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Authors: Juned Akhtar, Mikael Ljung Aust, Rickard J. Eriksson, Helen Fagerlind, Alene Høye, Ross Phillips and Fridulv Sagberg
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Summary:

Factors contributing to road fatalities

Analysis of in-depth investigation data from passenger car intersection crashes and from collisions between bicycles and motorized vehicles

Inattention or distraction among drivers are frequent causes of intersection crashes and of collisions between bicycles and motorized vehicles. This is shown by analyses of data from in-depth studies of fatal road crashes for the years 2005-2007, collected by crash investigation teams of the Norwegian Public Roads Administration. The intersection crashes that were analysed included cases involving at least one car, and in the majority of crashes the other party was either a heavy vehicle or a motorcycle; i.e., most fatal intersection crashes are collisions between vehicles with a large mass difference. The most frequent course of events was a car driver turning left before an oncoming vehicle that was not observed or observed too late. High speed combined with expectancies that the turning driver would yield, in some cases contributed to the failure of an avoidance manoeuvre on the part of the driver going straight. In the bicycle crashes there were many cases where the car driver had not seen the bicyclist before the crash, either due to inattention and low expectancy of bicycle traffic, or to sight obstacles in the vehicle or in the road environment. The crashes were analysed by using the "Driver Reliability and Error Analysis Method" (DREAM), and the analyses revealed some needs for improvement in road crash data collection and causation analyses.

Analyses based on reports from accident investigation teams of the Norwegian Public Roads Administration

All fatal road crashes in Norway are investigated in depth by multidisciplinary teams within the Norwegian Public Roads Administration (NPRA), and a report is prepared for each crash. In this study, reports from the NPRA investigation teams were used for further investigation of two selected types of crashes. The first type is intersection crashes involving at least one passenger car, and the second type is collisions between bicycles and motorized vehicles.

The main purpose of the study was two-fold. The first objective was to apply the Driver Reliability and Error Analysis Method (DREAM) for analysis of contributing factors, in order to get a more complete picture of the most frequent risk factors in the two types of crashes. The second purpose was to make an assessment of the data and analyses provided in the reports from the NPRA crash

The report can be ordered from:
Institute of Transport Economics, Gaustadalléen 21, NO 0349 Oslo
Telephone: +47 22 57 38 00 Telefax: +47 22 60 92 00

investigation teams, and to discuss the need for improvements regarding data collection and/or methods of analysis.

An additional purpose was to develop a computerbased tool (a ”wiki”) to assist in the use of DREAM for causal analysis, including links to relevant parts of the DREAM manual in English, Swedish and Norwegian.

From among the crash reports for the years 2005-2007 all crashes of the two mentioned types were selected. This resulted in 28 intersection crashes and 15 collisions between bicycle and motorised vehicle. In the case where the two categories overlapped, i.e. intersection crash between bicycle and passenger car, the crash was included among bicycle crashes.

DREAM – a tool for analysing events and their possible causes

DREAM is an adaptation to the traffic safety domain of the Cognitive Reliability and Error Analysis Method CREAM (E. Hollnagel: Cognitive reliability and error analysis method CREAM. Oxford: Elsevier Science, 1998). DREAM contains a classification scheme with a large number of factors that can be used to code crash causation information. The scheme distinguishes between observable effects due to loss of control (called phenotypes) and the contributing factors which bring those effects about (called genotypes). The genotypes include contributing factors both at the sharp end (close in time/space to the crash) as well as at the blunt end (more distant in time/space, yet important for the development of events).

DREAM also includes a linking system which specifies possible interactions between contributing factors. When information on causation is coded into a chart, the linking system ensures that the description of how one contributing factor leads to another is not arbitrary. The linking system basically limits the range of possible factor interactions to those currently supported by scientific knowledge, thus restricting and guiding the coding of causation information. The inherent structure in the linking system also makes it possible to aggregate causation information from multiple case studies in a structured, and principally semi-automated fashion, reducing the number of subjective judgements necessary to identify a pattern of contributing factors for a group of crashes. An important aspect of DREAM (and other applications based on CREAM) is its ability to capture the complexity of accident causation, resulting in a network of possibly contributing factors.

