COMPARATIVE ANALYSIS OF JUNCTION SAFETY IN EUROPE

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ABSTRACT

In Europe about 25% of road accident fatalities occur at junctions of various types, with the higher percentage (34%) being observed in the United Kingdom and the lower (<10%) in Greece. The objective of this research is the analysis of road safety related parameters in European road junctions through the use of the EU CARE database with disaggregate data on road accidents as well as of other international data sources (OECD/IRTAD, Eurostat, etc.). Time-series data from 16 EU countries over a period of 10 year (1997-2006) are correlated with basic safety parameters, such as junction geometric design, vehicle type, area type, gender of the driver, and weather and lighting conditions. During this period an overall decrease of almost 25 percent in traffic accident fatalities in junctions was observed, with values ranging between a decrease of 60% for France and an increase of 35% for Greece. The results of the analysis allow for an overall assessment of the road safety level in the European road junctions in comparison to the remaining road network, providing thus useful support to decision makers working for the improvement of safety in the European road network.

KEY-WORDS

Junctions; Road accident data; Road safety; European countries

INTRODUCTION

The objective of this research is the macroscopic analysis of road safety related parameters in junctions in the European road networks, using data from the EU CARE database with disaggregate data on road accidents, together with data from other international data files (e.g. IRTAD, as well as national sources). More specifically, road accident data on junctions for the period 1997-2006 and 16 EU countries are correlated with basic safety parameters like the vehicle type, prevailing weather and lighting conditions and the person age. The data on which this analysis is based, along with much of the analysis, is obtained through the SAFETY-NET project and the European Road Safety Observatory (ERSO). Many of the source data can be found in ERSO (2008), as well as other ERSO deliverables.

The results of this comparative analysis among countries will allow for drawing an overall picture of the road safety level in junctions in Europe in comparison with the remaining road network, providing thus useful support to all decision makers working for the improvement of safety in the European road network. The analysis of safety at junctions is hardly a new topic (see e.g. Kulmala, 1994, or Amudsen and Elvik, 2004), but this paper presents a wealth of macroscopic data that provides an up-to-date view on the topic of road junction safety. The analysis can be used to develop strategies for the decision support of targeting infrastructure improvements so that they will be most effective (e.g. along the lines of efforts in the US such as Lu and Wang, 2005, UDOT, 2008, FHWA, 2009).

Table 1 summarizes the definition of the country abbreviations that are used in the remainder of this paper.

Table 1. Definition of used country abbreviations

EU-12		**EU-16 = EU-12 +**	
BE	Belgium	EE	Estonia
DK	Denmark	HU	Hungary
EL	Greece	PL	Poland
ES	Spain	CZ	Czech Republic
FR	France		
IT	Italy	**EU-25 = EU-16 +**	
LU	Luxemburg	DE	Germany
NL	Netherlands	IE	Ireland
AT	Austria	CY	Cyprus
PT	Portugal	LV	Latvia
FI	Finland	LT	Lithuania
UK	United Kingdom	MT	Malta
		SE	Sweden
		SI	Slovenia
		SK	Slovakia

It is stressed that, like many road safety statistics, statistics related to junction road accidents should be read carefully due to the presence of a high proportion of "unknown" entries in specific countries (e.g. AT, EE, IE, MT, PT, SE), which might affect the percentages presented. The highest proportions of “unknown” entries though are observed for IE, MT and SE (from 2003 onwards) (79,4%, 100% and 75,3% respectively) therefore these countries are excluded from the following Tables and Figures.

Furthermore, for all presented statistics (where specific dates are not indicated, latest available data are used, i.e. 2006 for all countries except LU (2002), NL (2003), IT (2004). For the UK, 2006 data stands for GB (Great Britain) and 2005 data for NI (North Ireland).

The remainder of this paper is structured as follows. The following Section includes an outline the overall trends in numbers of fatalities at junctions in the context of the overall evolution of traffic fatalities over a period of 10 years (1997-2006). In the next Section, the distribution of traffic accident fatalities by junction type is presented, while in the next Section the number of fatalities by country is related to characteristics, such as the type of area in which the junction is situated, the transport modes used by the involved persons and their basic socioeconomics characteristics. Concluding remarks are provided in the last Section.

