Compact accident research

Quad bikes in accident statistics

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Preliminary remarks

Quad bikes (quadricycles or ATV, all-terrain vehicles) have become increasingly popular in Germany in the last 10 years or so. It is estimated that there are now over 150,000 of these vehicles. They are now being used not just for pleasure on private land but also on the roads. This has had an impact on the accident statistics. The challenge when analyzing the situation is to identify the quad bikes involved in accidents and draw a well-grounded conclusion about the relevance of accidents involving quad bikes.

Inhalt

Technical aspects

Quad bikes are open, four-wheeled vehicles with specific technical characteristics. Most of these vehicles do not have a differential at the rear axle, and they have a thumb throttle rather than the twist throttle found on motorcycles. Riders are unprotected in the same way as motorcyclists. In addition, quad bikes have a high center of gravity combined with a narrow track width. This means the vehicles have an increased tendency to overturn.

Figure 1:
Quad bike with thumb throttle

Figure 2:
Quad bike without differential

Categorizing quad bikes

Quad bikes are generally subdivided into three different categories. "Light" quad bikes are vehicles with a maximum power output of 4 kW and a maximum speed of 45 km/h. These vehicles do not have to be registered. However, they do need to have an insurance sticker. Visually, it is hard to distinguish "light" quad bikes from "heavy" quad bikes, which do have to be registered. "Light" quad bikes (quadricycles), as defined by Directive 2002/24/EC [1], belong to vehicle category L6e.

Figure 3:
"Light" quad bike

Figure 4:
"Heavy" quad bike

"Heavy" quad bikes have to be registered and fitted with a license plate. They have a maximum power output of 15 kW and an unladen mass of not more than 400 kg. They thus belong to vehicle category L7e, as defined by Directive 2002/2024/EC [1].

Quad bikes can also be registered as agricultural or forestry tractors. Such vehicles are also referred to as ATVs (all-terrain vehicles). In order to be registered as agricultural or forestry vehicles, they have to meet the following key technical requirements:

Figure 5:
Quad bike as an agricultural or forestry vehicle

- Electric lighting with two headlights and two tail lights with a brake light, rear fog light and turn signal lights at the front and rear
- Two license plates (front and rear)
- A certified, registered towbar with electrics for a trailer
- A parking brake

The vehicles are generally converted by the dealer or importer in consultation with the official inspection authorities. If a vehicle meets these technical requirements and is approved as an agricultural or forestry vehicle, the engine's entire power output, which can be up to 15 kW, can be used. This results in maximum speeds that can exceed 100 km/h.

Driving license

"Light" quad bikes with an insurance sticker can be driven with a category AM driving license (from the age of 16), which is included in category B. All other quad bikes can be driven with a category B license. If a quad bike is approved as an agricultural or forestry vehicle, category L (from the age of 16) and category T (from the age of 18) driving licenses come into consideration. None of the above driving license categories permitting people to drive quad bikes take into account the particular driving dynamics involved with quad bikes. For example, practice drives with quad bikes are not included in the driving tuition for these license categories.

Numbers of registered vehicles

In the same way as it is currently impossible to ascertain the number of accidents in which quad bikes are involved, there is a problem ascertaining the number of quad bikes registered in Germany because the Federal Motor Transport Authority (KBA) does not have a separate vehicle class for them. As far as the "heavy" quad bikes are concerned, all we know is that there were 116,339 registered light four-wheeled motor vehicles in the year 2012 [2]. Clearly, more precise distinctions need to be made to obtain a more accurate figure. The same applies to quad bikes used as agricultural or forestry vehicles. According to the Federal Motor Transport Authority, 43,707 vehicles were registered in 2012 [2].

The Federal Motor Transport Authority does not keep records of "light" quad bikes that require only an insurance sticker. Although the GDV (German Insurance Association) does include them in its figures, they come under the same category as mopeds. It is thus not possible to know how many of these vehicles there are.

