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TØI Report 1067/2010

tøi Institute of Transport Economics
Norwegian Centre for Transport Research

Factors contributing to road fatalities

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

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Title: Factors contributing to road fatalities: Analysis of in-depth investigation data from passenger car intersection crashes and from collisions between bicycles and motorized vehicles

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Summary:

In-depth studies were made of intersection crashes involving a passenger car, and of collisions between bicycle and motorized vehicle. Most intersection crashes were collisions between left-turning car and oncoming motorcycle or heavy vehicle. The most frequent contributing factor for the turning driver was failure to observe the oncoming vehicle, because of attention being focused on other aspects of traffic.

In most bicycle crashes the driver reported failure to observe the bicyclist. This was found to be a result of inattention and/or poor visibility. Low expectation of seeing bicyclists in traffic was a likely contributing factor to inattention. Poor visibility was partly due to the road design or environment, and partly to the vehicle. Especially for heavy vehicles the blind zones make it difficult to observe bicyclists close to the vehicle. The analyses give rise to recommendations for improvement regarding data collection in in-depth analyses of road crashes.

Tittel: Faktorer som bidrar til dødsulykker i veitrafikken: Analyse av data fra dybdestudier av kryssulykker med personbil og kollisjoner mellom sykkel og bil

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Sammendrag:

Det ble foretatt dybdeanalyser av kryssulykker med personbil innblandet, og av kollisjoner mellom syklist og motorkjøretøy. De fleste kryssulykkene var kollisjon mellom personbil som svingte til venstre, og møtende motorsykkel eller tungbil. Den vanligste medvirkende faktoren for føreren i bilen som svingte, var at han/hun ikke la merke til møtende trafikant, på grunn av at oppmerksomheten var rettet mot andre aspekter ved trafikken.

I de fleste sykkelulykkene hadde bilisten oversett syklisten, enten på grunn av uoppmerksomhet eller på grunn av vanskelige siktforhold. Lav forventning om syklister i trafikken er en medvirkende faktor til uoppmerksomhet. Dårlige siktforhold var dels knyttet til veiutformingen og dels til kjøretøy. Spesielt for tunge kjøretøy er de store blindsonene rundt kjøretøyet et problem med hensyn til å oppfatte syklister. Analysene gir grunnlag for flere anbefalinger om forbedringer av datainnsamlingen når det gjelder dybdestudier av veiulykker.

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Preface

This report presents aggregate analyses of in-depth crash investigations of two types of road crashes, i.e., intersection crashes involving at least one passenger car, and collisions between bicycles and motorised vehicles. It makes up one part of the documentation from the project ”Investigating transport accidents and incidents: Method development and analysis of preconditions for learning”, funded by the Research Council of Norway, under the RISIT programme (“Risk and Safety in Transport”).

The project was carried out by TØI together with Chalmers University of Technology, as a part of TØI’s involvement in the SAFER Vehicle and Traffic Safety Centre in Gothenburg. The Norwegian Public Roads Administration has helpfully provided access to in-depth study reports from their crash investigation teams (UAG).

Mikael Ljung Aust at Chalmers has analysed the intersection crashes and authored Part 1 of the report together with Helen Fagerlind. Rickard J. Eriksson has developed the ”DREAM wiki” analysis tool that is described in Section 3.2. The bicycle crashes were analysed by Juned Akhtar, Alena Høye, and Ross Phillips at TØI. Juned Akhtar has also written Part 2 of the report. Fridulv Sagberg at TØI has been project manager and has edited the report. Trude C. Rømming has prepared the report for publishing and printing.

Oslo, May 2010
Transportøkonomisk institutt

Lasse Fridstrøm
instituttsjef

Torkel Bjørnskau
forskningsleder

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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 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).

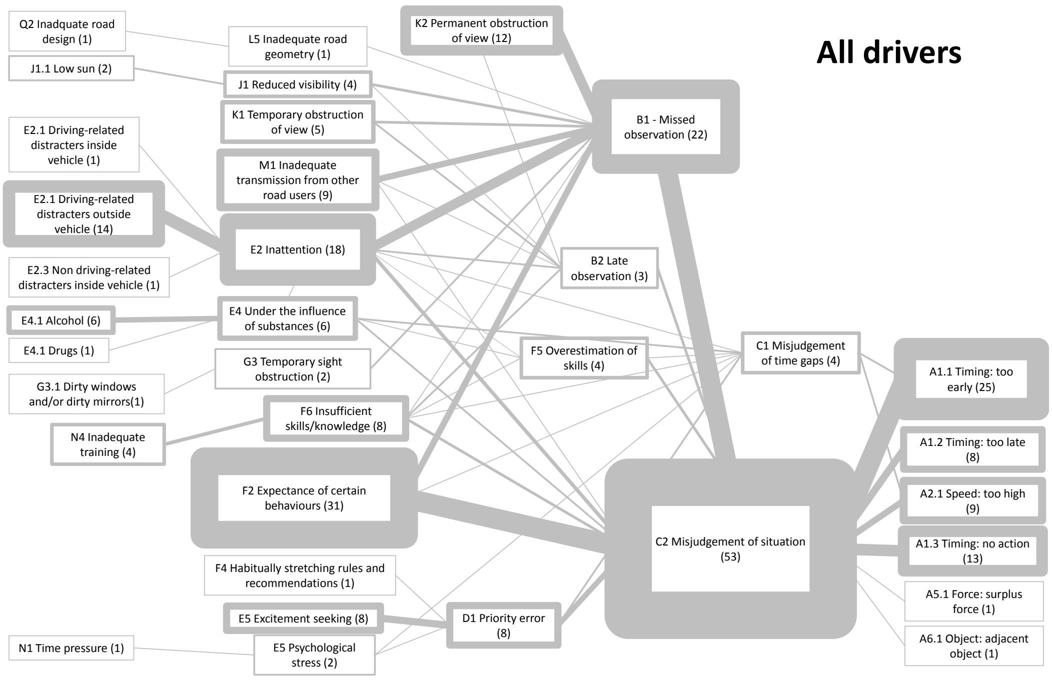
DREAM also includes a linking system which specifies possible interactions between contributing factors. When information on causation is coded into a chart, the linking system ensures that the description of how one contributing factor leads to another is not arbitrary. The linking system basically 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.

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Sammendrag:

Faktorer som bidrar til dødsulykker på vei

Analyse av data fra dybdestudier av kryssulykker med personbil og kollisjoner mellom sykkel og bil

Uoppmerksomhet eller distraksjon blant bilførere er viktige årsaker til kryssulykker og til kollisjoner mellom bil og sykkel. Det viser en gjennomgang av materiale fra dybdestudier av dødsulykker for årene 2005-2007, innsamlet av Statens vegvesens ulykkesanalysegrupper. Kryssulykkene omfattet tilfeller hvor det var minst én personbil innblandet, og i et stort flertall av ulykkene var motparten enten et tungt kjøretøy eller en motorsyklist; dvs. at dødsulykker i kryss i stor grad er kollisjoner mellom kjøretøyer med ulik masse. Det hyppigste hendelsesforløpet var en bilist som svingte til venstre foran møtende kjøretøy som ikke ble oppdaget, eller ble oppdaget for sent. Stor fart kombinert med forventning om at svingende trafikant ville vike, bidro i noen tilfeller til at møtende trafikant ikke klarte å unngå ulykken. I sykkelulykkene var det mange tilfeller hvor bilisten ikke hadde sett syklisten på forhånd, enten på grunn av uoppmerksomhet og lav forventning om sykkeltrafikk, eller på grunn av sikthindringer i kjøretøyet (spesielt i tunge kjøretøy) eller i vegmiljøet. Ulykkene ble analysert ved hjelp av ”Driver Reliability and Error Analysis Method” (DREAM). Analysene avdekker behov for flere forbedringer når det gjelder datainnsamling og årsaksanalyse i forbindelse med veitrafikkulykker.

Analyser basert på Statens vegvesens UAG-materiale

Alle dødsulykker på norske veier blir gjenstand for dybdeanalyser som gjennomføres av ulykkesanalysegrupper (UAG) i Statens vegvesen. Det lages en rapport fra hver ulykke. I dette prosjektet ble materiale fra ulykkesanalysene benyttet for nærmere studier av mulige årsaksfaktorer ved to utvalgte typer ulykker. Den ene ulykkestypen er kryssulykker hvor minst én personbil er innblandet, og den andre typen er kollisjoner mellom syklister og motorkjøretøy. Analysene omfatter bare atferden til førerne av de involverte motorkjøretøyene, og ikke syklistene.

Det var to hovedformål med undersøkelsen. Det første var å anvende ”Driver Reliability and Error Analysis Method” (DREAM) for å få et mer fullstendig bilde av de hyppigste medvirkende faktorer til de to ulykkestypene. Det andre formålet var å vurdere kvaliteten av datainnsamling og analyser som ligger til grunn for rapportene fra UAGene, og å drøfte behov for forbedringer.

Et tilleggsformål var å utviklet et datamaskinbasert verktøy (en ”wiki”) for å bruke DREAM i ulykkesanalyser. Dette verktøyet inneholder lenker til de relevante delene av håndboka for DREAM på engelsk, svensk og norsk.

Fra ulykkesrapportene for årene 2005-2007 ble alle ulykker av de to nevnte typene valgt ut. Dette utvalget omfattet 28 kryssulykker og 15 sykkelulykker. I de tilfellene hvor kategoriene var overlappende, dvs. kryssulykker med syklist og personbil, ble ulykkene inkludert blant sykkelulykkene.

