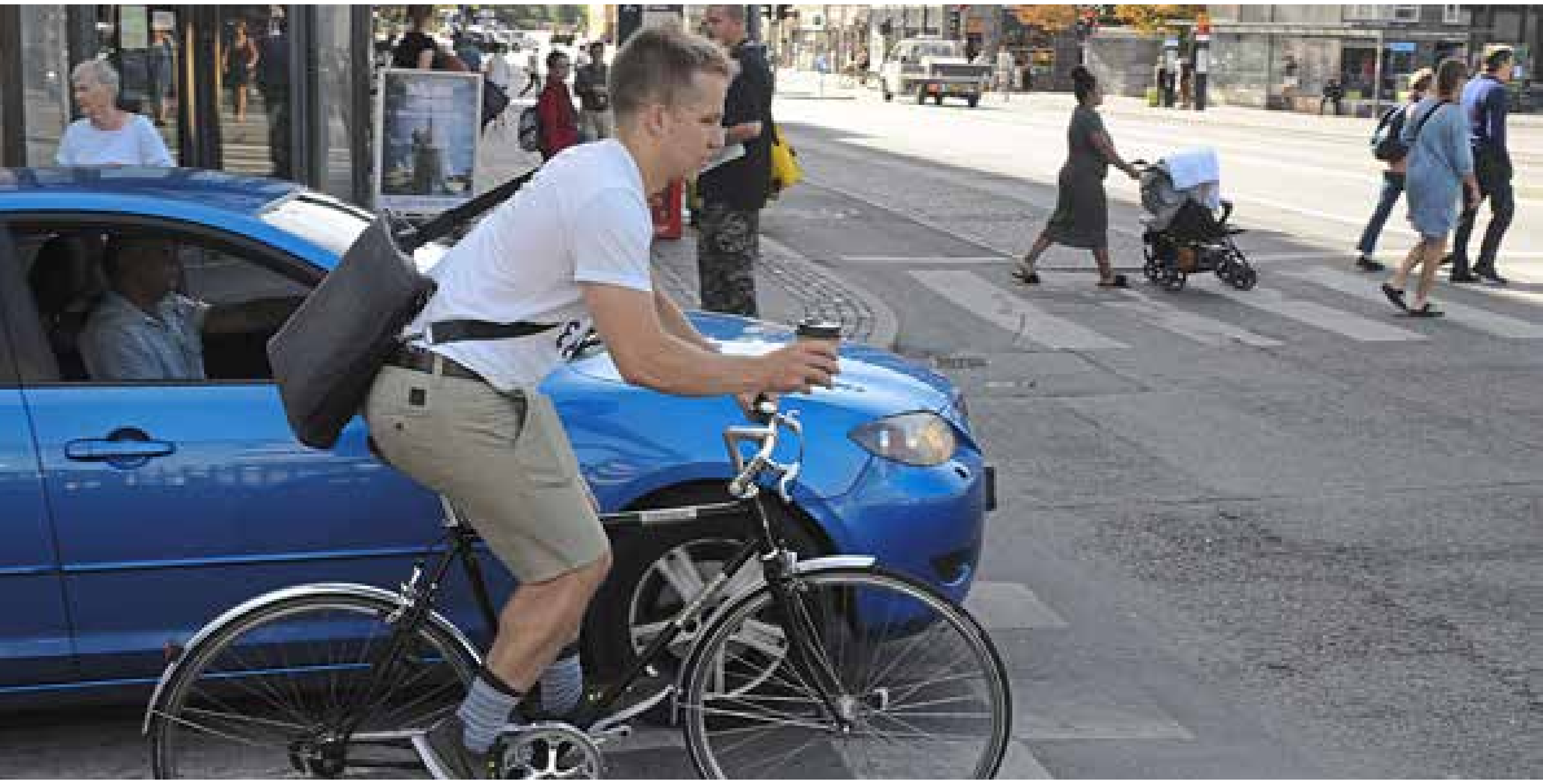
At the point of the impact with the windshield, the load values measured in the head area far exceeded the biomechanical limits. The load values measured in the head area during the secondary impact, when the dummy hit the floor of the crash facility, were even higher. In a real-life accident scenario, a human being would have almost no chance of surviving such a crash without a helmet. It was not possible to determine through reconstruction the reasons why the airbag helmet failed to trigger during either the initial crash or the secondary impact against the floor.

Avoidance measures, mitigation of consequences/strategy for road safety measures:

A bicycle helmet would have provided protection during both the primary impact against the windshield and the secondary impact against the floor of the crash facility, and significantly increased the chance of survival. In many crash scenarios, the airbag helmet demonstrates a higher level of protection than conventional bicycle helmets. However, as demonstrated by a further DEKRA crash test, there still seem to be problems with the trigger algorithm in case of collisions between bicycles and cars. Improvements in this area would be welcomed.

1–2 Position mock-up for crash scenario
3–5 Sequence of events during crash
6 Impact, front view
7 Final position of the cyclist
8 Damage to car





Human Error is the Biggest Risk Factor

What is true for car and truck drivers also applies to users of motorized and non-motorized two-wheeled vehicles: When accidents occur, they are often at least partly the result of a lack of risk awareness, a failure to observe traffic regulations, driving too fast, driving under the influence of alcohol, being distracted, or not exercising sufficient consideration for other road users. It doesn't have to be this way. Acting, interacting, and communicating with other road users responsibly, judging one's own ability accurately, and taking appropriate training courses are all efficient ways of counteracting these problems.

As we have already seen from the facts and figures listed in the Accident Statistics section, human error among road users – particularly users of motorized and non-motorized two-wheeled vehicles – is a huge risk factor. For example, according to the German Federal Statistical Office's figures for 2018, "incorrect use of the road" was by far the most common cause of accidents for cyclists in Germany, accounting for almost 12,500 accidents resulting in personal injury, while the figures for both motorcyclists and users of motorcycles with insurance tags (light motorcycles, small mopeds, pedelecs, three-wheeled motor vehicles, and light four-wheeled motor vehicles) were dominated by a "failure to adjust speed" (accounting for around 6,600 and almost 1,700 accidents resulting in personal damage, respectively). Other common forms of human error include driving under the influence of alcohol, a failure to observe rights of way, risky overtaking maneuvers, and mistakes made when making a turn, turning around, reversing, entering traffic and setting off (Figures 22 and 23).

INTERACTION IMPROVES SAFETY.

WHEN SOMEONE CHANGES THEIR MODE OF TRANSPORT, THIS ALSO ALTERS THEIR PERCEPTION AND THE WAY THEY ASSESS SITUATIONS ON THE ROAD.

In this context, it is also interesting to look at the Allianz Center for Technology's calculations on the main causes of accidents that resulted in personal injury in Germany by type of road user from 1991 to 2018. These figures show that the number of accidents that were caused primarily by a cyclist has risen by almost 30 percent in the specified time period – from almost 33,000 in 1991 to around 42,550 in 2018. Especially since 2013, the increase in this percentage has been constant and occasionally dramatic – however, it is also importan to not that the absolute number of cyclists on the road and the total mileage have also been continuously on the rise during this period. Over the same period of time, there has been an almost 25 percent drop in the number of accidents resulting in personal injury that were caused primarily by drivers of cars, falling from around 273,500 to approximately 206,000 (Figure 24).

MOTORISTS AND CYCLISTS – TWO DIFFERENT SPECIES?

Motorcyclist, cyclist, pedelec rider, or user of a scooter or e-scooter – for every one of these groups, interaction and communication with other road users are key factors in their safety, and sometimes even their survival. This is especially true when it comes to ensuring an understanding between users of two-wheeled vehicles and motorists. Research results on this subject indicate that there are a wide range of communication patterns, some of which increase road safety while others are more likely to escalate the situation. The latter effect is particularly common when emotional factors such as anger and rage come to the fore.

The fact is, as the acceptance and presence of bicycles as an everyday mode of transport increases, people who used to prefer driving are now more commonly choosing to cycle instead. The mode of transport a person chooses often depends on the situation, with factors such as the distance and quality of the route and the current traffic situation coming into play. When someone changes their mode of transport, this inevitably also alters their perception and the way they assess situations on

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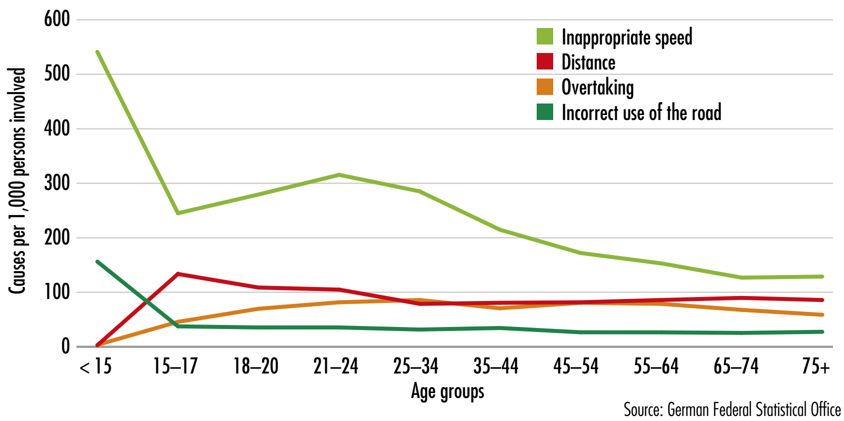
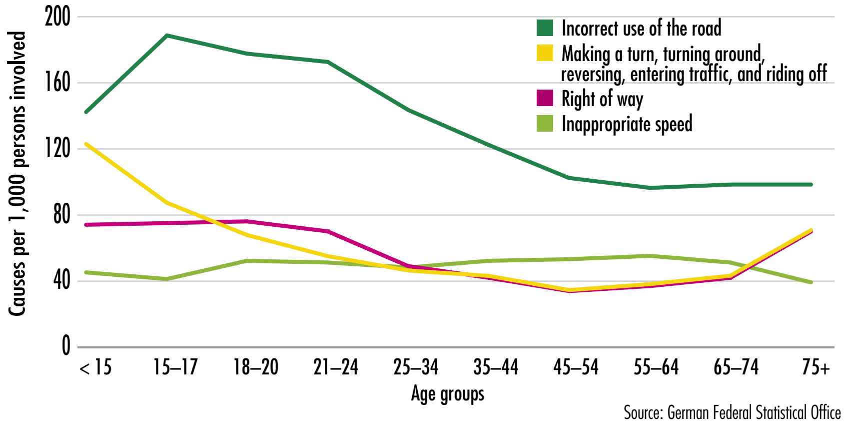
Errors Made by Riders of Motorcycles with License Plates in Accidents in 2018



Source: German Federal Statistical Office

23

Errors Made by Cyclists in Accidents in 2018 (incl. Pedelec Riders)



Source: German Federal Statistical Office

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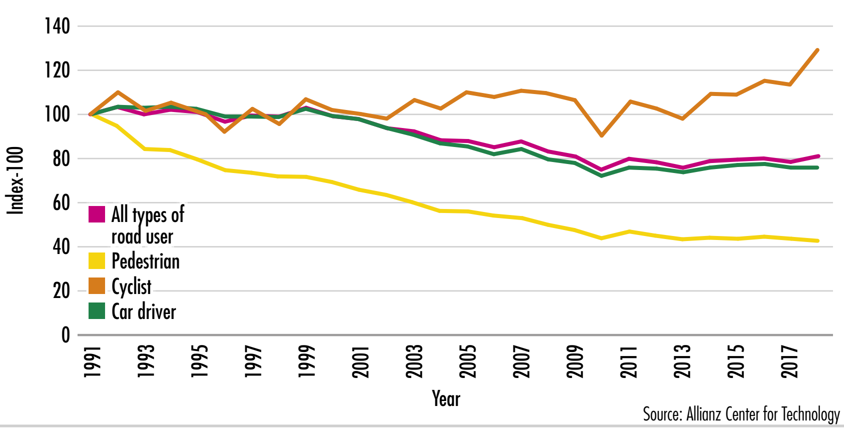
Main Causers of Accidents Resulting in Personal Injury



Source: Allianz Center for Technology

Fernando Pedrosa
specialist in traffic safety and prevention, founding partner and planning and promotion coordinator of the Association of Traffic Victims, Relatives and Friends (ONG TRÂNSITO AMIGO), and business consultant on the issue

There is a need for strict monitoring

Good instruction for motorists/drivers (something which is still rare in Brazil) needs to provide an accurate picture of the enormous risk that two-wheeled vehicles represent. This is the first step in ensuring that proper use of protective equipment, mandatory or not, becomes routine. In addition to this, awareness of your vulnerability when sharing the road with other vehicles is another essential component in ensuring road safety.

In the case of scooters, their original intended purpose hasn't changed – they are, in essence, still toys designed for short distances, despite all the technology and their current electric drive (as opposed to the manual force required previously). Their vulnerability is huge, and their maneuverability is extremely limited; therefore, all safety measures possible should be required. Never use them on the road, sharing the same space as motorcycles, cars, and bigger vehicles! They are a threat to pedestrians on sidewalks due to their electric drive, which provides them with certain level of speed. The only things left for this electric toy are bike paths or lanes and use limited to people over 12 years of age with the same equipment as required for skaters.

The Brazilian Traffic Code, approved in 1998, underwent several changes and updates, and is one of the best pieces of traffic legislation in the world. The issue is not a lack of laws and regulations. Instead, the problem can be traced back to three factors involving humans: the motorist/driver who does not comply with the rules despite being aware of them, the traffic authority which, for several reasons, does not monitor the problem as much as is required, and lastly, the punishment not being handed out to the offender promptly due to a lack of resources. It therefore cannot play its part in penalizing and re-educating drivers. A penalty that takes years to reach the offender gives them time to repeat the behavior several times. Such a long wait also means that they forget the original violation that caused the penalty.

There is a need for strict monitoring. In the case of motorcycles, DPVAT data indicates that accidents have skyrocketed in the north-eastern region. In that region, motorcycles have become a substitute for donkeys. There are a large number of drivers without a license who do not respect the rules, do not use a helmet or proper shoes, and who often have more than one passenger or transport inappropriate loads for the type of vehicle.

the road. This change in individual perspective can help to teach both drivers and cyclists safer patterns of interaction with one another.

In this context, it is particularly interesting to look at the results of a study commissioned by Ford in 2018 as part of its "Share the Road" campaign. The study showed that using different modes of transport affects a person's perception. Around 2,000 people from Germany, France, Italy, Spain, and the United Kingdom were asked to recognize and distinguish between pictures under laboratory conditions. The results showed that motorists who also rode bicycles demonstrated better situational awareness. In 100 percent of the scenarios they were shown, these test subjects were quicker at identifying the pictures and spotting the differences between two pictures.

According to a study by Rowden, P. et. al. (2016), it can be generally assumed that many drivers are more likely to adhere to the regulations when traveling by car than when riding a bicycle. One reason for this may be that they see themselves as less of a danger when cycling than they would when driving a car, and thus perceive their non-observance of the regulations as being less serious. Schleinitz, K. et al. (2016) collected data from real-life situations for a study comparing the natural riding styles of riders of different classes of bicycle (bicycles and pedelecs). The participants in the study used their own bicycles, which were fitted with measuring equipment and cameras. Among other things, the report analyzed situations where cyclists breached the regulations, for example by ignoring a red light.

The results showed that the cyclists breached regulations in order to avoid stopping at a red light in more than 20 percent of situations, though this figure varied significantly depending on the type of bicycle. Common approaches included riding straight through the red light without stopping,

MANY ROAD USERS FOLLOW THE RULES MORE WHEN DRIVING A CAR THAN WHEN RIDING A BICYCLE.

and stopping briefly before crossing while the light was still red. In particular, red lights were ignored with above-average frequency when turning right at a junction. Running red lights was particularly common at T-junctions, which shows that cyclists are more willing to breach regulations in situations that are easy to assess. When asked why they had breached the rules, the participants were particularly likely to respond that they wanted to maintain their speed, or also to make their journey shorter.

In addition to the running of red lights, improper use of infrastructure was also common. Cyclists and pedelec riders often rode on sidewalks illegally. Due to the large number of breaches, it seems sensible to strive for closer monitoring and stricter punishment of cyclists, though other measures such as corrective training should also be part of the solution. In all cases, punishment for conduct-related offenses should always include an inspection of the vehicle to ensure that it complies with the legal regulations and is road safe.

COMMUNICATION CONFLICTS ARE A HAZARD TO ROAD SAFETY

One of the biggest risks to road safety are the conflicts in communication that can develop between cyclists and motorists. These arise primarily as a result of behavior that the other group of road users perceives as inappropriate, or even aggressive. For example, aggressive behavior on the part of cyclists is often a response to cars performing driving maneuvers the cyclist views as dangerous, and vice versa. Cyclists also often see cars parking in bicycle paths, overtaking too close to bicycles, and opening car doors without due care as deliberate provocation.

Generally speaking, many motorists see cyclists as an “outgroup” (Walker et al. (2007)) who do not belong on the road. The dismissive or even aggressive attitude displayed by such drivers is the consequence of the perception of cyclists as “interlopers” and the resulting emotional stress. This perception is more common in countries with a poorly developed bicycle infrastructure and where cyclists make up a smaller percentage of the total traffic. Cyclists and motorists display different reactions to stressful situations: Cyclists tend to avoid open conflict, whereas motorists react more confrontationally. This should also be interpreted as a result of the differences in the two groups’ subjective senses of safety.

Cars and vans that pull out of parking bays suddenly are very dangerous, especially to users of two-wheeled vehicles.

A study by Heesch, K. C. (2011) tackles cyclists’ experiences with harassment and bullying by motorists. An online survey conducted by Bicycle Queensland, an organization that promotes bike use, received 1,830 responses. In total, 76 percent of the men and 72 percent of the women who responded reported that they had experienced harassment or bullying by motorists on the roads in the past twelve months. The most common forms of such behavior included overtaking too close to the cyclist (66 percent), verbal abuse (63 percent) and sexual harassment (45 percent). The probability of a cyclist being subjected to such behavior is dependent on factors such as age, body weight, cycling experience/frequency, and the location of the journey. Young to middle-aged cyclists with more experience on the road seem to be more likely to be affected by this than older cyclists. According to the aforementioned survey, the same applies to both cyclists who cycle competitively and purely for fun, and also to those cycling in more well-off areas.

The fear of such harassment is a barrier to people who would like to cycle but do not yet do so. One way of counteracting this problem would be

"Dooring" accidents between motorists and cyclists usually end badly for the cyclist. The "Dutch Reach" technique can help with this. This means that car occupants on the left side simply open the door with their right hand, and anyone who wants to get out on the right side opens the door with their left hand. This stops motorists from having to remember to look over their shoulder, as they do so automatically.

using campaigns that draw attention to the appropriate way to behave on the road while also providing information on the applicable traffic regulations and, most importantly, stressing the rights of cyclists on the road. Another approach would be to use driver training to make motorists more aware of the diversity of road users and of specific hazards and necessary safety measures.

INTERACTION IS THE KEY TO FEWER ACCIDENTS

A study by Walker, I. et al. (2007) showed that motorists usually direct their gaze to a cyclist's face when they come into contact with them. While gestures made by the cyclists, such as an outstretched arm indicating that they want to turn off at a junction, help drivers to deduce the cyclist's intentions and the direction in which they intend to ride next, it is the cyclist's face that the driver looks at first and for longest. This trend was true irrespective of the gender and experience of the test subject, and became more pronounced when the cyclist seemed to be looking at the test subject. These results indicate that social cognitions are triggered during interaction with cyclists. From an evolutionary perspective, the tendency to look at a person's face during a social interaction can be explained by the fact that the appearance and facial expressions a person makes can provide their opposite number with a lot of information on their intentions and characteristics. However, the presence of indicators such as a person's face and the direction in which they were looking when a motorist was required to interact with cyclists or other vulnerable road users often distracted the motorist and extended their reaction time. Yet since focusing on the face is not a reflex, it is a tendency that can be lessened through training and awareness-raising measures.