New EU regulations

When EU Regulation No. 168/2013 takes effect on January 1, 2016, new conditions will come into force for "light" and "heavy" quad bikes (quadricycles) [3]. Among other things, the ve-

hicle categories for "light" and "heavy" quad bikes will be redefined. For the first time, there will be special registration categories for quad bikes. These will in turn be divided into subcategories. In addition, quad bikes will have to meet new requirements with effect from 2016 or 2017. For instance, a differential will be mandatory for all quad bikes. This makes them safer in bends. Further details will included in the delegated acts, which are currently still in preparation. Quad bikes as agricultural or forestry tractors are described in the new EU Regulation No. 167/2013 [4]. This will also come into force on January 1, 2016. The delegated acts and thus further technical details are not yet available.

Accidents involving quad bikes

448 accidents involving quad bikes in Bavaria from the years 2009 to 2012 were available for investigation in this study. Bavaria is one of the few federal states in Germany that includes quad bikes as a traffic participation type. A nationwide record of accidents, including those involving quad bikes and electric-assist bicycles (pedelecs), based on a modified list of traffic participation types, will be kept from January 2014. The accidents involving quad bikes in Germany will thus be documented, and the data will be available for the year 2014 by 2015 at the earliest.

In addition, the accident files of a German insurer from the year 2012 were also available for this study. 142 accidents involving property damage and/or personal injury and at least one quad bike were documented.

Accident data for Bavaria

The figure below shows the number of accidents with quad bikes involving personal injury and the number of casualties in each of the years from 2009 to 2012. In these four years there were 488 accidents with quad bikes involving personal injury and 601 casualties

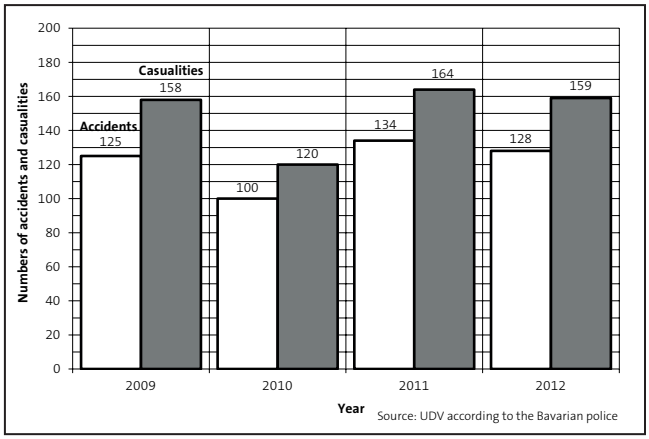
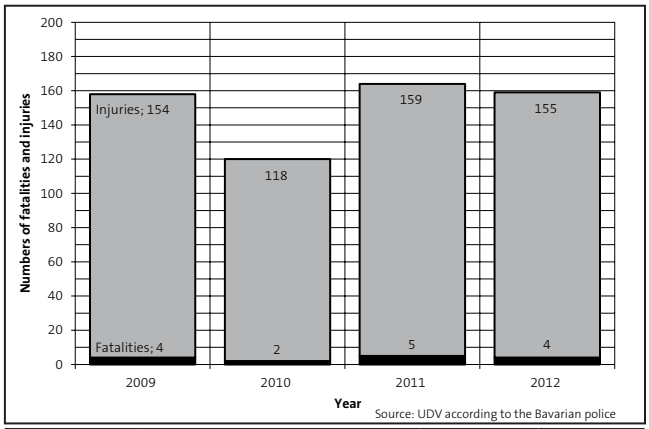


Figure 6:
Numbers of accidents with quad bikes involving personal injury and numbers of casualties from 2009 to 2012

Figure 7 shows the fatalities and injuries in accidents involving quad bikes. It is clear that accidents involving quad bikes have serious consequences. Around twice as many people are killed in every 100 accidents involving quad bikes as are killed in all accidents involving personal injury (A(I)) in Bavaria.



