Identifying the causes of road crashes in Europe

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ABSTRACT – This research applies a recently developed model of accident causation, developed to investigate industrial accidents, to a specially gathered sample of 997 crashes investigated in-depth in 6 countries. Based on the work of Hollnagel the model considers a collision to be a consequence of a breakdown in the interaction between road users, vehicles and the organisation of the traffic environment. 54% of road users experienced interpretation errors while 44% made observation errors and 37% planning errors. In contrast to other studies only 11% of drivers were distracted and 8% inattentive. There was remarkably little variation in these errors between the main road user types. The application of the model to future in-depth crash studies offers the opportunity to identify new measures to improve safety and to mitigate the social impact of collisions. Examples given include the potential value of co-driver advisory technologies to reduce observation errors and predictive technologies to avoid conflicting interactions between road users.

INTRODUCTION

The search for effective countermeasures to reduce the social costs of traffic crashes has prompted many crash investigation studies globally which analyse the characteristics and circumstances of individual crashes in order to identify common factors. An early model of accident causation was developed by Heinrich (1931) who proposed the so-called domino theory in the context of industrial accidents. The model explained an accident as a step in a sequential chain of events or circumstances, each of which was dependent on the previous event. By removing one of the events the consequent circumstance would be avoided and the accident prevented. The model is typical of what are now called simple linear sequential models and Heinrich identified five categories of factor

- Social environment/ancestry
- Fault of the person
- Unsafe acts, mechanical and physical hazards
- Accident
- Injury

The identification of human behaviour, framed within the concept of blame, is one that continues to influence road safety management practises today. Heinrich's model has influenced road safety management for over 30 years and crash prevention strategies still frequently focus on identifying the "root cause" with the intention of eliminating it and thereby preventing future crashes. It resonates with the concept of a crash mainly being a result of high-risk factors such as high levels of alcohol and speed, inadequate road design or low crashworthiness standards.

Since the 1930's accident causation models have recognised the multi-factorial nature of crash causation and modified versions of the simple linear model have been developed. Haddon (1968) applied epidemiological concepts to propose what is now termed the Haddon matrix as a method to capture the influence of several components of safety including the road user, vehicle and infrastructure. He also introduced the sequential nature of crash events by identifying separately the pre-crash, crash and post-crash phases. The model has had widespread application to clarifying road safety problems and has led to many successful safety interventions. Nevertheless the model has limitations as it does not explicitly incorporate the concept of exposure, nor does it facilitate an assessment of the interactions between components. If an aspect of human behaviour is identified as a risk factor the tendency is to look for a countermeasure that directly addresses that behaviour whereas there may be more efficient but indirect solutions. It reinforces the concept of risky behaviours as violations of the traffic rules.

More recent models of accident causation developed for industrial processes have come to consider the development of risks within a closely coupled, integrated system of which humans are a part. All

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components of all systems have a variation in performance whether they are human, mechanical or algorithmic. Systems that are increasingly tightly coupled are less resilient to the effects of adverse circumstances. Humans in the control loop have the opportunity to adapt behaviour to enable the system accommodate to adverse conditions but in a tightly coupled system a minor human error can result in a major outcome.

In considering the behaviour of systems Reason (2000) identified two types of error that may occur. Active failures are unsafe acts that are committed by people who are components in the system. He states that they may take a variety of forms including slips, lapses, fumbles, mistakes, and procedural violations. In traditional safety models they are often attributed as the root cause and associated with blame. Secondly he identifies latent conditions, which represent attributes of the system – design, functionality, operation. Normally these deficiencies have no consequence and there are no adverse outcomes. However when the trigger of an active failure aligns with the latent conditions of the system it may result in an adverse outcome. Reason (2000) illustrates this with the so-called Swiss cheese model (Fig 1)

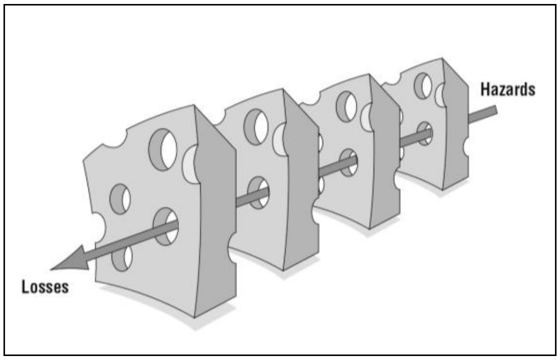

Fig 1: Swiss cheese model of accident causation (Reason 2000).