In situations where the cyclist offered no clear formal information such as hand signals, the motorists paid more attention to the bicycle itself. Earlier studies have shown that motorists are also highly capable of determining a cyclist's intentions based on their position on the road. Since many of the channels of communication employed by cyclists are informal and thus not clear, young cyclists in particular should be provided with more information on potential communication problems – such as the fact that motorists often do not see their signals and cannot predict what they are going to do. Public information campaigns tailored to safety education among all groups of road users and their interaction should emphasize cooperative and considerate conduct on the road, and teach that all road users have the same rights to the use of public space.

Walker and his research colleagues indicated a few other factors that affect the behavior of road users. The study shows that a cyclist's position on the road, the type of bicycle they are riding, whether or not they are wearing a helmet, and their gender all have an impact on how motorists overtake them, as motorists ascribe different character traits to the cyclist based on these indicators. The further away from the curb a cyclist is riding, the less space a motorist will give them. In summary, the research showed that motorists give cyclists less space if they are wearing a helmet, cycling in the middle of the road, and are male, and also if

PUBLIC ROADS ARE FOR EVERYONE.

the motorist in question is a bus or truck driver. This indicates that these motorists usually follow a certain course when overtaking, on which the position of the cyclist has only minimal effect. However, it is not necessarily safer for cyclists to ride closer to the side of the road, as this may put them at risk due to other factors, such as sewer grates and parked vehicles. In particular, it is less safe for cyclists to stay close to the side of the road at junctions, as motorists mainly focus on the area around the middle of the road when watching for traffic, which makes it easy for them not to notice cyclists.

The finding that cyclists are afforded less space when wearing a helmet indicates that they are seen as safer and more protected against severe injury in case of an accident. As a result, motorists see it as less dangerous to overtake a cyclist wearing a helmet than one who is not. Motorists overtook at a greater distance when they perceived the cyclist to be female, possibly because they judged female cyclists to be more unpredictable or more easily susceptible to injury. It is true that each of these studies focuses on a specific region, and that driving styles are dependent on a number of factors which can vary from region to region. Nevertheless, it is clear from these points that motorists adapt their overtaking behavior based on the characteristics they perceive a cyclist to possess, and that they do not have an impartial overtaking pattern that they apply to all cyclists as a group.

THE INTERPLAY OF DRIVING STYLE WITH TECHNOLOGY AND INFRASTRUCTURE

In addition to the characteristics of the cyclist, the type of vehicle overtaking the cyclist also played a role. Buses and heavy goods vehicles were the types of vehicle that overtook significantly more closely to the cyclist. This is probably due to the fact that these vehicles require more time to complete an overtaking maneuver due to their dimensions and slow acceleration, and that they also need to pull further into the other lane than other vehicles in order to overtake. Since long gaps in oncoming traffic are rarer, these vehicles overtake closer to the cyclist. In addition to this, there is also a risk that drivers of larger vehicles may not be able to see a cyclist at all times during an overtaking maneuver, which leads to them pulling back into their lane earlier even though the cyclist is still riding alongside their vehicle. This example demonstrates particularly clearly that separate bicycle paths are essential to increasing cyclist safety.

A PERSON'S FACIAL EXPRESSIONS AND HOW THEY LOOK CONVEY A LOT OF INFORMATION ABOUT THEIR INTENTIONS.

In their study, Horswill, M. S. et al. (2015) tackle in more detail the interplay between driving style and technology and infrastructure. Generally speaking, extending the cycleway network reduces the number of accidents that occur in terms of mileage. When the cycle infrastructure enables safe separation of cyclists from fast motorized traffic, this improves cyclist safety. This effect is particularly noticeable at junctions, though on the other hand, infrastructural separation has proven particularly difficult in such areas. In turn, increased safety results in a higher number of cyclists. Alongside changes to cycle infrastructure, measures that make it easier to clearly assess the traffic on a road so that vulnerable road users such as pedestrians and cyclists are not overlooked as easily are also useful. Driver assistance functions in the motor vehicle that make it easier for drivers to notice cyclists and pedestrians could also help with this. Despite the fact that cyclists are not generally permitted to ride on the sidewalk – at least not in Germany – measures such as restrictions and prohibitions on parking on sidewalks, together with stricter sanctions for those who disregard such regulations, would also be effective in increasing the visibility of users of two-wheeled vehicles.

An unmistakable instruction from from police in Germany: Motorists must maintain a safe distance from cyclists.

Hamilton-Baillie, B. et al (2008) also tackle the issue of communication behaviors between different groups of road users, and present the concept of a “shared space”. This concept aims to integrate road users in a single place without impairing safety, mobility, or accessibility. In particular, it aims to improve road safety through mutual consideration of others. Communication between road users plays the key role here and is the top priority, as all road users have equal rights. The features of this model include the principle of mixing all road users together and thus doing away with most signs and restrictions, as all road users would follow implicit rules. This principle is by no means new, and has in fact been practiced in a range of towns and cities for several decades. Positive examples of the application of this concept include the Laweiplein junction in Drachten (Netherlands) and Blackett Street in Newcastle (England).

Typical design techniques for shared spaces include keeping the all parts of the space the same height so that pedestrians and users of motor vehicles and non-motorized vehicles all interact on the same level and the space feels like a single, self-contained area, and subtle markings that identify the different areas. The removal of most of the signs and traffic lights promotes organic communication and reduces speeds. Shared space usually results in a successful restructuring of the way a road is used: There are fewer traffic jams, and the lower speeds mean that there are fewer accidents and that the consequences of said accidents are less severe. There is also evidence that shared spaces increase the satisfaction levels of all road users. However, traffic planners should always thoroughly assess whether it makes sense to implement a shared space in a specific location before doing so.

MOTORCYCLISTS IN THE FLOW

In terms of frequency and severity of accidents, motorcyclists are one of the most at-risk groups of road users. The public perception of them is often as extremely fast and often aggressive in their riding style. To what extent do the results of objective research support this preconception?

In their study, Rowden, P. et al. (2016) explain that aggression must be seen as part of everyday life, and thus also part of road use. From a legal and psychological perspective, typical characteristics of aggressive actions include acting erratically, breaking rules, endangering themselves/others, and threatening to injure people or damage objects, or actually doing so. In a psychological context, the motivation and thus the intent behind the action, i.e. willfully causing injury to another person, are at the heart of the meaning of the construct. Experts agree that an aggression is “any behavior that deviates from the norm and also causes endangerment.”

A series of studies have connected aggressive behavior to personality traits such as rage, anxiety, a craving for sensation, and narcissism. It has also been repeatedly confirmed that aggressive behavior on the roads is primarily exhibited by males. In addition to a person’s characteristics, however, “contextual factors” such as traffic jams, and certain perceptions such as the belief that one is able

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Chair, Motorcycle Safety Advisory Council
Director, VTNZ (DEKRA NZ Limited)

Developing a More Dynamic Policy Response

Motorcycling in New Zealand is experiencing a growth in popularity – around 5% annually. After a peak in popularity in the 1970s, motorcycling went into decline for the next twenty years. Since the mid-1990s, popularity has grown and today there are around 150,000 motorcycles in New Zealand, and 80,000 of these are registered for the road – 2% of the total road fleet. Smaller mopeds are proving popular with millennials due to favorable licensing conditions.

Since the proportion of motorcyclists has increased, so too has the crash rate. Around fifty motorcyclists are killed each year on our roads – approximately 15% of the total toll. Motorcyclists remain five times more at risk of crashing, and 26 times more likely to suffer death or serious injury.

The cost of accidents in New Zealand is met by the Accident Compensation Corporation (ACC), the agency responsible for personal injury claims across all sectors. ACC, with the Motorcycle Safety Advisory Council (established in 2011), supports the design of motorcycle safety initiatives that improve local conditions, including subsidized rider training, motorcycle friendly road designs and targeted road safety campaigns.

The high accident rates, along with a renewed government focus on road safety (Vision Zero), have recently led to proposed regulatory changes and the adoption of new standards similar to those used in other jurisdictions. These have included mandating ABS brakes on motorcycles, more stringent training and licensing requirements for new motorcyclists, and the targeting of vulnerable road users, including cyclists, pedestrians, and motorcyclists.

Future challenges include developing a more dynamic policy response that keeps pace with new transport modes, many of them two wheelers. Also, we acknowledge the need to increase our knowledge of the “human factors” that lead to crashes and believe greater understanding is central to improving motorcyclist safety in New Zealand.

Chasing the thrill of speed exponentially increases the risk of accidents for motorcyclists.

to act anonymously also affect aggressive behavior – though it should be noted that the findings on this matter are not yet conclusive.

The aforementioned Rowden study also investigated potential differences in aggression levels when using different modes of transport, specifically when using a motorcycle as opposed to a car. At the start of the study, the authors expected motorcyclists to have lower aggression levels than car drivers. This hypothesis was based on the assumption that motorcycles are more vulnerable, and their riders thus less protected. The results confirmed this assumption. Drivers of cars stated more frequently that they had experienced aggressive feelings, and at the same time expressed said feelings. These differences are explained by the fact that motorcyclists have a more defensive driving style because they are more susceptible to injury, and that aggression on the road is dependent on context. The personality psychology prediction variables for aggressive behavior are similar for both groups: The extent to which we seek thrills and carry out risky driving maneuvers varies from one person to the next, but car drivers as a group are more likely to do this than motorcyclists.

A study by Rheinberg, F. (1994) investigated how the experience of "flow" affects a motorcyclist's perception of themselves and their abilities. In the context of the study, "flow" is defined as the state of completely losing oneself in an activity one is performing and thus losing one's sense of time while doing so. This state feels very pleasant, and facilitates a good behavioral response by enabling the individual experiencing it to be completely in the zone. When riding a motorcycle, however, it becomes a problem. When someone is "in the flow," their level of conscious control over and reflection on what they are doing decreases. As a result, their unconscious objectives may make their behavior more undesirable. Their conscious perception and their intention to ride safely then become no longer directly relevant to how they steer and control their vehicle. As a result, the deeper "in the flow" they are, the more they lose sight of this intention. Their riding style becomes more dangerous than is actually appropriate. Maintaining a state of flow requires a certain level of attention and focus. This results in a faster and more dangerous driving style than the person would adopt when not in this state. Although a motorcyclist in this state is working at an optimum level from a functional point of view, the way they are riding is far from ideal. Almost all the motorcyclists surveyed in the study said that they had experienced a state of flow before, though only a few of them realized that experiencing this state could also have negative effects.

AGGRESSION MAKES A POOR "COMPANION" ON THE ROAD.

For those who want to enjoy motorcycling safely, regular professional rider safety training is recommended in addition to the basic training.

It should be assumed that a person's reaction capabilities are limited when riding in the flow. The sensation of being in the flow is often associated with excessive speeds, and a person will often only come out of this state if they sense a strong distraction, such as sudden surprise or fear. In a road-use context, this is often linked to near-accidents. This can lead to critical situations, especially for older motorcyclists, as their reaction times are slower on average than younger riders. Since the majority of motorcyclists are currently over 40, the fact that it is so common for them to seek the sensation of being in the flow represents a danger not just to motorcyclists themselves, but also to other road users. Many motorcyclists in this particular age group ride simply for pleasure and have taken up motorcycling after a long break, or who are just discovering the joys of motorcycling for the first time and are able to afford high-performance vehicles. As such, older motorcyclists as a group are at a high risk of severe accidents.

SOUND RIDER TRAINING AND FURTHER TRAINING ARE INDISPENSABLE FOR MOTORCYCLISTS

No matter how efficient measures to improve road safety become, a defensive, anticipatory driving style will always be the best safety strategy for motorcyclists. This approach helps to prevent not only collisions with other vehicles, but single-vehicle accidents as well. Every motorcyclist must lay the foundations for healthy risk awareness themselves – in the form of sound rider training.

One of the main points to focus on here is adequately combining "competence" (theoretical and practical rider training) with the physical and mental conditioning required, with both medical (sight, sense of balance, general health aspects, medical conditions) and performance-psychology factors (psycho-functional capacity, awareness, reaction speed, concentration, coordination) needing to be taken into account here.

Above all, it is important to ensure that riders receive training on vehicles that are suitable for practice purposes, and whose performance is similar to that of the vehicles the learners are likely to use once they have passed their test. Riders who wish to ride high-performance vehicles should complete further training and provide suitable evidence that they are able to handle such vehicles. Furthermore, the training must emphasize the need for future motorcyclists to take responsibility for ensuring that they are seen by other road users and teach them how to do so (lights, colored/retroreflective clothing, maintaining a safe distance, being aware of blind spots). It also goes without saying that training courses should produce motorcyclists who always wear full protective gear and a certified helmet, even for short journeys.

It is absolutely recommended that all motorcyclists take a rider safety course at the start of every season, regardless of how experienced they are. Special attention should be paid to practicing braking – even for riders whose motorcycles have anti-lock braking systems (ABS), as even experienced motorcyclists may not manage to control their braking power optimally in an emergency.

HANDLING A PEDELEC ALSO REQUIRES TRAINING.

CHALLENGES IN THE AGE OF AUTOMATED DRIVING

The forms automated driving might take and the contexts it might be used in are currently taking up a lot of space in debates in society and among experts. However, there is still little consensus among experts with regard to the time frames in which the various stages of automation – up to and including full automation of private cars – might be completed. While progressive forecasts suggest that more than 40 percent of all motor vehicles will be highly automated – and some even fully automated – by 2050, conservative predictions estimate the figure to 30 percent at most. According to a study by Prognos AG, only an infinitesimal fraction of this number would be made up of true “door-to-door” traffic that requires no contribution from a human driver. At some point in the future, we should expect our roads to be made up of a mixture of vehicles with different levels of technological advancement, plus different levels of infrastructural development. Within this structure, users of two-wheeled vehicles will have the same rights as other road users, just as they do today.

In their recent publication, Zwicker, L. et al. (2019) tackle the issue of communication between automated motor vehicles and other road users. The article looks into a number of forms of communication in the context of increasing automation. One of the most important questions here is whether automated vehicles should be designed based on currently established means of communication, or whether there might be clearer ways of communicating with them. For example, would an automated car be able to recognize informal means of communication that are not technologically assisted, such as hand signals or eye contact, or do we need to ensure that cyclists are also able to signal their intentions using technological aids, such as turn signal lights and brake lights, in order to guarantee that they are recognized clearly?

Generally speaking, it is evident that communication on the road is most successful when it conveys not just a status (e.g. when a pedestrian or cyclist is seen by a motorist or an automated vehicle), but also the intention of the road user in question (e.g. to cross the road), as status-only messages are easier to misinterpret. Whether or not a message is interpreted correctly depends on a number of factors, including the flow of traffic, the atmosphere in the traffic, the visibility of the road users to each other, and the clarity and comprehensibility of their signals. In light of this, more research is still required in order to ensure that communication patterns between vehi-

Pedelec Training Is in Fashion

In light of the fact that accidents involving pedelecs have increased drastically, more and more institutions and associations are offering special rider safety training for pedelec riders. Experience shows that many users – especially senior citizens – underestimate the speed and weight of these electric bicycles. This makes it all the more important to handle them with care and adopt an anticipatory riding style. In addition to teaching the fundamental theory on how to handle a pedelec, these training courses focus primarily on safe use of two-wheeled vehicles. Participants practice balance, coordination, and braking at different speeds, as well as cornering and hill starts.

Dr. Christopher Spering
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Helmet or Head Airbag When Riding a Bicycle or Pedelec – for All Ages

Due to their susceptibility to injury, not just young people but also older people in particular should observe the DGOU's recommendation for cyclists to wear helmets. This applies especially when using a pedelec. The higher speeds of these electric bicycles increase the risk of an accident, and together with age-related medical conditions this leads to severe injury patterns. Data from TraumaRegister DGU® shows that severe traumatic brain injury is the most common injury among cyclists who suffer life-threatening injuries. However, the chance of surviving severe traumatic brain injury decreases with age. But for those who take blood-thinning medication – as is often the case for older people – even a minor accident can lead to a severe brain hemorrhage.

There are many reasons why people do not wear helmets in spite of these risks. Many find them cumbersome and awkward to wear. Others see them as unflattering or worry that they will ruin their hair. A head airbag can help with this. This is like a collar worn around the neck. In case of an accident, such as a collision with a car, the sensors on the collar are triggered and the airbag inflates. It then resembles a full-face helmet that firmly envelops both the head and the area around the neck and lower jaw. Authors of a study conducted at Stanford University attested that the head airbag reduced the risk of concussion by up to eight times compared to a helmet. When the airbag is deployed in case of an accident, it cushions the head against the impact and stabilizes the cervical spine, thus reducing the risk of traumatic brain injury and whiplash.

ONE OF MANY RESULTS OF A DEKRA STUDY:

IN LONDON, ALMOST 61 PERCENT OF CYCLISTS WEAR A HELMET.

cles and users of two-wheeled vehicles remain safe in the age of automated driving.

DEKRA STUDY ON HELMET USE AMONG CYCLISTS IN EUROPE

In case of an accident, a helmet is a piece of safety equipment that can save a cyclist or motorcyclist's life. The "Technology" section of this Report will look in more detail at how this works. For now, we want to look at figures for helmet use. A 2018 publication by the German Federal Highway Research Institute provides the numbers for Germany across different age groups. In 2018, almost 100 percent of riders of two-wheeled motor vehicles wore helmets. For cyclists, on the other hand, this number dropped to just 18 percent, although children (82 percent) were much more likely to wear a helmet than adults. The publication also compares these figures to those for the previous year, clearly showing that the trend for wearing a helmet is at least on the rise.

In order to determine the current helmet use figures for cyclists, pedelec riders, and e-scooter users, DEKRA Accident Research drew up a quantitative, cross-sectional study in 2019 to measure helmet usage in nine bike-friendly European capitals that had been selected: Berlin, Warsaw, Copenhagen, Zagreb, Ljubljana, Vienna, London, Amsterdam, and Paris (Figure 25). To ensure that the results were as representative as possible, the study observed bicycle traffic in each of the cities at different times of day, in different locations around the city center, and exclusively on weekdays. A pilot study had been conducted in Stuttgart.

In total, 12,700 cyclists, pedelec riders, and scooter/e-scooter users across the nine selected capitals were checked for helmet use. Over all cities, 22 percent of riders were wearing one. As such, around one in five cyclists, pedelec riders and scooter/e-scooter users wore a helmet on the road. London recorded the highest helmet use by far at 60.9 percent, followed by Vienna at 26.7 percent, and Berlin at 24.3 percent. Amsterdam had the lowest helmet use, at just 1.1 percent. In Ljubljana and Zagreb, the figures were 9.1 and 5.9 percent respectively. In all of the cities in the study, most of the cyclists were using privately owned bicycles. The average helmet use among these cyclists was much

■ *In the Netherlands, "the country of the bike", many cyclists do not wear helmets.*

higher than for persons on rented bicycles. E-scooters had a significant impact on the absolute usage figures, especially in Berlin, Warsaw, Vienna, and Paris. Helmet use on these vehicles was very low, and was far below the average helmet use figures overall for these cities. In Berlin, 173 e-scooters were recorded. None of the riders of these scooters were wearing helmets. In Paris, the situation was slightly better, with nine percent of the 316 e-scooter users in the study wearing a helmet.

