



Compact accident research

Improving road safety in Münster - A pilot project on systematic accident analysis in local authorities

Imprint

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Preliminary remarks

Guaranteeing road safety is a key factor in ensuring that personal mobility functions smoothly. Despite all the efforts of those responsible (such as the Accident Commission), it is possible that the number and severity of accidents cannot be reduced, because there is no way of identifying the causes underlying the apparently unstructured set of accident statistics.

The city of Münster was faced with a situation precisely like this. They therefore requested the assistance of the German Insurers Accident Research (UDV) in thoroughly investigating the various interrelationships and the background that were contributing to the accident statistics that been constantly poor over a period of many years. The UDV responded by carrying out a pilot project in Münster in order to develop an accident analysis procedure that could be applied to other local authorities.



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Initial situation

The road traffic accident statistics for the Ministry of the Interior in North Rhine-Westphalia (NRW) show that the city of Münster has for many years had the worst road traffic accident record with respect to accidents involving personal injury. In contrast to the rest of the Federal State of North Rhine-Westphalia, where accidents involving personal injury have been on the decline, Münster has been showing an increase over the past years. Cyclists have been most affected by this trend. The increase in the numbers of accidents has also been caused by the constant increase in both motor vehicle traffic and the proportion of cyclists in Münster. This means that the potential for conflict between the groups of road users has inevitably increased.

The traffic systems have now begun to reach their limits with respect to road safety and in their current state, many places and routes are no longer adequate for ensuring a safe flow of traffic. In particular, the extent of the cycle paths and the cycle traffic control systems at intersections can no longer cope with the high proportion of cyclists in Münster.



Systematic approach

A comprehensive and systematic analysis of all 27,741 accidents that occurred in the years 2004 through 2006 coupled with supplementary observation of behavior allowed the UDV to identify not only accident blackspots, but also systematic causes of accidents and to draft recommendations for measures to be taken. The investigation covered the following aspects:

▪ Identification of accident black spots

The data used for the investigation was a network-based analysis of the entire city using the accident type maps provided by the police according to the criteria laid down in the Code of Practice for Evaluating Road Traffic Accidents (FGSV, 2001)¹⁾.

▪ Local accident investigation

In the areas where significant numbers of accidents were identified, more detailed examination of the local accident situation was carried out using the police documents (notifications of accidents, lists of accidents, accident diagrams, collections of accident reports, etc.) in order to identify structural similarities between the accidents, which can then be used as the basis for targeted improvement measures and strategies to reduce the accident rate. In addition, accident diagrams were created for all black spots, for frequent accident spots (FAS) as well as for frequent accident lines (FAL). The local situation in each case was documented during accident-site inspections (photos, sketches and sometimes video recordings).

▪ Route-based safety analysis

In addition, a route-based safety analysis was carried out for the primary road network in

¹⁾ According to the code of practice, a location is classified as an accident black spot irrespective of the volume of traffic if at least five accidents of the same type have occurred at the location within one year, or if five accidents involving personal injury or three accidents involving serious personal injury have occurred at the location within three years.

accordance with the FGSV recommendations on performing safety analyses on road networks. The results of this analysis indicate those stretches of roads on which measures designed to improve safety can achieve the greatest effect.

▪ Observation of behavior

It is not possible to eliminate all accidents by means of construction measures or traffic control measures. It is possible that a typical pattern of incorrect behavior on the part of the road users contributes to the accidents. In order to develop targeted measures against incorrect behavior (e.g. surveillance and specific road safety activities), general and specific observations of behavior were performed, concentrating particularly on

cyclist and pedestrian traffic in areas with high accident frequency and in areas that showed no significant frequency of accidents.

Results of the analysis

27,741 accidents were recorded by the police in Münster between 2004 and 2006, 2,541 of which involved cyclists. A total of 23 people were killed, 797 suffered serious injuries and 3,839 suffered minor injuries. 47 % of all accidents involving personal injury (accident categories 1 through 3) were accidents involving cyclists in which 6 people were killed 341 suffered serious injuries and 1,582 suffered minor injuries. 12 % of the accidents involving cyclists involved cyclists only.

Table 1:
Summary of all accidents by category, 2004 - 2006

Accidents 2004 - 2006	Accidents in 2004	Accidents in 2005	Accidents in 2006	Total	Cost per accident* [€]	Total accident costs [€]
Number of accidents	9.238	9.342	9.161	27.741	-	281.287.500
Category 1 fatal accident	11	7	5	23	145.000	3.335.000
Category 2 accident with seriously injured persons	247	215	281	743	145.000	107.735.000
Category 3 accident with slightly injured persons	1.049	1.102	1.005	3.156	11.000	34.716.000
Category 4 accident with serious damage to property	266	255	234	755	11.500	8.682.500
Category 5 other accident with damage to property	6.126	6.061	5.993	18.180	5.500	99.990.000
Category 6 other accident under the influence of alcohol	72	52	39	163	5.500	896.500
Category 7 other hit and run accident	1.464	1.649	1.602	4.715	5.500	25.932.500
Not categorized	3	1	1	5	-	-
Number of injured persons	1.555	1.585	1.519	4.659		
Number of fatalities	11	7	5	23		
Number of seriously injured persons	266	233	298	797		
Number of slightly injured persons	1.278	1.345	1.216	3.839		