OVERALL TRENDS

The trends of number of fatalities overall and at junctions in 12 European Union countries are shown in Figure 1. More than 62.000 persons were killed in traffic accidents at junctions in 12 European Union countries between 1997 and 2006. This figure corresponds to more than one fifth (about 21%) of all traffic accident fatalities in those countries. In these 12 countries there were 24,8% fewer traffic accident fatalities at junctions in 2006 than in 1997, whereas the total number of fatalities fell by 29,2% over the same period.

The number of traffic accident fatalities at junctions increased by 5,4% in 2001 compared to 2000, whereas the overall number of fatalities fell by 1,8%. This increase is mainly attributed to Italy where accidents at junctions increased by 34%, although the total number of fatalities rose only by 0,6%. The two fatality trends are similar after 2001, as indicated in Figure 1.

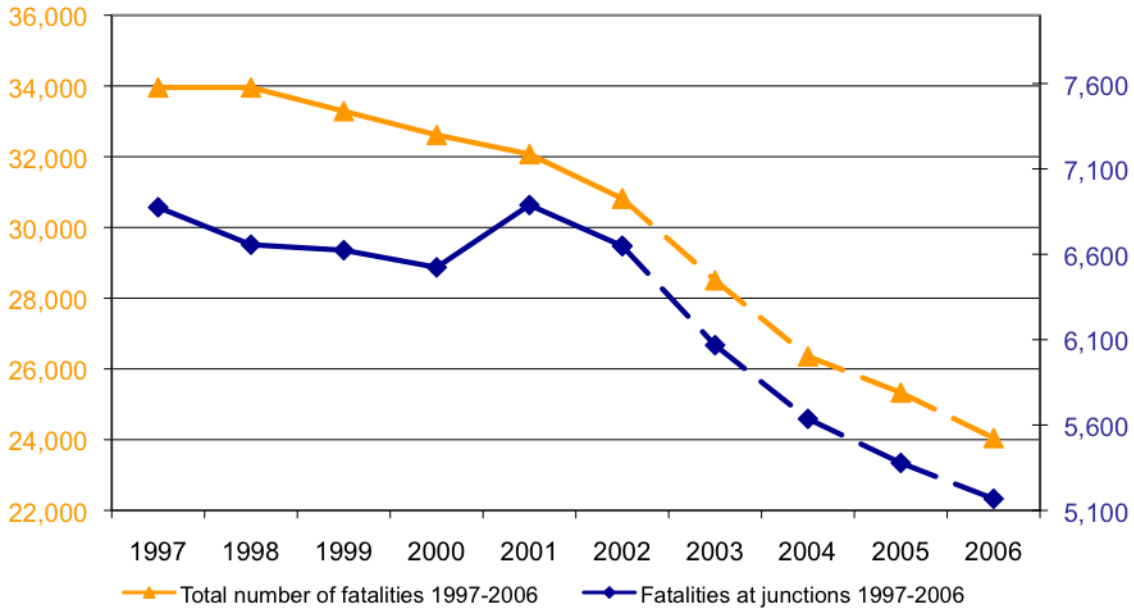
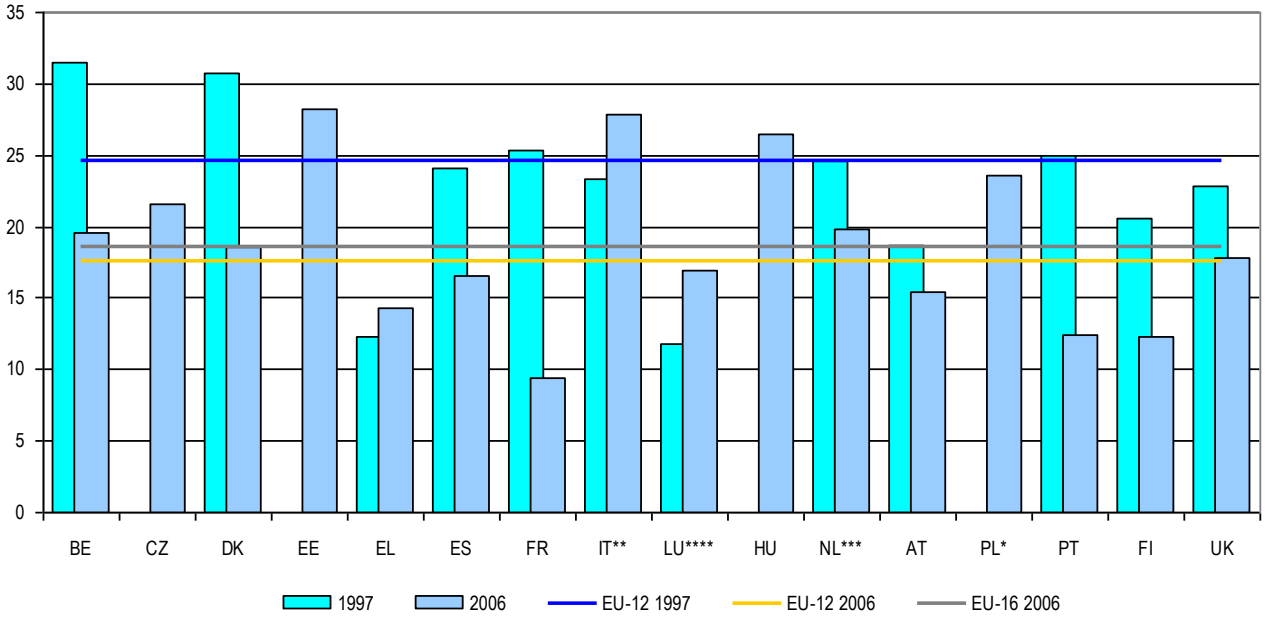