The study also showed that children wore helmets more frequently when riding their bicycles than any other age group. This is doubtless mainly due to the fact that parents exercise greater caution when it comes to the safety of their children, and ideally act as role models. In addition to this, wearing a helmet is a legal requirement in the countries of four of the capital cities included in the DEKRA study: for children aged under 12 in Austria and France, under 15 in Slovenia, and under 16 in Croatia. In

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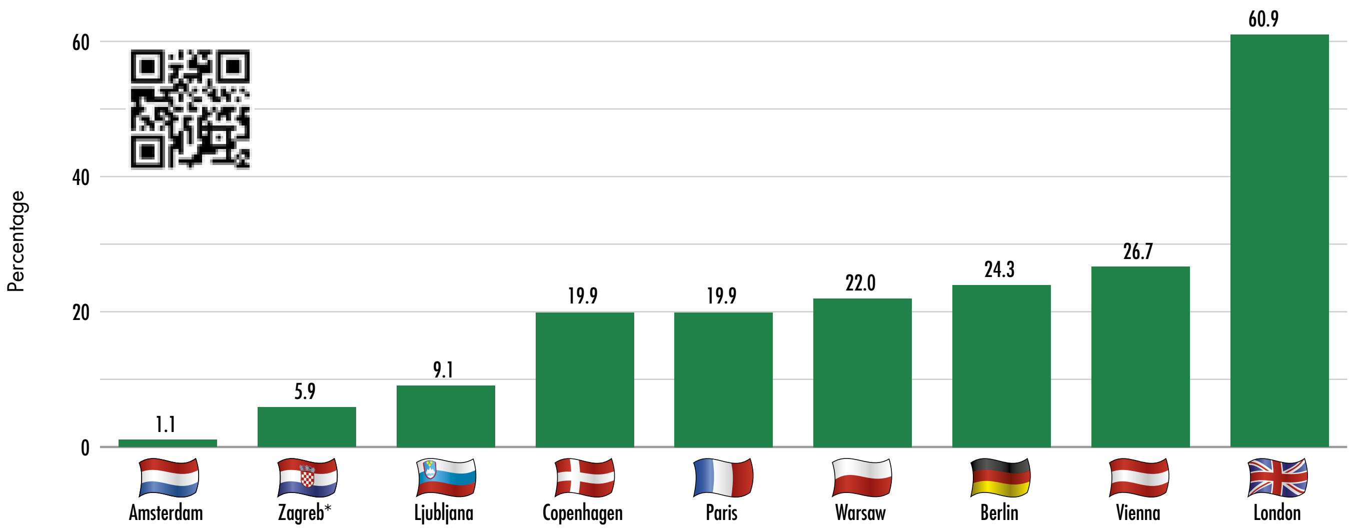
Comparison of International Figures for Helmet Use



In each case, n = 1,500, *n = 700

Source: DEKRA Accident Research

contrast to this, the lowest figures for helmet use were recorded among teenagers. This group was more likely to be cycling with friends or on their own than with their parents. The fact that many in this group did not wear helmets may be caused by their development during puberty. During this phase, teenagers often do the opposite of what parents and society recommend.

A BICYCLE HELMET CAN HELP TO PREVENT SEVERE INJURIES.

INFRASTRUCTURE IS AN IMPORTANT FACTOR IN WHETHER CYCLISTS FEEL SAFE AND/OR WEAR A HELMET

Other city-specific observations: Since many residents of London see the British capital's roads as dangerous for cyclists, many of them wear a helmet on their way to work. During data collection, it was also noted that a large number of cyclists in London wear safety clothing, such as yellow high-visibility jackets that enable them to be seen better in traffic.

The Netherlands are seen as "the" country for cyclists. In light of this, it seems confusing at first glance that the investigation in Amsterdam showed that just 1.1 percent of the city's cyclists wear helmets. Look more closely, however, and it makes sense. After all, the state began investing heavily in suitable infrastructure to make the country's roads safer for cyclists back in the 1970s. In 1975, The Hague and Tilburg became the first model cities for bicycle boulevards, while Delft was the first city to install a complete network of bicycle paths. In the Netherlands, the bicycle plays a bigger everyday role in traffic than in almost any other country. The infrastructure development is unparalleled, and due to this the population feels safe when cycling. As such, helmets are seen as an unnecessary burden, and the idea of making them a legal requirement dismissed. Overall, the Netherlands and Denmark are two of the safest countries in the world for cyclists in terms of mileage.

Copenhagen is often compared to Dutch cities in terms of its bicycle traffic. In light of this, it is surprising that, at 19.9 percent, its rate of helmet use is much higher than the figure for Amsterdam,

Even though everyone in this picture is wearing a helmet, they won't have sufficient protection in case of an accident – especially not the children.

and in the middle bracket for all the cities included in the study. Alongside its well-developed infrastructure, Denmark also relies on large-scale helmet use campaigns to increase safety. Unlike in Amsterdam, many of Copenhagen's bicycle paths are not physically separated from car lanes except for by low curbs. This makes cycling in Copenhagen seem more dangerous, which is why cyclists there rely on helmets more than in Amsterdam.

In light of the results of this DEKRA study and the aforementioned figures from the German Federal Highway Research Institute, we need to determine the factors on which acceptance of wearing a bicycle helmet depends, and how we can improve this acceptance. Royal, S. et al. (2007) created a meta-analysis of eleven studies on types of intervention and their effects on helmet-wearing behavior among children and teenagers. The results show that non-legislative intervention and support measures that are not part of legal regulations can be very effective. In comparison to campaigns that originated in schools or used subsidized helmets as a promotional measure, campaigns that were conducted at the local community level close to people's homes and involved the distribution of free helmets were far more effective. Interventions that comprised solely of educational work were the least effective. However, even these measures produced a significant, if smaller, improvement. Interventions in schools were most effective when they addressed younger students. This indicates that particular attention must be paid to this group. Nevertheless, and no matter what the age of the cyclist, even the best infrastructure cannot prevent accidents. And when accidents happen, a helmet remains an indispensable tool for protecting against injuries that can be severe or even fatal.

E-scooter riders rarely wear helmets.

The Facts at a Glance

- **Human error on the road, especially on the part of users or motorized and non-motorized two-wheeled vehicles, is to a large degree responsible for many accidents.**
- **Interaction and communication with other road users are key factors for safety, and sometimes even survival.**
- **Aggressive behavior on the part of cyclists is often a response to cars performing driving maneuvers the cyclist views as dangerous, and vice versa.**
- **Being "in the flow" while on a motorcycle can lead to critical situations, especially for older motorcyclists, as their reaction times are slower than those of younger motorcyclists.**
- **Every motorcyclist must lay the foundations for healthy risk awareness in the form of sound rider training.**
- **In case of an accident, a helmet is a piece of safety equipment that can save a cyclist or motorcyclist's life.**

Added Value for Safe Road Use

Careful and considerate behavior that respects the rules of the road is essential in reducing accident numbers. In addition to this, users of two-wheeled vehicles in particular can prevent accidents completely, or at least lessen the severity of their consequences, by keeping their vehicles – especially their brakes and lights – in good technical condition, wearing properly fitted helmets, and using active safety systems.

No matter what form of transport you choose, the braking distance is often the deciding factor in whether or not an accident occurs – and whether it results in minor, severe, or even fatal injuries if it does. This applies especially to unprotected road users such as cyclists. Among other things, the various European standards that govern safety requirements and test procedures for bicycles focus on well-modulated braking power that, regardless of the conditions, enables both cyclist and bicycle to be slowed down or brought to a stop according to the situation at hand. Bicycle brakes also need to reliably guarantee steady deceleration, even in wet conditions.

GOOD BRAKES ARE THE MOST IMPORTANT FACTOR IN ENSURING SAFE CYCLING.

In Germany, for example, Section 65 of the Road Traffic Permit Act (StVZO) states that all bicycles must have two independently functioning brakes. The design and character of the brakes are not important as long as they are permanently installed on the vehicle and enable the rider to adequately reduce the speed of the bicycle and hold it in place. Similar regulations apply to e-scooters.

But what is the situation with regard to the braking power of modern bicycles, pedelecs, and speed pedelecs? DEKRA conducted brake tests at its Technology Center at the DEKRA Lausitzring race track in Klettwitz, Germany, to find out. Up until the test, the six test bicycles had been subjected to everyday use. No changes were made to their technical condition before conducting the tests. The test team simply checked the tire pressure and adjusted it where necessary. They also checked that the braking systems were in good condition and fully functional.

When selecting the test bicycles, care was taken to ensure that they all had a similar tire contact area. This made mountain, touring, and trekking bikes particularly well suited to the test. “Fat bikes” and road bikes were not included in the test. The objective of the brake tests was to demonstrate the differences in the braking power of different brake systems, to illustrate the effects of different weather conditions (dry/wet road surfaces), and to highlight the specific advantages and disadvantages of each brake system. The following systems were installed on the test bicycles:

City bike:
Caliper brake at front/
coaster brake at rear

Trekking bike:
Caliper brake at front/
caliper brake at rear

Mountain bike 1:
Caliper brake at front/
caliper brake at rear

Mountain bike 2:
Disc brake at front/
disc brake at rear

Speed pedelec:
Disc brake at front/
disc brake at rear

Pedelec:
Disc brake with
Bosch ABS at front/
disc brake at rear

1 Final positions, dry
2 Final positions, wet
3 Caliper brake
4 Hub gear with coaster brake
5 Front disc brake
6 Rear disc brake
7 Pedelec ABS control unit

DEKRA's experts conducted a number of measurements during the brake tests at the Lausitzring race track in Klettwitz, Germany.

PEDELEC ABS PROVIDES SIGNIFICANT ADVANTAGES ON WET SURFACES

The test scenario required the testing rider to carry out multiple braking procedures on each of the test bicycles, both on a surface with a high adhesion coefficient (dry) and on a surface with a reduced adhesion coefficient (wet). All the braking procedures were initiated at a speed of 25 km/h with the maximum deceleration possible, by an experienced test rider. For the wet-surface braking procedures, large quantities of water were applied to the entire run-up and travel surface, the braking area, and the test bicycles and their braking systems. The measurements were taken using a tape measure, and the measuring point was the axle of the front wheel. The tests produced the following results:

The disc brakes demonstrated good modulation overall. On the dry surface, all the test bicycles demonstrated appropriate braking power; there was no significant drop-off in any of the braking systems. The longest braking distance on the dry surface was recorded by the bicycle with the caliper brake at the front and the coaster brake at the rear. The mean braking distance for this bicycle was 4.55 meters. The speed pedelec recorded the shortest mean braking distance on the dry surface, with 3.66 meters. The difference between the shortest and longest mean braking distances on the dry surface was thus 89 centimeters.

On the wet surface, however, the differences were much more stark: In this scenario, the braking distance increased by over 20 percent for all of the test bicycles except the pedelec with ABS. The biggest difference was recorded for the test bicycles with caliper brakes at the front and rear. The braking distance for these bicycles increased by almost 30 percent on the wet surface. Overall, the ABS brake on the pedelec demonstrated the best performance on the wet surface, recording a braking distance that was only just under ten percent longer than its braking distance on the dry surface. On the wet surface, the longest braking distance was again recorded by the bicycle with the caliper brake at the front and the coaster brake at the rear. The mean braking distance for this bicycle was 5.53 meters. The pedelec with ABS recorded the shortest mean braking distance on the wet surface, with 4.15 meters. The difference between the shortest and longest braking distances on the wet surface was 1.38 meters.

Deceleration values of between 5.3 and 6.6 m/s^2 were achieved during the braking procedures conducted in dry conditions, while the deceleration values in wet conditions were between 4.4 and 5.8 m/s^2. As such, all the bicycles achieved the minimum deceleration for motor vehicles of 5.0 m/s^2 in the dry braking test. One model even exceeded this value on the wet surface: The ABS bicycle achieved a mean fully developed deceleration of 5.8 m/s^2.

BRAKING COMPARISON: E-SCOOTERS VERSUS PUSH SCOOTERS

Using the same test setup, the DEKRA experts also conducted brake tests on a conventional push scooter equipped with just a foot brake on the rear wheel, and an e-scooter. The e-scooter was a standard model with drum brakes that is available for rental in many German cities. On this model, both the front and the rear brakes were operated by separate brake levers on the handlebars. The brake tests were conducted at a speed of 20 km/h.

The results were as follows: In the brake tests on the dry surface, the push scooter recorded a mean braking distance of 9.70 meters, which is equivalent to a deceleration of 1.6 m/s^2. The push scooter's braking performance was alarmingly poor compared to that of the e-scooter, which recorded a mean braking distance of just over 3.37 meters on the dry surface, equivalent to a deceleration of 4.6 m/s^2. The differences were even starker on the wet surface and with a wet rear brake. While the e-scooter braked with almost exactly the same effectiveness in these conditions, the foot brake on the push scooter had almost zero braking effect – the push scooter's mean braking distance doubled to 19.25 meters, equivalent to a deceleration of just about 0.8 m/s^2. In light of this, it is recommended that push scooter riders place one foot on the asphalt to brake under these conditions. When using this type of manual braking, the push scooter achieved braking distances of 9.10 meters on the wet surface. Nevertheless, the use of push scooters that are equipped with only a foot brake should be avoided on damp and wet surfaces. It should be noted that the e-scooter's brakes produced positive results. It was possible to exert the maximum pressure on both brake levers without any cause for concern. The braking procedures were steady and gave the rider a sense of safety.

BICYCLE HELMETS OFFER GOOD PROTECTION IN IMPACT TEST

The potential benefits of bicycle helmets in protecting a cyclist's head in case of an accident are indisputable. At the same time, figures for helmet usage around the globe are extremely varied, as illustrated strikingly by the data collected from different European countries in the DEKRA Accident Research study presented in the section of this report on the human factor. The reasons why a cyclist chooses to

DEKRA also tested the braking behavior of an e-scooter compared to that of a push scooter, on dry and wet surfaces.

wear a helmet – or not – vary, and are influenced by many different factors. The fear of ruining one's hair or appearance carries just as much weight as factors such as personal experience, the numbers of cyclists on the roads in the area, the type of bicycle, the purpose of the journey and, last but not least, the legal requirements.

Generally speaking, there is a wide variety of helmet models and designs available on the market. The number of products available is as large as the price range. The fundamental requirements are defined in a number of standards, such as EN 1078, CPSC, JIS T 8134, and CAN/CSA-D113.2-M89 (R2014). These standards must be complied with in their respective regions. Providing they meet these basic requirements, however, manufacturers have a large degree of creative freedom in terms of the design. In order to gather information on cushioning behavior, DEKRA subjected a number of different helmets to impact testing in a non-standardized series of tests.

In order to generate added value, the team deliberately chose to use a test that is not included in the same form in the European standard EN 1078. For the purposes of this test, each helmet was fitted onto a steel test head equipped with measurement technology, positioned at an angle of 30 degrees from the vertical, and hit with a round test specimen weighing five kilograms. The test specimen was dropped onto the helmet from heights of one and two meters. The resulting energy, which was transferred into the helmet, was thus 50 or 100 joules respectively. This load applied at a point occurs in a number of real-life accident situations, for example if the head of the cyclist strikes a solid part of a vehicle during the collision, such as the A-column or the edge of the roof above the windshield. Of course, the vehicle's surface geometry would not usually match the hemispherical test specimen; despite this, it is still possible to draw conclusions with regard to a helmet's cushioning behavior based on this type of impact.

For this series of tests, a number of different helmets were purchased from a large German online shop; two older, used helmets were also tested. All the conventional bicycle helmets demonstrated an excellent protective effect during the impact tests. The shell and structure of the helmets effectively distributed the force exerted by the test projectile at the specific point onto the inside section that touched the head. In addition to this, deformations and breaks in the rigid foam of the helmet shell absorbed energy, further reducing the load that acted on the head.

Saul Billingsley
Executive Director, FIA Foundation

Don't Delay, Act Now

Many parts of the world are experiencing an explosion in motorcycle use. It is easy to understand why: motorbikes are a cheap, accessible, and versatile mode of transport, with low barriers for use. In many countries, a rider – and multiple passengers – can literally jump on and go. As incomes rise, but don't reach as far as expensive (or non-existent) public transit, let alone a car, powered two-wheelers provide much-needed mobility.

But motorbikes exact an expensive price in human life. Fatalities and injuries amongst motorcycle users are also on the increase. Speed, failure to use motorcycle crash helmets, overloading, poor road design, and lack of segregation from heavy vehicles – all these are contributing to the casualty toll. Riders are often young, poor, and untrained, including on the usually unregulated motorcycle taxis ubiquitous across the Global South.

But there are solutions. The FIA Foundation's partner in South East Asia, AIP Foundation, has worked on motorcycle safety in Vietnam for more than twenty years, and latterly in Thailand, Cambodia, Laos, and Myanmar, too. Some of their experience is captured in the 2017 report 'Head First: A Case Study of Vietnam's Motorcycle Helmet Campaign'. Sustained political commitment is vital to build the key legislative and regulatory foundations for helmet quality and use; proactive and consistent enforcement coupled with clear, public health information campaigns to build understanding and consent; permanent vigilance and regular reinforcement of both enforcement and awareness raising – these are the ingredients that have helped Vietnam introduce universal helmet use, and save $3.5 billion from an estimated 500,000 avoided head injuries since 2008.

Vietnamese officials are the first to admit that there is still much to do, not least in regulating the market in helmet quality and safety. And there are other lessons from other countries that any government grappling with high two-wheeler injury rates should be thinking of adopting, including separated motorcycle lanes on high volume corridors and requiring automatic braking systems as standard on all new motorbikes.

As we enter the SDG Decade of Action, with a target to halve road deaths by 2030, the first lesson for governments from the Vietnamese experience is clear – don't delay, act now.

DEKRA conducted special impact tests with a variety of helmets.

The best result in the test was achieved by a modern, high-quality helmet with a built-in Multi-directional Impact Protection System (MIPS). The MIPS was developed to absorb the rotational forces that are generated in the head and brain in case of an impact. In most cases, the cyclist's head hits the ground at an angle during an accident, rather than vertically. The resulting rotational forces can cause brain damage. The MIPS is designed to counteract this danger and reduce the rotational forces. This is achieved by attaching a moving layer of plastic to the inside of the helmet. This plastic layer can move back and forth by about one centimeter in every direction. The system is generally compatible with any type of helmet, and in theory can also be retrofitted onto conventional models by their respective manufacturers. In the test with the MIPS helmet, the force that acted on the head was measured at 3.8 kN. A model of the same design without the MIPS recorded slightly higher load values of 4.0 kN.

In order to determine how the age of a helmet affects its performance, a seven-year-old helmet from a discount store was also tested. The force measured when testing this helmet was 4.2 kN. A very high-quality helmet that was almost 21 years old achieved a value of 4.5 kN. Two of the helmets for teenagers bought in fall 2019 had been manufactured in January 2018 and December 2016 respectively. The newer helmet achieved a value of 4.9 kN in the test; the older one only 5.4 kN. Another helmet designed for teenagers reduced the load to 4.3 kN.

Another helmet included in the test, which complies with the requirements for speed pedelecs with an electrically assisted maximum speed of 45 km/h, recorded similar results to the regular bicycle helmets in this test, with load values of 4.8 kN and 5.1 kN. However, due to differences in its shape it also covers additional impact scenarios and provides good head protection in situations that would push traditional bicycle helmets to their limits.

An airbag helmet included in the test had no effect in terms

DURING A FALL, THE HEAD IS SUBJECTED TO HIGH FORCES.

of reducing the impact. Due to the weight of the falling object, the material of the airbag tore open at a point on the side, causing it to lose the gas inside it, and thus its protective function. Within the framework of the tests carried out, it was not possible to ascertain to what extent such behavior would also occur in case of impact against a "sharp-edged" curb, if the wearer's head went through a shattering windshield with the airbag inflated, or if the airbag came into contact with slender but hard vehicle components such as an A-column during a collision (see accident example 8 for more information).