* costs to the economy

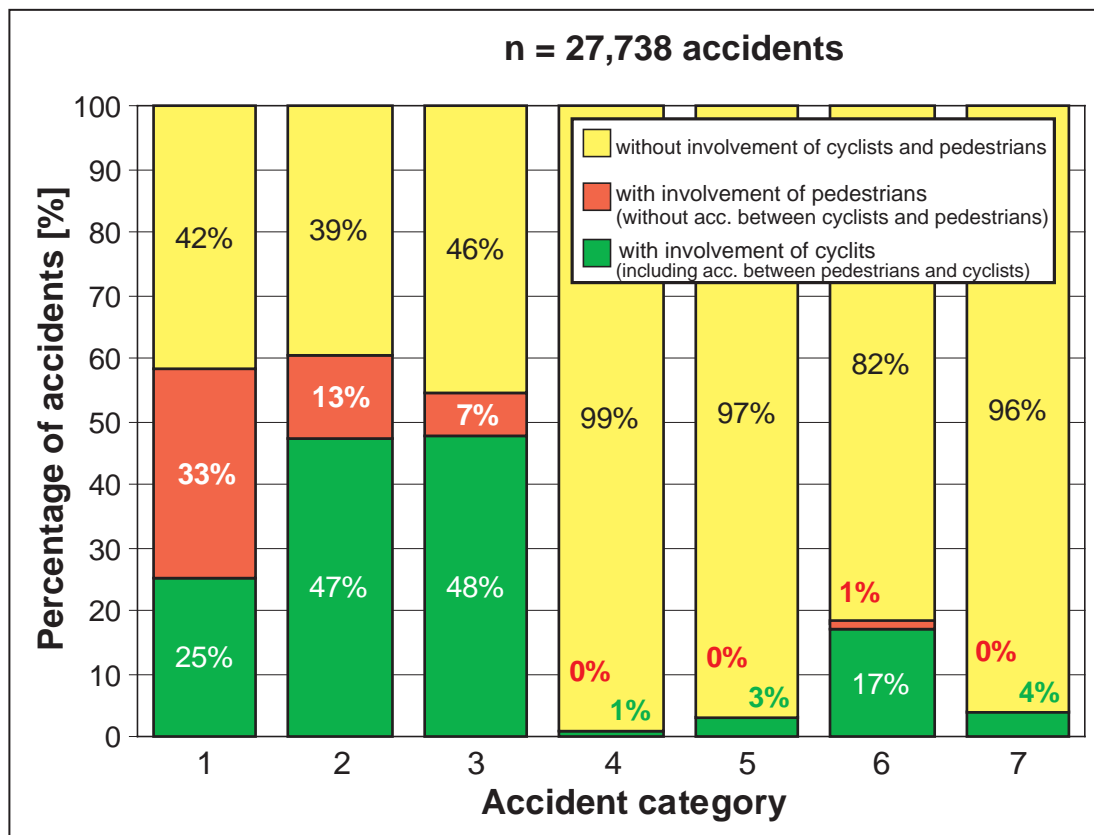


Figure 1:
Percentage of accidents involving cyclists and pedestrians 2004 - 2006

Even though the occurrence of accidents in Münster is distributed across the entire urban area, detailed evaluation of the accident type maps and accident data lists allowed 63 FAS and 22 FAL to be identified in accordance with the FGSV's Code of Practice for Evaluating Road Traffic Accidents.

- 59 frequent accident spots from the 3-year map 2004 - 2006,
- 4 frequent accident spots from the 1-year map 2006 and
- 22 frequent accident lines from the 3-year map 2004 - 2006.

Furthermore, the safety analysis revealed a large number of stretches of roads with a high potential for improving safety, and these largely correspond with the FAL or FAS.

Approximately one third of the accidents involving personal injury in Münster occur within the FAS and FAL. It was particularly conspicuous that 86 % of the accident black spots are intersections controlled by traffic signals or junctions. Approximately one third of accidents involving personal injury in built-up areas in Münster occur at intersections controlled by traffic signals and approximately one half of all accidents involving personal injury are „turning-off accidents“ and „turning into/crossing accidents“, in other words typical intersection accidents.

