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Transportation Research Procedia 24C (2017) 474–481

Transportation Research Procedia

www.elsevier.com/locate/procedia

3rd Conference on Sustainable Urban Mobility, 3rd CSUM 2016, 26 – 27 May 2016, Volos, Greece

Car-pedestrian and car-cyclist accidents in Hungary

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Abstract

This study is connected to the PROSPECT project (PROactive Safety for PEdestrians and CyclisTs) that has a goal of developing a proactive on-board-system to cars. This system will more effectively identify and manage the incidents with VRUs (Vulnerable Road User) compared to those that are currently on the market. One of the first steps of our task is to define with statistical examination the main causes and circumstances which lead to car-pedestrian and car-cyclist accidents in Hungary. The basis of the accident research was a database about raw accident data (in chart form) provided by the Hungarian Central Statistical Office (KSH). This data was then systematized by a data managing system, and after the relevant queries, we processed it. This paper presents the results of this investigation which will be used to improve the software and hardware of the on-board-system.

Peer-review under responsibility of the organizing committee of the 3rd CSUM 2016.

Keywords: accident; car accident; pedestrian accident; cycling accident; vulnerable road users
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1. Introduction

The White Paper (Roadmap to a Single European Transport Area – Towards a Competitive and Resource Efficient Transport System) contains European Union goals on the area of traffic safety. *„By 2050, move close to zero fatalities in road transport. In line with this goal the EU aims at halving road casualties by 2020."* (European Commission, 2011) The goal set to 2020 is compared to the year 2010.

The reduction of pedestrian deaths in the EU in 2011 and 2012 was about 4% and was 2% in 2013. In the case of cycling accidents the reduction was annually lower than 1% in the period of 2011-2013 (European Transport Safety Council, 2015). According to these numbers the reduction of pedestrian and cyclist deaths is not enough to reach the 2020 goal (assuming equally 50% reduction per all modes of transport.)

In order to reach the EU goals, more effective methods are needed than currently in usage in order to improve traffic safety. Regarding this the White Paper suggests many actions, among them the introduction of the driver assistance systems and the particular attention to vulnerable road users such as pedestrians, cyclists and motorcyclists.

The goal of PROSPECT project is to develop a sensor and interruption system that can be integrated into cars and is able to recognize traffic situations that has accident hazard with pedestrians or cyclists. The method of identifying these situations consists partially of the examination of previous accidents, which shows what circumstances lead to these accidents, so in what cases the system needs to think that there is a probability of such a conflict. During the

2352-1465
Peer-review under responsibility of the organizing committee of the 3rd CSUM 2016.
10.1016/j.trpro.2017.05.085

project such analytical statistics were made by the traffic accident databases from Sweden (made by Chalmers University of Technology), from Germany (made by Bundesanstalt für Straßenwesen, as BASt) and from Hungary (made by Budapest University of Technology and Economics, as BME).

2. Method

The data for the preparing of road traffic injury statistics are from the database of KSH. This database is based on accident data sheets that are recorded during the police crime scene after an accident. According to international practice, **the outcome of an accident and the injury severity** (fatal, serious, slight / killed, seriously injured, slightly injured) **were taken into account 30 days after the accident**. In contrast, **for the suspected offender and the primary reason of the accident we relied on the findings at the crime scene**.

The database basically consists of 3 charts, the first one contains the data of accident (place, date, outcome, accident type etc.), the second one of participants (suspected offender, role in the traffic etc.), and the third one of the injured (age, sex, injury severity etc.). The participants and injured who were in the same accident can be identified by their unique accident identifier. The other identifier that belongs to the participants can be used to assign the injured to a vehicle. This structure of the database made it necessary to use a data managing system. After we managed to build an adequate database structure, we used the relevant queries and sorted the results in chart and graph form. We summarized the results of the research in the third chapter.