BICYCLE HELMETS SIGNIFICANTLY REDUCE THE RISK OF SEVERE HEAD INJURIES WHEN WORN CORRECTLY

In the past, countless crash tests have been conducted – many of them by DEKRA – in order to test and illustrate the potential benefits of bicycle helmets in real-life accident scenarios. As the use of e-scooters becomes more widespread, it becomes relevant to ask whether bicycle helmets can also have a protective effect for users of these vehicles. To this end, three tests were conducted at the DEKRA Crash Test Center. The tests simulated a situation where a scooter crashed into a curb and the user, represented by a Hybrid III crash test dummy, subsequently fell off the scooter. The dummy had no protection in the first test, and wore a helmet in the second. In the third test, an airbag helmet – a highly practical and space-saving last mile mobility solution – was used.

The load placed on the head was measured using the standard sensor systems in the dummy. This involved measuring the acceleration levels that acted on the head. The acceleration figures were converted into the risk of injury using the head injury criterion val-

HOW WELL A HELMET FITS PLAYS A KEY ROLE IN ITS EFFECTIVENESS AS A PROTECTIVE MEASURE.

Mar Cogollos
Director of AESLEME (Asociación para el Estudio de la Lesión Medular = Association for the Study of Spinal Medullary Lesions)

Two-Wheeled Vehicles – Sustainable and Safe?

Urban mobility is evolving rapidly. In urban spaces, which were almost exclusively the preserve of the car just a few years ago, a variety of road users now compete with one another, including riders of micro-vehicles and bicycles. This means that there are a large number of unprotected road users sharing the road with fast, heavy motor vehicles – an incredibly risky situation. This is compounded by the fact that many cyclists and users of e-scooters are not aware of the rules, risks, and potential consequences of riding their vehicles, or do not observe the regulations.

We see these people almost every day, crossing at crosswalks without dismounting, riding without helmets (in Spain, helmets are currently only a legal requirement for cyclists under the age of 16), riding at night or through tunnels in urban areas without reflective elements, or using their headphones or cellphone while on the road.

These modes of transport are popular among young people as a sustainable and more affordable way of getting around town. However, the fact that no driver's license is required to ride a bicycle or an e-scooter is a problem, as it leads to a large number of road users who have not received any training. While it is obviously essential that we reduce congestion and find more sustainable means of transport, the safety of all the road users who share our roads must be our absolute top priority.

The increase in two-wheeled vehicles on the roads in our towns and cities will lead to an increased number of accidents, because the infrastructure is not designed to cater to road users in this vehicle category: There are not enough separate lanes and – as I have already mentioned – ensuring safe interaction between buses, vans, cars, motorcycles, bicycles, and e-scooters is difficult because the vehicle categories differ in terms of their weight, mass, and the active and passive safety measures with which they are equipped.

AESLEME's recommendations:

- Certificate or approval from school for cyclists and users of e-scooters (13 to 15 years old): Theory and practical training on rules, requirements, penalties, hazard perception, etc. with assistance from parents, teachers, local police, road safety instructors, and professional associations
- Make wearing helmets and reflective jackets (on urban roads) a legal requirement for all age groups
- Set a minimum age for unaccompanied use (14 for bicycles and 16 for e-scooters)
- Ensure that local police have a stronger presence and perform more frequent checks, issuing penalties if necessary, in order to ensure awareness of and compliance with the rules, and prevent accidents and collisions
- Install emergency braking systems, pedestrian and cyclist detection systems and blind spot monitoring (driver assistance systems) in cars in order to prevent accidents in this vehicle category

"Nothing is more valuable than life!" Let's take steps to help us live together safely and encourage greater respect so that we can protect our most vulnerable road users.

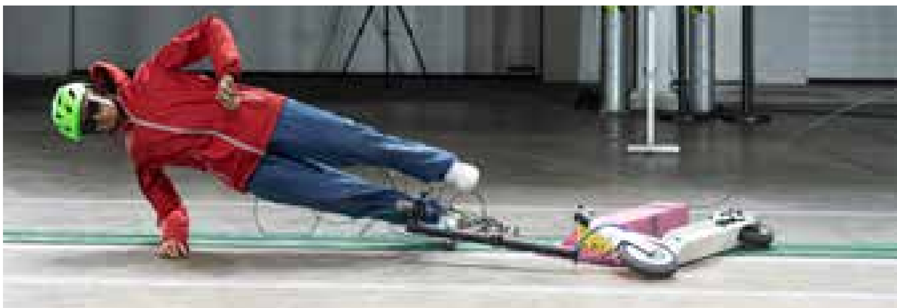
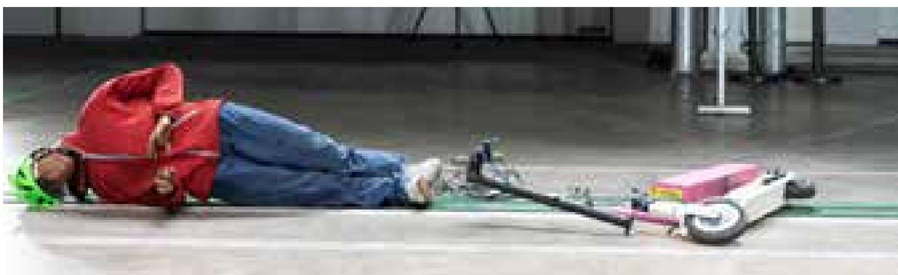


In a real-life traffic situation, the scooter rider without the helmet would have suffered severe head injuries.

ue (HIC). Background: The human head is subjected to different forms of stress in every accident, some of which overlap. These include the translational and rotatory stresses that act mainly on the bone and brain mass. Depending on the stress to which the body is subjected, the brain mass may undergo relative displacement within the skull. This can lead to minor or severe injury. The dimensionless HIC has been developed to enable us to assess and compare the potential severity of different injuries.

In crash tests, this criterion is calculated using a dummy, or sometimes in a simulation. It is based on the connection between the level and the duration of the deceleration that acts on the head along every dimensional axis during an accident. The duration is key to determining the extent to which the acceleration influences the risk of irreversible cranial or brain injury. If the head briefly impacts against an object for around 15 milliseconds, the HIC15 value of 1,000 represents a 50 percent probability of irreversible injury. In case of a longer deceleration, relatively speaking, whereby there is no direct, hard head impact (duration approx. 36 milliseconds), the HIC36 value of 700 is used as the defining threshold for a 50 percent risk of intolerable, irreversible injury.

In the crash test with no helmet, the acceleration levels measured when the head impacted the ground were very high, with an HIC36 value of 5,282. This value would be expected to cause critical to fatal injury. In the second test, the dummy wore a bicycle helmet. This reduced the load on the head to an HIC36 value of 122, thus significantly reducing the risk of a severe head injury. In the third test, the airbag helmet's trigger algorithm detected the dummy's fall, and the airbag was deployed. The HIC36 value of 169 measured in this test was also a clear indicator that the risk of a severe head injury when wearing such helmets is very low.

Helmets also offer a relatively high level of injury protection in case of scooter crashes.

Since – unlike a sober person with normal reactions – a dummy does not execute any form of defensive reaction to a crash, such as using its hands to break its fall, the values measured in all the tests are at the high end of the expected range. Nevertheless, the enormous potential for protection offered by a helmet or airbag helmet in any scenario is clear. The airbag helmet also shows signs of an additional effect that could not be reflected in the tests. According to a study by Stanford University, the large-volume airbag helps to reduce the risk of concussion compared to conventional bicycle helmets.

In summary, it is clear that, when worn correctly, bicycle helmets significantly reduce the risk of severe head injury in case of an accident – regardless of whether said accident involves another party or is simply a fall that does not involve any other persons. In DEKRA's car-versus-bicycle tests, the airbag helmet demonstrated significant vulnerabilities in terms of crash detection (see accident example 8, page 35). These issues have also been reported in tests conducted by other institutes, so this cannot be assumed to be a one-off. In case of falls, however, the airbag was triggered with a very high degree of reliability and provided at least the same level of protection as a conventional helmet. The airbag helmet represents a potential alternative for anyone who does not want to wear a helmet because it might ruin their hair or does not match their own aesthetic ideals, and also for those who find a conventional helmet too cumbersome to wear on their way to work with various modes of transport.

However, the tests have also shown that bicycle helmets are not only a suitable form of protection for cyclists. They are also a legitimate safety measure for users of personal light electric vehicles, and should be worn for every journey. However, the tests also confirmed that while an old helmet is better than no helmet at all, the manufacturer's specifications with regard to replacing a helmet once it has reached a certain service life should be observed in order to maintain the optimum protective effect. For the helmets included in the test, the recommended service life was three to five years. Helmets that undergo a lot of stress, such as children's or teenagers' helmets that are constantly being dropped, should generally be replaced more frequently. Manufacturers specify the date of purchase as the start of the service life; howev-

The airbag helmet triggered reliably during the crash simulation.

Airbag helmet in "normal" and inflated state.

er, consumers should check the legally required date of manufacture printed inside the helmet before buying, and make sure that it has not been sat on the shelf or in the storeroom for too long.

The fit of the helmet is also important. As with shoes, this can vary depending on the manufacturer and the model. This makes it important to try on and compare different helmets before buying. Even the most expensive helmet that comes out on top in all the tests will be useless if it ends up not being worn because it does not fit properly, or if a poor fit prevents it from providing its full protective effect.

ACTIVE AND PASSIVE LIGHTING SYSTEMS FOR CYCLISTS

When it comes to the safety of cyclists – both with and without electrically assisted vehicles – lighting plays a key role. Fully functional lighting that complies with the legal requirements is essential to ensuring that cyclists can see well, and especially that they can be seen, all year round (Figure 26). In Germany, Section 67 of the Road Traffic Permit Act (StVZO) on lighting systems on bicycles was revised back in 2017, and Section 67a on lighting systems on bicycle trailers was added at the same time. This legislation places a high degree of responsibility in the hands of cyclists: They are not required to have potentially detachable active lighting equipment – i.e. head lamps and tail lights – mounted on their bicycle during the day, nor are they required to carry it with them. When cycling in darkness, however, they must ensure that their lights are attached and, of course, in full working order.

If a cyclist is unable to comply with this requirement in a one-off situation – if one of their lights suddenly develops a fault, for example – then their passive lighting equipment becomes particularly important. Passive lighting equipment can only fulfill its function as a potentially life-saving safety measure to the required level if all the legally required

Transporting Children in a Cargo Bike – Always Use a Seatbelt and a Helmet!

Parents transporting their children in cargo bikes are becoming an increasingly common sight on our streets. But how safe is this mode of transport for our offspring? This question was the focus of a series of tests conducted by DEKRA at the DEKRA Technology Center at the Lausitzring race track. In one of the cases, the dummy was wearing a seatbelt – the seatbelt system installed on the bicycle was the type recommended for children by the manufacturer. In the other case, the dummy was seated in the cargo box without a seatbelt. The braking procedure was executed at a speed of 25 km/h using the bicycle's built-in brakes. The results are clear: The dummy without the seatbelt was thrown out of the box and its head hit the ground. In a real-life scenario, this would have resulted in severe head injuries – especially if the child was not wearing a helmet. The dummy that was wearing the seatbelt, on the other hand, barely moved from the position in which it was seated when the bicycle braked. In light of this, we should follow the maxim that anyone transporting their children in a cargo bike should always make sure that they are wearing seatbelts. In order to cover all eventualities, the children should also wear helmets.

26 Legally Required Lighting Equipment on Bicycles in Germany

	IN DAYLIGHT	IN THE DARK	
	Active lighting equipment Removable items do not need to be attached or carried around during the day	**Passive lighting equipment** All items must be permanently installed and unobscured at all times	**Active lighting equipment** Must be attached and fully functional when riding in the dark
Forward-facing	Headlamp	Reflector, white Pedal reflectors, yellow	Headlamp
Rear-facing	Tail light, red	Reflector, Cat. Z (according to StVZO), red	Tail light, red
Side-facing		Alternative: Retroreflective strips on tires or wheel rims, white Retroreflective spokes/spoke sheaths, white Spoke reflectors, yellow	

CYCLISTS OFTEN LACK AWARENESS OF THE PROBLEMS AND DANGERS OF NOT HAVING SUFFICIENT LIGHTING.

reflectors and retro-reflective devices are permanently attached to the bicycle and not covered up.

This means that road cyclists and mountain bikers likewise do not require battery-powered lighting on their person or their bicycle in daylight. But when the sun starts to set or they enter a tunnel, they should have lights on their bikes in order to avoid penalties – and, more importantly, to keep themselves safe. Generally speaking, lighting systems, including those on bicycles, need to be of an officially approved design, which means they need to have a test or approval mark on them. In addition to this, care must be taken with all types of headlamp to ensure that they do not dazzle oncoming traffic.

There are also several other important changes: Bicycles with a width of over one meter must be equipped with paired horizontal reflectors facing the front and rear, plus at least two white headlamps and two red tail lights fitted in pairs no more than 20 centimeters from the outer edge of the sides of the vehicle. Front and rear-facing turn signals are only permitted on cycles with more than two wheels

Finding New Paths Forward

In light of the rising numbers of accidents involving cyclists and the expectation that the volume of bicycle traffic will continue to increase, especially in urban areas, we need to improve road safety and be open to ways of doing so that have previously been dismissed as far-fetched. Even the most simple tools may prove effective in this regard. Take bicycle lighting equipment, for example:

There are now headlamps with built-in laser lights that project a bicycle symbol onto the ground in order to make other road users aware of cyclists and announce their arrival at busy junctions before the cyclists themselves can actually be seen. These systems are also designed to project the presence of a cyclist into the line of sight of motorists so that they notice the cyclist even when they are in the motorist's blind spot. New bicycle tail lights are also available that project a virtual bicycle lane onto the road using a laser in order to show overtaking vehicles the safety area around the bicycle and encourage them to maintain a greater distance when overtaking.

These systems are already in use in some countries, especially on rental bicycles. In others, such as Germany, they are prohibited. We need to find a path between categorically ruling out new forms of technology that can improve safety and allowing the producers of stylish new gadgets to run wild, flooding the market in a way that would be counterproductive to safety concerns. As a general rule, however, all additional functions of this kind need to be thoroughly discussed and examined by the relevant expert committees, such as the GRE and the UN-ECE in Geneva – just like many other proposed new forms of lighting technology in the automotive sector.

and bicycles whose design results in the rider's hand signals being partially or completely obscured. For trailers being pulled by bicycles, the relevant provisions of the new Section 67a of the StVZO apply. These are a life-saving measure, especially when riding with children on board.

During both standard bicycle checks carried out on the road and those included in road safety training at schools, there are regular issues. Among the most common of these is bikes on which the passive lighting equipment (reflectors) that forms part of the legally required equipment when cycling both in daylight and at night is either missing or not attached in full. Legally prescribed lighting equipment only becomes noticeable when it is dark –especially if it is absent (Section 67/67a, StVZO), if it is not switched on (Section 17, StVO), or if it is defective.

In order to counteract the increasing frequency on the road of bicycles that do not have all the legally required reflectors facing the front, rear, and sides, we need to increase awareness of this problem/requirement by reminding cyclists and the entire bicycle industry of it. In many countries around the world, police bicycle squads are becoming increasingly common as a way of conducting more bicycle checks. Despite the wide variety of irregularities and violations in everyday traffic, it seems expedient to subject cyclists and their bikes to a "full inspection" with every police check and whenever a punishment is issued for a severe offense, regardless of the original reason for pulling them over. If any issues are found during the inspection, for instance with the passive lighting equipment that is also required when riding in daylight, care should be taken to ensure that the act of pointing out the problem is used as a teaching moment – and, where necessary, combined with a verbal warning and/or the threat of a fine if it turns into a repeat offense.

RIDING SAFELY WITH ROAD-SAFE MOTORCYCLES

Throughout Europe, statistics show that most accidents involving motorcycles are caused by the human factor in the situation. Other risk factors commonly involved include the road conditions, the weather conditions, and obstacles in the road. In addition to this, the number of accidents where technical defects can also play a role should not be underestimated – which makes it all the more important to carry out regular safety inspections on motorcycles. In many EU countries, periodical vehicle inspections have been a requirement for two-wheeled motor vehicles for many years, just as they are for other motor vehicles (Figure 27). In the DEKRA accident database, the proportion of vehicles found to have technical defects after having been involved in a traffic accident was 20 percent for motorcycles, 50 percent for mopeds, and around 80 percent for small mopeds.

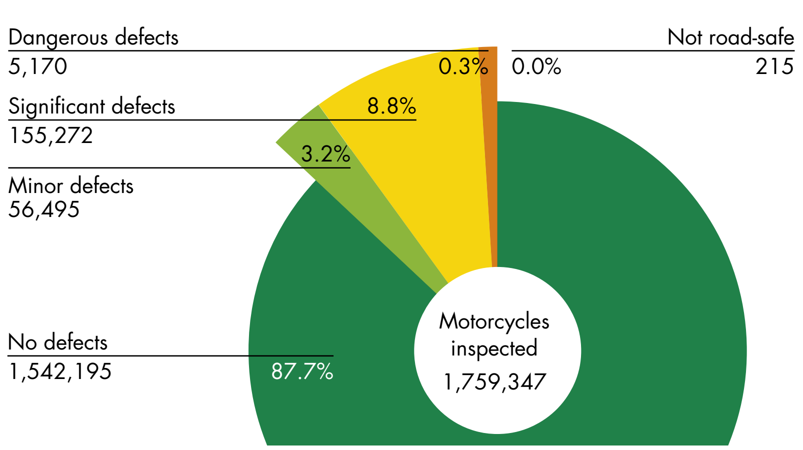
In Germany, the majority of the motorcycles subjected to general inspections in 2018 (Figure 28) were found to be in good technical condition. According to figures published by

27 Regulations for the Periodic Technical Inspection (PTI) of Motorcycles in the EU

	PTI	Test interval in months		PTI	Test interval in months
Belgium	X	–	Malta	X	–
Bulgaria	✔	24	Netherlands	X	–
Denmark	X	–	Austria	✔	12
Germany	✔	24	Poland	✔	36/24/12
Estonia	✔	36/24/24/ 24/12/12/12	Portugal	X	–
Finland	X	–	Romania	✔	24
France	X	–	Sweden	✔	24
Greece	✔	24	Slovakia	✔	48/24
Ireland	X	–	Slovenia	✔	48/24/24/12
Italy	✔	48/24	Spain	✔	48/24
Croatia	✔	24/12	Czech Republic	✔	48/24
Latvia	✔	24	Hungary	✔	48/24
Lithuania	✔	36/24	United Kingdom	✔	12
Luxembourg	✔	48/24/12	Cyprus	X	–

Date: 2018 Source: EU Commission

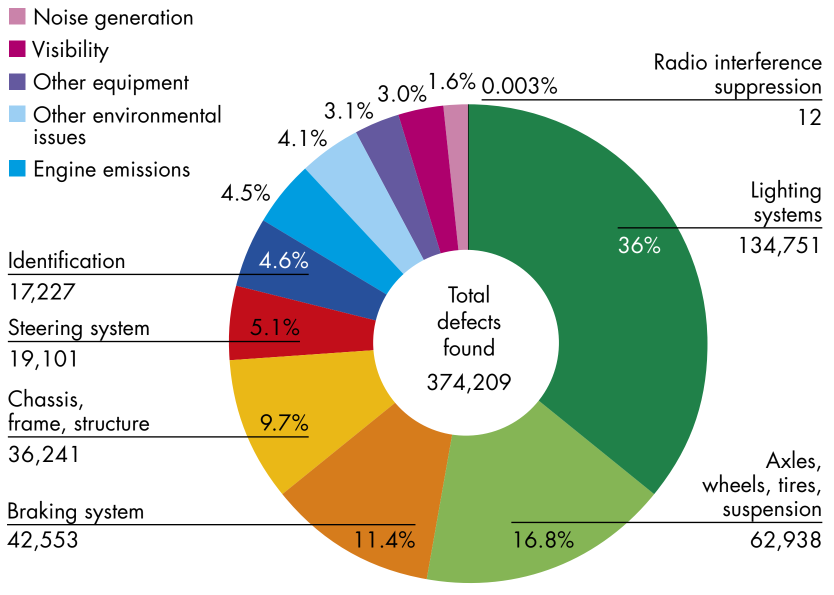
28 Motorcycle Inspection Results for Germany in 2018



Source: Kraftfahrt-Bundesamt (German Federal Motor Transport Authority)

29

Motorcycle Inspection Results for 2018 in Defect Groups



Source: Kraftfahrt-Bundesamt (German Federal Motor Transport Authority)

the Kraftfahrt-Bundesamt (Federal Motor Transport Authority), 87.7 percent of the over 1.75 million motorcycles inspected in total showed no signs of defects. With regard to the defects found in the individual assemblies (Figure 29), lighting systems were the most common problem area, accounting for over 36 percent of all defects. In almost 17 percent of the motorcycles with defects, the axles/wheels/tires/suspension assembly was the most common problem area, followed by the braking system and the chassis/frame/structure, which accounted for 11.4 and 9.7 percent of all defects respectively.