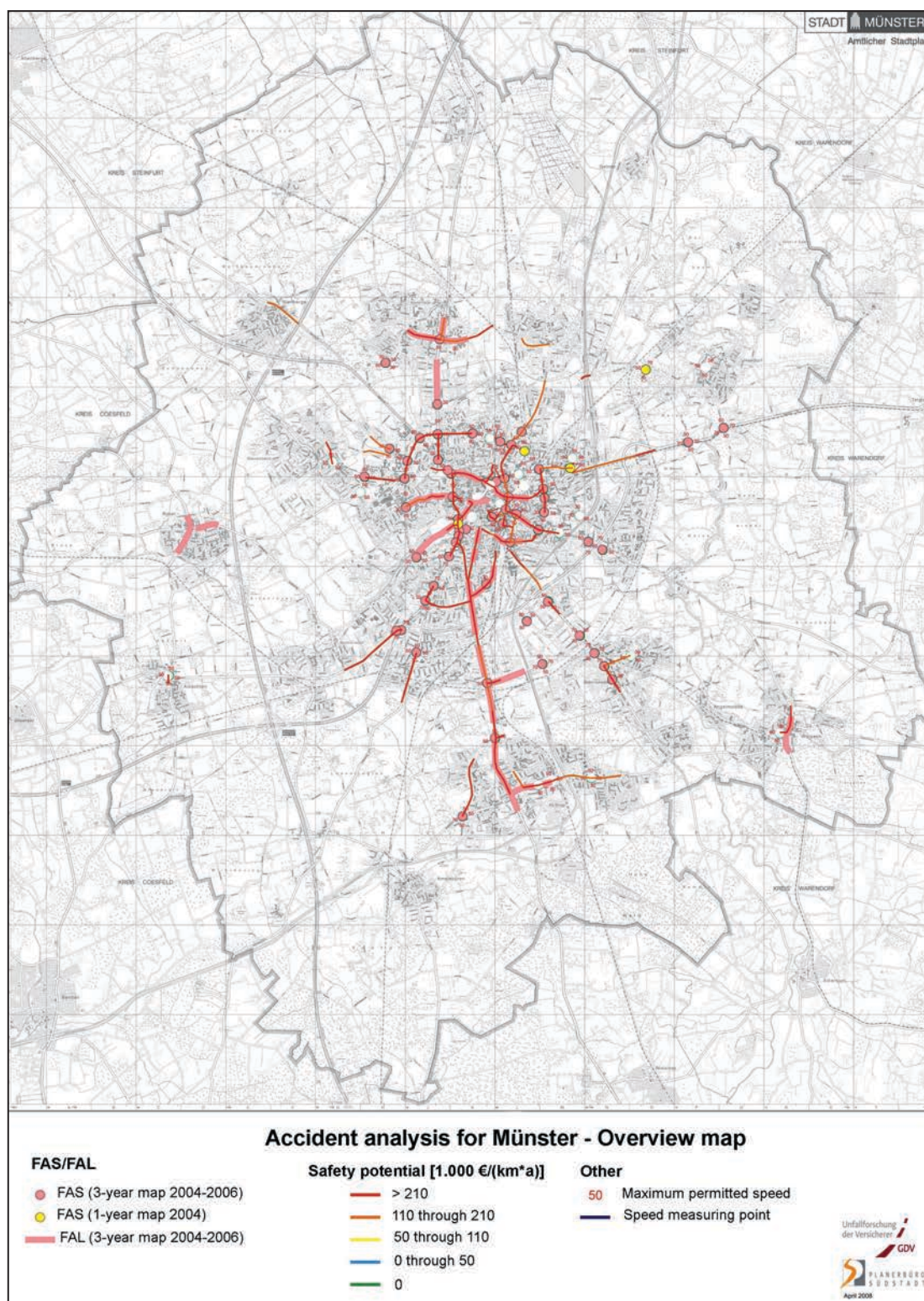


Figure 2:
Safety analysis of the road network (extract)