In this project **we examined accidents between 2011 and 2014 in Hungary**. First we identified some general accident rate indicators and from there we proceeded to investigate the pedestrian and cycling accidents and particularly to a more detailed examination of the car-pedestrian and car-cyclist accidents. This task of PROSPECT project has a lower focus on pedestrian accidents because those were investigated by another project before (AsPeCSS – Assessment Methodologies for Forward Looking Integrated Pedestrian and Further Extension to Cyclists Safety). During the work, of course, we have to consult with partners who are also responsible for analysis of accident data in their own country, because their accident database may have another structure and contain other data.

3. Results

3.1 General accident data

In the investigated four-year period annually an average of 15-16,000, a total of 62,539 personal injury traffic accidents occurred. From these accidents 2,217 (3.6%) were fatal, 18,282 (29.2%) were serious and 42,040 (67.2%) were slight. In these accidents approximately 20,000 people injured each year, a total of 81,874 in 4 years, of which 2,460 (3.0%) were killed, 20,775 (25.4%) were seriously injured, 58,639 (71.6%) were slightly injured. (Table 1.)

The number of accidents and injuries over the years did not change significantly, it stayed approximately the same. In terms of all accidents the suspected offender in 37,185 cases (59.4%) were the car driver, in 7,660 cases (12.2%) the cyclist and in 3,823 cases (6.1%) the pedestrian.

The next two subchapters present the results of investigation of car-cyclist and car-pedestrian accidents.

Table 1. Accidents in Hungary between 2011 and 2014.

	Outcome of accident	2011	2012	2013	2014	Total
Number of accidents	Fatal	563	541	540	573	2,217
	Serious	4527	4,355	4,687	4,713	18,282
	Slight	10,737	10,278	10,464	10,561	42,040
	Total	15,827	15,174	15,691	15,847	62,539
Number of persons killed or injured	Killed	638	605	591	626	2,460
	Seriously injured	5,154	4,921	5,369	5,331	20,775
	Slightly injured	15,051	14,064	14,729	14,795	58,639

Total	20,843	19,590	20,689	20,752	81,874

3.2 Car-cyclist accidents

We investigated cycling accidents in the course of the project, **in which a car and a cyclist were involved, this is called a car-cyclist accident.**

Out of 14,005 cycling accidents 7,920 (56.6%) were car-cyclist accidents. This value also shows how much potential is for an improvement tool. The car-cyclist accidents were fatal in 142 cases (1.8%), serious in 2,152 cases (27.2%) and slight in 5,626 cases (71.0%).

In terms of accident type 4,342 cases (54.8%) occurred between crossing (and turning) vehicles, 1,708 cases (21.6%) between turning and moving in the same direction or oncoming and turning vehicles. Between parallel moving vehicles 1,132 (14.3%) accidents occurred, 450 (5.7%) accidents befell with a parked vehicle and 162 (2.0%) accidents happened in a roundabout. (Table 2.)

Table 2. Number of car-cyclist accidents by accident type between 2011 and 2014.

Accident type	Number of accidents
Collision of vehicles moving straight ahead in the same direction	848
Collision of oncoming vehicles moving straight ahead	284
Collision of turning vehicles moving in the same direction	983
Collision of oncoming AND turning vehicles	725
Collision of crossing (but not turning) vehicles at intersections	2,264
Collision of crossing AND turning vehicles at intersections	2,078
Collision with parked vehicles	450
Accidents in roundabout	162
Unknown or typo	*126*
Total	7,920

The **suspected primary reason** of car-cyclist accidents was almost exclusively the driver's fault, in a total of 7,889 cases (99.6%), therefore we did not detail the accident numbers belonging to other reasons individually. Most of the car-cyclist accidents occurred in built-up areas (92.3%), nonetheless accidents occurred on the open road can't be ignored, because these accidents have a more serious outcome due to the typically higher impact speed. 47.2% of fatal and 10.1% of serious car-cyclist accidents occurred on the open road. (Table 3.)

Table 3. Number of car-cyclist accidents by primary reason between 2011 and 2014.