Reason provides the analogy that the slices of the cheese represent defensive layers based on engineering or behaviour constraints while the holes represent the active and latent failures in the system. Normally the holes are moving around, opening and closing and there are a number of defensive layers in operation that prevent adverse events. A hazardous scenario is only able to result in damage when the holes are aligned and each defensive layer is breached. One challenge when applying systems-based approaches to road safety concerns the availability of a tool to generalise results and to consider population effects. Industrial accidents are typically viewed individually however traffic crashes occur in large numbers and there is a need to generalise for the purposes of road safety policymaking. In parallel with the work of Reason, Hollnagel (1998) has developed the Cognitive Reliability and Error Analysis Method (CREAM) where an accident is defined as an unsuccessful interaction between the person, technology and organisation. In it he identifies a critical event that is the single immediate precursor to the accident and which is defined to describe an action of a person. The method then requires the analyst to attribute a single general causation factor that Hollnagel terms Phenotypes. There are nine classes of these factors that together are taken to describe all types of physical interaction and which characterise an action, these are

- Timing,
- Duration,
- Sequence,
- Object,
- Force,
- Direction,
- Speed,
- Distance
- Volume.

Each of these general factors is sub-divided and related to specific causation factors Hollnagel termed Genotypes which precede the general factors both chronologically and within a causation chain. In turn these may also be related to further antecedents with a set of predefined relationships specified by the method. CREAM is a general approach and is intended to be applicable across domains. Ljung (2002) has developed CREAM for application to the road safety domain with the derivative titled Driver Reliability and Error Analysis Method (DREAM). Between 2004 and 2008 the European Commission supported the SafetyNet project (Thomas et al, 2008) with the objective of establishing the European Road Safety Observatory (ERSO). This included the development of a new approach to investigate crash causation for policymaking purposes and for this activity Ljung adapted the genotypes and coding rules of DREAM to be appropriate for traffic safety analysis. The resulting analysis method was termed SafetyNet Accident Causation System (SNACS). Ljung et al developed a coding manual to specify the phenotypes and genotypes available together with the coding rules. To assess the method it was applied to the active road users involved in 997 specially conducted crash investigations in seven countries following which it was modified by Wallén Warner et al (2008) and titled DREAM 3.0. The SNACS has been applied in several studies such as those by Habibovic et al (2011, 2012).

This paper describes the SafetyNet Accident Causation System and presents an analysis of the main causation factors identified by applying the system to 998 in-depth crash investigations. To avoid confusion in this paper Hollnagels' Phenotypes are termed General Causation Factors while the Genotypes are called Specific Causation Factors.

METHODS

In-depth crash investigations were made in six countries for the purpose of developing and validating SNACS. Most teams used on-scene methods to gather the data and the distribution between countries is shown in Table 1.

It should be noted that the distribution of cases numbers between countries and the selection of the countries involved means that the data is not strictly representative of the 27 Member States of the European Union.

Table 1. Crashes – investigating countries

Country	Case total	
Germany	98	10%
Finland	196	20%
Italy	259	26%
The Netherlands	126	13%
Sweden	68	7 %
United Kingdom	250	25%
Total	997	100%

In the cases studied there was information on 1151 cars, 178 motorcycles and 169 large vehicles. There were also 90 pedestrians and 93 cyclists involved in these crashes.

Normal in-depth crash investigation practices were utilised and the combination of witness interviews, physical evidence and collision reconstructions were used to identify and classify the critical event and the preceding general and specific causation factors to the active drivers, riders and pedestrians. This information was combined with the characteristics of the vehicle, road environment and road users and made available for analysis. The categories and sub-categories of the general and specific causation factors used in the analysis are illustrated in Appendix 1, a full description of each category can be found in Paulsson (2005).

RESULTS

Table 2 shows the distribution of general causation factors for the road user in the 997 collisions according to the vehicle type. Timing errors were the most common amongst each road user group and were recorded for 51% of car drivers, 42% of motorcyclists, 68% of pedestrians and 46% of cyclists. Drivers and motorcyclists most commonly did not act when they should have done, on the other hand both pedestrians and cyclists responded too quickly. Speed errors were also prominent for motorcyclists, 24% were considered to be travelling too fast while only 2% were too slow. Cyclists also committed direction errors (18%) meaning that they decided to take an unorthodox route, and also distance errors (14%).