Figure 1. Overall trends in number of fatalities (1997-2006)

Figure 2 summarises the fatality rate at junctions in 1997 and 2006 for some EU countries, along with the average trends for EU-12 in 1997 and 2006, as well as EU-16 in 2006. From the underlying data it can be seen that the fatality rate at junctions decreased by 28,6% between 1997 and 2006 in the 12 EU countries (from 24,5 in 1997 to 17,5 in 2006). France shows the most significant decrease by 62,5% in road fatality rates at junctions within the examined period.

In 1997 the highest fatality rate was in 30,3 (in Belgium), whereas in 2006 the highest rate was 28,3 (in Estonia). Eight of the countries are lower than the average rate of all EU-16 countries for 2006, with France having a fatality rate almost half the average EU-16 rate. The inclusion of data from three new Member States (Czech Republic, Hungary, Estonia and Poland) increased the EU average for 2006 slightly (being equal to 18,6 with the new countries included, and 17,5 without).



* Data from 2005 (UK = GB 2006 + NI 2005)
** Data from 2004
*** Data from 2003
**** Data from 2002

Source: CARE Database / EC
Date of query: July 2008

Figure 2: Fatalities at junctions per million inhabitants in the EU-12/16, 1997 versus 2006

An analysis of the proportion of the overall road fatalities in 2006 that occurred at junctions indicates that the highest percentages were obtained in the United Kingdom, where more than one third of the overall road accident fatalities in 2006 occurred at junctions (34,1%), Denmark (33%) and the Netherlands (31,5%). On the other hand, in Greece (9,6%) and Portugal (10,5%) fatalities at junctions constitute a minority of the overall road accident fatalities. One explanation for this could be sought in the different overall level of traffic safety in these groups of countries. In particular, it can be argued that in the countries where great success has been achieved in terms of road safety, the number of fatalities in the general network has been reduced considerably, leaving a large proportion of fatalities occurring at junctions (where arguably there are more risk factors). On the other hand, in countries where there is a lot of potential of improvement in terms of road safety, accidents tend to happen throughout the road network.

DISTRIBUTION BY JUNCTION TYPE

The term “junction” can have a very broad range and include different configurations, or even definitions. In this section, definitions for the various types of junction configurations for each country are outlined and the number of fatalities by each type per country is presented. Table 2 presents the number of fatalities by type of junction by country for the year 2006.

The definition of a junction is that of a road intersection with three or more arms and which is not grade separated. It includes the following categories: T-junction, Y-junction, crossroad (road intersection with four arms), level crossing (except for DK, FI, GB, NI), roundabout (circular highway, in some cases, i.e. GB, IE, NI, AT, includes sections of the road leading into it within 20m) (except for FR) and multiple junction.

Fatalities are classified as not being at a junction if their position is on a road more than 20m from a junction or roundabout (GB, IE, NI, NL, AT), or more than 50m from a junction (FR). For the other countries the classification is based on the opinion of the police officer who filed the report.