DREAM – et analyseverktøy for hendelser og faktorer som medvirker til disse

DREAM er en tilpasning av ”Cognitive Reliability and Error Analysis Method” (CREAM) til veitrafikkulykker (E. Hollnagel: Cognitive reliability and error analysis CREAM. Oxford: Elsevier Science, 1998). DREAM inneholder et klassifikasjonsskjema med et stort antall hendelser og tilstander som benyttes for å kode medvirkende faktorer til ulykkene. Skjemaet skiller mellom *fenotyper*, dvs. observerbare hendelser som skyldes tap av kontroll, og *genotyper*, dvs. faktorer som antas å forårsake de observerbare hendelsene. Genotypene omfatter medvirkende faktorer både i ”den spisse enden” (nært hendelsen i tid og/eller rom) og i ”den butte enden” (lenger unna i tid og/eller rom, men likevel av betydning for hendelsesforløpet).

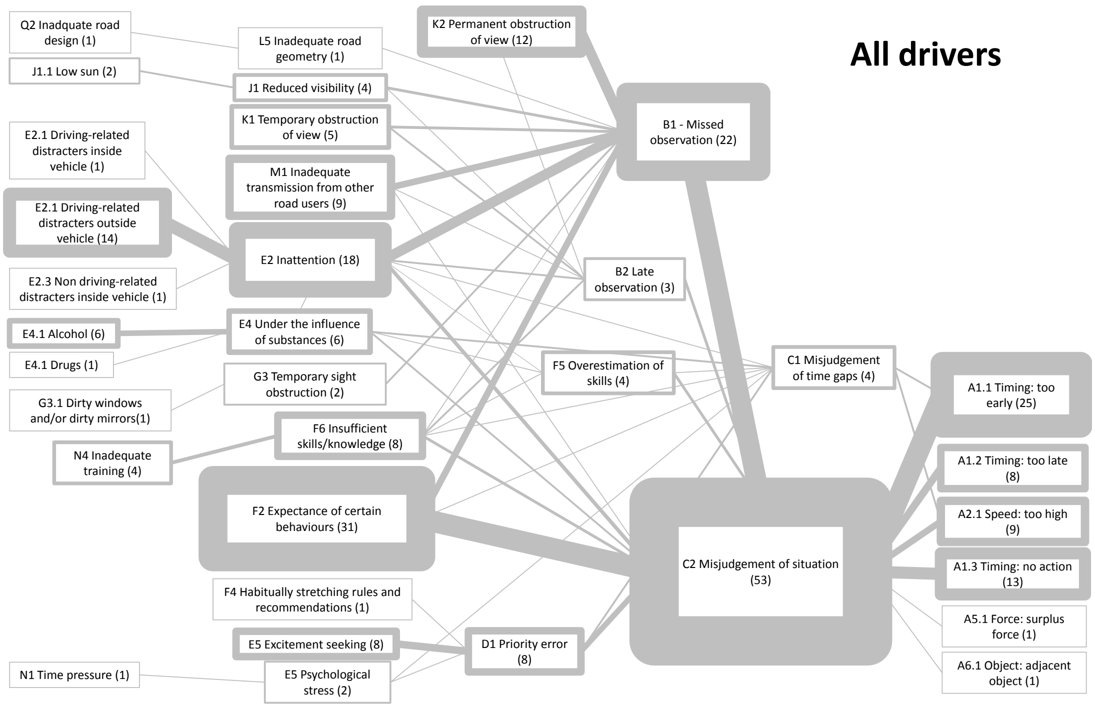
DREAM inneholder dessuten et system for lenking mellom de medvirkende faktorene. Når informasjon om en medvirkende faktor kodes inn i et diagram, sikrer lenkingssystemet at beskrivelsen av hvordan en faktor kan påvirkes av en annen, ikke blir tilfeldig. Lenkingssystemet begrenser mulige koblinger mellom faktorer til dem som det foreligger vitenskapelig grunnlag for, og på den måten begrenser og styrer lenkingssystemet analysearbeidet. Strukturen i lenkingssystemet og klassifikasjonsskjemaet, med forhåndsdefinerte kategorier, gjør det også mulig å aggregere analyseresultater fra et antall enkelthendelser på en strukturert, og halvveis automatisk, måte slik at en reduserer bruk av subjektivt skjønn for å finne mønstre av medvirkende faktorer for en gitt type hendelser. Et viktig aspekt ved DREAM (og også ved andre CREAM-baserte metoder) er at den fanger kompleksiteten i hendelsesforløpet fram mot en ulykke eller farlig hendelse og genererer et nettverk av mulige medvirkende faktorer.

Perseptuelle problemer og feil forventninger er kritiske faktorer

For kryssulykkene ble DREAM-diagrammene for enkeltulykkene aggregert basert på en typologi hvor ulykkene ble sortert etter faktiske og intenderte trafikk-retninger for de involverte kjøretøyene.

For førere som svinger i kryss tyder resultatene på at perseptuelle problemer og uventet atferd fra motpartens side, kombinert med håndtering av en krevende trafikksituasjon, medvirket til ulykkene. Førere som kjører rett fram, berøres i mindre grad av perseptuelle problemer. Deres hovedproblem er at de stort sett forventer at den svingende parten vil vike. Når denne forventningen ikke innfris, klarer de ikke å reagere raskt nok, eller reagerer ikke i det hele tatt.

Det var påfallende at personbilens motpart i de aller fleste tilfellene var et kjøretøy med enten mye større masse (tungt kjøretøy) eller mye mindre masse (motorsykkel/moped). Det var svært få dødsulykker hvor begge parter var personbiler.



Aggregerte DREAM-diagrammer for alle førere innblandet i kryssulykker, med antall forekomster av hver fenotype og genotype.

Kjente årsaksfaktorer fra tidligere ulykkesforskning, som f.eks. ruspåvirkning, høy fart, eller utilstrekkelig erfaring/trening, hadde betydning i 12 av de 28 ulykkene, og dette gjaldt nesten utelukkende motorsyklister som kjørte rett fram. Selv om dette bekrefter forekomsten av disse kjente risikofaktorene, indikerer det også at de fleste førerne havner i disse situasjonene som følge av andre medvirkende faktorer.

De individuelle DREAM-diagrammene fra de 15 sykkelulykkene ble aggregert på samme måte som for kryssulykkene. Hovedkonklusjonen er at bilførerne har problemer med å legge merke til syklistene. Dette gjelder spesielt i kryss med begrenset sikt og i situasjoner der bilføreren distraheres av objekter eller hendelser i eller utenfor bilen.

Sikthindringer, uheldig utforming av bilen, og svakheter ved veimiljøet bidrar også til persepsjonsproblemer. De to første faktorene bidrar til at førerne ikke ser syklisten tidsnok, mens veiutformingen bidrar til feilvurdering av situasjonen. Generelt er det imidlertid en kombinasjon av de nevnte faktorene som bidrar til at en bilist feilbedømmer situasjonen, slik at det fører til kollisjon med en syklist. Psykologisk stress og feilprioritering er andre medvirkende faktorer som kom tydelig fram i de aggregerte diagrammene.

Materialet omfattet et relativt lite antall ulykker, og vi vil derfor være forsiktig med å trekke generelle konklusjoner om årsakssammenhenger, og særlig når det gjelder anbefalinger om tiltak. Ikke desto mindre indikerer høy forekomst av "missed observation" i denne undersøkelsen at det er grunnlag for å foreslå tiltak som kan øke synbarheten av syklister i trafikken, slik at bilistene kan oppfatte dem lettere og dermed unngå kollisjoner.

Potensial for forbedring av UAG-rapportene

Når det gjelder data og analyser i rapportene fra UAGene, viste gjennomgangen en del begrensninger og utfordringer. En generell observasjon er at det er registrert færre medvirkende faktorer for førere som ikke blir vurdert til å ha "skyld" i ulykken, f.eks. den som kjører rett fram og kolliderer med en venstresvingende bil. Det er lett å komme til å tro at granskingen bør fokusere mer på den "skyldige" parten, og at forebyggende tiltak er viktigst i forhold til denne parten. Imidlertid er det fra et ulykkesforebyggende perspektiv i de fleste tilfeller irrelevant hvilken part som har skyld i juridisk forstand.

Det var også en tendens til at informasjon om faktorer i "den butte enden" (lengre fra ulykken i tid og/eller rom) var mer begrenset enn informasjon om de direkte utløsende faktorene. Dette viser behovet for en eksplisitt analysemetode som klart definerer rammene for mulige medvirkende faktorer og forhold som bør sjekkes i ulykkesanalyser.

På et mer detaljert nivå ser det ut til å være en del variasjon mellom de ulike UAGene når det gjelder innsamling og håndtering av data. Videre er rapportene stort sett skrevet slik at de viser inkluderte faktorer, dvs. faktorer som har vist seg eller som antas å ha medvirket, mens det ikke framgår om det er andre faktorer som har vært vurdert men ikke vist seg å ha hatt betydning. Når risikofaktorer er fraværende i en ulykkesrapport, kan det ha to mulige forklaringer. Den ene er at granskerne ikke har undersøkt disse faktorenes selv om de kan ha medvirket, og den andre forklaringen er at disse faktorene ganske enkelt ikke har forekommet. Det er viktig at granskerne er systematiske både når det gjelder å dokumentere mulige medvirkende faktorer og å avkrefte faktorer som ikke har medvirket.

Klassifikasjonsskjemaet i DREAM inneholder et stort antall faktorer som ikke var benyttet i noen av analysene i denne undersøkelsen. Dette kan ha sammenheng med at datainnsamlingen har vært for begrenset i første omgang. En bør se nærmere på om det er mulighet for forbedringer av selve datainnsamlingen.

1 General introduction

All fatal crashes in Norway are analyzed in depth by multidisciplinary crash investigation teams (UAGs[1]) organized by the Norwegian Public Roads Administration (NPRA). The teams collect data from on-the-scene and/or on-the-site investigations and produce a report of each crash. For the purpose of this study we obtained reports and related data from all fatal crashes in Norway in the period 2005 – 2007.

This report consists of three parts. Parts 1 and 2 consist of analyses of fatal road crashes, based on the mentioned reports from the NPRA in-depth investigations.

Part 1 is an analysis of intersection crashes involving at least one passenger car, and Part 2 is a similar analysis of collisions between bicycles and motorized vehicles. Part 3 is a general discussion and some concluding comments on the two preceding parts.