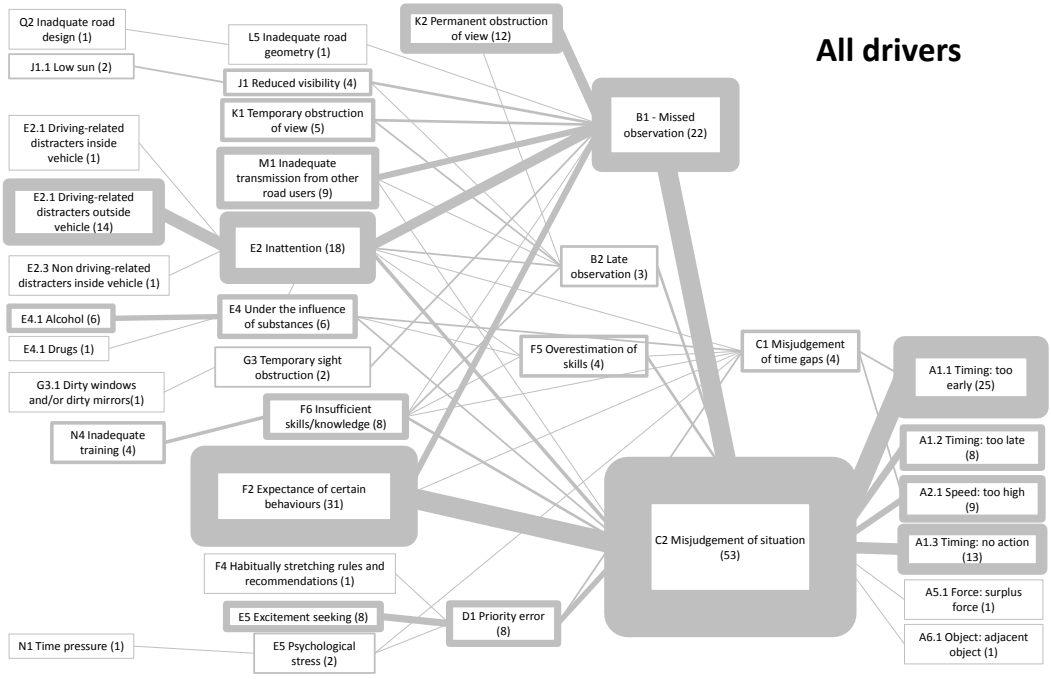
Perceptual problems and wrong expectations are critical factors

For the intersection crashes the DREAM charts for individual crashes were aggregated based on a crash typology where crashes are sorted according to actual and intended vehicle trajectories.

Overall, results indicate that turning drivers to a large extent are faced with perception difficulties and unexpected behaviours in relation to the conflict vehicle, while at the same time trying to negotiate a demanding traffic situation. Drivers going straight on the other hand have less perception difficulties. Instead,

their main problem is that they largely expect turning drivers to yield. When this assumption is violated, they are either slow to react or do not react at all.

It is notable that in a majority of crashes the other party was either a heavy vehicle or a motorcycle; i.e., most fatal intersection crashes are collisions between vehicles with a large mass difference. Very few fatal intersection crashes involve only two passenger cars.



Aggregation of all DREAM analysis charts for all involved drivers in intersection crashes (57 total), showing the frequency of genotypes and phenotypes.

Contributing factors often pointed to in literature, e.g. high speed, drugs and/or alcohol and inadequate driver training, played a role in 12 of 28 accidents, almost exclusively affecting motorcycle riders going straight. While this confirms the prevalence of these known risk factors, it also indicates that most drivers end up in these situations due to combinations of less auspicious contributing factors.

The individual DREAM charts from the 15 crashes involving bicyclists were aggregated in a similar manner as the intersection crashes. The main conclusion is that the drivers of the vehicles have difficulties perceiving the cyclists. This applies especially in crossings with limited view or in situations where the driver is being distracted by either in-vehicle or outside objects or events.

Sight obstruction, inadequate driver environment and poor road design also contribute significantly to perception difficulties. The first two factors lead to the driver failing to notice the cyclist, while the latter often lead to misjudgement of the situation.

Generally however, a combination of the above mentioned factors led to the driver misjudging the situation and as a result colliding with a bicyclist. Psychological stress and wrong prioritization are other factors that stood out in our aggregation charts leading to misjudgement of the situation.

The investigated accidents were limited in number, and general conclusions should therefore be drawn with caution, and even more caution is required for proposing concrete countermeasures. Nevertheless on the ground of the many "missed observations" in our study, it stands to reason to suggest general measures to increase bicyclist visibility, and to help drivers observe bicyclists in time and consequently avoiding collision.

Potential for improvement of data collection from road crashes

Concerning the data and analyses contained in the NPRA crash investigation reports, some limitations and challenges were noted. A general observation is that there are overall fewer contributing factors coded for drivers who are not considered legally "at fault" for a crash, for example, the driver going straight in a crash with a left-turning driver. It is easy to come to think that the investigation effort should focus more on the driver at fault, since that driver is the one who needs accident countermeasures the most. However, question of who is to blame is in a majority of cases irrelevant from a countermeasure development point of view. This underlying investigator mindset therefore needs addressing, to avoid future bias in the reported information.

In can also be seen that information on relevant factors more distant in time/space (the blunt end) is more limited than information on those close in time/space to the crash. This points to the importance of having an explicit analysis method which clearly defines the scope of possible contributing factors and influences to be controlled for in accident investigation.

On a more detailed level, there seem to be certain discrepancies between teams and investigators in terms of how data collection is managed. Furthermore, the main reports are written to describe inclusions rather than exclusions, i.e. reasons for why certain factors are thought to contribute are included, but reasons for excluding other possible factors are left out. When a risk factor is absent in a crash report, there may be two possible explanations. One is that the accident investigations have failed to identify instances where these factors have contributed despite their assumed association with traffic accidents, and the other that these factors simply do not contribute. It is important that the analysts are systematic in trying both to prove the presence of possible contributing factors as well as to disprove the presence of other factors.

The DREAM methodology used here contains a number of factors which were not applicable to any of the analysed crashes. There is reason to further investigate whether this may be related to a too limited collection of data about the crashes in the first place, in order to point out possible room for improvement.