The categories of specific causation factors, which were not mutually exclusive, are shown in Table 3. Interpretation and planning errors were common amongst each type of active road user. These relate to errors concerning the identification of other road users or features of the traffic environment, errors in

Table 2: General causation factors

	Car drivers		Motorcyclists		Pedestrians		Bicyclists		Total	
Timing	584	51%	75	42%	61	68%	43	46%	763	50%
Duration	24	2%	7	4%	5	6%	8	9%	44	3%
Force/Power	63	5%	13	7%	0	0%	2	2%	78	5%
Distance	115	10%	19	11%	11	12%	15	16%	160	11%
Speed	167	15%	45	25%	6	7%	3	3%	221	15%
Direction	156	14%	18	10%	0	0%	18	19%	192	13%
Object	3	0%	0	0%	0	0%	0	0%	3	0%
Sequence	39	3%	1	1%	7	8%	4	4%	51	3%
Total	1151	100%	178	100%	90	100%	93	100%	1512	100%

Table 3: Specific causation factors

Specific Causation Factor	Car drivers		Motorcyclists		Pedestrians		Bicyclists		Total	
Observation	114	6%	18	6%	4	3%	11	7%	147	6%
Interpretation	293	16%	39	14%	30	21%	35	24%	397	16%
Planning	232	13%	58	20%	22	16%	39	27%	351	15%
Temporary person related function	460	25%	52	18%	39	28%	19	13%	570	24%
Permanent person related functions	39	2%	1	0%	4	3%	1	1%	45	2%
Temporary HMI	7	0%		0%		0%		0%	7	0%
Permanent HMI problem	14	1%		0%	1	1%		0%	15	1%
Equipment	33	2%	4	1%		0%	1	1%	38	2%
Communication	283	15%	35	12%	17	12%	15	10%	350	14%
Maintenance	76	4%	10	4%		0%	3	2%	89	4%
Experience and training	67	4%	24	8%	6	4%	5	3%	102	4%
Organisation	10	1%	7	2%	1	1%	1	1%	19	1%
Design of traffic environment	216	12%	35	12%	16	11%	17	12%	284	12%
Vehicle design	3	0%	2	1%		0%		0%	5	0%
Total	1847	100%	285	100%	140	100%	147	100%	2419	100%

analysing the current and predicted behaviour of other road users and errors in planning a suitable set of actions that would avoid a collision. Temporary personal factors were also identified as a relatively common specific causation factor, particularly amongst pedestrians and car/MPV drivers. Communication errors were also observed, particularly amongst car/MPV drivers while factors associated with the traffic environment were also common. Together these five groups of factors accounted for 81% of the total factors identified. The following tables show a further sub-categorisation of the three largest groups of causation factors.

Interpretation errors typically include quick and automated (routine) procedures where typical situations and their associated actions are recognized and acted upon. Table 4 shows the specific causation factors for the interpretation errors, which were observed to have been made by 397 of the active road users. 42% of the interpretation errors involved a faulty diagnosis due to an error in the mental model. These occurred where the mental model of the road users led them to expect other road users to take one action when in fact something different took place. A further 20% of the interpretation errors related to a misjudgement of time or distance.

Table 5 shows the errors in planning made by the road users. These errors are made once the road user has observed the traffic situation, identified the key characteristics relevant for decision making and is preparing to act on the basis of the information available. There can be deficiencies in the plan due to an incorrect mental model, unexpected side effects or prioritisation errors.

The nature of the planning errors is shown in Table 5. Planning errors were generally preceded by either unintended side effects (47%) or errors in the mental model (39%). Unintended side effects occurred where the road user does not realise their action will have an adverse impact on others. For example a driver might brake hard in reaction to a red light which results in an collision with a following vehicle.

Table 4: Interpretation errors

Interpretation error	Car drivers		Motorcyclists		Pedestrians		Bicyclists		Total	
Faulty Diagnosis - Error in Mental Model	128	44%	13	33%	11	37%	15	43%	167	42%
Faulty Diagnosis - New Situation	30	10%	3	8%	0	0%	0	0%	33	8%
Faulty Diagnosis - Incorrect Analogy/Comparison	35	12%	6	15%	4	13%	7	20%	52	13%
Faulty Diagnosis - Misjudgement of Time/Distance	54	18%	10	26%	9	30%	7	20%	80	20%
Faulty Diagnosis - Other	30	10%	1	3%	0	0%	3	9%	34	9%
Wrong Reasoning - Incorrect analogy/comparison	2	1%	1	3%	3	10%	0	0%	6	2%
Wrong Reasoning - Error in Mental Model	5	2%	3	8%	0	0%	2	6%	10	3%
Decision Error - Shock	1	0%	0	0%	0	0%	0	0%	1	0%
Decision Error - Other	8	3%	2	5%	3	10%	1	3%	14	4%
Total	293	100%	39	100%	30	100%	35	100%	397	100%