Bavaria 2009 - 2012	Number of accidents involing personal injuries A(I)	Number of fatalities	Fatalities per 100 A(I)
Quad bike A(I)	488	15	3.07
All A(I)	209245	2923	1.40

Source: Federal Statistical Office

Figure 7:
Fatalities and injuries in accidents involving quad bikes

Table 1:
Accident risk and vehicle type

Accidents(I) / (million vehicles × km)		Casualities / (million vehicles × km)			
Bavaria	**Quad bikes*[1]**	Casualities (riders and passengers)			
Year	**A(I)**	Total	Fatalities	Serious injuries	**Fatalities and serious injuries**
2009-11	**1.2**	1.4	0.03	0.56	**0.59**
* Licensed vehicles of over 50cc with a maximum speed of over 45 km/h		Source: Bavarian police, Federal Motor Transport Authority (KBA)			
Bavaria	**Two-wheel motor vehicles***	Casualities (riders and passengers)			
Year	**A(I)**	Total	Fatalities	Serious injuries	**Fatalities and serious injuries**
2009-11	**2.1**	2.3	0.05	0.76	**0.82**
* Licensed vehicles of over 50cc with a maximum speed of over 45 km/h		Source: Bavarian State Office for Statistics and Data Processing, Destatis			
Bavaria	**Cars**	Casualities (riders and passengers)			
Year	**A(I)**	Total	Fatalities	Serious injuries	**Fatalities and serious injuries**
2009-11	**0.52**	0.43	0.004	0.05	**0.06**
[1] The annual distance driven by quad bikes was estimated from random samples of classified ads for used vehicles for sale in Bavaria.		Source: Bavarian State Office for Statistics and Data Processing, Federal Motor Transport Authority (KBA)			

In order to answer the question as to the relevance of quad bike accidents in Bavaria, it is necessary to select a suitable indicator. Absolute figures such as those in Figure 7 do not permit a conclusion to be drawn about the relevance and risk of these accidents, but that changes if you combine the figures with the distance driven by the vehicle type and the associated number of vehicles in existence. In this way, you get an idea of the risk of being involved in an accident and of being killed when using a vehicle of this type. The average distance driven by quad bikes in Bavaria is around 1,800 km, compared to 3,100 km for motorcycles. The average distance driven for cars is 14,200 km [5]. The driving distances for quad bikes and motorcycles were estimated for the region of Bavaria based on a random sample. This applies to licensed quad bikes of over 50cc and with a maximum speed of over 45 km/h. The number of vehicles on the road for the vehicle types listed in Table 1 was obtained using the list of the Federal Motor Transport Authority (KBA).

The calculations show that the risk of a quad bike accident involving personal injury is twice as high as that for a car accident involving personal injury for every million vehicles and million kilometers driven. This risk of being killed or seriously injured when using a quad bike, on the other hand, is ten times greater than for a car. These figures show that it is necessary to take a look at the accidents involving quad bikes and analyze the circumstances of these accidents in some detail.

If you look at the location, the condition of the road and the light conditions for accidents involving quad bikes, nothing stands out as being of relevance (Figure 8 to 10).