Common to both parts is the use of the method Driver Reliability and Error Analysis Method (DREAM) for identifying the factors contributing to crashes. This general introduction contains a short description of DREAM.

1.1 A brief description of DREAM 3.0

DREAM is based on the Cognitive Reliability and Error Assessment Method (CREAM), was developed by Erik Hollnagel (1998) for the analysis of safety-related errors in MTO (Man- Technology-Organisation) systems, and to determine the human, technological and organizational factors that may be involved in error causation. Although CREAM was originally developed in a setting of nuclear power plant operation, it is a generic approach including a taxonomy of cognitive reliability and error concepts that are relevant to any MTO system. However, to capture the domain-specific technological and organizational factors, the taxonomy needs to be adapted when the method is applied in other domains.

The Driving Reliability and Error Assessment Method DREAM (Ljung, 2002; Ljung, Furberg and Hollnagel, 2005; Huang & Ljung, 2004) is an adaptation of CREAM to the road transport domain. DREAM was developed in the FICA project at Chalmers University of Technology (Ljung, Fagerlind, Lövsund and Sandin 2007) to help provide condensed overviews of crash contributing factors on a case by case basis, as well as to facilitate aggregation of case causation data into aggregated causation patterns, or causation charts. It was also used in the EU project SafetyNet (SAFETYNET 2005, 2008, Wallén Warner, Ljung Aust, Björklund, Johansson and Sandin 2008). For a discussion of how to create and interpret aggregated causation charts using DREAM, see Sandin (Sandin and Ljung 2007, Sandin 2008, Wallén Warner and Sandin 2009).

[1] UAG = ”ulykkesanalysegruppe”

CREAM has also been adapted to the railway sector and to maritime accidents. Although the taxonomies differ between domains, there is a common core in all applications, and the method of causation analysis is the same, which potentially makes this approach useful for comparative studies across domains. In this study DREAM version 3.0 is used (Wallén Warner et al., 2008).

1.2 Phenotypes

The starting point of a *CREAM-based* analysis, and in our case DREAM analysis, is the identification of the action (by a human operator or by a system such as a driver-and-car) immediately leading up to the critical event. This action is called the *error mode* or, using a biological analogy to designate *observable events,* a *phenotype,* as opposed to a *genotype*, which is a more or less covert cause of a phenotype.

For a given incident, the relevant general phenotype is chosen from a list of six classes, presumed to cover all possible physical relations between objects, which characterize an action: Timing, Speed, Distance, Direction, Force and Object.

1.3 Genotypes

The error modes are specifications of the general phenotypes, such as for example “too short distance”, “too high speed”, or “wrong direction”. Possible causal factors are thus specified in a predefined classification system, and the analysis consists of establishing links backwards from the phenotype to the different genotypes. In our version of DREAM (3.0) all phenotypes link to same first-order genotypes.

In the analysis, a given genotype is always an *antecedent* either to a phenotype or to a different genotype. At the same time it may be a *consequent* of other genotypes. The taxonomy specifies the possible connections backward from a consequent to an antecedent, which in turn is the consequent of one or more other antecedents. In this way, and according to the rules for the analysis, a network of (assumed) causal relationships is constructed.

The relationship between the various categories in the taxonomy is based on a cognitive theoretical model. Thus, the whole analysis is built on three components, which according to Hollnagel (1998) are necessary preconditions for any valid causal analysis; the MCM framework: a Model of human cognition, a Classification scheme, and a Method describing the links between the model and the classification.

In DREAM 3.0 there are 51 genotypes. These are organized according to the driver – vehicle/traffic environment – organization triad.

PART 1:

DREAM analysis of in-depth study data of fatal intersection accidents

2 Introduction

This part is devoted to the analysis of fatal intersection accidents, occurring in the years 2005-2007. For every analysis, the source material has been the in-depth study reports produced by the different UAG's. This means that the analysis solely has made use of the available material, no attempt at further reconstructions or bringing new information to light has been made.

The data available per accident varies in scope; for some accidents there is just the final report (usually a 5-10 page pdf document) available, whereas for other accidents the files include various protocols filled out by the investigators, such as Åstedsrapport, Kjøretøyskjema, etc. As will be discussed below, the extra information available through the protocols outside the main report sometimes (but not always) hold valuable extra information. Valuable is here taken not to mean that it brings new information to light which is unavailable in the main report, but in the sense that can it be used to discard possible contributing factors not mentioned in the main report.

2.1 Source material characteristics

The material encompasses a total of 28 intersection crashes with fatal outcome. These were retrieved from a total of 559 fatal crashes, occurring in the years 2005-2007. Somewhat surprisingly, only 3 of these are car-to-car crashes. In the other 25 there is a large mass difference between the involved vehicles, since at least one of the vehicles is either a light vehicle (e.g. a motorcycle) or a heavy vehicle (e.g. a truck). When conjuncted with the fact that intersection accidents is on the top three list of common car-to-car accident types, one immediate conclusion from this is that the forces generated by intersection collisions generally are sufficiently low to leave car drivers alive.

The 28 crashes all involve two vehicles, except one, which involves three vehicles. An overview of the number and type of vehicles is given in table 1. In that table, there is also a listing of to which extent each vehicle type was turning or going straight through the intersection.

Table 1. Vehicle types involved in the 28 fatal intersection crashes

Vehicle type		**All**	**Turning**	**Going Straight**
Light	MC	17	0	17
Medium	Car	21	20	1
	Small lorry	1	0	1
	Minibus	1	1	0
	Van	6	4	2
	Tractor	1	1	0
Heavy	Lorry	3	1	2
	Articulated lorry	1	0	1
	Lorry and trailer	6	1	5
Total		**57**	**28**	**29**

In Table 1 it is noticeable that all light vehicles, e.g. the motorcycles, and most of the heavy vehicles (8 out of 10) were going straight through the intersection, while most of the medium-size vehicles (cars, delivery vans…) were on a turning path. Turning drivers of medium-size vehicles thus obviously have problems with motorcycles going straight. The underlying reasons for this will be further discussed in the analysis.

3 Method

3.1 DREAM methodology

Details on crash contributing factors for each driver in each in-depth study case file were first coded using the Driving Reliability and Error Analysis Method (DREAM) (Ljung 2002, Ljung, Furberg and Hollnagel 2005). DREAM is an adaptation to the traffic safety domain of the Cognitive Reliability and Error Analysis Method (CREAM) (Hollnagel 1998).

As mentioned in Chapter 1 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). Phenotypes are expressed in the general dimensions of time, space and energy, and consist of the following:

Table 2. Phenotypes in DREAM 3.0

Phenotypes	*Specific phenotypes*
Timing	Too early action; Too late action; No action
Speed	Surplus speed; Insufficient speed
Distance	Too short distance
Direction	Wrong direction
Force	Insufficient force; Surplus force
Object	Adjacent object

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). In DREAM version 3.0 which was used here, genotypes are divided into 16 main categories, each belonging to one of four main groups: Driver, Vehicle, Traffic environment, and Organisation.

DREAM also includes a linking system which specifies possible interactions between contributing factors. When case 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. Naturally, the linking system can be updated as new knowledge is gained.

Table 3. Genotypes in DREAM 3.0

GENOTYPES (B-Q)

HUMAN (B-F)	**TECHNOLOGY (G-M)**		**ORGANISATION (N-Q)**
Driver	**Vehicle (G-I)**	**Traffic environment (J-M)**	**Organisation**
B: Observation Missed observation (B1) Late observation (B2) False observation (B3)	**G: Temporary HMI problems** Temporary illumination problems (G1) Temporary sound problems (G2) Temporary sight obstructions (G3) Temporary access limitations (G4) Incorrect ITS-information (G5)	**J: Weather conditions** Reduced visibility (J1) Strong side winds (J2)	**N: Organisation** Time pressure (N1) Irregular working hours (N2) Heavy physical activity before drive (N3) Inadequate training (N4)
C: Interpretation Misjudgement of time gaps (C1) Misjudgement of situation (C2)	**H: Permanent HMI problems** Permanent illumination problems (H1) Permanent sound problems (H2) Permanent sight obstruction (H3)	**K: Obstruction of view due to object** Temporary obstruction of view (K1) Permanent obstruction of view (K2)	**O: Maintenance** Inadequate vehicle maintenance (O1) Inadequate road maintenance (O2)
D: Planning Priority error (D1)		**L: State of road** Insufficient guidance (L1) Reduced friction (L2) Road surface degradation (L3) Object on road (L4) Inadequate road geometry (L5)	**P: Vehicle design** Inadequate design of driver environment (P1) Inadequate design of communication devices (P2) Inadequate construction of vehicle parts and/or structures (P3) Unpredictable system characteristics (P4)
E: Temporary Personal Factors Fear (E1) Inattention (E2) Fatigue (E3) Under the influence of substances (E4) Excitement seeking (E5) Sudden functional impairment (E6) Psychological stress (E7)	**I: Vehicle equipment failure** Equipment failure (I1)	**M: Communication** Inadequate transmission from other road users (M1) Inadequate transmission from road environment (M2)	**Q: Road design** Inadequate information design (Q1) Inadequate road design (Q2)
F: Permanent Personal Factors Permanent functional impairment (F1) Expectance of certain behaviours (F2) Expectance of stable road environment (F3) Habitually stretching rules and recommendations (F4) Overestimation of skills (F5) Insufficient skills/knowledge (F6)			

3.2 DREAM wiki

To make the Manual for DREAM 3.0 more accessible and easy to work with, the paper version of the manual has been supplemented with an online version. When developing the online version of the manual the software PmWiki (www.pmwiki.org) was used. There are several different wiki software products available, among which PmWiki is one of the most commonly used. The advantages with a wiki compared to a conventional html page are easier installation, maintenance and editing. The simplest editing operations can be performed without any prerequisites or software.