TUNING OF MOPEDS AND SMALL MOPEDS REMAINS A PROBLEM

For many teenagers, especially in rural areas, the small moped – or, increasingly, the e-bike – is the gateway to personal motorized mobility. Sub-

Two Examples to Illustrate the Extent to Which Technical Defects Cause Traffic Accidents

Not every technical defect that is found in conjunction with an accident should necessarily be seen as the cause of the accident. In order to determine whether or not this is the case, the accident needs to be examined in detail by an expert, as illustrated by the two examples below:

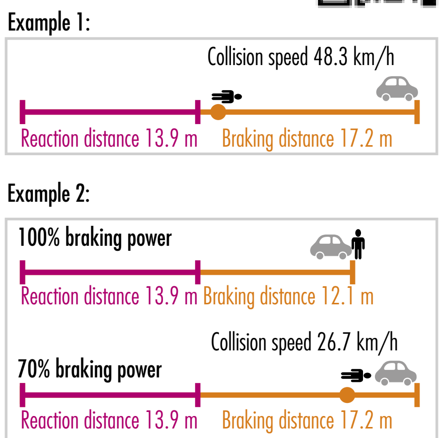
Example 1:
A car is driving through a built-up area at a speed of 50 km/h. The dry asphalt road has two lanes: one in each direction. There are several vehicles driving toward the car on the opposite side of the road, also at 50 km/h. An e-scooter user traveling slowly pulls out from between two parked vehicles into the same lane as the car, 15 meters in front of it. The driver of the car initiates a braking procedure. Shortly after the car begins to brake, it hits the e-scooter user at the height of its right headlamp. The vehicle comes to a stop after a braking distance of 17.2 meters. The e-scooter user is severely injured, or possibly even killed. At the site of the accident, it becomes clear that the two rear brake discs were both partially rusted.

If we assume a reaction time of one second – including all system times, such as the brake force build up time – emergency braking at full power would begin after a reaction distance of 13.9 meters if the car was traveling at 50 km/h. Braking begins just before the collision. It does not stop until the car has traveled 16.1 meters (= 13.9 meters + 17.2 meters - 15 meters) beyond the point of the collision. The collision speed is 48.3 km/h.

An expert performs a detailed examination of the braking system in a workshop to determine what effect the defect in the braking system has. The expert finds that the rear brakes were barely able to transfer any braking force. As such, the braking system's performance is only 70 percent of that of a system that has been maintained in optimum working condition. Despite this, the defect in the braking system is not a cause of the accident in example 1. The car would always have hit the e-scooter user at a speed of 50 km/h or just below regardless of the condition of the brakes.

Example 2:
Instead of the 15 meters in the previous example, the e-scooter user now pulls out into the lane at a distance of 26 meters in front of the car. Assuming the same reaction time (one second) and 70 percent of the original braking power, the car collides with the e-scooter user 4.9 meters before it comes to a stop. This corresponds to a residual speed of 26.7 km/h. The e-scooter user will probably be injured. A fully functional braking system would bring the car to a stop after 26 meters (13.9 meters reaction distance + 12.1 meters braking distance). The e-scooter user would not suffer any physical injuries. In this case, the defect in the braking system would be a cause of the accident.

Results:
The accident cannot be reconstructed correctly until the braking deceleration possible with the defect has been calculated. If the defect in the braking system is not detected at all, the speed at which the car was traveling would be calculated as being 59.7 km/h, based on a braking distance of 17.2 meters and a braking deceleration of 8 m/s², which is the same deceleration rate we assumed earlier. This could result in the cause of the accident being deemed in court to have been "excessive speed" rather than "technical defect." This makes the technical examination of the vehicles involved an extremely important part of the accident reconstruction process.



ject to a minimum age of 15 in Germany and 14 in Switzerland, it represents a real alternative to a bicycle, the bus, or relying on their parents to drive them around. However, the fact that these vehicles' top speed is restricted to 25 km/h is a limitation that many users still see as unreasonable. As a result of this, tampering with the technology of a vehicle in order to increase its speed has long been common for those that own these vehicles.

Due to changes made to the European permit laws in 2002, the traditional small moped has increasingly fallen out of favor and been superseded by throttled motor scooters. Where tuning was once focused on modifying mechanical aspects such as the carburetor, the exhaust, and the transmission ratio, a vehicle's electronic systems are now the more common target of any illegal tweaks. Tailor-made tuning kits for different vehicles are available to purchase online. Similar tuning procedures are commonly carried out on light motorcycles, which have a legally limited top speed of 45 km/h. Likewise, the choice of tuning kits available for pedelecs is increasing constantly.

Most users of tuned two-wheeled vehicles are not fully aware of the potential risks of such modifications. Tuning a vehicle invalidates its type approval, making it illegal to use it on public roads. In addition to this, increasing its top speed moves means that a different driver's license class is required, meaning its user may be guilty of operating a motor vehicle without a driver's license. The increased speed also presents a further problem for traditional small mopeds and pedelecs, which are often not designed to handle such velocities.

Traveling at a higher speed subjects the vehicle to much greater strain, which leads to a risk of component failure. Likewise, the braking systems on some of these vehicles are not designed to handle the higher speeds that can be achieved through tuning. Since tuning invalidates the type approval, insurance companies can reduce their payouts, or completely refuse to pay out at all in case of damage incurred during an accident. In light of this, it is important both as a follow-up to accidents and as part of general traffic monitoring procedures to determine whether vehicles have been modified illegally. If the police spot a vehicle on the road that seems unusual, they can have it inspected for illegal technical modifications by their own specialists or experts.

Jörg Ahlgrimm
President of the European Association for Accident Research and Analysis

Lack of Road Safety for Light Motorcyclists

Users of two-wheeled motor vehicles are particularly at risk on the roads. This is mainly due to the fact that there are only limited technical options for protecting them from the injuries they might suffer if they are involved in a traffic accident while using this type of vehicle. In addition to this, many two-wheeled light motorcycles with insurance plates are in particularly poor condition. These include low-priced vehicles from the Far East that are available in supermarkets and big-box stores. The design and technical construction of these vehicles alone cause them to wear more quickly than the average rate. Spare parts for safety components such as the braking system are very hard to get hold of. As such, it is no wonder that these vehicles are often found to have significant technical defects or even not be in roadsafe condition when they appear in accident statistics or are pulled over for traffic checks.

Many of the accidents involving these vehicles occur when they are being used by young road users, who often lack risk awareness and experience on the road. In addition to this, it is common for the technology on speed-restricted vehicles to be tampered with in order to increase their power and top speed. This is not a new development. But while the government continues to impose important constraints on manufacturers in an effort to prevent such tampering, there is still a significant gap between the ambition and the reality. It is particularly difficult to find proof of tampering in vehicles that possess electronic speed limiters that can be temporarily deactivated, and likewise in the electric vehicles that are becoming increasingly common on the market. As a group, older road users are also overrepresented in the statistics for injuries and deaths among motorcyclists. Unfortunately, a limited fitness to drive due to consumption of alcohol often plays a role here.

Traffic checks are currently the only effective means of counteracting the causes of accidents that arise from technology and the people driving or riding the vehicles in question. However, there is no systematic log of the problems found during these checks,
so it is not possible to draw statistical conclusions based on their findings. Spain has taken a different approach: For around ten years, Class L1e vehicles in the Mediterranean country have been subjected to inspections as part of a periodic monitoring scheme. According to a study conducted on behalf of the European Commission, the introduction of periodic monitoring has had a positive effect in that it has reduced the number of deaths and injuries among users of light motorcycles. In addition to this, the measure offers a good cost/benefit ratio. Serious analysis should be conducted to determine whether this model is also suited to reducing the number of accidents and minimizing their consequences in line with the objectives of "Vision Zero" in other countries.

THE PERCENTAGE OF TWO-WHEELED VEHICLES WITH ILLEGAL TECHNICAL MODIFICATIONS IS CONSPICUOUSLY HIGH.

Matthias Haasper
Head of Research, Institute for Two-Wheeler Safety (ifz)

Welcome Innovations for Greater Motorcycle Safety

According to the findings of a recent study by the Institut für Zweiradsicherheit (Institute for Motorcycle Safety, ifz), 94.6 of the motorcyclists surveyed viewed rider assistance systems on motorcycles as useful for safety reasons. As the word "assistance" implies, these systems are designed to help relieve the burden on motorcyclists in complex situations, thus increasing their safety.

The transfer of technology is not always easy in this field, as much of it comes from the car sector and is more complex to adapt when working with only two wheels. Nevertheless, there is now a wide range of rider assistance systems for motorcycles and scooters, such as traction control systems, semi-active chassis, cornering lights, daylight riding lights, tire pressure control systems, blind spot assistants, and many more. ABS is the classic example. This assistant was first included as standard in a motorcycle back in 1988, and has been a legal requirement for all newly licensed vehicles since January 2017. It is without a doubt the best-known rider assistance system, and was given first place in the ad-hoc listing of various systems in the ifz study.

The strides being made in technological development will continue to help reduce accident numbers in the future – that is our belief, and one shared by over 60 percent of the participants in the study. The latest findings on what can make motorcycle riding safer in the future will by presented at the ifz's 13th International Motorcycle Conference in Cologne in October 2020. "Networking" is one of the key buzzwords in this regard. On the one hand, the cooperative systems of the future will react within the context of the infrastructure, to elements such as traffic lights and traffic management systems. At the same time, vehicles will communicate with one another before either reacting automatically or passing the information they have gleaned on to their riders. This can be done in a number of ways. For example, acoustic signals could be used to speak to the rider via speakers in their helmet, or visual information could be in the helmet via a heads-up display in addition to the instrument panel. Riders could also receive notifications in the form of vibrations, e.g. in the handlebars or the seat. It is important that motorcyclists familiarize themselves in detail with the rider assistance systems on their motorcycles now, and also that they know how these systems can help them on the road. After all, the greatest responsibility still lies with the rider themselves.

DEKRA Accident Research collects the results of these inspections after traffic checks and accidents in its own database. Tuning measures designed to increase the vehicle's top speed are often found in two-wheeled motor vehicles during such inspections, especially in light motorcycles and small mopeds. The analysis for 2001 to 2018 shows that there was evidence of illegal technical modifications in 69.5 percent of the small mopeds that were investigated after an accident, and in 32.3 percent of the mopeds investigated after an accident. By way of comparison, only 2.4 percent of the cars investigated after accidents within the same period showed signs of illegal modification. The percentage of vehicles found to have illegal technical modifications following traffic checks was also conspicuously high, especially among two-wheeled vehicles. These types of modifications were found in 85.1 percent of the small mopeds that were investigated, 67.6 percent of the mopeds, and 72.2 percent of the motorcycles with license plates. The figures for traffic checks are naturally higher, since these vehicles are deliberately pulled over by police before being subjected to the additional expert inspection based on this initial suspicion.

As yet, no conclusive statistics are available for pedelecs. Nevertheless, the large range of tuning kits and the initial accident research findings indicate that this also represents a potential problem area. However, manufacturers of pedelec motors and the relevant professional associations have both expressed an interest in ensuring that these vehicles do not undergo tuning, and are prepared to take extensive countermeasures to prevent this from happening.

The risk of being killed in an accident is 18 times higher for motorcyclists than for car drivers. In light of this, technical systems for communication between motorcycles and cars are being designed to reduce the risk of accidents and improve road safety.

There is currently no data available on e-scooters for the German market, as they have only been approved for use on public roads since summer 2019. The design of these vehicles, which are subject to approval for use on the road, limits their speed to a maximum of 20 km/h. However, vehicles which have no chance of approval are still available, some of which can reach much higher speeds and would thus be unable to obtain a type approval. Since most markets are not currently subject to the same strict regulations as the German market and the majority of e-scooters on the road are owned by sharing service providers anyway, it remains to be seen whether this market ever becomes attractive to manufacturers of tuning kits.

ABS FOR GREATER MOTORCYCLE SAFETY

Ever since 2017, no new registrations for any motorcycle that does not have an anti-lock braking system (ABS) have been permitted. Based on the analysis of German and Indian accident databases (German In-Depth Accident Study [GIDAS], conducted from 2001 to 2004, and Road Accident Sampling System [RASSI], conducted from 2009 to 2013), Bosch Accident Research has predicted that this system could prevent around one quarter of all relevant motorcycle accidents that result in deaths or injuries. This is because such systems stop the wheels of the vehicle from locking. Especially in cases involving emergency braking or heavy deceleration on slippery surfaces, this helps to ensure that two-wheeled vehicles in particular come to a safe stop and remain easier to control within the limits set by the driving dynamics. They also pre-

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Investments in Research and Innovation Will Enable us to Keep Developing Safer Vehicles

Due to their design, scooters and motorcycles are vehicles with a particularly high risk of being involved in an accident. In order to reduce the associated risks, the two-wheeled vehicle industry will continue to take a number of different approaches in the future. The first factor is the technology made available to the motorcyclists by the manufacturers. Investments in research and innovation will enable us to keep developing safer vehicles. Generally speaking, the new rider assistance systems for motorcyclists are contributing significantly to accident prevention, as they offer motorcyclists support in the most critical riding situations. In the future, the challenge will be to introduce high-tech applications across the entire product range.

Phase 2.0 in the drive for motorcycle safety will be to apply the digital revolution to the world of mobility: "Cooperative ITS" – systems designed to connect vehicles to one another and to the infrastructure so that they can exchange information with one another and interact with the road infrastructure – will play a fundamental role in preventing the risk of accidents. The European companies that make up the ACEM – the European Association of Motorcycle Manufacturers – have signed a declaration of consent to support the introduction of "cooperative ITS" in the motorcycle industry, pledging to install a C-ITS system as a standard or optional feature in at least one of the models in their range by 2020.

It is also important to emphasize our industry's dedication to the development of eCall systems that can be mounted either on the motorcycle itself or on accessories such as motorcycle helmets and jackets. In both of these cases, our representatives are working hard to define a platform of technical requirements and standards that fits the European context.

There is also the matter of passive safety, which is largely dependent on technical functional clothing. Over the last few years, we have noticed an increase in awareness among motorcyclists, with more and more of them recognizing the need to wear special functional clothing designed to protect them in case of an accident. According to the Istituto Superiore di Sanità (Italian National Institute of Health), using a back protector reduces the risk of spinal injuries in case of an accident by 40 percent. In light of this, governments should also create incentives for the use of certified functional clothing, in the form of tax rebates. At the European level, the introduction of the new standard on protective clothing for motorcyclists, which covers items such as full motorcycle suits, jackets, and boots, has been of fundamental importance. This is a huge step forward, akin almost to a revolution, and will shape the development of protective motorcycle clothing for the next decade.

vent the front wheel from locking, which is dangerous and generally leads to a fall. As a result, they enable motorcyclists to brake at full power.

Incidentally, pedelecs with ABS have also been available since 2018. One example of this is the Bosch eBike ABS, which received the DEKRA Award 2019 for "Safety on the Road". This model combines the front-wheel ABS with rear wheel lift control for increased safety. During difficult braking maneuvers, this system regulates the braking pressure, thus optimizing the riding stability and steering of the e-bike. This reduces the chance of the front wheel locking and slipping, or the rear wheel lifting off the ground, which in turn means there is less risk of rollover and the rider falling off.

There is now technical further development of ABS technology for motorcycles toward electronic stability control, which is already commonly used in larger vehicles under the name ESP, or electronic stability program. This type of motorcycle stability control, which was first launched by Bosch under the name MSC, also comes with an additional safety benefit. The system, which uses ABS data and is also assisted by an angle sensor, intervenes during the exact maneuver that is most dangerous for a two-wheeled vehicle: cornering. Even today, almost one in two motorcycle accidents occurs during cornering.

Motorcycle stability control, or MSC, is like ESP for motorcycles. Among other things, the system detects the angle of a motorcycle and adapts the electronic control interventions when the rider is braking or accelerating in the blink of an eye to suit the riding situation at hand.

Bosch claims that MSC offers the best protection possible when accelerating and braking, even when cornering at high speeds. The braking system's interventions are precisely calibrated to the angle of the motorcycle, and the braking pressure builds up smoothly while still increasing rapidly when the bike is cornering. The system also detects when the front or rear wheel lifts of the ground during heavy acceleration or braking. If this occurs, the MSC performs extremely fast and targeted intervention into the braking controls or the engine management in order to counteract the wheel lift by flexibly channeling the forces to the front or rear wheel as required. Based on evaluation of the figures in the German accident database GIDAS (German In-Depth Accident Study, a joint project by the German Federal Highway Research Institute [BASt] and the Research Association for Automotive Technology [FAT]), the stability system could help to prevent two thirds of all cornering accidents that are caused by the motorcyclist themselves.

ECALL SYSTEM CAN SAVE LIVES

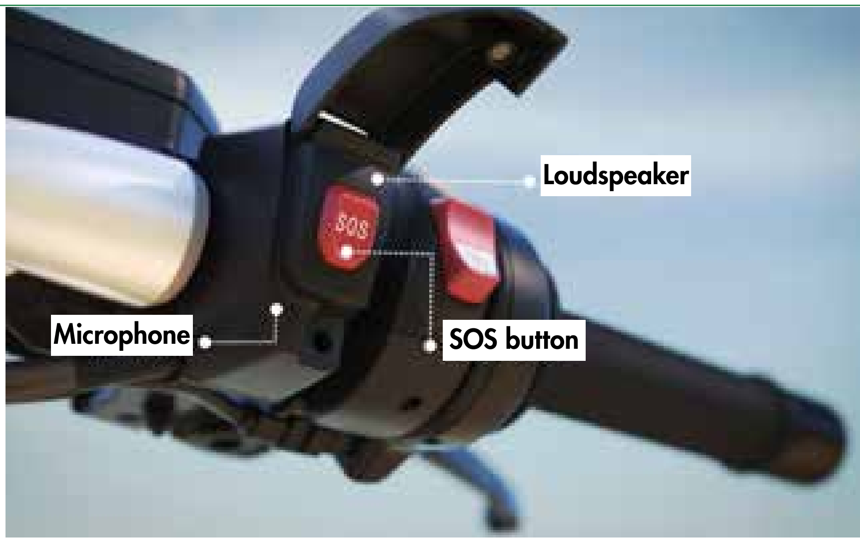
If an accident that results in injuries occurs despite all the passive and active safety systems being in place, contacting the emergency services quickly could be the difference between life and death, especially in case of severe injuries. While eCall is therefore already a mandatory feature of new passenger car models with EU type approval after March 31, 2018, it is not currently obligatory for motorcycles to use eCall. Nevertheless, the benefits of this system are obvious – especially for single-vehicle accidents, where other road users who subsequently pass by may not notice the motorcyclist and its riders, and there may be no traces of the accident. If the rider is unable to call for help themselves after the accident, an eCall system can activate the emergency call-out procedure more quickly and provide the exact location of the accident, just as it would for a car.