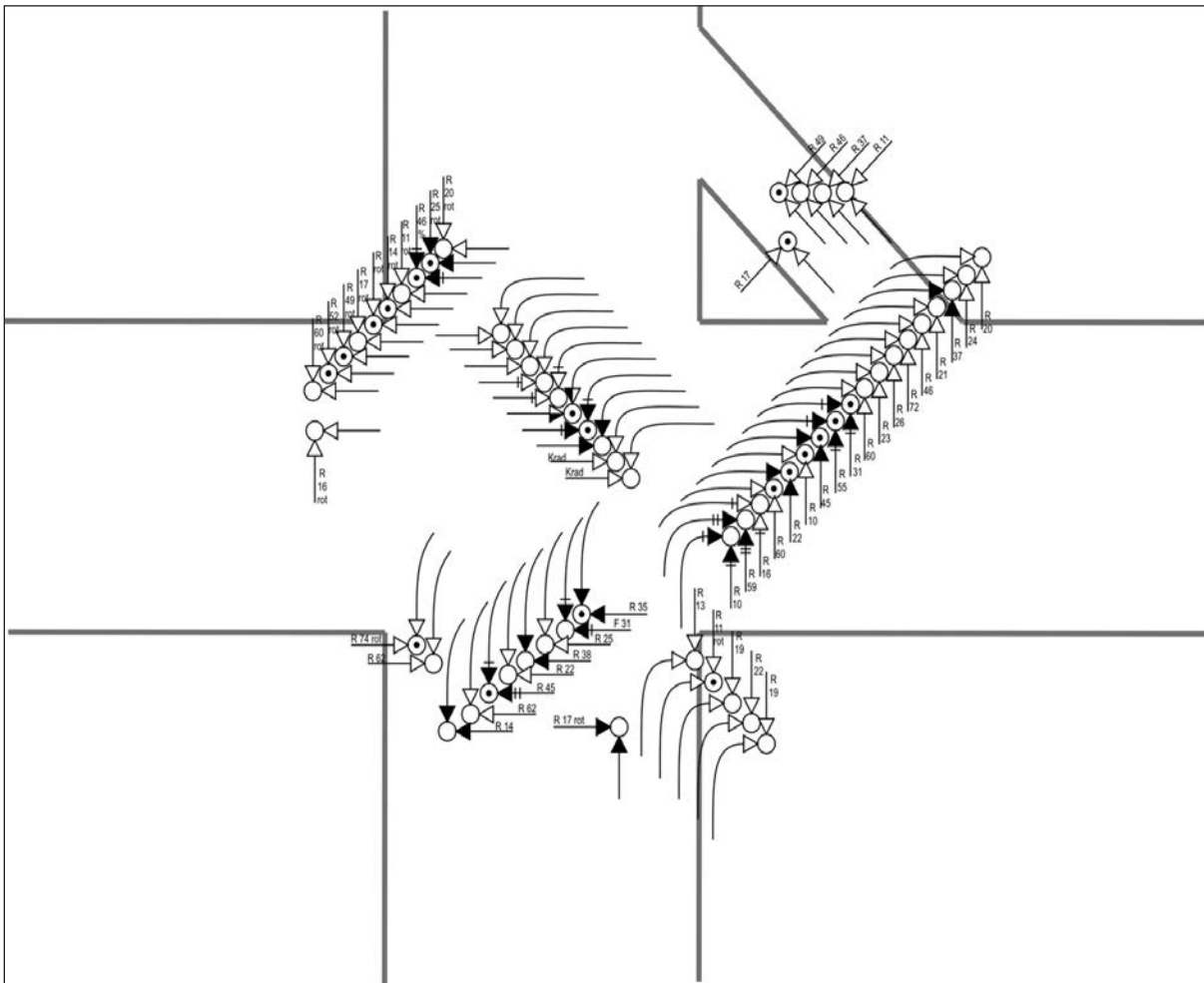


Figure 3:
Typical course of accidents at intersections controlled by traffic signals

Accidents involving cyclists

The number of accidents involving cyclists in Münster has risen dramatically over the past 10 years. Notably, a significant rise in accidents involving cyclists which are caused by other road users can be observed since 2002.

During the period 2004 through 2006, 2,541 accidents involving cyclists were recorded by the police in Münster. 1,859 involved personal injury, representing 47 % of all accidents involving personal injury. A total of 51 % of the accidents involving cyclists were caused

by motorized vehicles, 46 % were caused by cyclists and 3 % by pedestrians. 12 % of the accidents involving cyclists (302 accidents) involved cyclists only.

The main causes of the 1,286 accidents involving cyclists and caused by drivers of motorized vehicles are as follows:

- Failure to observe right of way (34 %),
- Error when turning off (28 %) and
- Error when turning into flowing traffic (10 %).

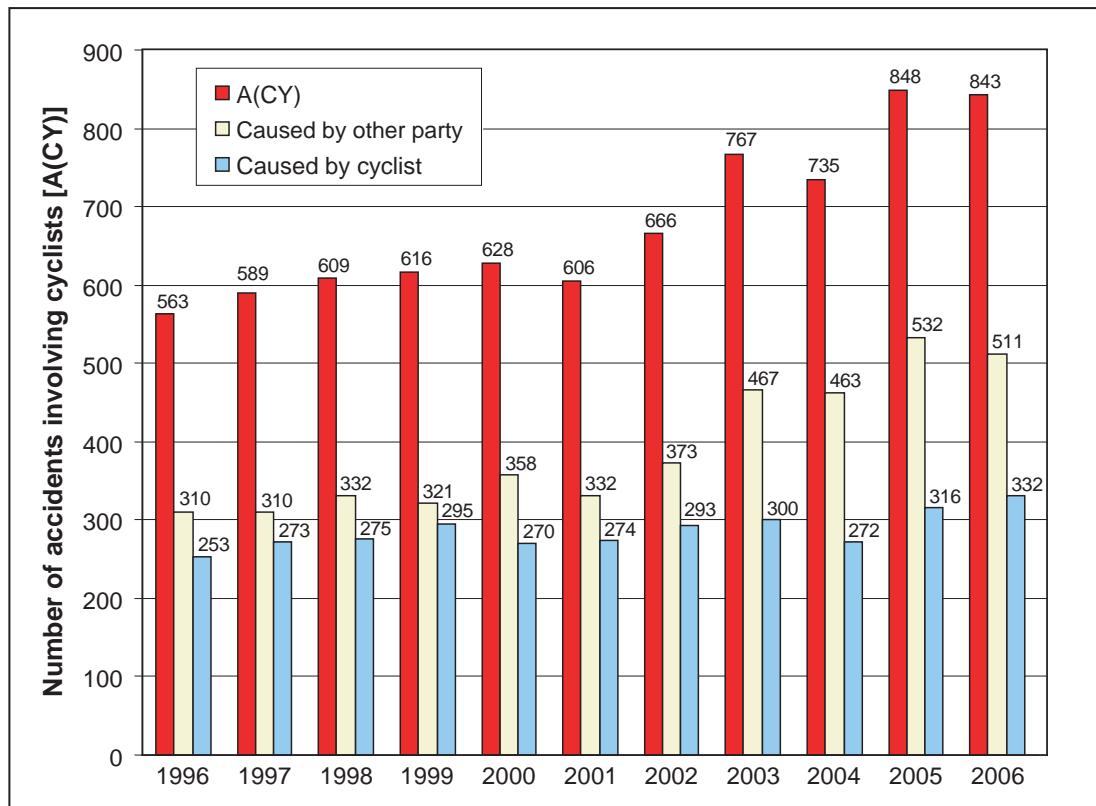


Figure 4:
Accidents involving cyclists 1996 - 2006

In addition to bicycle handling errors (19%), the primary cause of the 1,164 accidents caused by cyclists is as follows:

- Failure to observe right of way (18%),
- insufficient safety distance (15%) and
- Influence of alcohol (12%).