While the lack of exposure data, or even data on the number of each of the junction configuration, are not available, some observations can be made. For example, roundabouts seem to have a low number of fatalities; a finding consistent with prevailing expectations and the state-of-fhe-art (e.g. De Brabandera et al, 2005, Elvik, 2003).

Table 2. Number of fatalities by type of junction by country, 2006

	Not at junction	At junction					Not defined	Total
		Cross road	Level crossing	T or Y junction	Other junction	Round about		
BE	862	0	0	0	194	13	0	1.069
CZ	838	89	33	99	0	0	4	1.063
DK	205	51	2	1	43	4	0	306
EE	146	11	0	15	11	1	20	204
EL	1.498	0	0	0	0	0	0	1.657
ES	3.376	259	0	285	115	69	0	4.104
FR	4.116	243	24	150	123	53	0	4.709
IE***	0	16	0	48	5	4	264	337
IT**	3.984	774	7	0	789	71	0	5.625
LU****	54	6	0	2	0	0	0	62
HU	1.037	234	20	0	9	3	0	1.303
MT	0	0	0	0	0	0	11	11
NL***	704	161	29	122	0	9	0	1.028
AT	402	81	18	26	0	3	200	730
PL*	4.546	892	0	0	0	6	0	5.444
PT	620	30	7	80	2	13	218	969
FI	264	0	0	0	65	0	7	336
SE	9	83	0	0	11	5	337	445
UK*	2.172	169	0	655	243	68	0	3.307
EU-19	24.748	3.087	137	1.476	1.610	322	1.060	32.709
% by junction	75,9%	9,5%	0,4%	4,5%	4,9%	1,0%	3,3%	100,0%

* Data 2005 (UK = GB(2006) + NI(2005))
** Data 2004
*** Data 2003
**** Data 2002
Source: CARE Database / EC
Date of query: July 2008

DISTRIBUTION BY DIFFERENT CHARACTERISTICS

Classification by area types

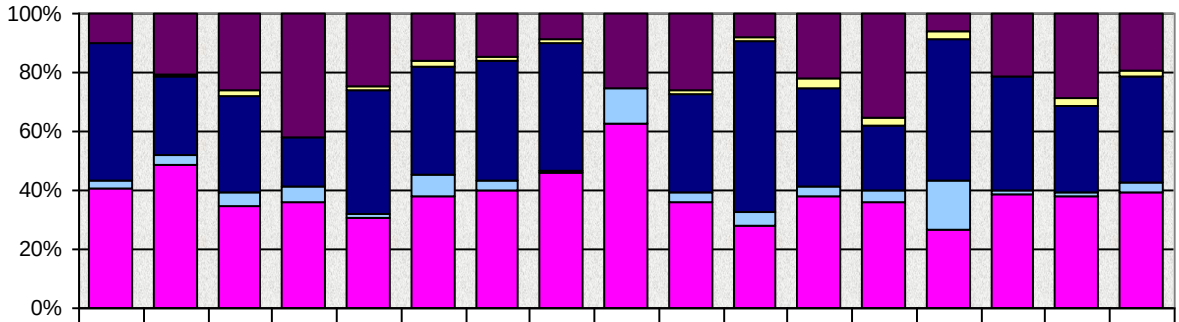
The percentage of fatalities at junctions inside (respectively outside) urban areas per country for year 2006 is presented in Table 3. Road accident fatalities at junctions occur mostly within urban areas in the 12 EU countries (more than 3.4 of fatalities in junctions in Greece and Luxemburg are inside urban areas, while in Hungary, Poland, the UK and Portugal this percentage is above 60%). Of course, there are exceptions to this patter, with Belgium and Spain recording about 65% of the fatalities at junctions outside of urban areas. Furthermore, it can be observed from the underlying data that the number of fatalities at junctions has fallen more quickly in recent years (1997 - 2005) in urban (-25,1 %) than in rural areas (-17,9%).