The main parts of the structure from the paper version are kept in the online version to allow using the paper version and the online version in parallel and still be familiar with the structure of the manual. The layout of the theory part is very much alike while the layout of the appendixes has been changed somewhat. In the appendices the advantages of PmWiki software have been used to develop more of a linking tool than the linking tables that can be found in the paper version of the report. Every specific Phenotype and every general Genotype has its own page and every page contains links that correspond to the possible choices that can be made in each position in the linking scheme. The path that was used to retrieve a specific page is saved in the page heading so that it can easily be transferred to the linking table template when a linking chain stops. In this way a more effective and correct linking is achieved. The DREAMwiki contains three language versions, one English which is the original and two translations into Swedish and Norwegian. The DREAMwiki is open to the public and can be found at www.dreamwiki.eu. An example from the DREAMwiki is shown in Figure 1.1.

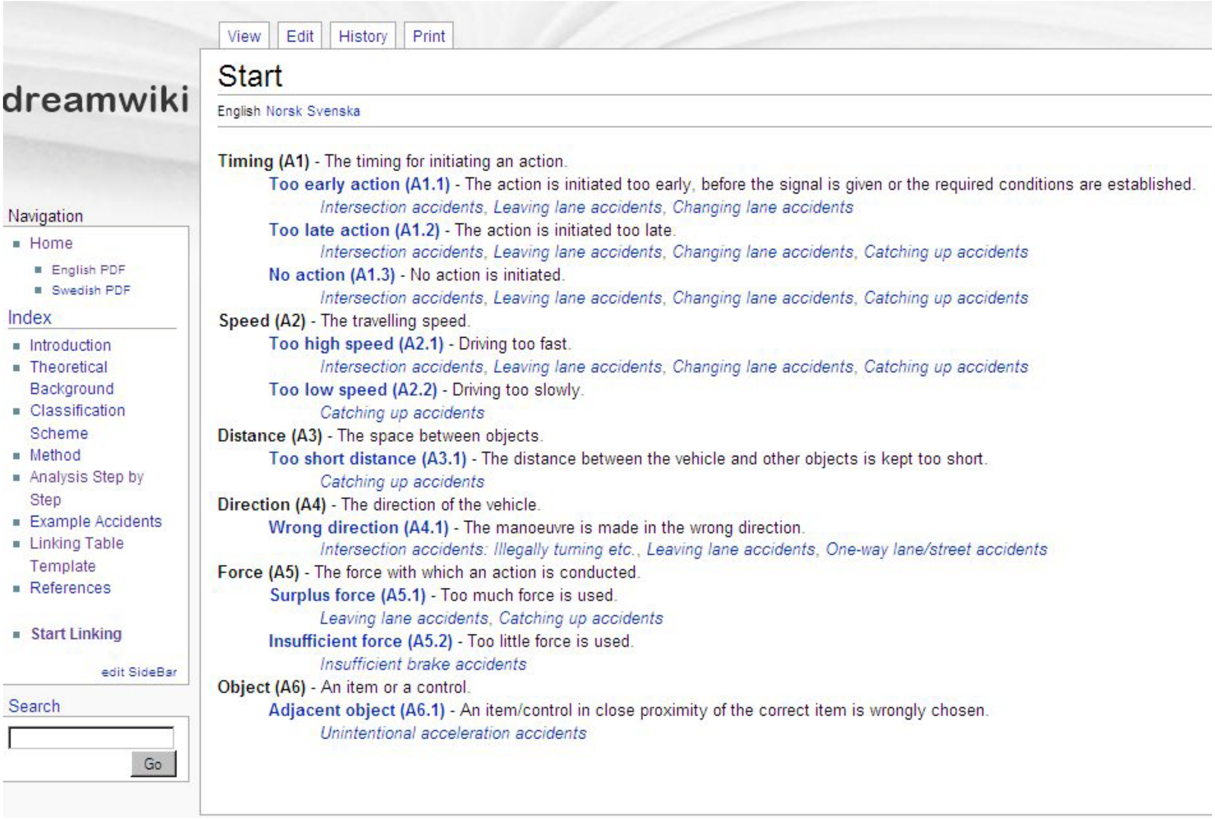


Figure 1.1. One example of the DREAMwiki (www.dreamwiki.eu)

3.3 Analysis procedure

In any analysis procedure, some overall classifications usually are applied to organise the analysis. In this study, the organising principles come from a statistical study carried out at Volpe National Transportation Systems Center to describe crossing path crashes in the US (Najm et al., 2001). The researchers developed a crash typology which sorts crashes into groups based on actual and intended vehicle trajectories prior to the crash.

One reason for selecting this typology is that vehicle trajectories are coded in most types of data sources which can be used to study intersection crashes, something which facilitates comparison of this material to other intersection crash studies. Another reason is that vehicle trajectories provide a very natural frame of reference if study results are to be used for countermeasure development.

The crash types developed by Najm et al (2001) are shown in Figure 1.2. As an example, the typical scenario for an LTAP/OD crash is a left turning vehicle cutting across the path of another vehicle coming from the opposite direction, and which intends to cross the intersection on a straight path.

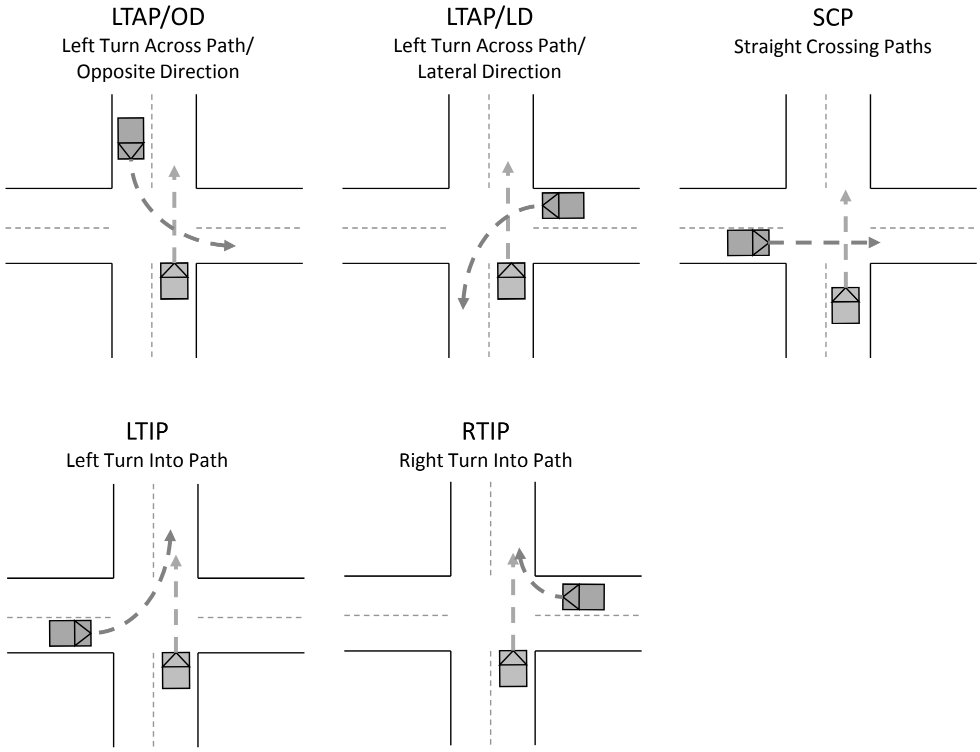


Figure 1.2. Intersection crash types as defined by Najm et al. (2001)

In the analysed material, the distribution of crashes according to this typology is presented in table 4Table. As can be seen, the most frequent crashes are LTAP-OD and LTAP-LD crashes. This corresponds partially to the crash proportions found in Najm et al. (2001), where LTAP-OD and LTAP-LD crashes were two of the three largest intersection crash types. However, the largest crash type in was SCP crashes, a type which is nearly absent from this material. This is somewhat surprising, as SCP crashes in general are abundant not only in the US, but in for example Sweden as well (SIKA 2007).

Table 4. Distribution of crash types in analysed material according to the typology from Najm et al (2001).

Fatal intersection accident conflict patterns					
LTAP-OD	LTAP-LD	SCP	RTIP	LTIP	**Total**
13	10	1	2	2	**28**

Details on crash contributing factors for each driver in each in-depth study case file were first coded using the DREAM 3.0. An underlying assumption of the analysis carried out here is that each driver has his/her own reasons for failing to adapt to the driving situation. Causation information is therefore coded separately for each involved driver; resulting in one schema of contributing factors, or causation chart, per involved driver.

Next, the individual causation charts were aggregated in a number of ways in order to provide a foundation for analysis of patterns among crash contributing factors. First, all causation charts were aggregated into a single graph, to provide a kind of complete overview of the analysed data and illustrate how complex the interactions which lead to fatal crashes can be.

However, to understand more in detail why particular groups of drivers ended up in out-of-control situations, the 57 individual causation charts were sorted and compiled according to the crash typology in Figure 1.2 above, and furthermore according to which path each driver was on. This resulted in two aggregate causation charts for each crash type, i.e. one for each vehicle trajectory. For example, for LTAP / OD crashes, one aggregate causation chart for all left turning drivers (those on a LTAP trajectory) was created, and one for all drivers going straight (those on the OD trajectory). An exception was made for drivers involved in the single SCP crash in the data, where both drivers by definition were on the same type of trajectory. The two SCP drivers were therefore aggregated into a single causation chart. Finally, in order to "zoom out" a bit, all drivers going straight and all drivers on a turning path were aggregated for the full data set, i.e. all crashes.

4 Results

In the figures below, the total number of times a contributing factor occurs is represented by the number in brackets within each box. Note that DREAM allows attribution of, for example, multiple planning failures or multiple missed observations to a single driver. Some contributing factors can therefore exist in more than one instance per chart, which means their frequency of occurrence can exceed the number of aggregated charts (i.e. the number of drivers).

For visual guidance when looking for patterns, the factor frequency numbers are indicated through box border thickness as well. For links between boxes, the number of times a link occurs is not written out, but indirectly represented through the thickness of the connecting lines.