There are essentially two types of this system: built-in systems like BMW's "Intelligent Emergency Call" system, and retrofit solutions like Digades' "dguard". The eCall system in a motorcycle works in exactly the same way as one installed in a car. This means that the eCall is activated automatically when sensors register a severe accident. As soon as the system activates, it calls the saved telephone number – 112 for the emergency services in Europe, 911 in the USA, or the number of a permanently staffed call center. Of course, this can only be achieved with complete network coverage. The system transmits data on the accident – a "minimum set of data" specifying the time and location of the accident, and the direction in which the vehicle was traveling – to the recipient. In addition to this, many systems also establish voice communication. The eCall can also be triggered manually at the push of a button.

However, special requirements in the motorcycle sector make it harder to calibrate the trigger algorithm, as there are certain situations where the system must not be allowed to trigger. These "misuse cases" include riding over speed bumps, cobblestones, railroad crossings, tracks, bridge joints, and pot holes without reducing one's speed. Performing wheelstands, overbraking the front wheel, emergency braking with ABS or "stutter braking," tipping over while at a standstill, riding up and down curbs without reducing one's speed, riding along a wall at low speed, riding up and down steps and ramps, and controlled "drifting" with the front or rear wheel are other examples of misuse cases.

DEKRA conducted a study in order to observe the use of eCall systems for motorcycles based on real-life motorcycle accident data. 100 accidents involving motorcycles that occurred in Germany were analyzed for the study. The analysis showed that, in 59 percent of accidents that had resulted in injuries, the eCall system helped the injured parties to receive treatment or care more quickly and thus reduce the consequences of the accident that occurred as a result of the injuries. 46 of the 115 people involved in the accidents died at the site of the accident, while nine percent of the accidents were not detected immediately. Two of these cases were accidents in which the riders and the motorcycle were not visible to other road users after the crash, and the riders died at the site of the accident as a result of their injuries and the emergency services arriving too late. If these riders had had eCall systems installed in their motorcycles, this could very probably have saved their lives. In 19 cases, the onboard power supply was no longer functional and had been destroyed in the accident. This is why it is essential for eCall systems to have an internal backup power supply.

In summary, the eCall system for motorcycles can save lives and reduce the consequences of accidents. Generally speaking, motorcyclists are particularly vulnerable and subject to a high risk of accidents. As a result, an eCall system like the ones mentioned above could increase the speed of a call to the emergency services, ensuring that the chain of professional aid is set in motion immediately and thus enabling the victims of the accident to receive the care they require more quickly and precisely. This system could be particularly valuable in addressing single-vehicle accidents whereby both rider and motorcyclist disappear "without a trace", for example if they slide down behind an embankment or are concealed by bushes at the side of the road – especially as the rider will often no longer be able to contact the emergency services manually. Such systems, which are now legally required for new motorcycle types in the EU, are undoubtedly a positive development, and DEKRA Accident Research also recommends that they be retrofitted to older vehicles. Nevertheless, manufacturers still need to continue their work and research on these systems in order to reduce the chances of them being triggered incorrectly by misuse cases, and to push the boundaries of the systems.



In case of an accident, having a built-in eCall system in your vehicle can mean the difference between life and death.

The Facts at a Glance

- **A series of tests conducted by DEKRA found that bicycles with disc brakes at the front and rear offered better braking modulation than other brake systems on both wet and dry surfaces.**
- **On wet surfaces, the braking distance for bicycles was up to 20 percent longer.**
- **In impact tests conducted by DEKRA, traditional bicycle helmets demonstrated a high level of protection.**
- **The fit of a bicycle helmet plays a key role in determining the risk of severe head injuries in case of an accident.**
- **As in other vehicles, children should never be transported in a cargo bicycle without a seatbelt.**
- **A stability system can help to prevent two thirds of all cornering accidents caused by the motorcyclist themselves.**
- **The eCall system for motorcycles and bicycles can save lives and reduce the consequences of accidents.**

Safe Roads are the Key to Ensuring Fewer Accidents for Two-Wheeled Vehicles

Experience has shown us time and time again that infrastructure plays a major role in accidents. While it is true that the overwhelming majority of accidents can be traced back to human error, in many cases defects in the infrastructure have a negative impact on the root of the accident, the resulting accident risk, and the severity of the accident when it occurs.

Alongside active and passive safety systems, adherence to traffic regulations, and correct conduct and alertness among road users, infrastructure also plays a key role in road safety. There are a whole range of measures that offer potential for improvement in this area – such as making danger areas safer, maintenance of road equipment and ensuring that road surfaces are safe for traffic, speed monitoring at accident hot spots, installing suitable traffic barriers, extending bicycle paths, and much more. Generally speaking, however, sustainable infrastructure and traffic route planning is only possible with a long-term approach.

This can be seen very clearly when it comes to bicycle traffic. In general terms, the funding and support afforded to bicycle traffic in many European cities and municipalities is a positive approach that enables us to gain better control over the problems that arise in conjunction with increased

CYCLISTS ARE KILLED MOST FREQUENTLY IN BUILT-UP AREAS.

volumes of traffic, such as traffic jams and pollution – that much is indisputable. However, since there is often no overall concept in place for the expansion of a safe bicycle path infrastructure, it is not uncommon for such measures to result in the opposite of the desired effect in terms of both making cycling more attractive and, ultimately, improving road safety. The speed at which the mobility landscape can shift is another factor that makes this process more difficult. Whether the boom is in wide cargo bicycles, fast pedelecs, or one of the many different types of personal light electric vehicle, long-term construction plans often lose their effectiveness before the concept, planning, and approval procedure can even be completed.

OPTIMIZING BICYCLE PATHS IN URBAN AREAS

Especially in town and city centers – data published by the EU Commission indicates that, for years now, an average of almost 60 percent of all cyclists who have lost their lives on the road have been killed in built-up areas in the EU – bicycle path maintenance and the road-safe expansion of the bicycle path network are undoubtedly key to reducing the risk of accidents for cyclists. While more bicycle paths are in fact being built, not all traffic lanes provide their users with the level of protection required. Especially in built-up areas, where there is rarely space for a separate bicycle path between buildings, cyclists often have to share road space with busy traffic, separated from it – if at all – only by a line painted on the road surface, which they cannot even see easily if it is old and worn. As on roads with no bicycle lane, this puts riders of two-wheeled vehicles at great risk of being caught by motor vehicles especially trucks – or even being forced off the road or run over if the motor vehicle is turning right. On roads where cyclists have their own bicycle path, the main problems are ensuring sufficient separation of this path from the sidewalk, and poor markings around exits. It is also common for bicycle paths to come to an end suddenly without any prior warning.

Emmanuel Barbe
Interministerial Delegate for Road Safety

Micro-Mobility: A Question of Navigational Lines and Mutual Respect

According to current estimates by the Observatoire national interministériel de la sécurité routière (French Road Safety Observatory), 3,239 people were killed on French roads in 2019. This is nine fewer people than in 2018 (–0.3 percent). This means that the number of deaths on the road has reached an all-time low – an achievement that follows on from the fact that fewer deaths were recorded in 2018 than in the four previous years. Between 2014 and 2017, the number of people killed on the roads initially increased or stagnated. At the same time, traffic volume increased (+7 percent between 2013 and 2018). As such, we are now looking at a milestone: the best result in the history of road safety statistics. With 50 deaths per million inhabitants (still), France is thus about average among European countries.

However, if we take a look at riders of motorized and non-motorized two-wheeled vehicles and micro-mobility devotees, the overall picture loses much of its sheen. This applies in particular to the figures for cyclists, where a 25 percent increase in deaths has been recorded since 2010 (+9 road deaths in 2019). 472 pedestrians lost their lives on the road in 2019 (one more than in 2018). Today, everything is centered on the invasion of micro-vehicles – e-scooters, Segways, and hoverboards – that has been taking place since 2019. Up until 2018, French accident statistics still recorded all these vehicles as equivalent to pedestrians. Since the end of 2019, law enforcement agencies have listed them as a separate vehicle category for the purposes of this statistic, and on October 25, 2019, they were incorporated as such by decree into the French Road Traffic Act and Article 51 of the Loi d'orientation des mobilités (Mobility Orientation Act) of December 24, 2019.

In both their motorized and non-motorized forms, these alternatives to cars and public transport are revolutionizing mobility in urban and peri-urban areas. Micro-mobility in France has developed at an astonishing rate since 2017 (+43 percent increase in sales between 2017 and 2018). Its presence on the roads in cities, which is permitted by law in France, will doubtlessly be reflected in the accident statistics. Nonetheless, it should be taken into account that this means increased safety for pedestrians, especially senior citizens. In 2019, eleven people lost their lives while using this type of vehicle in either motorized or non-motorized form, and one pedestrian was killed in an accident involving a motorized micro-vehicle. In light of this, it is vital that we introduce training measures for the use of this new form of transport, especially for novices, in order to foster an atmosphere of mutual respect on the roads of France.

The second new development in 2020 concerns the new motorcycle license, which was voted into effect in the Interministerial Committee for Road Safety (Comité interministériel de la sécurité routière) session on January 9, 2018 (the last reform took place in 2013). Motorcyclists make up almost 1.6 percent of motorized traffic, yet account for 19 percent of all fatal accidents. The risk for this particularly vulnerable group of road users is 22 times higher than for car drivers. In light of this, a new element that better reflects the reality of road use has been incorporated into the new motorcycle license test. The aim of this element is to teach beginner motorcyclists an effective and safe navigational line to follow on the road: the "trajectoire de sécurité" already used by the police and Gendarmerie. Following this optimum navigational line can save lives, as it enables motorcyclists to adopt an anticipatory riding style and avoid frontal collisions with oncoming vehicles. This riding technique has already proven effective in its use by the law enforcement agencies, and as of March 2020 is now taught as part of motorcycle training courses.

The aim of all these reforms can be summed up by the new motto for road use: "Vivre, ensemble" – Live, together. Our roads are our largest shared network. In this arena, treating each other with respect is the difference between life and death.

IT IS OFTEN DIFFICULT OR IMPOSSIBLE FOR TRUCK DRIVERS TO SPOT CYCLISTS WHEN TURNING RIGHT.

When bicycle paths are in poor condition, cyclists will usually ride on the road instead, in spite of the higher risk involved. This applies especially to those who cycle fast. For example, cyclists in Germany are legally required to use a bicycle path if it is marked as such. However, the bicycle path in question also needs to run alongside the road, and be in reasonable and usable condition. Among other things, the constructional requirements for an acceptable bicycle path include sufficient width, clear and consistent markings, and safe routing at junctions. It is a general matter of urgency for our cities, towns, and communities to focus even more strongly on the principle of "seeing and being seen" when planning, building, and maintaining bicycle paths. At the same time, however, we must appeal to cyclists to use bicycle paths wherever they are available. It is becoming increasingly common for "faster" cyclists who are very confident in their abilities to prefer riding with the faster traffic on the road even on routes where there are well-developed bicycle paths in place – and to weave dangerously in and out of traffic when there are hold-ups. Those who do this are either unaware of or deliberately ignore the increased risk of accidents involved with such activity – until they eventually "draw the short straw" or their behavior clashes with what other road users expect of them, thus increasing the potential for aggression.

BICYCLE BOULEVARDS AND OTHER REGULATIONS IN GERMANY

In accordance with the German Road Traffic Act (StVO), the building of "bicycle boulevards" – roads on which bicycles have right of way – has been permitted in Germany since October 1, 1997. Vehicles other than cyclists are only permitted to use these roads if this is indicated by an additional sign. A speed limit of 30 km/h applies to all vehicles on these roads – including cyclists. In some cases, motorists are required to reduce their speed even further. Cyclists are permitted to ride side by side.

However, one problem with such roads is that car drivers often show a general lack of acceptance for cyclists on them. In addition to this, drivers often fail to observe the speed limit on bicycle boulevards because there are no signs explicitly stating it. It is also common for cyclists to be permitted to ride both ways on one-way streets in town and city centers. However, this can represent a potential accident risk for motorists and cyclists alike, as many drivers

More and more traffic zones in Germany are being explicitly marked as bicycle boulevards.

are not familiar with the associated signs, or simply do not notice the small additional sign that indicates this rule. Likewise, pedestrians crossing such streets may not always be on the lookout for quiet vehicles coming from the "wrong" direction. Recurring markings on the surface of the road itself can help with this problem. Additional conflicts are especially inevitable in situations where road users do not observe the requirement to drive on the right – even on one-way streets – and reduce their speed. Nevertheless, the option of making suitable one-way streets available for bicycle traffic to use in both directions should be welcomed, as it plays a significant role in making cycling more attractive. The more one-way streets that are opened up to cyclists in this way, the more normal – and thus safer – this situation will become.

In Germany, the amendment to the Road Traffic Act that came into effect in April 2020 passed a number of new regulations, including some specifically designed to promote bicycle use. For example, motor vehicles overtaking bicycles are now required to maintain a minimum distance of 1.5 meters in built-up areas and two meters in non-built-up areas. A general no stopping restriction also now applies to designated bicycle lanes. Under the amendment, authorities are now also permitted to introduce separate bicycle zones and green arrow signs that apply exclusively to cyclists. Furthermore, two cyclists are now permitted to ride alongside one another providing they do not obstruct other road users by doing so, and cyclists aged 16 and over are permitted to carry passengers providing their bicycles are designed to do so and equipped accordingly. A new road sign that bans the overtaking of two-wheeled vehicles has also been introduced; this is designed especially for use on narrow stretches of road. In addition to this, motor vehicles weighing 3.5 metric tons or more must now reduce their speed to walking speed when turning right.

Speaking of turning right: The high potential for conflict between trucks and cyclists here is due in part to the fact that both types of road user are often traveling at very similar speeds in this situation. This means that if a cyclist is in an area next to the truck where the driver cannot see them easily – or at all – they will remain in this area for an extended period of time. This is one of the main reasons why it can be difficult or impossible for truck drivers to spot cyclists when turning right. We have already discussed this in the section of this report on accident statistics. The requirement for trucks to maintain walking speed when turning right may very well reduce the number of such conflicts that occur. However, DEKRA believes that there is a risk that this measure will put pedestrians at risk instead, as they are more likely to end up in the critical area of this type of vehicle if it is traveling at walking speed.

JOINT POSITION PAPER ON TRUCK TURNING ACCIDENTS

The General German Bicycle Club (ADFC) and the German Federal Association of Road Haulage,

Claes Tingvall

Professor at the Chalmers University of Technology and Senior Consultant at ÅF Consult

Global Road Safety is Part of the 2030 UN Agenda for Sustainability

As a society, we are no doubt facing times of massive change. Climate change, digitalization, and shared economy are just a few of global issues that need our attention, reflection, and action. And they all have a major impact on our mobility.

Using two-wheelers instead of four-wheeled vehicles no doubt has a number of exciting benefits. When transporting one person, they offer increased effectiveness when it comes to use of space, may consume less energy, and cost less to run. They also pollute less and make less or no noise. Compared to walking, you can move faster and travel longer distances. These are all attributes and characteristics that are positive in a society striving for sustainability in a broad sense.

However, they are also less safe for the user. Our infrastructure has mainly been developed for cars, trucks, and buses, not bicycles and motorized two-wheelers – and certainly not for micro-mobility vehicles and users. Before we demonize both traditional two-wheelers and the new forms, we should look at a number of possibilities to enhance their safety and retain all their positive qualities at the same time. This is what is proposed in the Academic Expert Group recommendations. These recommendations were prepared for the upcoming Third Ministerial Conference on Road Safety in Stockholm 2020 and the years ahead. For the first time, global road safety is part of the 2030 UN Agenda for sustainability.

For two-wheelers, both improved infrastructure and better design have been suggested, as well as 30 km/h as maximum speed in urban areas alongside a "zero speeding" policy. Producers of motorized two-wheelers have also been encouraged to improve and report on their results in sustainability reporting procedures. In addition, they have been called upon to use technology to better manage the use of vehicles, such as geofencing for maximum speed. The micro-mobility providers have already been introducing technology to limit the maximum speed of their vehicles at some locations, and they are showing the way to make use of simple and clever techniques to improve safety and security.

Ceri Woolsgrove
Road Safety Policy Officer,
European Cyclists' Federation (ECF)

Towards Vision Zero: Prioritize Cycling for Safer Roads

ECF supports the Safe System approach to road safety. The goal of safe systems is to ensure that human error does not lead to a road accident; or, if a crash does occur, that it is sufficiently controlled to lessen the outcome of a death or life-changing injuries. It is based on the assumption that human life and health are paramount over all else and should be the first consideration when designing a road network. It is also referred to as Vision Zero, which focuses on zero fatalities as a realistic target.

This approach calls for promoting and improving sustainable modes of transport, which also happen to be the safest. The reduction of motor vehicle use, the re-purposing of roads and urban spaces for a range of community purposes, and the increased use of sustainable modes of transport are recognized as tools to make roads safer. Cyclists, pedestrians, and public transport users rarely cause the death of or serious injuries to other road users, and taking energy and mass out of the transport system can be a key safety tool to reduce danger on the streets.

Road safety is just one of the benefits of active modes of mobility. Switching to cycling can also improve air quality, ease congestion, promote livable cities, and enable sustainable, democratic access to city amenities and services. Active commuting by bicycle is associated with a substantial decrease in the risk of death, including cancer and cardiovascular disease, compared with non-active commuting. Active transport use significantly improves self-esteem, mood, sleep quality, and energy, as well as reducing the risk of stress, depression, dementia, and Alzheimer's disease. Therefore, we also see the opportunity to go beyond Vision Zero to incorporate a general public health approach to safety.

Improving cycling conditions and prioritizing active modes should then be a key component of the Vision Zero/Safe Systems approach. A significant barrier to increasing cycling is the perception of risks, so it is important that beyond being safe, cycling also looks and feels safe and comfortable. Improving cycling and walking safety acts as a multiplier when improving public health: not only do we reduce fatalities and injuries of cyclists themselves, we also reduce 3rd party fatalities and injuries to other road users, and we promote healthier active lifestyles. Specifically bringing the health benefits into the Safe Systems paradigm means we can assess safety interventions from a full public health perspective.

We believe that creating safe environments for cycling should also be considered a public health investment and effective action against climate change.

We call for more funding of cycling infrastructure, better motor vehicle speed management including 30 kph as default in urban areas, safer vehicles with Intelligent Speed Assistance, and better urban planning that prioritizes walking, cycling, and public transport in urban areas. We should stop blaming the victims of crashes, cyclists, and pedestrians, by mandating legislation forcing them to wear helmets or hi-visibility jackets and creating barriers to their uptake. Rather, we need to encourage cycling and walking by making them safer. We need to address both actual risks and the perception of risk of active mobility.