Observation of behaviour

To supplement the accident-related analyses, random observations of behavior were carried out. The objective of the observations was to find any indications of whether there was any typical incorrect behavior on the part of the road users in Münster that contributed to accident occurrences. The observations of behavior demonstrate among other things that inconsistent rules or rules that

are difficult to understand can in particular contribute to a low level of acceptance.

Infringements against red light regulations

325 accidents were caused by infringements against red light regulations in Münster between 2004 and 2006. 186 of these involved personal injury in which a total of 243 road users were injured (2 fatalities, 64 serious injuries and 177 slight injuries). A total of 138 cyclists and 28 pedestrians were involved in these accidents. 88 of these accidents (27%) were caused by cyclists and 22 (7%) by pedestrians.

Observation of infringements against red light regulations by pedestrians and cyclists was carried out at 16 marked pedestrian crossings

Table 2:
Accidents caused by failure to observe traffic signals 2004 - 2006

					Consequence			Persons involved			
		A	A(PI)	PI	F	SI	MI	PED	CY	C	S
Quantity	Cause	325	186	243	2	64	177	28	138	29	66
Caused by cyclists	31	88	64	72	1	22	49	0	94	4	13
Caused by pedestrian	60	22	18	17	1	7	9	22	0	5	4
Caused by other	31	215	104	154	0	35	119	6	44	20	50

A	Number of accidents
A(PI)	Number of accidents with personal injury
PI	Number of persons injured
F	Number of fatalities
SI	Number of seriously injured persons
MI	Number of slightly injured persons
PED	Number of pedestrians
CY	Number of cyclists
C	Number of children
S	Number of senior citizens (>64 years old)

at 8 different traffic signals (intersections, junctions, signal-controlled pedestrian crossings). Selection of the locations took into account accident black spots and areas where accident frequency was not significant and at crossings with high and low volumes of traffic. Over an observation period of 24.5 hours in total, 1,177 pedestrians and 1,963 cyclists were observed crossing.



The random sample observation showed that the majority of pedestrians and cyclists observed the red signal. Extrapolating the relative share of infringements against the red signal rules by cyclists (7%) to the absolute number of crossings at all traffic signals in Münster means that it can nevertheless be assumed that approximately 10,000 through 13,000 such infringements occur each day.

Behaviour when turning of

195 accidents occurred between 2004 and 2006 involving vehicles turning right. One person was killed, 19 suffered serious injuries and 132 suffered slight injuries. A total of 170 cyclists were involved in these accidents.

Because the relatively large number of accidents between vehicles turning right and cyclists or pedestrians using the adjoining marked crossing was particularly conspicuous at the frequent accident spots that were investigated, the behavior of the drivers when turning right was observed at three selected crossings for nine different turning situations.

A total of 2,054 turning maneuvers were recorded over an observation period of 16 hours in total. A distinction was made whether pedestrians were on or beside the crossing or were approaching the crossing when the vehicle turned. The random sample observation of the turning behavior

Table 3:
Accidents when turning right 2004 - 2006

				Consequence			Persons involved			
	A	A(PI)	PI	F	SI	MI	PED	CY	C	S
Quantity	195	157	152	1	19	132	7	170	14	36