Note that for simplified reading, all detailed information which motivates the choice of each phenotype and genotype in the individual charts has been removed from the aggregations below. However, in the analysis, that information is of course used. For interested readers, the full analysis for each accident can be found in Appendix 3.

4.1 The full data set – an overview

Figure 1.3 illustrates the result of the aggregated DREAM analysis for all 57 involved drivers in the full data set.

As can be seen in Figure 1.3, the overall most common contributing factor is *Misjudgement of situation*, with 53 occurrences across all 28 crashes. The most common precursors, or antecedents, of those situational misjudgements are *Expectancy of certain behaviours* and *Missed observation.*

Interestingly, while many missed observations have *Permanent obstruction of view* as antecedent, there is also a frequent contribution from *Inattention*, which in turn is mainly linked to *Driving related distracters outside vehicle*. However, as can be seen in Figure 1.3, a large number of other contributing factors are involved as well. To gain further understanding, an analysis of the patterns among contributing factors for each crash types is necessary.

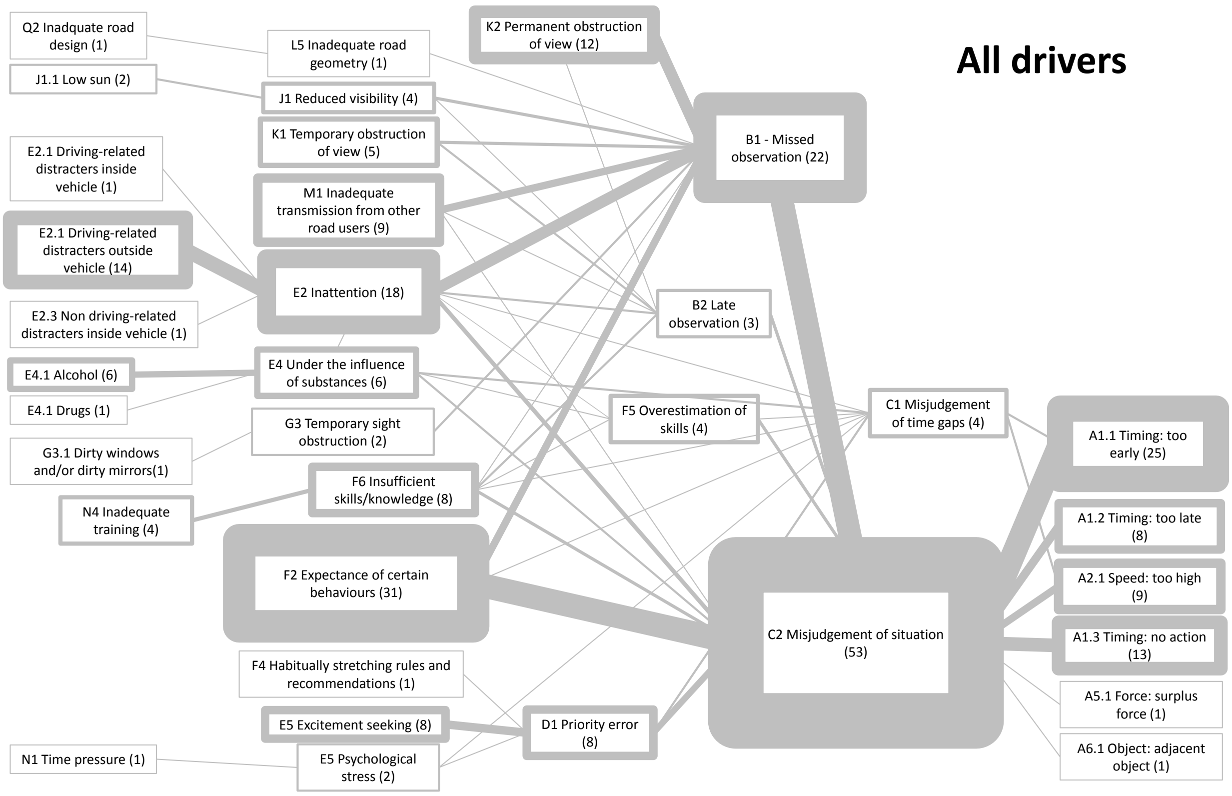


Figure 1.3. The full overview- aggregation of all DREAM analysis charts for all involved drivers in intersection crashes (57 total)

4.2 LTAP / OD Crashes

The first crash type to be analysed is Left Turn Across Path / Opposite direction (LTAP/OD) crashes. The conflict pattern in these crashes is illustrated in Figure 1.4. As described in the analysis procedure, the drivers involved were separated as being on a LTAP or OD trajectory prior to aggregation. In the causation charts below, the aggregate causation pattern for each such group of drivers is shown.

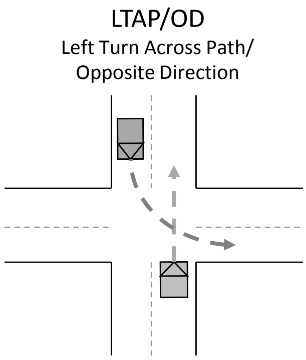


Figure 1.4. The LTAP-OD conflict pattern

4.2.1 LTAP drivers

Note that while there are 13 LTAP-OD accidents, there are a total of 14 phenotypes in Figure 1.5, indicating that there are 14 drivers analysed here. This is because one of the LTAP-OD crashes involved three vehicles, and two of those three were on a LTAP (turning) path, and therefore included below.

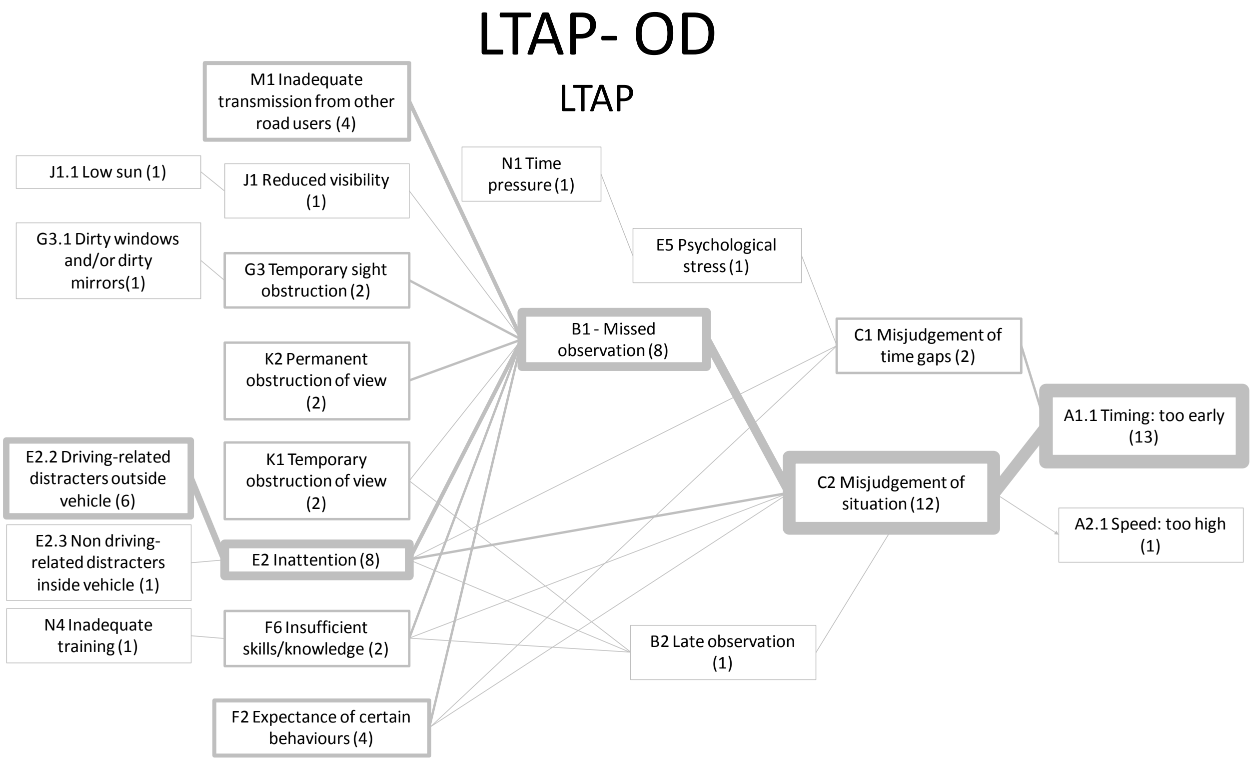


Figure 1.5. Aggregated causation chart for the 14 drivers involved in LTAP/OD crashes who were on a LTAP trajectory

A majority of LTAP drivers involved in LTAP-OD crashes were coded with the phenotype *Timing: too early* (13 of 14). This indicates that they began to turn through the intersection before it was appropriate to do so. In this context, "before it was appropriate" mainly refers to the fact that turning drivers generally are expected to yield to any vehicle on a straight crossing path, which they in these cases did not do.

Two of those early actions are attributed to a *Misjudgement of timegaps*, i.e. the turning driver has overestimated the time available for completing the turn before the oncoming vehicle reaches the intersection.

The other 11 have *Misjudgement of situation* as their main contributing factor. Contributing to those misjudgements are 8 instances of *Missed observation*. The basic meaning of this code is that the driver did not see the other vehicle at the time when s/he decided to carry out the turn. A closer reading of the individual charts reveals that the conflict vehicle in 7 of those 8 instances is some kind of motorcycle, which the drivers for a number of reasons were unable to perceive at "checkpoint time", i.e. when they decide that it is okay to make the turn.