Logistics and Disposal (BGL) also believe that a bicycle path infrastructure that is optimized for safety is an important road safety measure in terms of reducing the number of accidents that occur between trucks that are turning right and cyclists. In a joint position paper presented in February 2020, the ADFC and the BGL set out a number of requirements for tackling this issue. For example, the paper stated that truck, bicycle, and pedestrian traffic at junctions needed to be kept physically separate, and that "good visibility conditions" needed to be established in such areas. The paper suggested that safety elements such as installing paved barrier islands and moving stop lines much further forward could help to make junctions less dangerous. In addition to this, it was proposed that the green light for cyclists riding straight on should not be active at the same time as that for motor vehicles turning right. One potential solution here could be to implement separate traffic light phases for the different streams of traffic. The paper stated that shorter green-light phases for motor vehicles were an acceptable price to pay in order to improve road safety and ensure equality for all types of road user.

Likewise, the ADFC and the BGL called upon municipal authorities to ensure that access routes for construction vehicles generate as little conflict as possible when planning large, inner-city building projects. The paper proposed that the main axes of bicycle traffic and construction site traffic be kept separate wherever possible. In addition to this, the two interest groups also lamented the lack of research that assesses different types of junctions and

SEPARATING FAST MOTOR VEHICLES FROM UNPROTECTED ROAD USERS IS A TRIED-AND-TESTED SAFETY CONCEPT.

signaling systems, stating that this oversight must be rectified. Such research could then be used to develop new design standards for safe roads and junctions, and quickly enshrine these standards in the technical regulations. The paper also called for a systematic analysis of severe accidents from an infrastructure improvement perspective.

USING THE NETHERLANDS AS A ROLE MODEL

Neglect of existing bicycle path infrastructure has been a problem in many countries around the world for years. Having created this infrastructure to keep cyclists safe or prevent hold-ups in the flow of motor vehicles, the responsible authorities have subsequently often failed to prioritize the maintenance required in order to keep it in good working order. Cleaning and winter road maintenance have not been carried out, the needs of cyclists have not been taken into account when implementing new construction measures, and those who have misused bicycle paths to park their cars have escaped with either a meager punishment or no consequences at all.

As bicycle and pedelec use has increased dramatically in recent years for a variety of reasons and calls for good bicycle path infrastructure have grown louder, politicians have also started to respond to this issue. However, many of the politicians in charge of such matters seem to prefer

A Best-Practice Example of Changes in Road Design

In road safety work, as in many other fields, it is important to learn from cases that result in damage or loss, recognize key areas of risk, and implement improvements. Interdisciplinary accident committees, such as those that are widespread and have proven effective in Germany, play a role in this, as do the departments and authorities in charge of road building, who have the scope required to take such action – not to mention the political will to take a serious approach to road safety work and implement it accordingly.

If you look at sections of road where a severe accident or a spate of accidents has occurred some time after, you can often see that changes have since been made to their design. One example of such action took place after the accident between a pedelec rider and a truck that was turning right described on *page 33*. Road signs and bollards have been installed and a white line has been marked on the sidewalk and the bicycle path to show cyclists the safe route across the junction. This solution will permanently suppress the use of the dangerous shortcut that bypasses the crossing aid, which was facilitated by the infrastructure design at the time of the accident.

This unconventional, fast, and low-cost solution will increase safety levels for both cyclists and pedestrians until the area around the junction can be given a safer redesign overall the next time scheduled construction work takes place.

Before the road was redesigned, it was very difficult to assess the traffic situation clearly at this point on the road, especially for cyclists.

Thanks to clear bicycle path guidance measures, it is now much harder for cyclists to ride straight on dangerously without using the pedestrian crossing.

Copenhagen is one of many cities that already enjoy a very well-designed cycling infrastructure.

focusing on the distance covered by the infrastructure rather than its quality when attempting to put themselves on good footing for their next election campaign. Alternatively, perhaps they simply lack the courage to take space away from motor vehicles in order to improve the cycling infrastructure. This is the only possible explanation for the way that the bicycle paths marked out by the authorities continue to be too narrow, new markings on the road continue to confuse all road users instead of helping to improve road safety, and maintenance continues to be neglected.

Separating fast motor vehicles from unprotected road users is a concept that has been proven to be effective in improving the safety of all involved. One country that adopts this approach consistently is the Netherlands. There, the speed limit on all roads that are used by both cyclists and motorized traffic is 30 km/h. On routes with a speed limit of 50 or 70 km/h, separate bicycle paths or bicycle lanes are required. On routes with a speed limit of 100 or 120 km/h, cycling is prohibited. The bicycle path infrastructure in the Netherlands now covers a total distance of approx. 35,000 kilometers, plus around 55,000 kilometers of mixed-use roads. Bicycle paths are planned according to clear parameters, while there is also political support for cycling, and research is conducted on associated topics. This is a system that could be used as a role model. There are also other countries, regions, and cities with clear concepts for the design of safe bicycle path infrastructure. However, since these are often not enshrined in law and their implementation is not binding, they are often used only as a guide – if at all. When these concepts are finally implemented, they are thus often not observed, which leads to the problems mentioned above.

WE NEED CLEAR REQUIREMENTS FOR PLANNING BICYCLE PATHS.

CHANGES IN MOBILITY BEHAVIOR MEAN WE NEED MORE SPACE FOR BICYCLE TRAFFIC

If they want to create an effective and safe cycling infrastructure, many towns and cities have no choice but to repurpose at least part of their existing infrastructure for use by bicycles. However, this results in less space (and parking space) being available to individual motorized vehicles. As such, approaches like this are often a difficult sell politically in regions that have a high volume of traffic and ascribe great value to the concept of privately owned cars. However, in some municipalities, there can be big problems with even keeping the existing bicycle path infrastructure clear. Drivers of motor vehicles often use the marked areas for parking or waiting – behavior that is enabled by a lack of sufficiently tight monitoring.

Siegfried Neuberger (†)*
Long-Serving Managing Director of the ZIV
(an association for the bicycle industry in Germany)

Supporting the Paradigm Shift in Road Use

Bicycles and e-bikes are the perfect modes of transport for an effective and environmentally friendly paradigm shift in road use. As such, it is now more important than ever for politicians to ensure that road infrastructure is designed in a way that makes using Germany's roads safe and convenient for cyclists. In addition to this, the German Road Traffic Act (StVO) and Road Traffic Regulation (StVG) need to be reformed in a way that supports this paradigm shift and establishes Vision Zero as their guiding principle.

* Siegfried Neuberger passed away suddenly after submitting his statement for this report in June 2020.

When it comes to approaches for creating more space for bicycles and setting up areas that are clearly separated from car traffic, there are already plenty of examples from around the world that can be used as role models. In Copenhagen and Amsterdam, for example, safe bicycle lanes have been the standard for years, providing cyclists with wide paths covering huge distances, which are usually marked in a different color to the rest of the road. In addition to this, many of the bicycle paths in Copenhagen are separated from motorized traffic and the sidewalk by means of elevated curbs. The USA has also come relatively far in this regard, with special "protected bike lanes" in cities such as Chicago, New York, Portland, Seattle, and Washington D.C. that combine separate lanes with physical barriers such as bollards, concrete sleepers, flower boxes, and parking lanes.

PROTECTIVE EQUIPMENT FOR MOTORCYCLISTS

When it comes to improving road safety for motorcyclists, the topic of traffic barriers plays an important role in terms of road infrastructure. Studies conducted by various accident researchers indicate that around 80 percent of motorcyclists who lose their lives on the road in Germany do so due to obsta-

Many cities in the USA already have "protected bike lanes" to make cycling safer.

Traffic barriers with secondary rails reduce the risk of injury to motorcyclists in case of a crash.

cles encountered in non-built-up areas – and around half of this number are killed in accidents involving traffic barriers. The problem is that, by default, countless numbers of traffic barriers are built with their primary goal in mind: that the rail should be at the same height as the hood of a car. While this enables them to offer maximum protection for car drivers, the remaining space between the barrier and the ground represents a huge risk for motorcyclists. If a motorcyclist crashes, there is a danger that they could slide under the traffic barrier or hit one of its supporting posts. In such situations, severe or even fatal injuries are not unusual. However, traffic barriers can also be designed to offer optimum protection for motorcyclists who crash into them.

In many locations, a combination of a large top surface, such as that offered by a box shape, and a secondary rail under the main rail to prevent people from crashing into the posts has proven effective in both crash tests and real-life accidents. The secondary rails used in this design can also be retrofitted to many existing systems. For example, the "Euskirchen Plus" system further developed by DEKRA several years ago on behalf of the German Federal Highway Research Institute (BASt), offers motorcyclists involved in collisions a relatively high level of protection. This system was proven to provide an improved protective effect for motorcyclists both when riding upright and when sliding across the road on their side. Thankfully, a statistic published by the as-

Common Accident Situations From a Motorcyclist's Perspective

Accident situation	Road conditions potentially influencing the situation			
Cornering accidents	Lack of traction between wheel and road surface (cracks, repairs made using bitumen, change in surface, markings, objects, or liquids on the road, etc.)	Poor visibility of the course of the road (diffuse lighting, slopes, plants, etc.)	Inconsistent navigational lines (sequence of radii, jumps in radius within a single bend)	Unfavorable bank angles (low traction between wheel and road surface)
Cornering accident	Junction difficult to see and assess		Traffic with right of way difficult to see	
Joining/ crossing accident	Junction difficult to see and assess		Traffic with right of way difficult to see	
Parallel traffic accidents at corners and bends	Poor visibility of the course of the road (diffuse lighting, slopes, plants, etc.)			
Other accidents	Collision with an obstacle on the road (branch, lost cargo, etc.)			

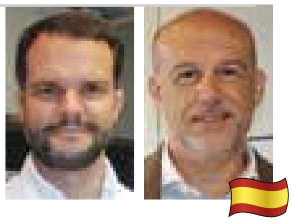
Source: Forschungsgesellschaft für Straßen- und Verkehrswesen e.V. (Road and Transportation Research Association), Cologne sociation MEHRSi (MEHR Sicherheit für Biker – More Safety for Bikers) shows that road-building authorities are fitting more and more corners and bends in Germany with secondary rail systems: Around 900 bends and corners in eleven of Germany's sixteen federal states now use secondary rails, covering a total distance of almost 113 kilometers. By way of comparison, in 2010 these systems were employed on just under 500 corners and bends, covering approximately 63 kilometers.

PLASTIC CURVE MARKER SIGNS

Alongside adding secondary rail systems to protective equipment, replacing the rigid direction signs mounted on steel tubing that are often found at corners with flexible systems is also an important measure for reducing the consequences of injuries following a crash. To this end, the Ministry of Transport for the German state of Baden-Württemberg has joined forces with a local road equipment company to develop a plastic curve marker sign. The system, which was first presented in 2014, comprises a sign with an area of 50 square centimeters that is placed on a plastic mount that has the same shape as the old direction post and attached to it using screws.

The added value this innovation provides in terms of road safety was demonstrated in impressive form in a crash test conducted by DEKRA in 2017. In the crash test, a motorcycle traveling at 60 km/h was crashed into the old standard curve marker sign model, "metal plate on a steel post," then a second motorcycle traveling at the same speed was crashed into the new, plastic curve marker system. The load values measured

Plastic curve marker systems reduce the consequences of potential accidents.



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Challenges Posed by Two-Wheeled Vehicles

The two-wheeled vehicle and e-scooter sector is facing two major challenges: changes in the mobility model in the most highly developed, industrialized countries, and an increase in the risks for users of two-wheeled vehicles in emerging and developing countries. In the industrialized countries, the concept of sustainable mobility has been defined as a de facto traffic solution that can be used to help reduce congestion, pollutant emissions, and the number of accident victims.

Within the context of this concept, many cities in areas with high pollution levels have set up traffic restrictions, or established restrictions for environmentally unfriendly vehicles in parts of the city by introducing pedestrianized zones, tolls, and fines. At the same time, private companies are exploiting the niche in the market that has opened up as a result of the new policy on urban mobility in order to offer a range of e-mobility services. This new urban mobility concept brings with it a number or challenges:

- Different modes of transport sharing the road: Without an appropriate regulation, the new light vehicles will compete for space with cars, motorcycles, mopeds, and bicycles on the road, and with pedestrians on the sidewalk, making the latter road users at high risk.
- Low-noise vehicles: Personal light electric vehicles are low-noise. This is an advantage in socio-ecological terms but a risk in terms of road safety, as it means that pedestrians may not always realize when a vehicle is approaching until it is too late.
- Parking on sidewalks: Most private e-scooter rental companies do not provide special parking areas. As a result, users of these services leave the vehicles all over the sidewalk once their journeys are over. This is a disadvantage for pedestrians, especially those at the most risk, such as people with restricted movement or visual impairments.
- "Invisible" strain on the environment: E-mobility is often praised as being emissions-free. However, this overlooks the fact that both the manufacturing process for personal light electric vehicles and the fleet of vehicles used to transport them around the city generate significant emissions.

This problem is, to a large extent, caused by the fact that new forms of mobility have appeared without being accompanied by appropriate rules to regulate their impact. The bodies in charge of traffic management at the national and municipal levels are currently in the process of drawing up suitable regulations to improve interaction between the various types of road user.

In addition to this, emerging and developing countries are currently faced with a challenge in that the risk level for motorcyclists and moped riders is increasing significantly due to the fact that these vehicles are readily accessible and open up job opportunities, such as motorcycle taxi and delivery services. There are also a number of other significant difficulties in these countries, such as the minimal awareness of this group of unprotected road users among other vehicle users, the fact that many of the two-wheeled vehicles on the roads are very old, the lack of a proper procedure for acquiring a driver's license, low helmet usage, and the lack of an obligatory test of suitability for the road. All of these factors contribute to the alarming rate of fatal accidents among unprotected road users, which is more than 50 percent in many of these countries. Two-wheeled electric vehicles are often touted as the "future of mobility," but their use needs to be regulated appropriately in order to prevent negative consequences.

upon impact with the steel post far exceeded the biomechanical limits, while those recorded upon impact with the curve marker system were well below the limits. A motorcyclist would thus not have survived the crash into the steel post. However, a motorcyclist wearing appropriate protective clothing would have survived the crash into the new curve marker sign with only minor injuries.

Plastic curve marker signs also offer the additional benefit of being very easy for road users to notice. Accident analyses conducted on Federal Highway B500 in the Black Forest area of Germany using the state's own road safety screening system show that, in addition to lessening the consequences of accidents, their high visibility means that curve marker signs can also have a preventive effect that stops certain motorcycle accidents from occurring at all. Between 2012 and 2014 – a three-year period – there were eleven accidents in the Hornisgrinde area of Federal Highway B500, resulting in two deaths. Between 2015 and 2019 – the five years following the installation of curve marker signs in highly critical areas – there were only seven further accidents, and zero deaths. However, it should be noted that additional measures such as the installation of a second rail system, speed limits, and police speed checks were also implemented within this period.

Finally, no discussion of road planning measures would be complete without mentioning regular maintenance of the road surface. A road surface that has as good grip and is as even as possible plays a key role in the safety of motorcyclists. Insufficient friction coefficients lead to longer braking distances and increase the risk of a motorcyclist losing control when cornering or during evasive maneuvers, which in turn increases the risk of skidding. Grit on corners is also very dangerous for motorcyclists – especially in the first month after winter, or when tractors, cars, and trucks "collect" the grit by the side of the road and carry it onto the road itself. There is always a risk of this occurring and motorcyclists encountering this, even in areas that use modern road sweepers. In addition to this, unevenness can increase the probability of water collecting, which leads to a higher risk of aquaplaning and black ice. This must be taken into account during repairs. In particular, the bitumen mass that is still often used to mend pot holes and cracks in many countries can quickly become dangerous for motorcyclists, as it causes the road surface to become extremely slippery when wet. As such, repairs should always be carried out using materials with a similar friction coefficient to the rest of the road surface, otherwise the exit ramp could end up resembling an ice-skating rink.

WHERE POSSIBLE, THE USE OF CAST BITUMEN MASS SHOULD BE AVOIDED WHEN CARRYING OUT ROAD REPAIRS.

Maciej Wroński
President of the Polish Association of Transport and Logistics Employers

Regulations for E-Scooters Require a Comprehensive Approach

The majority of national regulations for e-scooters are limited to traffic regulations for these vehicles. Generally speaking, however, this problem should be tackled in more depth, for example by regulating the rental of these devices. In particular, this would enable us to define the technical standards to which the rental companies would have to adhere, while also guaranteeing that those who could potentially suffer damage or injury in conjunction with the use of an e-scooter are protected by civil law.

The electric scooters must be provided and the fees for their use collected by companies based in the country of use. This will make it easier for consumers and parties who may suffer damage or injury to file any claims arising from the use of these devices. At the same time, it would facilitate effective oversight over these business activities. Taxes are also an important factor – these should be paid in the country whose public road infrastructure the vehicles in question are using.

The activity should be regulated in this regard, and the requirements for obtaining corresponding approval should be as follows:

- Guarantee that the rented vehicles meet appropriate technical requirements
- Possession of a liability insurance policy that facilitates payment of appropriate damages to the persons suffering injury or damage due to the use of the e-scooters
- Keeping a record of users so that users who cause accidents before fleeing the scene can be identified
- Agreeing conditions for the use of the public infrastructure with the local authorities
- Guarantee that the e-scooters will be recycled at the end of their service life

Fulfillment of the technical requirements, particularly with regard to speed limits, the effectiveness of the braking system, and the required lighting, should also be a prerequisite for the approval of these vehicles for commercial use on the road. It would be best if these standards could be enshrined in EU law in order to ensure that the same fundamental rules apply throughout the single market. In addition to this, it is worth considering liability insurance for the private owners/owners of e-scooters.

Traffic regulations are the key: These also need to take into account a guarantee of safety for pedestrians – especially children, senior citizens, and the visually impaired. The most effective solution would be to keep private transport traffic completely separate from the least protected road users. In view of the often life-threatening head injuries that can occur, it is also worth weighing up whether wearing a helmet should be made a legal requirement.

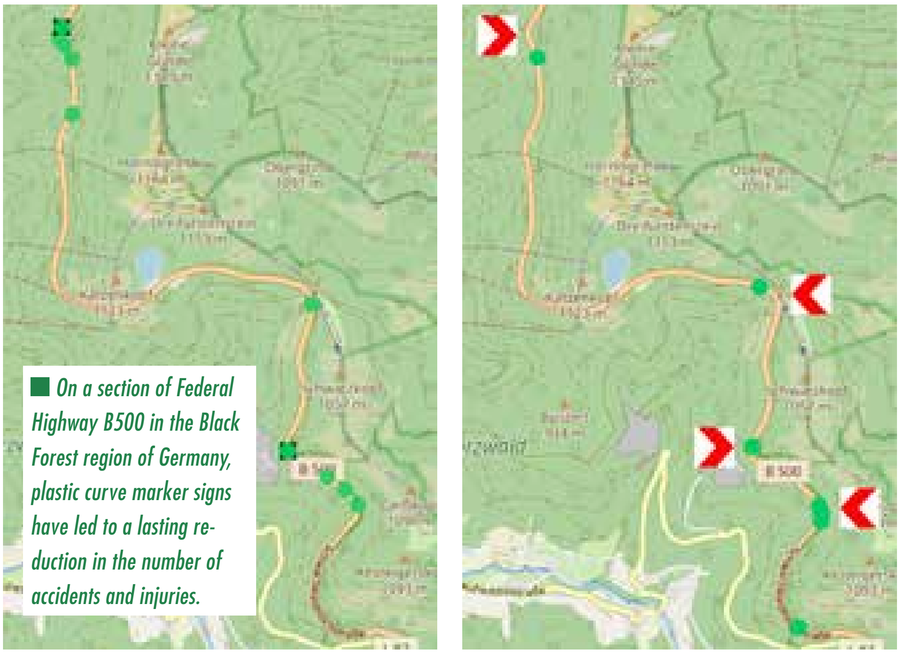
To Vision Zero with the Transparent Road

In order to reduce the number of deaths on the road in Baden-Württemberg, the Ministry of Transport for the German state has developed a road safety screening system that is probably the only one of its kind so far in Europe. The system detects stretches of road throughout the region that attract an unusually high number of accidents so that efficient optimization measures can be introduced to combat the problem. The screening program, which won 1st place in the "Best infrastructure project" category at the E-Government competition in Berlin in 2018, also acts as the perfect tool for Baden-Württemberg's 150 accident commissions when it comes to preparation and follow-up work for the essential site visit.