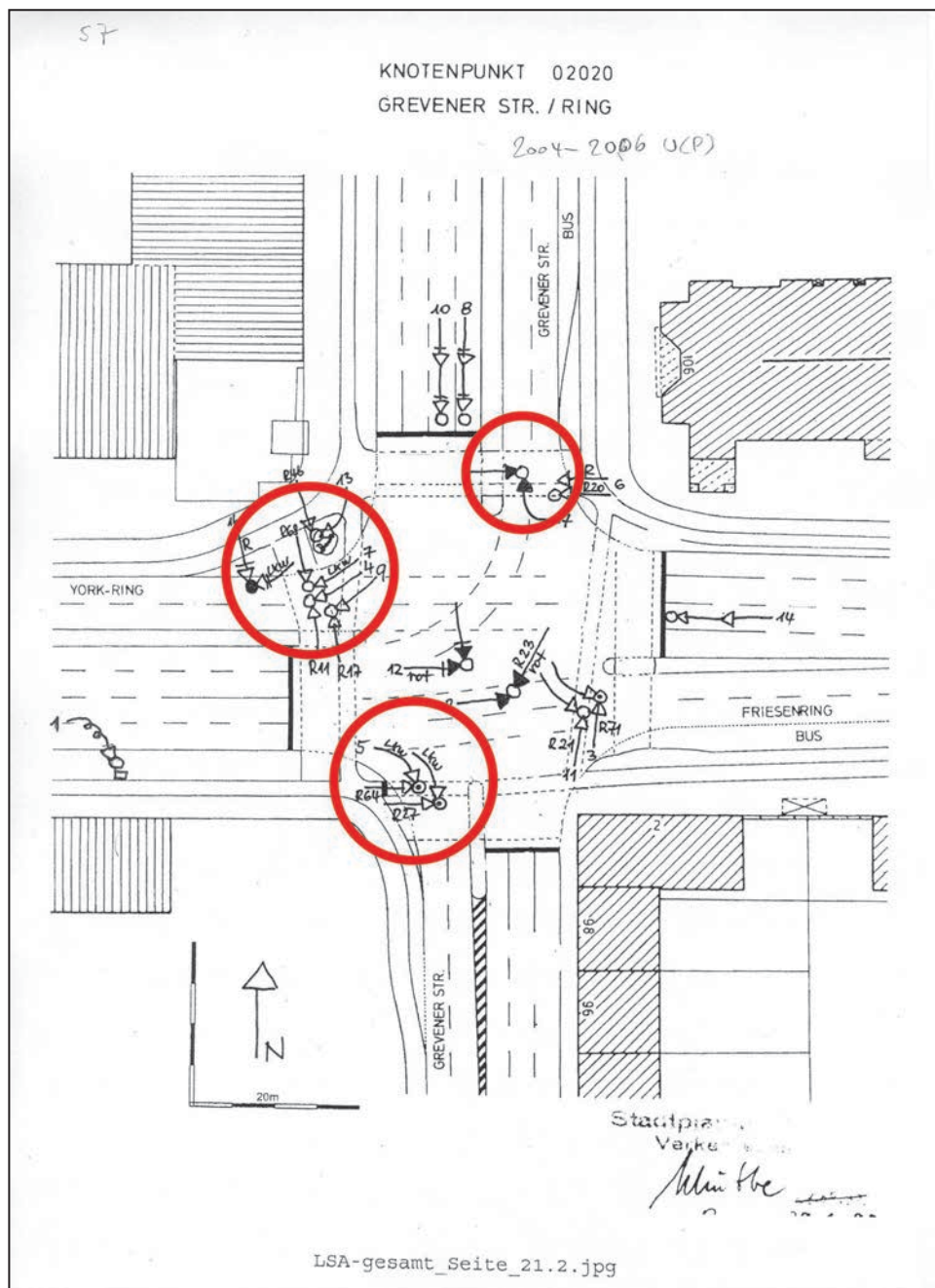


Figure 5:
Typical concentration of accident when turning off

of the drivers showed evidence of a high level of inattentiveness when turning. One third of drivers do not or do not adequately check whether cyclists wish to cross. Even if cyclists are on or directly beside the marked crossing, they are ignored by 15 % of drivers.

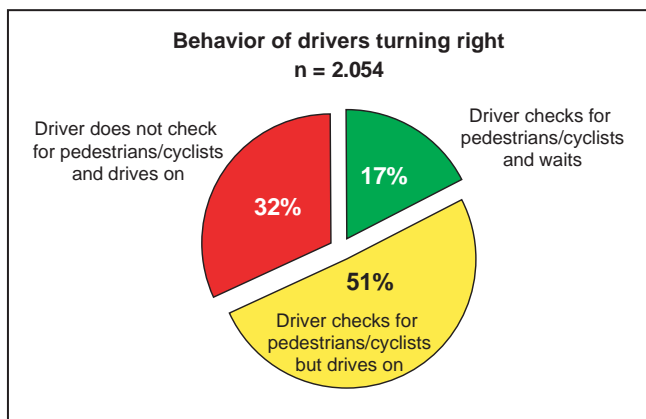


Figure 6:
A third of drivers do not check for pedestrians and cyclists when turning off

In addition, a large number of drivers were observed who did not allow cyclists right of way when turning off.

Conservative extrapolation to the total number of crossings by cyclists at signal-controlled intersections and junctions alone means that it can be assumed that at least 2,000 through 5,000 critical situations will be triggered each day by drivers turning right.

Use of the incorrect side of the road

414 accidents occurred with cyclists using the left side of the road during the observation period between 2004 and 2006. 1 person was killed, 48 suffered serious injuries and 282 suffered slight injuries. Since use of the incorrect side of the road or failure to ride on the right was only given as the cause for 136 of these accidents, it is probable that the 278 remaining accidents happened in the vicinity of bi-directional cycle paths. This leads us to conclude that there is inadequate signage of the bi-directional traffic at driveways/entrances, junctions and intersections.



Table 4:
Accidents involving cyclists where the cyclist was on the incorrect side of the road 2004 - 2006

				Consequence			Persons involved			
	A	A(PI)	PI	F	SI	MI	PED	CY	C	S
Total	414	313	331	1	48	282	8	490	48	70
Caused by cyclist	167	126	145	1	30	114	8	249	21	30
Caused by other	247	187	186	0	18	168	0	241	27	40

Over an observation period of 25 hours in total, 2,062 cyclists were observed at 6 different road cross-sections. The cyclists were categorized by age groups (children, adolescents, adults, senior citizens) and the general use made of the cycle paths was also observed.