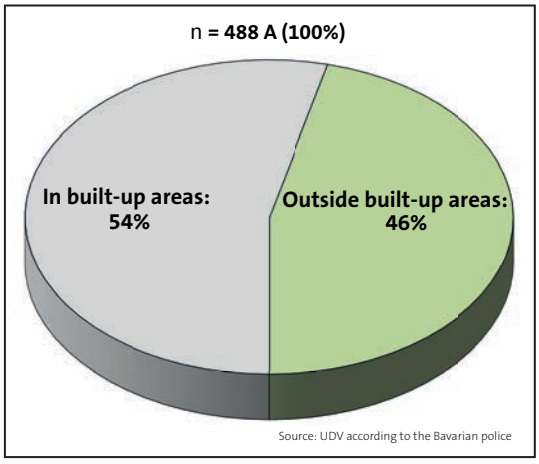


Figure 8:
Location

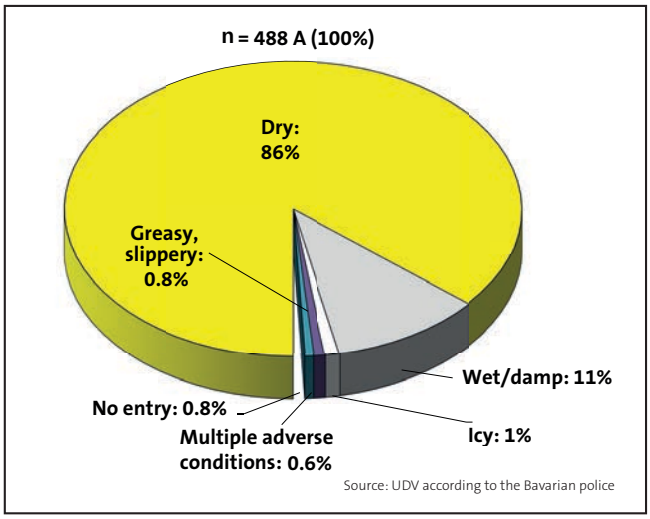


Figure 9:
Condition of the road

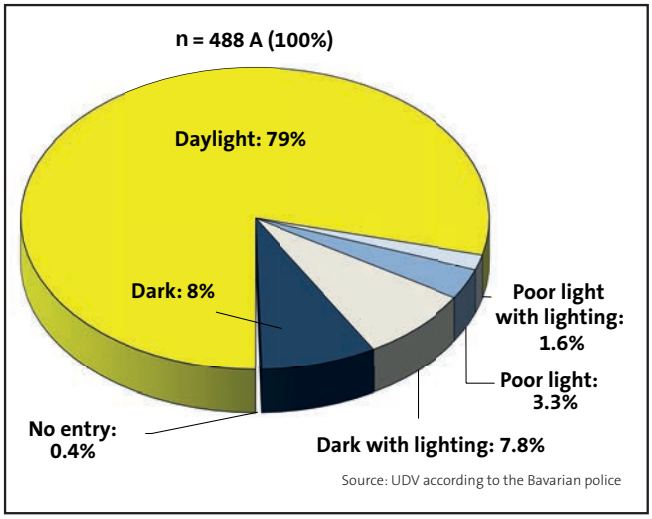


Figure 10:
Light conditions

The accidents happen predominantly on dry roads and in daylight. If you take the accident type into account, a clear pattern emerges. Driving accidents (where the driver or rider loses control as a result of not driving at the appropriate speed, for example) are by far the most common type of accident, making up 40 percent of all quad bike accidents in Bavaria.

These are followed by accidents in longitudinal traffic, which account for 18 percent, and turning-into/crossing accidents, which make up 16 percent.

The analyses also reveal that 77 percent of the driving accidents of quad bikes are single-vehicle accidents (Figure 11). If you take a clo-