To this end, a platform designed in partnership with engineering consultancy firm DTV-Verkehrsconsult is used to assess all the information relevant to the road safety work according to a standardized method, and present the results on topical maps. This information includes accident data, traffic volumes, and vehicle speeds based on the regular traffic monitoring that is now carried out at around 5,000 counting stations throughout the state, road geometry, road condition, and photos of the section of road in question. All the information for each short (usually 100-meter) stretch of road is compiled in profiles arranged by topic, and each section of road is marked green, yellow, or red to indicate the accident frequency.

The profiles form the general basis for analyzing the causes of the accident and corrective measures, and each one contains up to 700 separate items of information. In order to make the road safety work easier in terms of content, network assessments and special investigations that tackle the individual types of accident or vehicle separately are also carried out. For example, these studies may investigate cases where a vehicle runs off the road and crashes into an obstacle, truck accidents, motorcycle accidents, or accidents in parallel traffic. In addition to this, an online prioritization tool has also been developed; this allows users to weight accident parameters individually and then arranges them in order accordingly, identifying and marking out the most critical points for the issue at hand in the space of just a few minutes. Among other things, this ranking enables the Ministry to invest its allotted road infrastructure improvement budget in the locations where the need is greatest, resulting in a long-term improvement in road safety.

There are plans for development of the screening program to continue systematically, eventually including – among other things – accident data not just for the party that causes an accident, but for everyone involved in it. Such analysis is particularly important for motorcycle accidents, as these often result in severe injuries for persons who did not cause the accident themselves. The same problem applies to accidents that occur between trucks and bicycles.



On a section of Federal Highway B500 in the Black Forest region of Germany, plastic curve marker signs have led to a lasting reduction in the number of accidents and injuries.

The Facts at a Glance

- **Frequent defects in the road infrastructure increase the risk of accidents and make the consequences of them worse.**
- **Extending the bicycle path network in a way that provides safety on the road and ensuring that bicycle paths are properly maintained are indisputably important factors in reducing the risk of accidents for cyclists, especially in urban areas.**
- **A bicycle path infrastructure that is optimized for safety can also help to reduce the number of accidents that occur between trucks turning right and cyclists.**
- **Traffic barriers should also be designed to also offer optimum protection for motorcyclists who crash into them.**
- **Replacing rigid direction signs on bends with flexible systems is an important measure in reducing the consequences of injuries for motorcyclists following a crash.**

Staying Safe on Two Wheels

In order to improve road safety for users of motorized and non-motorized two-wheeled vehicles in the long term, there are a whole series of issues that need to be tackled. In addition to a wide range of measures in areas such as technology and infrastructure, the main onus in this regard is also on the road users themselves. It is their duty to adapt their behavior to improve their risk awareness and observe regulations and safety standards in order to help further reduce the number of accidents involving users of motorcycles, mopeds, bicycles, pedelecs, and e-scooters.

The previous sections of this Road Safety Report have clearly shown that the number or users of two-wheeled vehicles that are injured and killed on roads around the world can be reduced using a whole series of measures. We have already come a long way. Nevertheless, we still need to make every effort to prevent accidents before they even happen. After all, even if a car – by way of example as the most common second party in these accidents – is traveling relatively slowly, it can still cause severe injuries in case of a collision.

Riders of two-wheeled motor vehicles in particular are at the greatest risk of suffering an accident on the road when evaluating the statistics by mileage. This applies not only in non-built-up areas, where most motorcyclist deaths occur, but also on inner-city roads. This is confirmed by research such as the study "Road Safety in European Cities – Performance Indicators and Governance Solutions" published by the International Transport Forum in 2019. According to this study, when evaluating the statistics per million kilometers traveled, there are almost four times as many deaths among riders of two-wheeled motor vehicles as among cyclists. When compared to drivers of cars, the death rate is even worse – 23 times as bad. As such, prevention needs to be our top priority.

Generally speaking, it is true of all two-wheeled vehicles that, while the most expensive option is not always the best, being too cheap often leads to high risks. In DEKRA's e-scooter tests, models both with and without type approval in accordance with the German Road Traffic Permit Act (StVZO) were used. There were significant differences in terms of stability and manufacturing quality. For example, while the model approved for use on German roads withstood multiple curb crash tests with only minor damage, the steering column of the non-approved scooter broke during the very first identical crash. DEKRA's many years of experience with pedelecs have often also uncovered significant quality differences in this regard. These differences can manifest in the stability of the frame and the forks, as well as the quality of the brakes and the lighting equipment. There can also be significant differences in terms of motor control. Particularly on pedelecs with a front motor, the combination of forks with little torsional rigidity and poor motor control can severely impair the handling of the vehicle on corners – and thus the safety of the rider. In such situations, severe crashes are inevitable.

As this report has once again illustrated very clearly, detailed and standardized statistics of the kind consistently called for by DEKRA provide a starting point and an important foundation for any measures designed to tackle these issues. International statistics such as CARE's EU database and the annual reports published by IRTAD (the International Road Traffic and Accident Database) provide much more precise data than was available a few years ago, as do the national statistics. However, many accident statistics still fail to distinguish clearly between different types of two-wheeled motor vehicle: motorcycles, scooters, mopeds, and small mopeds. Specifically, a harmonized European accident database would be important because politicians can only establish the appropriate basic conditions for improved road safety if they have detailed and precise accident data on which to base their plans.

There are a whole series of measures that can be introduced in order to reduce the number of accidents involving unprotected road users, ranging from ensuring that vehicles are in good technical condition – particularly in terms of their brakes and lighting – to properly fitting helmets, active safety systems such as ABS and ESP, and the automatic emergency call system, eCall. In addition to this, the number of accidents where technical defects can also play a role should not be underestimated – which makes it all the more important to carry out safety checks as part of periodic technical inspections, especially for motorcycles. There is also significant room for improvement when it comes to making danger zones safer, proper maintenance of road equipment, speed monitoring at accident hot spots, installing suitable traffic barriers, and extending bicycle paths, to name just a few measures.

Finally, however – as has been stated in previous DEKRA Road Safety Reports – there is one clear requirement we should never forget: If we want to prevent as many dangerous situations as possible on the roads before they even occur, it remains absolutely essential for all road users to behave responsibly, be realistic when judging their own abilities, and demonstrate a high level of acceptance for the rules and regulations.

DEKRA's Demands

- **Users of motorized and non-motorized two-wheeled vehicles should always wear a suitable helmet – regardless of whether or not they are required to do so by law.**
- **All users of two-wheeled vehicles should be aware of how important active and passive lighting equipment is to their safety.**
- **In order to ensure more harmonious interaction, all road users should be taught the rules that apply with regard to cyclists.**
- **Elementary school children should be given bicycle training in order to teach them basic traffic regulations at as early an age as possible.**
- **When monitoring compliance with traffic regulations, specialist police bicycle squads should also focus on ensuring that bikes comply with legal requirements and do not display any irregularities.**
- **Periodic inspections should also be a standard procedure for motorcycles – and not just in Europe.**
- **Motorcycle ABS should be used more widely – if necessary, it should be made a legal requirement for smaller motorcycles.**
- **It should be made even harder to tamper with the software in pedelecs – and those who do so should be punished consistently.**
- **Newly purchased pedelecs should be equipped with a "learner" mode. This would allow users to voluntarily throttle their vehicle (or have it throttled) so that they can get used to it gradually.**
- **Speed pedelecs should be equipped with ABS as standard.**
- **Bicycles and e-scooters in rental systems should be subjected to regular and independent inspections to ensure their technical safety.**
- **Companies that rent out bicycles and e-scooters should find ways to enable users to wear suitable helmets.**
- **Companies that rent out e-scooters should provide training measures that will enable their users to handle the vehicles safely – in the form of a tutorial, for example.**
- **Before using their vehicle on the road for the first time, e-scooter users should practice how to handle the vehicle safely under controlled conditions.**
- **Strict alcohol limits should also apply to the use of e-scooters, and adherence to these limits should also be monitored.**
- **Infrastructure should be expanded and maintained for all road users. In particular, maintenance of bicycle paths is a key actor in ensuring the safety of cyclists.**
- **Cycling infrastructure should also be usable in winter weather conditions. This will require suitable gritting and clearing concepts.**
- **Research into important issues relating to two-wheeled vehicles should be increased. New road safety ideas should be evaluated thoroughly and, if they pass muster, approved quickly.**
- **A legal framework based on corresponding studies should also be established as quickly as possible for new mobility concepts in order to prevent a dangerous "Wild West" scenario whereby the market is flooded with unregulated designs.**

Any Questions?

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Bibliography/Statistics

Adminaite-Fodor, D., Jost, G. (2019). Safer Roads, Safer Cities: How to improve Urban Road Safety in the EU. European Transport Safety Council ETSC – PIN Flash Report 37. Brussels.

Adminaite-Fodor, D., Jost, G. (2020). How safe is Walking and Cycling in Europe? European Transport Safety Council ETSC – PIN Flash Report 38. Brussels.

von Below, A. (2016). Verkehrssicherheit von Radfahrern: Analyse sicherheitsrelevanter Motive, Einstellungen und Verhaltensweisen. (Road safety of cyclists: Analysis of motives relevant for security, settings and behaviour patterns.) Report on Research Project F1100.4311016, German Federal Highway Research Institute, Bergisch Gladbach.

German Federal Highway Research Institute (2018). Gurte, Kindersitze, Helme und Schutzkleidung. (Seat belts, child seats, helmets, and protective clothing.) In: Daten & Fakten kompakt. (Data & Facts Compact.) Bergisch Gladbach.

CARE: Community Road Accident Database

European Commission (2018). Traffic Safety Basic Facts on Cyclists. European Commission, Directorate General for Transport.

European Commission (2018). Traffic Safety Basic Facts on Motorcycles & Mopeds. European Commission, Directorate General for Transport.

Hamilton-Baillie, B. (2008). Shared Space: Reconciling People, Places and Traffic. Built Environment, 34(2), 161–181.

Heesch, K. C., Sahlqvist, S., & Garrard, J. (2011). Cyclists' experiences of harassment from motorists: Findings from a survey of cyclists in Queensland, Australia. Preventive Medicine, 53(6), 417–420.

Horswill, M. S., Hill, A., & Wetton M. (2015). Can a video-based hazard perception test used for driver licensing predict crash involvement? Accident Analysis & Prevention, 82, 213–219.

International Transport Forum ITF (2019). Road Safety in European Cities: Performance Indicators and Governance Solutions. International Transport Forum Policy Papers, No. 67, OECD Publishing, Paris.

International Transport Forum – International Traffic Safety Data and Analysis Group IRTAD (2019). Road Safety Annual Report 2019. Paris.

IRTAD Road Safety Database

Jeanne Breen Consulting, SWOV, Loughborough University (2018). Preparatory work for an EU road safety strategy 2020–2030, Final Report. European Commission, Brussels.

Kramer, F. (2008). Passive Sicherheit von Kraftfahrzeugen. Biomechanik – Simulation – Sicherheit im Entwicklungsprozess. (Passive Safety in Motor Vehicles. Biomechanics – Simulation – Safety During the Development Process.) Vieweg + Teubner, 3rd revised edition.

Kubitzki, J., Fastenmeier, W. (2019). Sicher zu Fuß – Mobilität und Sicherheit von Fußgängern. (Walking Safely – Mobility and Safety for Pedestrians.) Allianz Deutschland AG.

Mönnich, J. et al. (2018). Benefit estimation of an Antilock-Braking System (ABS) for Pedelecs based on simulation of real world accidents. Proceedings, 7th International Cycling Safety Conference 2018, Barcelona.

Morris, A.P. & al (2018). Saferwheels: Study on Powered Two-Wheeler and Bicycle Accidents in the EU, Final Report. European Commission, Brussels.

National Center for Statistics and Analysis (2019). Bicyclists and other cyclists: 2017 data. (Traffic Safety Facts. Report No. DOT HS 812 765). Washington, DC: National Highway Traffic Safety Administration.

National Center for Statistics and Analysis (2019). Motorcycles: 2017 data (Updated, Traffic Safety Facts. Report No. DOT HS 812 785). Washington, DC: National Highway Traffic Safety Administration.

OECD/International Transport Forum (2013). Cycling, Health and Safety. OECD Publishing/ITF, Paris.

Pozybill, M., Wolff, A. (2018). Verkehrssicherheitsscreening – Mit der gläsernen Straße zur Vision Zero. (Road Safety Screening – To Vision Zero with the transparent road.) In: "Straßenverkehrstechnik" (Road Safety Technology) scientific journal edition 11/2018, P. 787–799.

Rheinberg, F. (1994). Flow-Experience when Motorcycling: A Study of a Special Human Condition. In R. Brendicke (Ed.) Safety, Environment, Future – Proceedings of the 1991 International Motorcycle Conference (S. 349–362). Bochum: Institut für Zweiradsicherheit e.V. (Forschungshefte Nr. 7) [Institute for Two-Wheeler Safety, Research Brochure no. 7].

Rowden, P., Watson, B., Haworth, N., Lennon, A., Shaw, L., & Blackman, R. (2016). Motorcycle riders' self-reported aggression when riding compared with car driving. Transportation Research Part F: Traffic Psychology and Behaviour, 36, 92–103.

Royal, S., Kendrick, D., & Coleman, T. (2007). Promoting bicycle helmet wearing by children using non-legislative interventions: systematic review and meta-analysis. Injury Prevention, 13(3), 162–167.

Santacreu, A. (2018). Safer City Streets Global Benchmarking for Urban Road Safety. International Transport Forum Working Document, OECD Publishing, Paris.

Santacreu, A. & al. (2020). Safe Micromobility. International Transport Forum, OECD Publishing, Paris.

Schleinitz, K., Petzoldt, T., Krems J., Gehlert, T., & Kröling, S. (2016). Helmnutzung und regelwidriges Verhalten von Pedelec- und Fahrradfahrern. Forschungsbericht Nr. 43. (Helmet use and traffic rule infringements of pedelec riders and cyclists. Research Report no. 43.) Unfallforschung der Versicherer. Gesamtverband der Deutschen Versicherungswirtschaft e.V., Berlin. (Association for accident research on behalf of insurance companies in Germany, Part of the German Insurance Association, Berlin.)

German Federal Statistical Office (2019). Traffic Accidents 2018. Wiesbaden.

German Federal Statistical Office (2020). Traffic Accidents 2019. Wiesbaden.

German Federal Statistical Office (2019). Verkehrsunfälle – Kraftrad- und Fahrradunfälle im Straßenverkehr 2018. (Road Accidents Involving Motorbikes and Bicycles in 2018.) Wiesbaden.

German Federal Statistical Office (2020). Verkehrsunfälle – Kraftrad- und Fahrradunfälle im Straßenverkehr 2019. (Road Accidents Involving Motorbikes and Bicycles in 2019.) Wiesbaden.

Woolsgrove, C., Armstrong, J. (2020). Safer Cycling Advocate Program – Best Practice Guide. European Cyclists' Federation.

World Health Organization (2018). Global Status Report on Road Safety 2018. Geneva.

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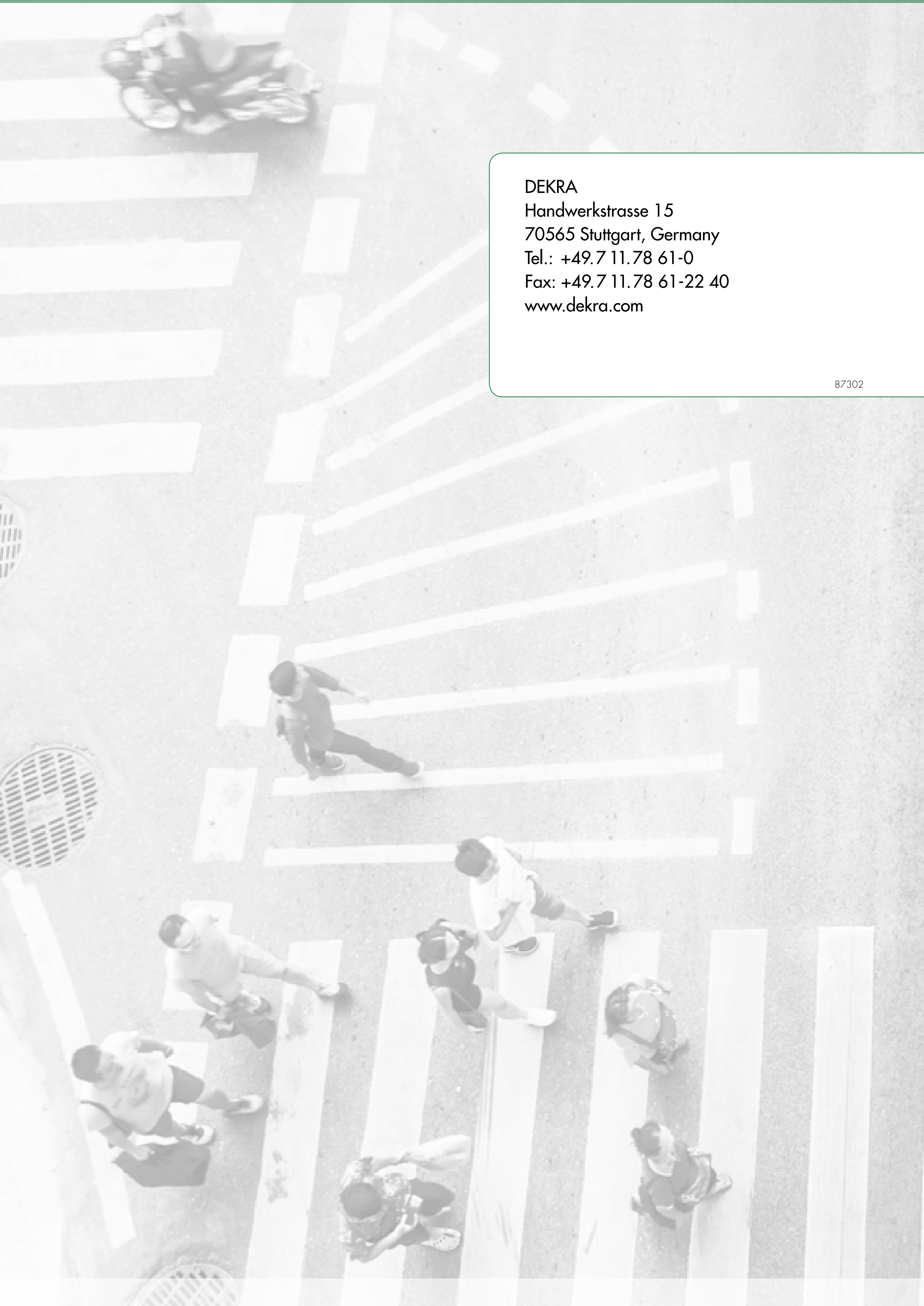

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