	Fatalities at junctions inside urban areas	outside urban areas
BE	35.0%	65.0%
CZ	56.8%	43.2%
DK	47.5%	52.5%
EE	44.7%	55.3%
EL	75.5%	24.5%
ES	35.3%	64.7%
FR	50.4%	49.6%
IT	50.5%	49.5%
LU	75.0%	25.0%
HU	66.9%	33.1%
NL	51.9%	48.1%
AT	56.3%	43.8%
PL	65.9%	34.1%
PT	62.6%	37.4%
FI	55.4%	44.6%
UK	64.1%	35.9%
EU-12	**51.9%**	**48.1%**

Table 3. Fatalities at junctions by type of area (percent inside/outside of urban areas), 2006

Classification by mode of transport

Figure 3 visualises the distribution of fatalities at junctions by mode of transport in the EU-16, for the year 2006. Several observations can be based on this data. For example, in Estonia and Poland the number of pedestrian fatalities at junctions is considerably higher than the EU-16 average (41,7% and 35,5% respectively, while the average is 19,5%). Additionally, in Portugal the number of lorries occupants' fatalities at junctions is more than five times the EU-16 average (16,5% compared to 3,1%), considerably higher than the respective rate in all other considered countries. In some countries (Belgium, Portugal) the percentage of two-wheeler fatalities at intersections exceeds 45%, while in the Netherlands it exceeds 55% (57,7%).



	BE	CZ	DK	EE	EL	ES	FR	IT**	LU****	HU	NL***	AT	PL*	PT	FI	UK*	EU-16
Pedestrian	9,7%	20,7%	25,7%	41,7%	24,5%	16,2%	14,8%	8,8%	25,0%	26,3%	8,0%	21,9%	35,5%	6,1%	21,5%	29,0%	19,5%
Others	0,5%	0,9%	2,0%	0,0%	1,3%	1,5%	1,2%	1,4%	0,0%	0,8%	1,5%	3,1%	2,4%	2,6%	0,0%	2,1%	1,6%
Two-wheelers	46,6%	26,6%	32,7%	16,7%	42,1%	36,7%	41,0%	42,9%	0,0%	33,8%	57,7%	33,6%	22,2%	47,8%	38,5%	29,3%	36,3%
Lorries	2,4%	3,2%	5,0%	5,6%	1,3%	7,6%	2,9%	0,8%	12,5%	3,0%	4,9%	3,1%	3,6%	16,5%	1,5%	1,5%	3,1%
Car / taxi	40,8%	48,6%	34,7%	36,1%	30,8%	38,0%	40,1%	46,0%	62,5%	36,1%	27,8%	38,3%	36,3%	27,0%	38,5%	38,1%	39,4%

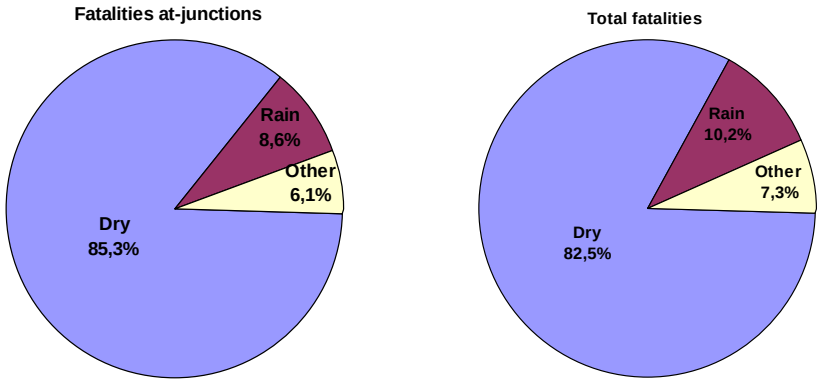
* Data from 2005 (UK = GB 2006 + NI 2005)
** Data from 2004
*** Data from 2003
**** Data from 2002

Source: CARE Database / EC
Date of query: July 2008

Figure 3: Distribution of fatalities at junctions by mode of transport in the EU-16, 2006