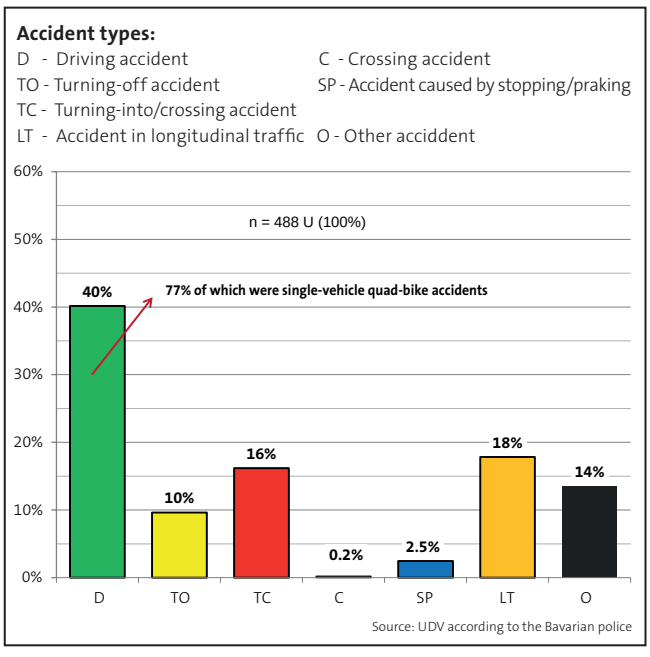


Figure 11:
Accident type

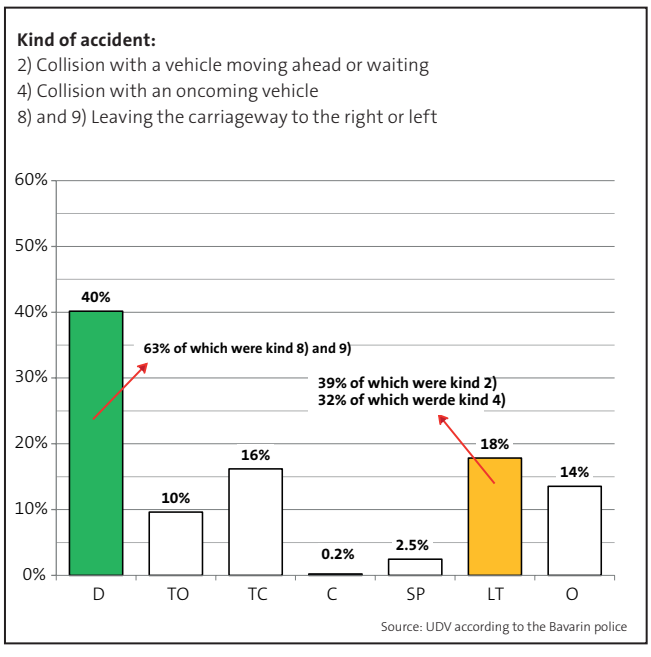


Figure 12:
Kind of accident

ser look at the accident scenario and consider the kind of accident together with the accident type, you see that 63 percent of driving accidents involve "leaving the carriageway to the right or left". This is clearly the most common kind of accident for this accident type. In accidents in longitudinal traffic, the most common kinds of accident are "collision with a vehicle moving ahead or waiting" and "collision with an oncoming vehicle". This is clearly shown in Figure 12.

Figure 13 indicates that driving accidents and accidents in longitudinal traffic are also the most serious accidents involving quad bikes.

The analysis shows that 50 percent of all fatalities and serious injuries happen in driving accidents alone. 21 percent of all fatalities and 14 percent of all serious injuries happen in accidents in longitudinal traffic. These two accident types together thus account for 71 percent of fatalities and 64 percent of serious injuries.

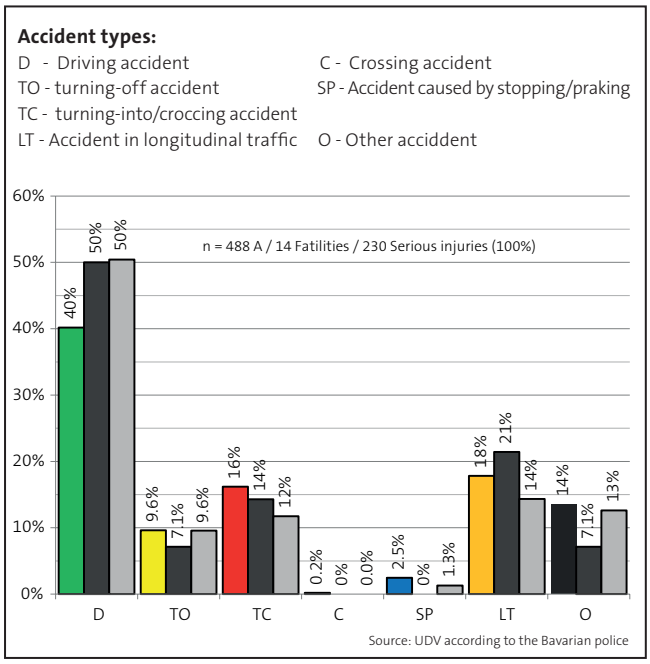


Figure 13:
Accident type and casualties

If you take a closer look at the accident data, a second clear pattern emerges in accidents involving quad bikes. A conspicuously high percentage of all quad bike accidents in Bavaria are single-vehicle accidents (41 percent). By comparison, the percentage of single-vehicle accidents in the year 2012 involving cars and motorcycles was relatively low at 13 and 30 percent, respectively [6].