The reasons for not perceiving these vehicles include the contributing factors *Reduced visibility* (here: MC driver wearing dark clothing against dark background), *Inadequate transmission from other road users* (here: sub-standard

MC lighting) and various obstructions to view. These include obstructions both inside the vehicle (*Temporary sight obstruction*, here items on the dashboard in one case and a dirty windshield in the other, as well as obstructions outside the vehicle. For outside distractions, *Temporary obstruction of view* indicates blocked lines of sight due to other vehicles in the traffic environment at critical decision moments, while *Permanent obstruction of view* primarily refers to vegetation. For the latter category, there is however also one instance of a traffic sign blocking the line of sight, and one instance where the design of the road lighting under certain circumstances (i.e. when it rains) actually hinders sight rather than helps.

Apart from difficulties in perceiving the other road user, the turning drivers of LTAP-OD accidents also have 8 instances of *Inattention* as antecedents to *Misjudgement of time*. These in turn are largely generated by *Driving-related distracters outside vehicle* (6 instances), which means that the drivers were using a significant part of their capacity to negotiating some other relevant task in the traffic environment. In four of the six instances, this involves keeping track of another vehicle which also is about to negotiate the intersection. The fifth instance involves tracking pedestrians on the sidewalks who are crossing somewhat at random (outside a school), and the sixth involves manoeuvring a large truck and trailer combination through a (for that vehicle combination) relatively tight turn.

Another general contributor worth noting is *Expectancy of certain behaviours,* with four instances. Three of these refer to drivers who expect other vehicles to keep approximately to posted speed limits, and thus limiting their scanning pattern accordingly (i.e. not looking sufficiently far down the road to discover a MC travelling at very high speed).

It is worth noting that there is just one instance of a secondary task inside the vehicle (*Non-driving related distracter inside vehicle*) acting as a contributing factor. Here, the driver was changing CDs just prior to getting involved in the critical event.

It is also worth noting that there are only two instances where lack of driver training is contributing, and only one accident where psychological stress has played a role. This can be taken to indicate that turning drivers do not end up in this situation due to a lack of driving experience or because they are under time pressure. Rather it seems to be the unwanted outcome driven by a combination of contributing factors which in these cases create a sufficiently large deviation between what the driver thinks is going on and what is really going on, to result in an accident outcome.

4.2.2 OD drivers

Now we turn to the drivers going straight in LTAP-OD crashes, i.e. those coming from an opposite direction (OD). Here, the number of involved drivers matches the crash count, i.e. there are 13 aggregated causation charts in Figure 1.6.

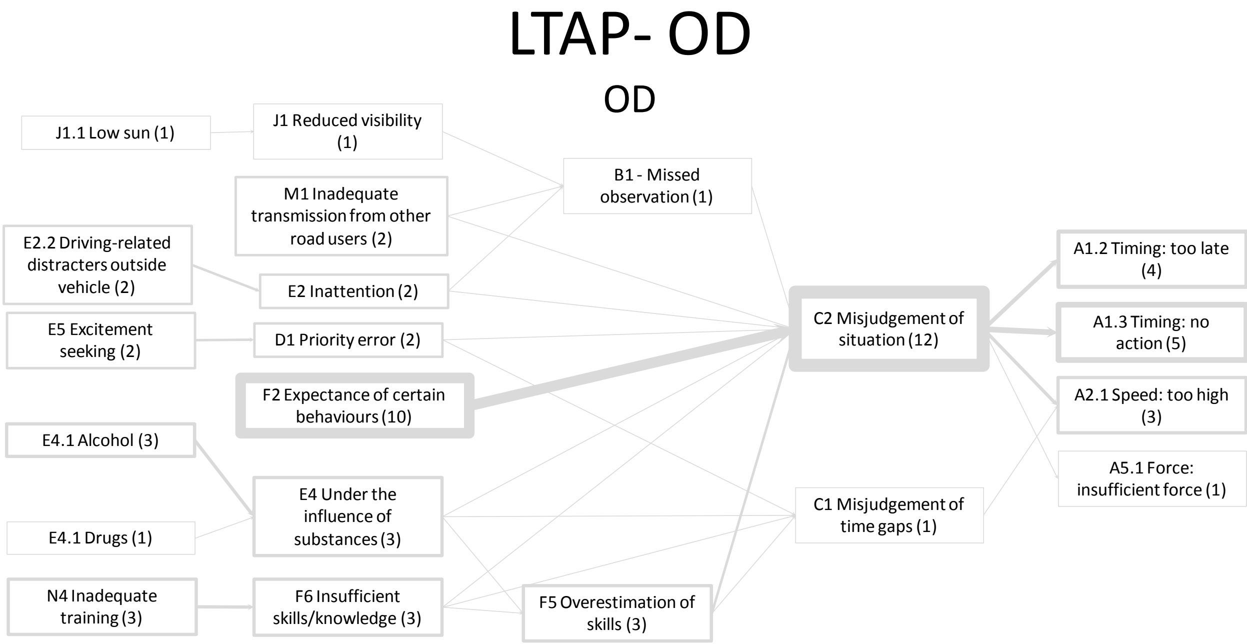


Figure 1.6. Aggregated causation chart for the 13 drivers involved in LTAP/OD crashes who were on an OD trajectory

One initial thing to notice is that the phenotype coding for OD drivers is more diverse than for their turning counterparts. 5 are coded as *Timing: no action*, which means that they did not perform any type of steering and/or braking prior to the crash. The 4 coded as *Timing: too late* have to some extent begun to take corrective actions, but start the process to late and therefore end up in a crash. One driver is coded as *Force: insufficient force*. Had this driver used the normal braking capacity of the MC he was driving the accident most likely would have been avoided.

Three drivers are coded as *Speed: too high*, 2 of which involve situations normally associated with too high speed; i.e., MCs travelling at substantially higher speeds than legally permitted, and thus substantially faster than what the turning drivers would expect and scan for. The third case however is slightly different. It involves a car which negotiates a curve with very limited visibility at, or slightly above, legal speed, which leaves the driver insufficient time to react to a stationary vehicle just after the curve (at an intersection).

The most common contributing factor to these phenotypes is *Misjudgement of situation* (12 instances). Of these 12, 10 are preceded by *Expectancy of certain behaviours*. Here this indicates that the drivers going straight expect any turning vehicles to yield, i.e. wait until they have passed. In a majority of cases, the drivers have most likely seen the other vehicle and expects it to stop/wait for them. In two of the cases, this involves a more general expectancy of other drivers' behaviours, including yielding to vehicles going straight when turning and expecting vehicles coming from the rear to stop for vehicles in front.

There are also three drivers which link to *Misjudgement of situation* through the chain *Inadequate training* → *Insufficient skills/knowledge*. Two of these are drivers who lack a drivers licence for the MC they are driving. These two are also coded as *Under the influence of substances*, as well as with the chain *Excitement* *seeking* → *Priority error*. The third driver is driving a high performance MC, the full brake capacity of which he is not capable of using.

In comparison to the turning drivers, there are only two instances of *Driving related distracters outside vehicle*, so traffic situation seems overall not to have been as taxing for the drivers going straight as for the turning drivers. This likely reflects the fact that drivers going straight have priority over any other traffic, and thus are less concerned with other vehicles approaching, or being in, the intersection.

Just as for LTAP drivers, there is also a notable absence of secondary distraction tasks and psychological stress. There is in other words no indication that these drivers were challenged with a particularly difficult traffic situation.

4.3 LTAP / LD crashes

The second crash type to be analysed is Left Turn Across Path / Lateral direction (LTAP/LD) crashes. The conflict pattern for this crash type is shown in Figure 1.7. There were 10 crashes of the LTAP-LD type in the material analysed.

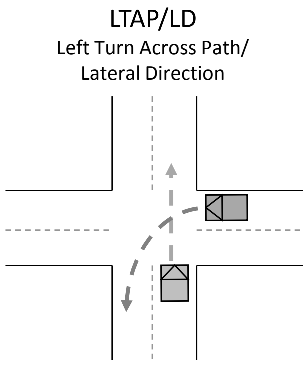


Figure 1.7. The LTAP - LD conflict pattern

4.3.1 LTAP drivers

The aggregated causation pattern for the 10 turning drivers in LTAP-LD crashes is shown below in Figure 1.8.

As can be seen in the chart, the turning drivers in LTAP-LD crashes are, just like the turning drivers in LTAP-OD crashes, almost exclusively phenotype coded as *Timing: too early* (9 of 10). As for LTAP-OD crashes, this indicates that they began to turn through the intersection before it was appropriate to do so.

The immediate antecedent for all of the 10 crashes is *Misjudgement of situation*. For 7 of the 10 drivers, a contributing factor to the misjudgement is *Missed observation*, which in turn mainly is driven by a combination of *Permanent obstruction to view* and *Inattention*. As above, the *Permanent obstruction to view* is mainly related to vegetation surrounding the intersection (6 of 7 instances), but there are also traffic environment design elements which play a part (2 instances of signposts and one case of intersection layout design).