Primary reason of accident	Built-up area				On the open road			
	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total
Driver's fault	74	1,924	5,282	7,280	66	217	326	609
Defects of vehicle or road, pedestrian's or passenger's fault, other causes	1	11	15	27	1	0	3	4
Total	75	1,935	5,297	7,307	67	217	329	613

In terms of on-board-system developing it is particularly important to determine what kinds of faults the drivers typically make. We found that in car-cyclist accident's the **suspected offender** were the car driver in 4,809 cases (61.0%) and in 3,080 cases (39.0%) the cyclist. Inside built-up areas the rate was 61.5-38.5% and on the open road it was 54.7-45.3%.

The two most common faults committed by car drivers or cyclists in built-up areas were, in order, the "priority rule violation" and the "violation of rules for changing lines, turning and going ahead". These two faults caused accidents

by car drivers in 76.5% of cases and 75.7% when the offender was a cyclist. The cyclists committed more malpractice than car drivers in only 2 categories: a "violation of stopping rules" and "inappropriate lights on the vehicle". However the latter fault is very rare, a total of 3 cyclists, and 2 car drivers caused accident because of it. (Figure 1.)

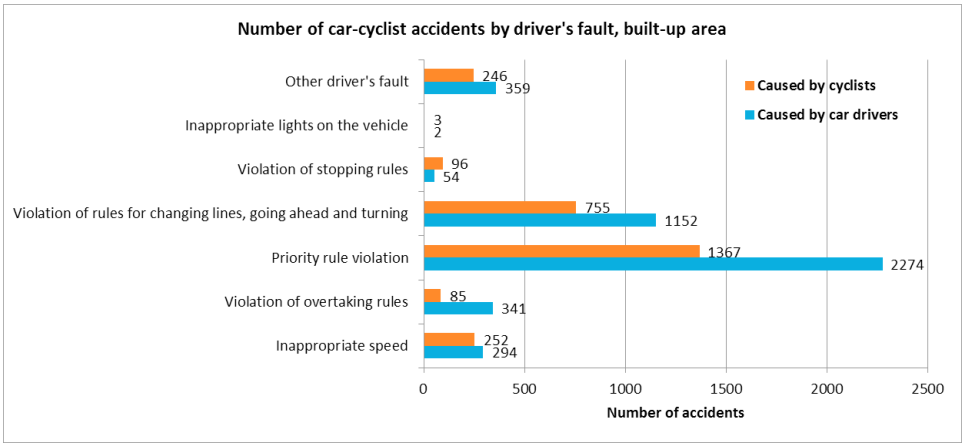

Figure 1. Number of car-cyclist accidents by drivers fault, built up area, between 2011 and 2014.

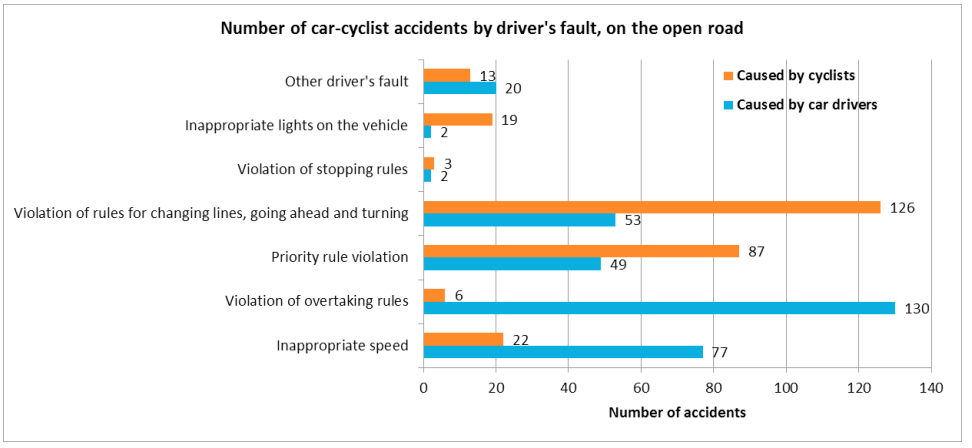

Figure 2. Number of car-cyclist accidents by drivers fault, on the open road, between 2011 and 2014.