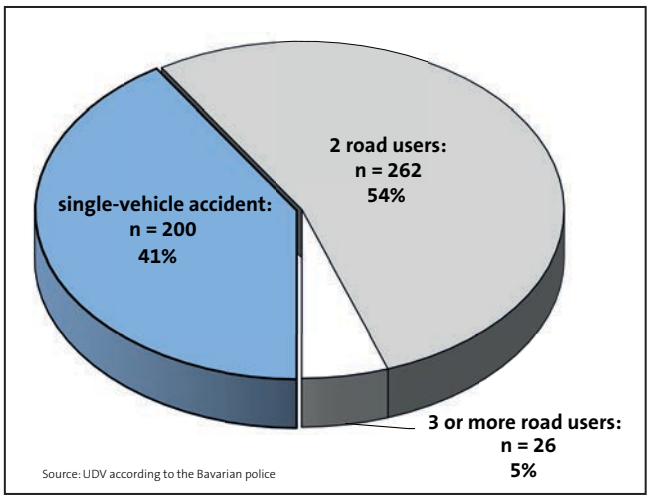


Figure 14:
Number of road users involved

According to the accident data of the Bavarian police, riders of quad bikes were primarily responsible for their accidents in 85 percent of cases. Single-vehicle accidents and accidents involving two road users were considered. Figure 15 shows that, in accidents involving two road users, the quad bike rider was primarily responsible for the accident in 57 percent of the cases. This is almost twice as high as the percentage of motorcyclists primarily responsible for accidents involving two road users.

The above analyses reveal a clear accident pattern, one that is also caused by the design of quad bikes. The driving accidents and the high percentage of quad bike riders primarily responsible for the accidents they were involved in suggest that handling these vehicles is

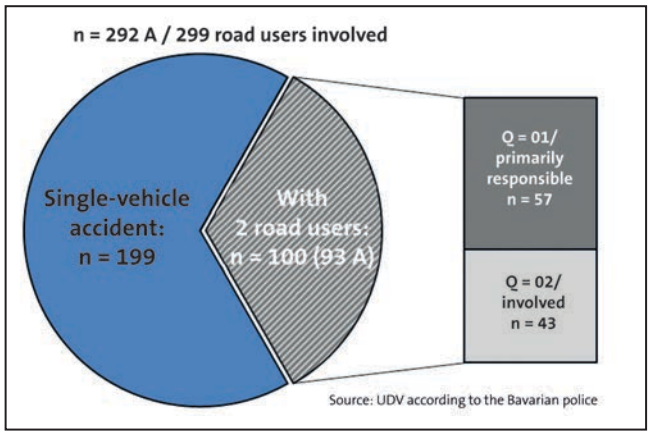


Figure 15:
Proportion of quad bike riders who were primarily responsible for their accidents

a problem. This becomes clear in the following analyses. Figure 16, for example, shows that 22 percent of the accidents investigated took place in a bend.

Collisions of quad bikes with an obstacle next to the road also happened conspicuously often. In 23 percent of cases these obstacles were trees or bushes, in 9 percent of cases crash barriers, and in 36 percent of cases they were some other kind of obstacle. This ties in with the analysis that revealed that in a high