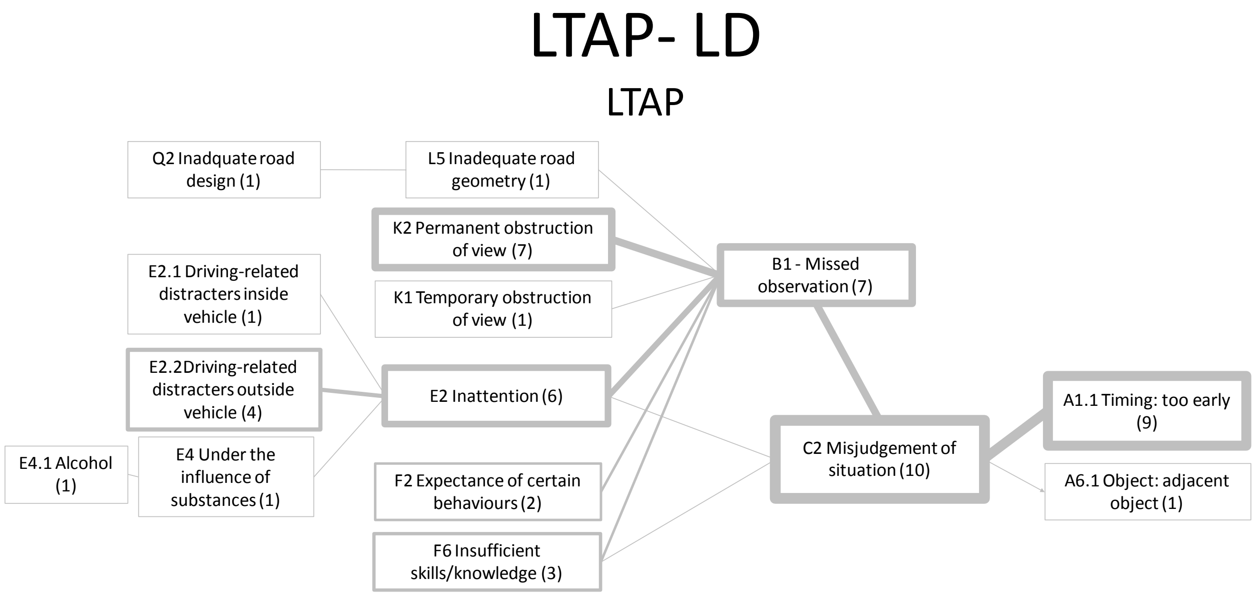


Figure 1.8. Aggregated causation chart for the 10 drivers involved in LTAP/LD crashes who were on a LTAP trajectory

The *6 Inattention* instances are mainly attributed to various distractors, the most common being the 4 instances of *Driving related distracters outside vehicle*, e.g. other vehicles which must be considered when negotiation of the traffic situation. There is also one instance of a *Driving related distracter inside vehicle* and one instance where *Inattention* is attributed to the driver being drunk (*Alcohol*).

In two of the three cases where *Insufficient skills/knowledge* has been coded, this refers to young (18 yrs) and relatively inexperienced drivers who have had their driving licences for a short time. The third case involves a driver who is negotiating the manual shift of a rental car, while being used to automatic gear in his own vehicle.

4.3.2 LD drivers

The aggregated causation pattern for the 10 drivers going straight in LTAP-LD crashes is shown below in Figure 1.9.

Like the OD drivers of LTAP-OD accidents, the LD drivers have a more diverse phenotype coding. 5 are coded as *Timing: no action*, which means that they did not perform any type of steering and/or braking prior to the crash. The 3 coded as *Timing: too late* have to some extent begun to take corrective actions, but start the process to late and therefore end up in a crash. One driver is coded as *Speed: too high*, indicating a travel speed substantially over the speed limit.

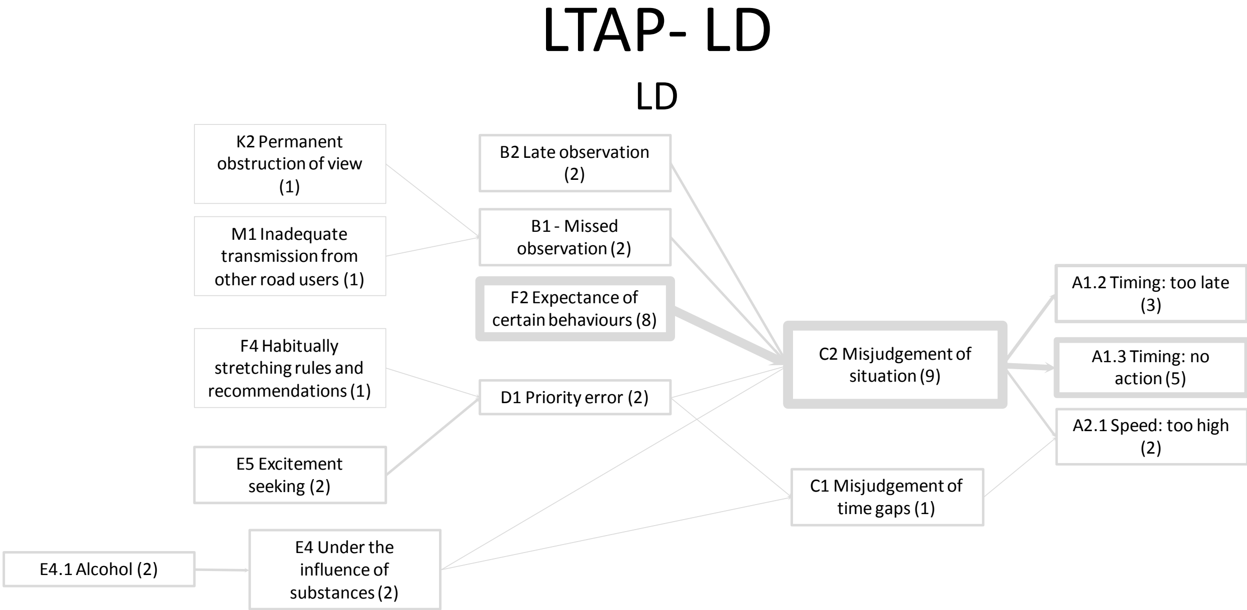


Figure 1.9. Aggregated causation chart for the 10 drivers involved in LTAP/LD crashes who were on a LD trajectory

In terms of contributing factors, there is one instance of *Misjudgement of timegaps*, where an MC driver overestimated the time available for passing through the intersection before the turning vehicle would be blocking the MC's travel path. This driver is also coded as *Excitement seeking → Priority error* and *Alcohol → Under the influence of substances*, and the phenotype attributed is *Speed: too* high, so this is a case of a speeding and drunk MC driver.

The other 9 phenotypes are attributed to *Misjudgement of situation*. As for OD drivers in LTAP-OD crashes, a majority of these have *Expectancy of certain behaviours* as a contributing factor. For most of those 8 instances, the LD driver has seen the conflict vehicle in, or approaching, the intersection, but expects that it will stop and yield.

There are some visibility issues reported for these drivers as well. There are 2 instances of *Missed observation* and 2 instances of *Late observation. The* instances of *Missed observation* are in turn attributed to one instance of *Inadequate transmission from other road users* and one instance of *Permanent obstruction to view*. It is worth noting that the latter are not nearly as many as for the turning drivers. This actually indicates an implicit contradiction, which is further discussed below under general aspects of which types of information on causation can be expected from turning drivers and drivers going straight, respectively.

4.4 SCP crashes

There was just one SCP crash in the material, the conflict pattern of which is shown in Figure 1.10.

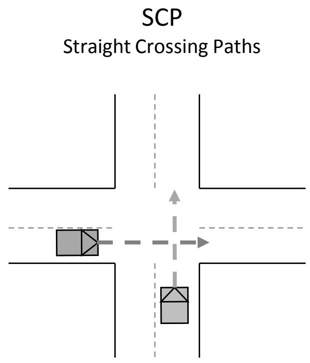


Figure 1.10. Conflict pattern for Straight Crossing Path crashes – note that the laterally crossing vehicle may come from the right as well.

The two individual aggregation charts for the drivers involved in the only SCP crash were aggregated (Figure 1.11).

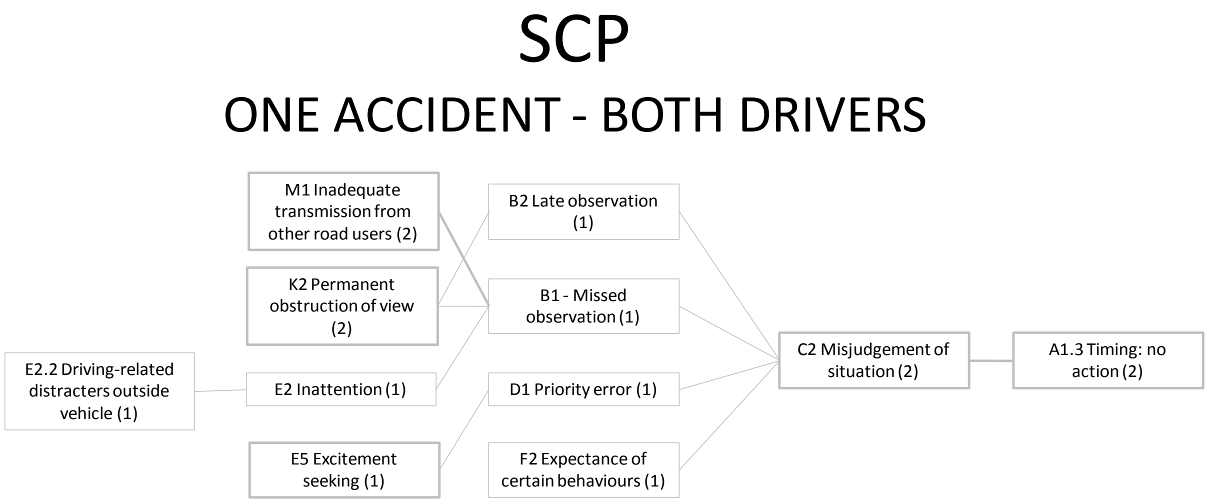


Figure 1.11. Aggregated causation chart for the 2 drivers involved in the only SCP crash (both on a LD trajectory)

As can be seen, both these drives are coded as *Timing: no action*, indicating that neither made any attempt to stop or yield as they approached the intersection. Both *drivers* had difficulties seeing the other vehicle (*Late observation* and *Missed observation* respectively), due to a mutual *Permanent obstruction of view*. One of the involved drivers is coded as *Excitement seeking* → *Priority error* in combination with *Driving-related distracters outside vehicle*, which here refers to the fact that he was reported as most likely trying to beat another vehicle coming from the right to the intersection by driving relatively fast (the conflict vehicle was coming from his left).

4.5 RTIP crashes

There were two RTIP crashes in the material, the conflict pattern of which is shown in Figure 1.12.