The crash investigators classified 570 of the road users as experiencing temporary personal factors that led to the crash occurring, these represented 24% of the 2419 factors coded. The nature of these factors is shown in Table 6. Of the total 570 temporary personal factors recorded 182 (30%) concerned distraction and another 123 (22%) concerned inattention. The influence of substances such as alcohol or drugs was recorded in 94 (17%) of the factors.Further details of the temporary personal factors are shown in Table 7. Of the distraction related factors the most common was associated with a competing external activity, in other words an event or object outside the vehicle that captured the attention of the driver. Distraction due to competing internal activities, such as operating a radio or navigation device, were also common representing 56 of the 182 distraction codes recorded.

There were 123 road users identified as being inattentive and common causes included boredom (27 cases) and a temporary inability (25 cases) such as sneezing or coughing. 53 cases were recorded as being due to other causes of inattention.

Of the 101 cases where road users were identified as being under the influence of substances there were 78 that involved alcohol and the cases included all types of road user. Prescription and non-prescription drugs accounted for 21 of the remaining cases.

DISCUSSION

This research has applied a recently developed method of causation classification to a specially investigated set of crash investigations in order to improve understanding of the reasons behind errors made by road users. The DREAM method has a strong underlying philosophy that crashes are a result of a breakdown in the interaction of human, technology or organisational aspects of the traffic environment. This philosophy provides a framework that is first used by the investigators to deconstruct the events preceding each crash and identify the range of related factors. Secondly the method includes a series of coding protocols that enable aggregate analysis of a larger quantity of collision

Table 5 Planning errors

Planning errors	Car drivers		Motorcyclists		Pedestrians		Bicyclists		Total	
Inadequate Plan - Error in Mental Model	91	39%	24	41%	8	36%	15	38%	138	39%
Inadequate Plan - Overlooked Side Effects	112	48%	29	50%	9	41%	15	38%	165	47%
Inadequate Plan - Other	28	12%	5	9%	5	23%	9	23%	47	13%
Priority Error - Legitimate Higher Priority	1	0%	0	0%	0	0%	0	0%	1	0%
Total	232	100%	58	100%	22	100%	39	100%	351	100%

data in order to identify patterns and trends.

Table 6: Types of temporary personal factor

Temporary personal factor	Total	%
Fear	20	4%
Distraction	182	30%
Fatigue	67	12%
Inattention	123	22%
Under influence	101	17%
Stress	76	15%
Other	1	0%
Total factors	570	100%

The data comprised 997 crashes occurring in six countries that were investigated in-depth including witness interviews taken either at the scene or slightly later. The data cannot be considered strictly representative of the EU due to the limited numbers of countries covered. The aggregate analysis showed that common causation factors are related to observation and interpretation of the road scene, planning a course of action and temporary personal factors. Other types of causation factors were recorded but less commonly observed, these included

- Equipment Failure
- Communication
- Maintenance
- Experience / Knowledge
- Organisation
- Road Design
- Vehicle Design

A total of 2419 factors were recorded in connection with the 1151 road users of all types studied and 1612 (67%) related to the road users themselves either in terms of errors they made or in terms of individual factors that related to the road user. This corresponds with many previous research studies that relate crash causation to the road users however the SNACS method is able to go further in many cases and identify reasons for these factors. In doing so there is no consideration of blame or culpability, instead it records an impartial analysis for the purposes of road safety improvement.

Where further detail of a road user error are lacking this may be due to two factors. Firstly it may not have been possible for the investigators to fully identify the reasons for an error. For example there was a lack of evidence in the road users' statements and crash reconstruction to explain most of the missed observations, this may have been the road users themselves did not know or that there was no supporting observable evidence. Secondly the SNACS method itself does have limitations where the classifications defined do not cover some of the most commonly observed real-world situations. In these cases it is anticipated the recent modifications to the method may be helpful.