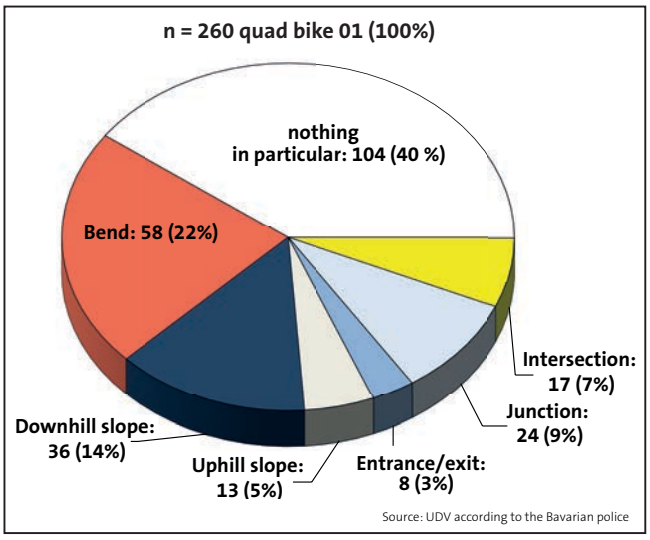


Figure 16:
Characteristics of the accident location

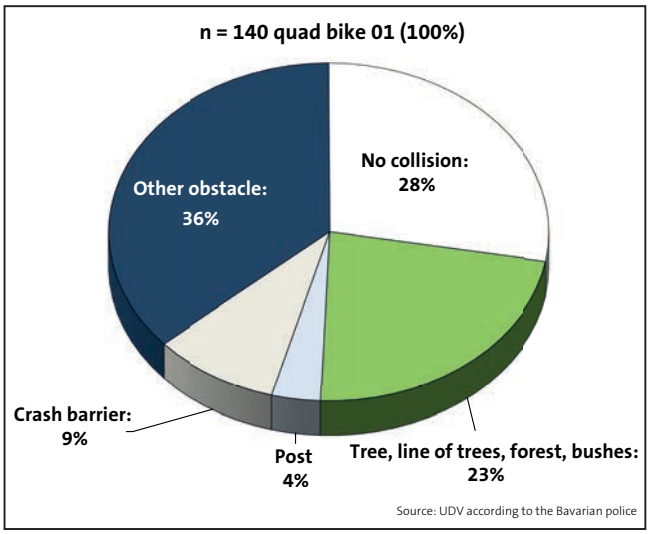


Figure 17:
Collision with an obstacle next to the road

percentage of accidents the vehicle left the carriageway to the right or left.

If you look at the age distribution of the quad bike riders involved in accidents, it becomes clear that over 50 percent of them were younger than 35. 13 of 14 young quad bike riders up to the age of 17 were primarily responsible for the accidents they were involved in. 10 of these accidents were single-vehicle accidents

Claims data of a car-insurer

As already mentioned, an additional 142 accidents involving property damage and/or personal injury and at least one quad bike were taken from a German insurer's claims data for the year 2012 and included in the study. 122 of these accidents involved property damage, and 20 involved personal injury: one fatality, 11 serious injuries and 12 minor injuries. In 56 percent of the cases, the accidents were caused by young people aged 18 to 24. 10 accidents were caused by riders of rented quad bikes.

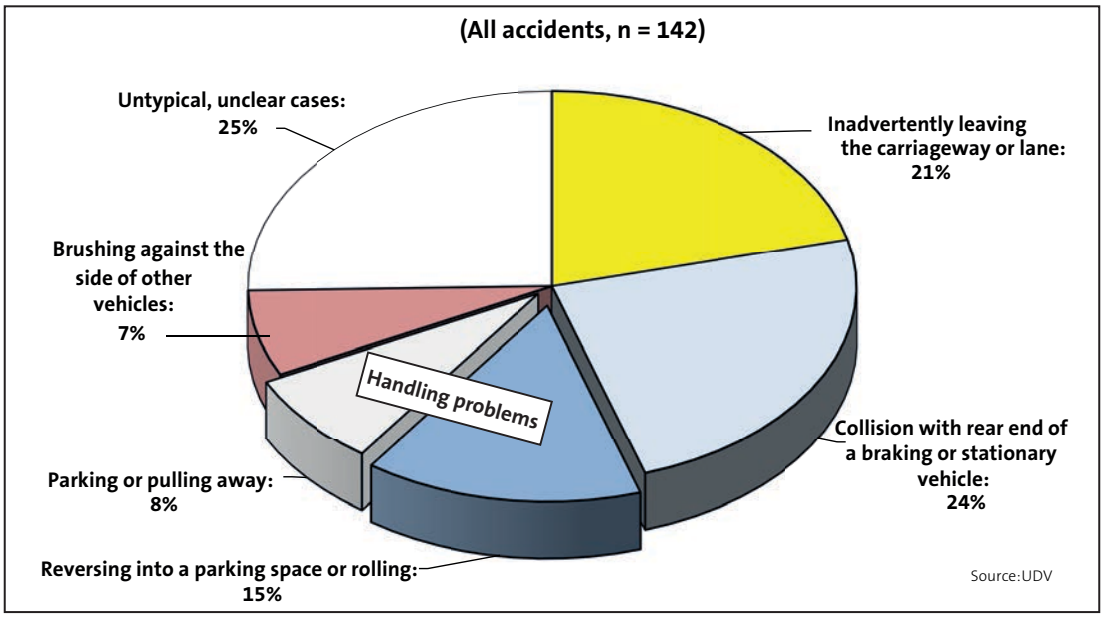


Figure 18:
Accident causes

An analysis of the the circumstances of the accidents involving property damage and personal injury reveals that collisions with the rear end of a braking or stationary vehicle were most common, accounting for 24 percent of these accidents, followed by riders inadvertently leaving the carriageway or their lane, which made up 21 percent of the accidents. It should be noted here that the selected accident scenarios do not correspond to the official definitions of the kinds of accident and accident types. Handling problems occurred in 23 percent of the claim cases examined. These involved parking, pulling away or rolling.