The random sample observation showed that an average of approximately 1 % of cyclists did not use the mandatory cycle paths and 4 % of cyclists (irrespective of age) rode on the wrong side of the road. This leads not only to critical situations at junctions and driveways/entrances, but also to accidents between cyclists. Riding on signal-controlled crossings against the permitted direction is also particularly hazardous. Approximately a quarter of cyclists use the marked crossings in the wrong direction.

Speed measurements

5,994 accidents occurred between 2004 and 2006 involving rear-end collisions and lane changing maneuvers. Two people were killed, 53 suffered serious injuries and 846 suffered slight injuries. The large number of these types of accidents can be an indication that the speeds traveled are not compatible with the design of the roads or with the traffic volumes. Further evidence of this is provided by the significantly higher adjusted accident cost units determined

for accidents with serious personal injury on stretches of roads in Münster with a permitted maximum speed of 60 kph or 70 kph.

For this reason, speed measurements were carried out on 11 stretches of road with different permitted maximum speeds in both directions over a period of 24 hours for each stretch. A total of 224,574 vehicles were recorded. 34 % of these exceeded the maximum permitted speed. 10 % of the vehicles were traveling at more than 10 kph too fast and 2 % (4,523 vehicles) were even traveling at 20 kph too fast. This is also reflected in the V85²⁾ figure. At virtually all the locations at which measurements were taken, this lies significantly above the maximum speed.

The maximum permitted speed of 50 kph in particular is exceeded significantly. It is also especially serious that on the stretches with a maximum permitted speed of 70 kph, 1,419 vehicles were traveling in excess of 90 kph over the 144 hours during which measurements were taken. This is an average of 10 vehicles per hour.

Particularly by night, only a third of drivers observe the maximum speed limit. Every third driver drives 10 kph to 20 kph too fast at night and every sixth to tenth driver drives up to 30 kph too fast.

Table 5:
Rear-end accidents and accidents changing lane 2004 - 2006

					Consequence			Persons involved			
		A	A(PI)	PI	F	SI	MI	PED	CY	C	S
Quantity	Typ	5994	720	901	2	53	846	5	105	56	143
Rear-end accidents	60,61,62	4992	648	817	2	48	767	5	88	53	122
Accidents changing lanes	63,64	1002	72	84	0	5	79	0	17	3	21

²⁾ Speed that is not exceeded by 85 % of vehicles.

Table 6:
Speed measurements, summary

Maximum permitted speed	50 kph	60 kph	70 kph	Total
Number of measurement locations	15	2	6	22
Total measurement duration in h	360	48	144	528
Number of vehicles measured	126.420	30.200	82.676	224.574
V _m	50,7	56,6	60,3	53,5
V ₈₅	59,2	66,8	71,3	62,8
Maximum speed exceeded	43,0 %	29,0 %	22,2 %	33,9 %
Quantity	54.412	8.763	18.392	76.154
Speed exceeded by more than 10 kph	13,3 %	5,2 %	6,6 %	10,1 %
Quantity	16.817	1.565	5.443	22.704
Speed exceeded by more than 20 kph	2,4 %	0,7 %	1,7 %	2,0 %
Quantity	3.054	204	1.419	4.523
Speed exceeded by more than 30 kph	0,4 %	0,1 %	ne*	0,3 %
Quantity	523	45	ne*	568

* Speeds of more than 100 kph were not recorded separately.