Despite the apparent precision of SNACS the conclusions of the analysis remain dependent on the conclusions of the investigator which are based on both observable and non-reproducible aspects of the investigation. This is in common with other causation classification methods and lies at the heart of attempts to identify key factors. The act of crash analysis requires the investigator to form conclusions that are inevitably in some part dependent on their subjective considerations. Nevertheless the availability of a highly structured approach to recording and interpreting the evidence reduces the subjective element. Comparisons of the individual case analyses undertaken within the SafetyNet project have identified a high level of inter-coder reproducibility (Warner et al 2009).

Like other approaches to understand road safety progress the analytic process explained in this paper is limited by a lack of information about the quantity of time in traffic or distance travelled as a measure of exposure. Crash data can be used to identify common characteristics of the collision and to prioritise problem areas to be addressed. The data will identify common events but without correspondingly detailed exposure data it cannot be used to estimate the risks associated with any characteristic. The collection of suitable exposure data is a major challenge to road safety and brings many challenges. The increasing interest in naturalistic driving studies does have the potential to supply such information however the challenges of data capture and particularly analysis are large.
Some traffic crashes may have a simple causation sequence, this is particularly common when high risk behaviours such as speed, alcohol or fatigue are adopted. There may be less additional insight provided by the SNACS method in these cases compared with standard methods however it still serves to provide an approach that avoids allocation of culpability and does enable a closer inspection of supporting factors.

Table 7 Temporary personal factors

Temporary personal factor	Car drivers		Motorcyclists		Pedestrians		Bicyclists		Total	
Memory Failure - Other	1	0%	0	0%	0	0%	0	0%	1	0%
Fear - Previous mistakes	1	0%	1	2%	0	0%	0	0%	2	0%
Fear - Insecurity	0	0%	1	2%	0	0%	1	5%	2	0%
Fear - Conceivable Consequences	11	2%	1	2%	0	0%	0	0%	12	2%
Fear - Other	2	0%	2	4%	0	0%	0	0%	4	1%
Distraction - Passengers	36	8%	0	0%	0	0%	0	0%	36	6%
Distraction - External Competing Activity	57	12%	5	10%	11	28%	5	26%	78	14%
Distraction - Internal Competing Activity	49	11%	0	0%	6	15%	1	5%	56	10%
Distraction - Other	7	2%	2	4%	2	5%	1	5%	12	2%
Fatigue - Circadian rhythm	28	6%	0	0%	0	0%	0	0%	28	5%
Fatigue - Extensive Driving Spell	4	1%	2	4%	0	0%	0	0%	6	1%
Fatigue - Other	30	7%	2	4%	0	0%	1	5%	33	6%
Inattention - Temporary Inability	21	5%	4	8%	0	0%	0	0%	25	4%
Inattention - Bored/Unmotivated	23	5%	3	6%	1	3%	0	0%	27	5%
Inattention - Habit/Expectation	11	2%	3	6%	0	0%	2	11%	16	3%
Inattention - Other	45	10%	6	12%	2	5%	2	11%	55	10%
Under Influence - Alcohol	59	13%	8	15%	8	21%	3	16%	78	14%
Under Influence - Drugs	9	2%	0	0%	0	0%	0	0%	9	2%
Under Influence - Medication	10	2%	1	2%	1	3%	0	0%	12	2%
Under Influence - Other	2	0%	0	0%	0	0%	0	0%	2	0%
Physiological Stress - Illness	10	2%	1	2%	0	0%	0	0%	11	2%
Physiological Stress - Other	1	0%	0	0%	1	3%	0	0%	2	0%
Psychological Stress - Other	43	9%	10	19%	7	18%	3	16%	63	11%
Total	460	100%	52	100%	39	100%	19	100%	570	100%

The purpose of a crash classification protocol is to provide greater detail and precision about the nature of the factors surrounding a crash and thereby to promote potential countermeasures. New technologies are rapidly entering the vehicle and infrastructure environment and many of these are either intended to address errors made by road users or are dependent on the behaviour of the vehicle users. By identifying the road user errors that are being made and understanding the constraints of road user decision making and actions future technologies can integrate more effectively with the normal demands and behaviours of road users. For example the common occurrence of missed observations, where a roadside object, junction or road user was not detected by the driver due to glare, noise or other factors indicates a potential value from the development of co-driver support technologies which might have the potential to avoid these missed objects. Recently developed technologies such as Autonomous Braking Systems with pedestrian detection are already capable of supporting drivers in missed observations of pedestrians and there potential impacts. Another example of a missed observation concerns the collision scenario where a car emerges from a junction into the path of an unobserved motorcyclist, this represents an observation error for the car driver and an interpretation error for the motorcyclist. An effective technology-based countermeasure would have to have a different functionality for each road user – for the car driver it would identify the motorcyclist's presence whereas for the motorcyclist it would predict the imminent movement of the car.