If you look only at the circumstances of accidents involving personal injury (n = 20), the picture is the same as the one gained from the Bavarian accident data. In 60 percent of the cases, inadvertent departure from the carriageway or lane was the main cause. This underlines the point made above about the problem in terms of driving dynamics when handling the vehicle in critical situations.

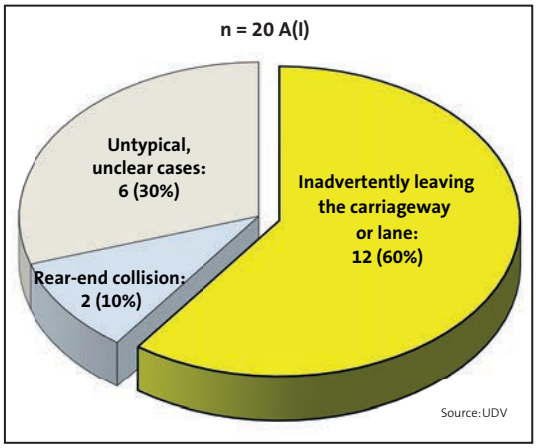


Figure 19:
Accidents involving personal injury

Summary of the analysis of the accident data

The analyses confirm that the risk of having an accident when riding a quad bike on the roads is high. The risk of having an accident in relation to the number of vehicles on the road and the distance driven annually is twice as high for quad bikes as for cars. Given the number of these vehicles on the road and the average

distance driven annually, the risk of being killed or seriously injured on a quad bike is ten times higher than that of being killed or seriously injured in a car. Around 40 percent of accidents involving quad bikes were single-vehicle accidents. In accidents involving two or more road users, the quad bike rider was primarily responsible for the accident in 57 percent of cases. Overall, 85 percent of all of the accidents involving quad bikes that were investigated were caused by the quad bike. The accident data also shows that 40 percent of the quad bike accidents were driving accidents, and these were responsible for about half of the fatalities and serious injuries. Driving accidents involve a loss of control of the vehicle. In two-thirds of these cases, the quad bike rider left the carriageway to the left or right. The figures also show that bends in the road represent a significant problem in relation to accidents.

Crash test

The crash test conducted reproduced a typical set of accident circumstances for quad bike accidents: leaving the carriageway in a bend followed by a collision with a line of trees next to the road. The speed of the quad bike on impact was 53.6 km/h. None of the load values measured on the dummy's head and neck were above the normal limit values. However, that does not mean that the accident is harmless, which it clearly isn't. Instead, it shows that the absence of suitable measuring points on a conventional dummy means that what might be serious injuries cannot be recorded.

Figure 20:
Crash test

Demands

The suitability of the driving licenses that allow people to drive quad bikes must be called into question. The accident statistics clearly show that it is necessary to familiarize quad bike riders with the particular driving dynamics of this vehicle type and show them how to respond correctly in critical situations. A minimum of an hour of instruction and a documented practice drive should be required before someone is permitted to ride a quad bike.

Quad bikes must also be technically equipped to allow bends to be negotiated safely. Although the installation of a differential is going to be made mandatory in future throughout Europe, this legal requirement is being implemented too late. All manufacturers should act now and voluntarily fit a differential to their vehicles.

The Bavarian accident data and the analyses of the claims cases of the insurer clearly show there is a problem with quad bikes in terms of accidents. At the latest, once the involvement of these vehicles in accidents is recorded in the official statistics nationwide, these analyses should be repeated so that a picture can be gained of the accident situation throughout Germany.

Links

Internet UDV: **http://www.udv.de/quad**
Crashtestvideo 1 YouTube: **http://ow.ly/sDAs9**
Crashtestvideo 2 YouTube: **http://ow.ly/sDAAN**

References

[1] Directive 2002/24/EC of March 18, 2002, OJ L 124 of May 9, 2002

[2] Statistische Mitteilungen des Kraftfahr-Bundesamtes FZ1 (statistical reports of the Federal Motor Transport Authority FZ 1), January 1, 2013

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