The two most common faults on the open road committed by car drivers were in order the "violation of overtaking rules" and the "inappropriate speed", by cyclists were the "violation of rules for changing lines, going ahead and turning" and the "priority rule violation". These two most common faults caused in the case of car drivers 62.2% and in the case of cyclists 77.2% the accidents. The cyclists committed the "inappropriate lights on the vehicle" malpractice more often than in built-up areas, a total of 19 times. (Figure 2.)

The BASt categorized the German car-cyclist accidents into 4 groups, more detailed 16 scenarios (plus parking and other). The categorization based on three main aspects, these are the driving direction of car driver or cyclist (straight on or turning), used infrastructure by cyclist and road shape (intersection or not). After that they defined the distribution of the killed or seriously injured (KSI) accidents among the 16+2 scenarios. According to the Hungarian accident database grouping of accidents was only partially performed. Nevertheless another necessary task of this project was to make a stratified sampling (based on type of accidents) and select 100 KSI car-cyclist accidents which were under in-depth analysis. This gave an opportunity to categorize these 100 accidents to 16+2 scenarios specified by BASt.

After the categorization we found that in Germany accidents where the car moves straight and the cyclist crosses from left or right (group I. and group II) are more typical. In Germany accidents that belong to group I. (cyclist come

from right) have the biggest probability. In Hungary accidents where the cyclist moves straight on and the car also moves straight on or turns left or right (group III. and group IV.) has a bigger probability. Group III. has the highest probability in Hungary. Looking at the scenarios, in Hungary in order the 16th and 11th were common while in Germany the 1st and 16th scenarios (expect scenario 0) were the most common. The difference between the two countries may be caused by the difference in transport infrastructures, different regulations, and the diversity of traffic culture. In the comparison of Hungarian and German data we used gray highlight to show the highest percentages. (Figure 3.)

						KSI [%]			
Group	Scenario	Intersection	Vehicle driving direction	Cyclist driving direction	Cyclist used lateral roadside areas	BME (Hungary)		BASt (Germany)	
	0	Other				1	1	14	14
I	1	yes	Straight on	From right	Yes, before intersection	4	16	12	32
	2				No, on normal road	9		7	
	3				Yes, after intersection	2		1	
	4	no			n/a	1		7	
II	5	yes	Straight on	From left	Yes, before intersection	5	16	5	24
	6				No, on normal road	7		9	
	7				Yes, after intersection	3		1	
	8	no			n/a	1		4	
III	9	yes	Turn into, NOT crossing oncoming traffic	Longitudinal	No, on normal road	8	37	5	27
	10				yes	8		6	
	11		Turn into, crossing oncoming traffic		No, on normal road	15		10	
	12				yes	6		5	
IV	13	yes	Longitudinal	Same or opposing direction	yes	0	29	1	15
	14				No, on normal road	9		2	
	15	no			yes	0		1	
	16				No, on normal road	20		11	
	17	no	Parking (forward and backwards driving) from lateral lineup	From side	n/a	1	1	0	0

Figure 3. Percentage of car-cyclist accidents in Hungary and Germany, between 2011 and 2014, classified as BASt.

3.3 Car-pedestrian accidents

We investigated pedestrian accidents in the course of the project, in which a car and a pedestrian were involved, this is called a car-pedestrian accident.

Out of 10,114 pedestrian accidents 6,685 (66.1%) were car-pedestrian accidents. This value, as at car-cyclist accidents, also shows how much potential is for an improvement on-board-system. The car-pedestrian accidents were fatal in 306 cases (4.6%), serious in 2,133 cases (31.9%) and slight in 4,246 cases (63.5%). The suspected primary reason of car-pedestrian accidents was almost exclusively the driver's or pedestrian's fault, in a total of 6,679 cases (99.9%), therefore we did not detail the accident numbers belonging to other reasons individually. Inside built-up-areas, where 91.9% of all car-pedestrian accidents occurred, the car drivers were the suspected offender by nearly twice as many accidents as pedestrians and it is true for all of three severities. Nevertheless on the open road the pedestrians occurred as suspected offender 50% more accidents as car drivers. Moreover, accidents occurred on the open road have a more serious outcome due to the typically higher impact speed. 43.8% of fatal and 9.4% of serious car-pedestrian accidents occurred on the open road. (Table 4.)