Classification by prevailing weather and lighting conditions

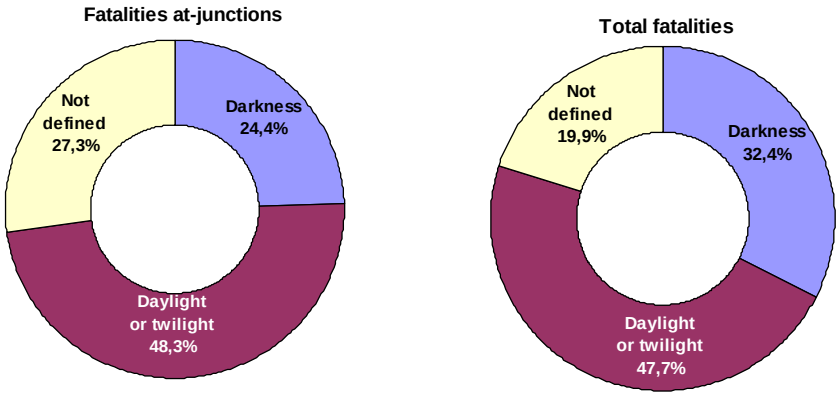
The impact of prevailing weather and lighting conditions on junction safety is an important topic. Based on the macroscopic data that is available from the CARE database and the European Road Safety Observatory, no clear conclusions can be drawn about specific characteristics of fatalities at junctions, as opposed to the total number of fatalities. As shown in Figure 4, weather conditions appear to affect accident fatalities at junctions in a similar way to fatalities in accidents that occur away from junctions.



Source: CARE Database / EC
Date of query: July 2008

Figure 4. Fatalities at junctions and total fatalities by weather conditions in the EU-16, 2006

As shown in Figure 5, in 2006 24,4% of the fatalities at junctions in 16 European countries (1.620 people) occurred when it was dark. The distribution of all fatalities according to lighting conditions is different, as there is a somewhat larger share of fatalities occurring when it is dark (32,4%, corresponding to 10.351 people). From the data it can also be inferred that almost half of all road accident fatalities (at junction or not) occurred during daylight or twilight.



Source: CARE Database / EC
Date of query: July 2008

Figure 5. Fatalities at junctions and total fatalities by lighting conditions in the EU-16, 2006

Classification by socioeconomic characteristics

Based on data from the 16 EU countries, accident involvement of female drivers at junctions is considerably lower than the involvement of male drivers (13,7% female fatalities at junctions and 86,3% of male respectively). This may be caused by the lower driving exposure (e.g. lower rate of driver license ownership, lower number of kilometres driven per unit time) of female drivers. Additionally, 60% of pedestrian fatalities at junctions are male and approximately 40% are female.

CONCLUSION

In Europe about 25% of road accident fatalities occur at junctions of various types, with the higher percentage (34%) being observed in the United Kingdom and the lower (<10%) in Greece. The objective of this research is the analysis of road safety related parameters in European road junctions through the use of the EU CARE database with disaggregate data on road accidents as well as of other international data sources (OECD/IRTAD, Eurostat, etc.). Time-series data from 16 EU countries over a period of 10 year (1997-2006) are correlated with basic safety parameters, such as junction geometric design, vehicle type, area type, gender of the driver, and weather and lighting conditions. During this period an overall decrease of almost 25 percent in traffic accident fatalities in junctions was observed, with values ranging between a decrease of 60% for France and an increase of 35% for Greece.

Tables and figures of the main analyses are presented and discussed, leading to findings such as the following:

- With respect to junction geometric design, 47% of fatal accidents at junctions in 2006 occurred at crossroads and 22% at T or Y intersections, while only 5% occurred at roundabouts.
- About 40% of the fatalities at junctions across the considered European countries are car or taxi occupants, followed by 35% two-wheeler users and almost 20% pedestrians. More than half of the fatalities at junctions in the Netherlands are two-wheeler users, a higher proportion than the other 15 countries. In Portugal the number of fatalities of lorry occupants at junctions is more than five times the average.
- Accident involvement of female drivers at junctions is considerably lower than the involvement of male drivers (86% of all drivers) and male pedestrians (60% of all pedestrians), possibly due to a higher exposure of male drivers.
- Almost a quarter of the fatalities at junctions occurred during the night, somewhat less than the proportion of fatalities occurring during the night for all accidents (almost one third of all fatalities).

The results of the analysis allow for an overall assessment of the road safety level in the European road junctions in comparison to the remaining road network, providing thus useful support to decision makers working for the improvement of safety in the European road network. Of course, the effort of data-collection is an ongoing challenge and there are additional

data that could help shed light to the problem of road safety. Of particular interest are exposure data. Furthermore, the macroscopic analysis presented in this paper could in the future be combined with in-depth analysis of intersection accident data, thus providing further insight into the causes and impacts of accidents occurring at junctions.

ACKNOWLEDGMENT

This paper is based on work carried out within the scope of the SafetyNet project (The European Road Safety Observatory) of the 6th Framework Program for Research, Technological Development and Demonstration of the European Commission.

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