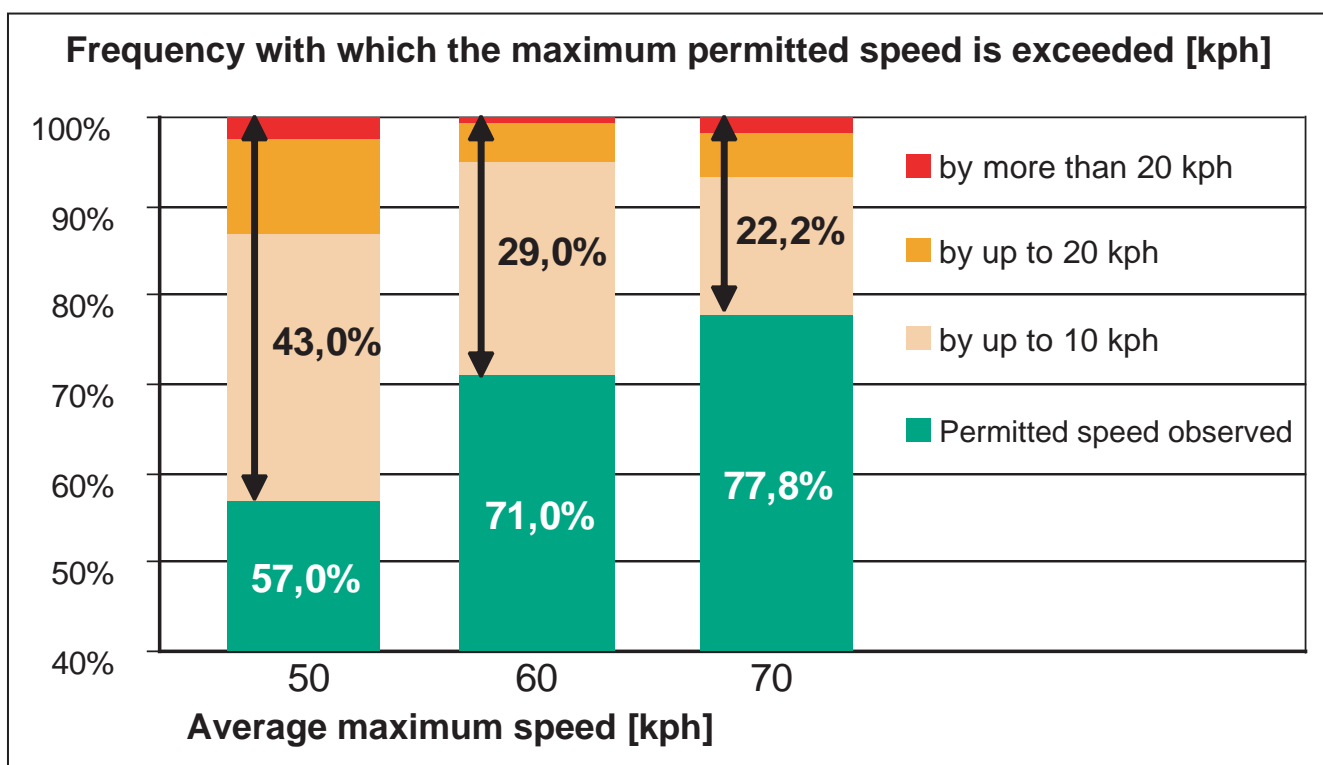


Figure 7:
Frequency with which the maximum permitted speed is exceeded

Summary and recommendations

On the basis of this expert report, it is now possible to continue development of the „Master Plan for the Prevention of Road Traffic Accidents in Münster“ as passed by the Council of the City of Münster and to establish a wide-reaching road traffic safety program for Münster that is to be updated annually by accident reports from the police and progress reports from the specialist administrative department.

Over the past years, the incidence of accidents involving personal injury has risen steeply in Münster, and this has particularly affected cyclists. Special attention must therefore be paid to the protection of the more vulnerable road users, and those who are most at risk, namely pedestrians and cyclists. Although these groups are only involved in approximately 10 % of all accidents (approx. 1,000 accidents per year), they represent around 60 % of all those injured and killed.

This rise in the number of accidents cannot just be put down to an increased willingness to take risks on the part of the individual road users. It is far more the case that the volume of traffic in respect of motor vehicles and cyclists has increased in recent years (1990 through 2007). The number of journeys made by vehicle has risen by 16 % and at the same time, the number of journeys made by bicycle has risen by 19 %³⁾. This means that the potential for conflict between the groups of road users has inevitably increased. The traffic systems have now begun to reach their limits with respect to road safety and in their current state, many places and routes are no longer adequate for ensuring a safe traffic flow. In particular, the extent of the cycle paths and the cycle traffic

control systems at intersections can no longer cope with the high proportion of cyclists in Münster.

Analysis of the accidents contained in the accident statistics for 2004-2006 and observation of the accident black spots (frequent accident spots as well as frequent accident lines) revealed intersections, stretches of roads and entire roads that showed enough evidence to conclude that there were systematic deficits.

The objective for the coming years must be to bring about effective improvements in road safety. Long-term success requires a combination of measures at different levels as derived from the analysis of the accidents, the observation of behavior and the speed measurements.

The measures involved will not only relate to construction or traffic control. It will also be necessary to develop road safety strategies and measures relating to educational and public relations activities in order to achieve a new quality of partnership between road users that will lead to a change in behavior on the roads.

The UDV has proposed concrete, suitable measures for improving road safety in the areas with significant numbers of accidents. In additions, strategies and recommendations have been worked out covering the whole of the city. Some of these are fundamental in nature and can be applied to other cities. These include:

- The introduction of separate turning phases at traffic signals in order to protect pedestrians and cyclists in particular.

³⁾ Data supplied by the City of Münster.

- Traffic signals will not be switched off at night.
- Surveillance to enforce traffic regulations and maximum speeds will be intensified.
- Clearer marking of cycle paths over driveways/entrances and junctions.
- Creation of safe crossings for pedestrians and cyclists.
- Targeted communication measures to improve the behavior of the road users.
- Increase the width of cycle paths, introduce cycle guidance markings on the road surface.

Conclusion

The results of the project show that a systematic approach making use of a comprehensive and detailed analysis of all accidents is vital if weaknesses in the infrastructure are to be uncovered and faults in the behavior of road users are to be identified. Only in this way is

it possible to develop and implement suitable measures and targeted strategies to improve road safety. Adequate financial resources and staffing are necessary to support the accident commissions in this work. However, the pilot project also shows that it can make sense to have the investigation carried out by external experts who are able to uncover shortcomings and recommend appropriate measures independently of any internal constraints. The systematic approach adopted in Münster should act as an example to be followed by as many local authorities as possible in order to achieve a marked reduction in the frequency and severity of accidents.

The City of Münster has now not only developed a „Master Plan for Improving Road Safety in Münster“ on the basis of the expert report provided by the Insurers Accident Research. For the next five years, it will be making available a budget of 5 million euros that will allow the majority of the proposed measures to be implemented.

For more information in this, visit www.udv.de and the section „Verkehrsinfrastruktur“ („Traffic Infrastructure“ - available in German only).



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