Table 4. Number of car-pedestrian accidents by primary reason between 2011 and 2014.

Primary reason of accident	Built-up area				On the open road			
	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total

Driver's fault	113	1,266	2,574	3,953	47	75	90	212
Pedestrian's fault	59	664	1,460	2,183	87	125	119	331
Defects of vehicle or road, passenger's fault, other causes	0	3	2	5	0	0	1	1
Total	172	1,933	4,036	6,141	134	200	210	544

More specifically examined the car-pedestrian accidents caused by pedestrians, inside built-up-areas the most common primary reason of accident was the "incautious, sudden downstep" (47.2%). The "crossing behind obstruction", „illegal crossing" and „crossing during red light" offences were also significant. These four primary reasons of accidents amount to 91.7% of all car-pedestrian accidents which caused by pedestrians inside built-up areas. On the open road the "incautious, sudden downstep" was also the most frequently primary reason of accident (41.7%), from just behind the "other pedestrian fault" (37.5%) was. This high rate of "other pedestrian fault" on the open road shows that it may be necessary to add new categories to a primary reason of accidents caused by pedestrians. It can improve the evaluation of pedestrian accidents. (Table 5.)

Table 5. Number of car-pedestrian accidents, caused by pedestrians, between 2011 and 2014.

Primary reason of accident	Built-up area				On the open road			
	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total
Incautious, sudden downstep	31	313	686	1,030	34	53	51	138
Crossing during red light	6	88	197	291	0	0	1	1
Illegal crossing	9	98	200	307	6	7	5	18
Crossing behind obstruction	4	109	260	373	2	10	5	17
Inappropriate behaviour during crossing	3	21	53	77	10	9	14	33
Leaving child without supervision	0	2	8	10	0	0	0	0
Other pedestrian fault	6	33	56	95	35	46	43	124

In terms of car-pedestrian accidents caused by car drivers inside built-up areas the most common suspected primary reason of accident was the "denied priority" (58.1%), it follows the „denied rules for changing lines, going ahead and turning" (16.4%) and after that the "other driver's fault" (10.3%). Although the "inappropriate speed" was only the 4th most common suspected primary reason of accident, but nearly as many fatal accident occurred as "denied priority".

On the open road the car-pedestrian accidents caused by car drivers the most frequently suspected primary reason of accident was the "inappropriate speed" (45.3%) and after that the "other driver's fault" (21.7%), other reasons were less frequently, especially with regard to fatal accidents. Note that in the case of car-pedestrian accidents caused by car drivers occurred 30 fatal accidents in that the suspected primary reason of accident was the "inappropriate speed", this is 63.8% of all car-pedestrian accidents which caused by car drivers. Therefor the "inappropriate speed" stands out with regard to fatal accidents inside built-up areas and on the open road equally. (Table 6).

Table 6. Number of car-pedestrian accidents, caused by car drivers, between 2011 and 2014.

Primary reason of accident	Built-up area				On the open road			
	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total

Inappropriate speed	36	135	187	358	30	35	31	96
Non observance of rules for overtaking	4	29	100	133	1	6	13	20
Denied priority	40	703	1,555	2,298	4	6	7	17
Denied rules for changing lines, going ahead and turning	6	222	421	649	0	12	19	31
Denied stop-sign and obligation	3	35	66	104	0	0	2	2
Denied lighting obligations	0	1	1	2	0	0	0	0
Other driver's fault	24	141	244	409	12	16	18	46

The BASt categorized the German car-pedestrian accidents into 7 groups (plus other). The categorization based on three main aspects, these are the moving direction of a pedestrian relative to the car (near- or off-side), the road shape (intersection or not), and the obstruction. Every 7 groups have two sub-group, daylight (A) and darkness (B). After that they defined the distribution of the fatal, the KSI and summarized each of three severity accidents among the 7+1 groups. According to the Hungarian accident database grouping of accidents was also only partially performed, because the Hungarian database did not store information about pedestrians moving direction in the case of "no obstruction". So the categories 1, 2 and 3, 4 could only be examined together.