An analysis of system errors such as that described in this paper, although providing a new insight of causation, will not of itself be sufficient to fully describe a collision. Additional information about the characteristics of the road, vehicle and infrastructure, reconstruction information and information about injuries remain essential to a full appraisal of the crash. Nevertheless the information provided by an analysis such as SNACS adds a very new dimension to the understanding of crashes that has not been provided by other approaches.

Road safety management is the function of policy-making and implantation intended to reduce casualties and improve safety on the roads. Historically the major measures have been concerned with reducing the prevalence of high-risk features such as poor vehicles, poor roads and poor road users. As the influence of these factors reduces in many countries with a well-developed road safety infrastructure the attention is increasingly turning to a focus on system design and operation in a recognition that crashes may involve well-behaving road users in safe vehicles on well-designed roads. Increasing proportions of crashes are occurring in the absence of high risk crash characteristics but with evidence of the type of system dysfunction identified in this analysis. The investigatory approach outlined in this analysis and its future development has great potential to reveal new underlying information and trends over the causation of crashes. In agreeing on a new Decade of Action for road safety the United Nations identified the Safe System Approach as a broad ranging paradigm for road safety. It is based on a shared approach and encapsulates the need to address all aspects of the crash. It incorporates the concept that crashes are a result of operational deficiencies in the road transport system and corresponds to the analytic concepts of the Dream analysis.

CONCLUSION

This analysis has applied a new approach to crash analysis to a sample of crashes specifically investigated. It has revealed that 72% of crashes involve factors related to road user factors and observation, interpretation and planning errors are relatively common. There is remarkably little variation in these errors between the main road user types. The analytic approach to identifying and understanding road user errors provides particular opportunities for future road safety policy-making.

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APPENDIX 1 – ILLUSTRATION OF SPECIFIC CAUSATION FACTORS

<table>
<tr><th>Categories</th><th>Definition/explanation of general cause</th><th>Definition/explanation of specific cause</th><th>Example</th></tr>
<tr><td rowspan="6">Maintenance (K)</td><td rowspan="5">Maintenance failure (K1)
The vehicle, or parts of the equipment, is out of order due to inadequate or incorrect maintenance.</td><td>Tyres (K1.1)
One or many tyres have been inadequately maintained or checked and does not perform as expected.</td><td>A tyre explodes because it has been worn out.</td></tr>
<tr><td>Steering (K1.2)
The steering system has been inadequately maintained or checked and does not perform as expected.</td><td>The level of servo oil is to low.</td></tr>
<tr><td>Brake system (K1.3)
The brake system has been inadequately maintained or checked and does not perform as expected.</td><td>The brake-blocks have not been replaced for a long time.</td></tr>
<tr><td>Lighting (K1.4)
The lighting has been inadequately maintained or checked and does not perform as expected.</td><td>A non-functioning brake light has not been replaced.</td></tr>
<tr><td>Other (K1.5)</td><td></td></tr>
<tr><td>Inadequate quality control (K3)
The vehicle, or parts of the equipment, have not been subject to adequate quality control by the responsible party, e.g. the user.</td><td>Other (K3.1)</td><td></td></tr>
<tr><td rowspan="4">Vehicle design (O)</td><td rowspan="2">Unpredictable system functions/characteristics (O1)
The characteristics of the vehicle become unpredictable under some circumstances.</td><td>Load (O1.1)
A certain amount of load makes the vehicle behave unpredictably.</td><td>If one is driving with a lot of baggage in the trunk and enters a curve with too much speed, the car might become under steered and go off the road.</td></tr>
<tr><td>Other (O1.2)</td><td></td></tr>
<tr><td>Inadequate HMI (O2)
The interaction between user and an in-vehicle system is inadequately designed.</td><td>Other (O2.1)</td><td></td></tr>
<tr><td>Inadequate ergonomics (O3)
The driver seat, for instance, is inadequately designed from an ergonomic point of view.</td><td>Other (O3.1)</td><td></td></tr>
</table>

Taken from Paulson R (2005)