After the categorization we found that in Hungary are more typical accidents (in terms of all of three severities) in that the pedestrian arrives not behind obstruction, particularly at daylight (group 1-4). In Germany accidents that belonging to group 5-6 (with obstruction) and to "other" has bigger probability. In the case of fatal accidents by group 1 and 2 is conspicuous that typically occurred in darkness in Germany while in Hungary are nearly equal numbers of those at daylight and in darkness. The difference between the two countries may be cause also by the difference in transport infrastructures, different regulations, and the diversity of traffic culture. In the comparison of Hungarian and German data we used gray highlight to show the highest percentages at "total". (Figure 4.)

		BME (Hungary)			BASt (Germany)		
No.	Description	Killed	KSI	Total	Killed	KSI	Total
1 and 2 A	Crossing a straight road from the near- or off-side; no obstuction	30%	36%	37%	16%	25%	23%
1 and 2 B		34%	24%	20%	47%	23%	14%
3 and 4 A	Crossing at a junction from the near- or off-side; vehicle turning or not turning across traffic	2%	8%	10%	3%	6%	3%
3 and 4 B		1%	3%	4%	2%	6%	4%
5 A	Crossing a straight road from the near-side; with obstuction	1%	2%	3%	3%	9%	6%
5 B		1%	0%	0%	3%	2%	1%
6 A	Crossing a straight road from the off-side; with obstuction	1%	1%	1%	1%	5%	4%
6 B		1%	0%	0%	2%	2%	1%
7 A	Along carriageway on a straight road; no obstruction	1%	3%	4%	2%	2%	4%
7 B		7%	3%	3%	9%	3%	3%
Other		18%	17%	17%	12%	17%	37%
n/a		3%	1%	1%	-	-	-

Figure 4. Percentage of car-pedestrian accidents in Hungary (between 2011 and 2014) and Germany (between 2008 and 2010), classified as BASt.

4. Conclusions

The analysis of accident data has shown that the number of car-pedestrian and car-cyclist accidents is significant. (56.6% of cycling accidents were car-cyclist accidents and 66.1% of pedestrian accidents were car-pedestrian accidents.) So the developed on-board-system has the possibility to effectively reduce the number and severity of accidents. Most of the analyzed accidents occurred inside built-up areas (92.1%), nonetheless accidents that occurred on the open road can't be ignored, because these accidents have more serious outcome due to the typically higher

impact speed. So 44.9% of all analyzed fatal accidents occurred on the open road.

Despite the fact that the number of car-pedestrian accidents are typically 10-20% lower than the car-cyclist accidents, fatal cases in car-pedestrian accidents happened twice as much. So collision with a car includes a significantly higher risk for a pedestrian than for a cyclist in terms of fatal accidents.

The suspected offender of car-cyclist accidents in 3/5 of the cases were the car driver. The most typical type of accidents are tied to crossing or turning movements, 76.4% of the accidents happened like this. In accordance with this the most common faults caused by cyclists and drivers are “priority rule violation” and the “violation of rules for changing lines, going ahead and turning”. These faults are common on the open road as well. This shows that in the development of the on-board system it is really important to effectively recognize these types of situations to prevent accidents. This conclusion is backed up by German accidents (BASt) data too.

91.9% of pedestrian accidents happened in built-up areas, however only 35.6% of the accidents were caused by pedestrians. On the road the situation is different, in 60.8% of the cases the pedestrian was the suspected offender. The most common fault caused by pedestrians is “incautious, sudden downstep”; while in the case of car drivers it is “denied priority”. So the recognition of priority rules, just like in car-cyclist cases, is really important. Necessary to note that fatal accidents caused by car drivers mostly happened because of “inappropriate speed”.

The above findings, of course, could not only be used to develop the on-board system; they could help in improving traffic behaviour and the education of car drivers by showing what traffic situations and rules should be focused on during practice and teaching.

Acknowledgements

The research leading to these results has received funding from the European Union's Horizon 2020 Programme for research, technological development and demonstration under the project PROSPECT (Proactive Safety for Pedestrian and Cyclists - Grant agreement number: 634149).

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