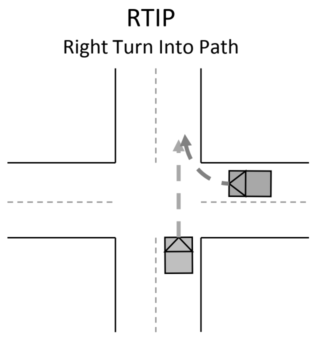


Figure 1.12. Conflict pattern for Right Turn Into Path crashes

The aggregated causation charts for drivers turning right in RTIP crashes are shown in Figure 1.13. One driver is phenotype coded as *Timing: too early*, which indicates that he commenced the turn before the intersection was clear. The other is coded as *Timing: no action*, which here indicates that the driver drove into the intersection without stopping for the vehicle on the crossing path. Contributing factors are *Misjudgement of situation* due to *Missed observation* and *Expectancy of certain behaviours.* Here the latter two refer to one of the drivers who was not looking for vehicles travelling at speeds much higher than posted speed limit, and who therefore did not look sufficiently far away to detect the approaching motorcycle.

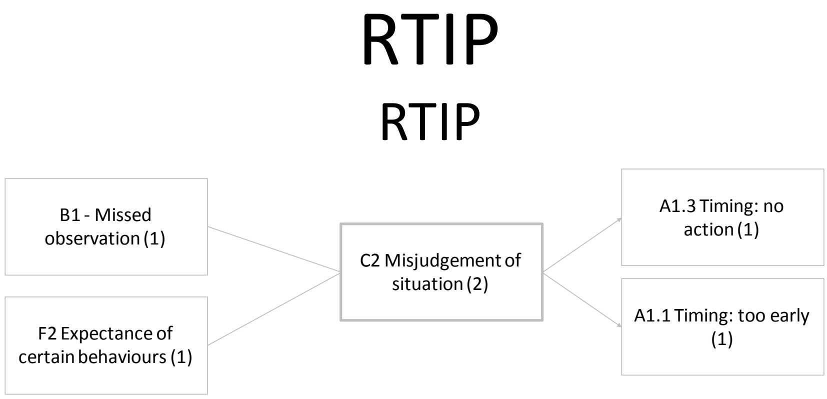


Figure 1.13: Aggregated causation chart for the 2 drivers involved in RTIP crashes who were on a RTIP trajectory

The aggregated causation chart for the two drivers going straight is shown in Figure 1.14. In one of the cases, the driver was speeding with a motorcycle but still expected the turning driver to yield. In the other case, the right turning car just pulled out in front of a semitrailer and the trailer driver did not have time to react at all.

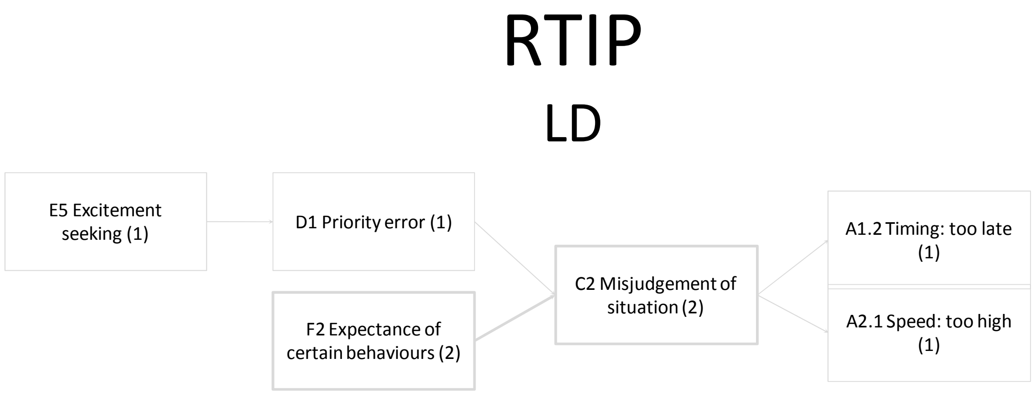


Figure 1.14: Aggregated causation chart for the 2 drivers involved in RTIP crashes who were on a LD trajectory

4.6 LTIP crashes

There were two LTIP crashes in the material, and the conflict pattern for these crashes is shown in Figure 1.15.

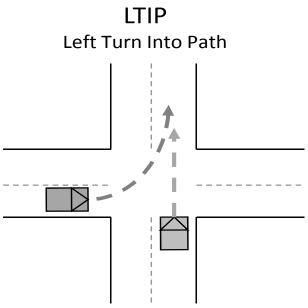


Figure 1.15. The conflict pattern for Left Turn Into Path crashes

The aggregated causation charts for drivers turning left in LTIP crashes are shown in Figure 1.16. In both cases, these involve a car driver who commence the turn because s/he did not see an oncoming motorcycle. In both cases, the motorcycle was both travelling much faster than the speed limit, and thus outside the expectancy range at the critical decision point, as well as difficult to observe.

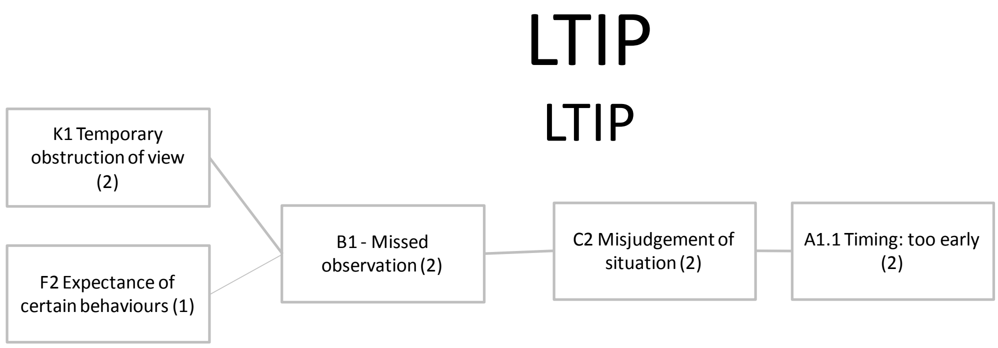


Figure 1.16 Aggregated causation chart for the 2 drivers involved in LTIP crashes who were on a LTIP trajectory

The aggregated causation charts for drivers going straight in LTIP crashes are shown in Figure 1.17. Both these involve motorcycle drivers who are driving much faster than legally permitted (as indicated by *Excitement seeking*→*Priority error*. One of the drivers is involved in what can be referred to as a peer pressure situation, i.e. he wants to show his friend what he can do (*Psychological stress*), and he also overestimates his own driving skills (*Overestimation of skills*).

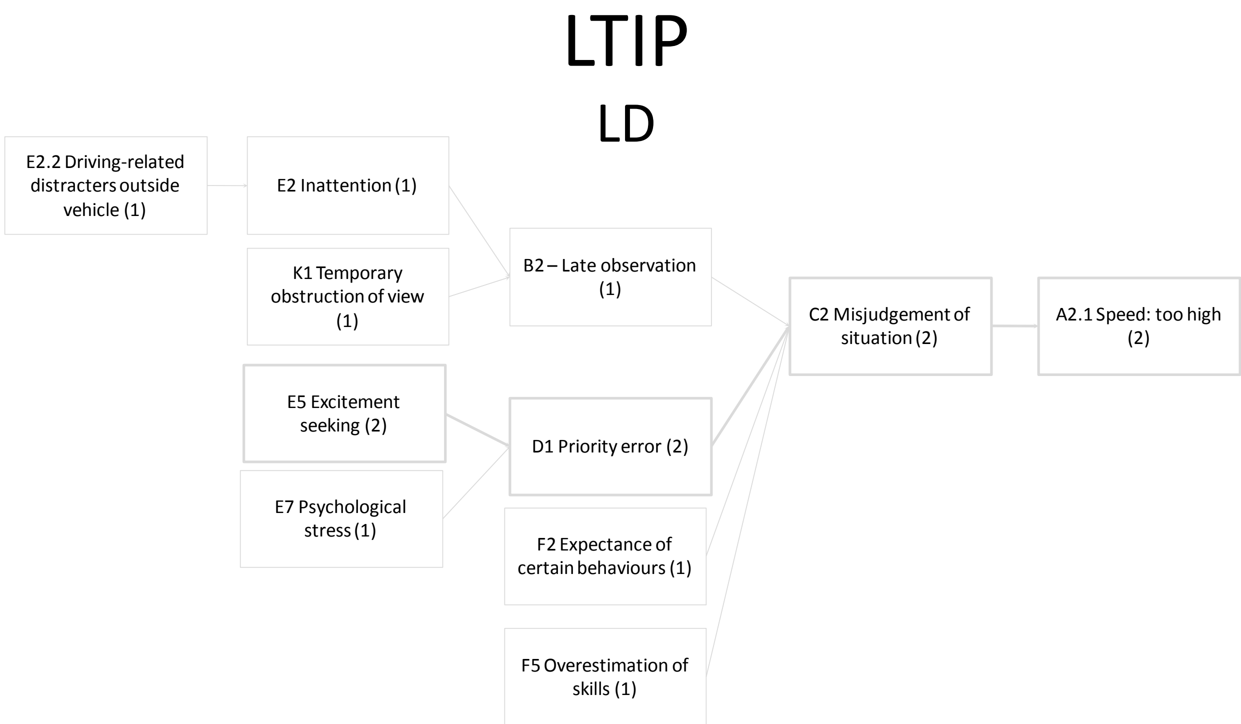


Figure 1.17. Aggregated causation chart for the 2 drivers involved in LTIP crashes who were on a LD trajectory

4.7 Aggregate analysis on a higher level

In order to find causation patterns on a further abstraction level, the full set of 57 crash involved drivers were divided according to whether they were going straight or turning, and their causation charts aggregated accordingly.

4.7.1 Turning drivers

The aggregated causation charts for all turning drivers are shown in Figure 1.18. As can be seen, the most prominent causation patterns for turning drivers is *Misjudgement of situation* due to *Missed observation,* which in its turn is brought about by various obstructions to view (mostly related to infrastructure elements), by *Driving related distracters outside vehicle* (linked through *Inattention*) and by *Expectancy of certain behaviours*.

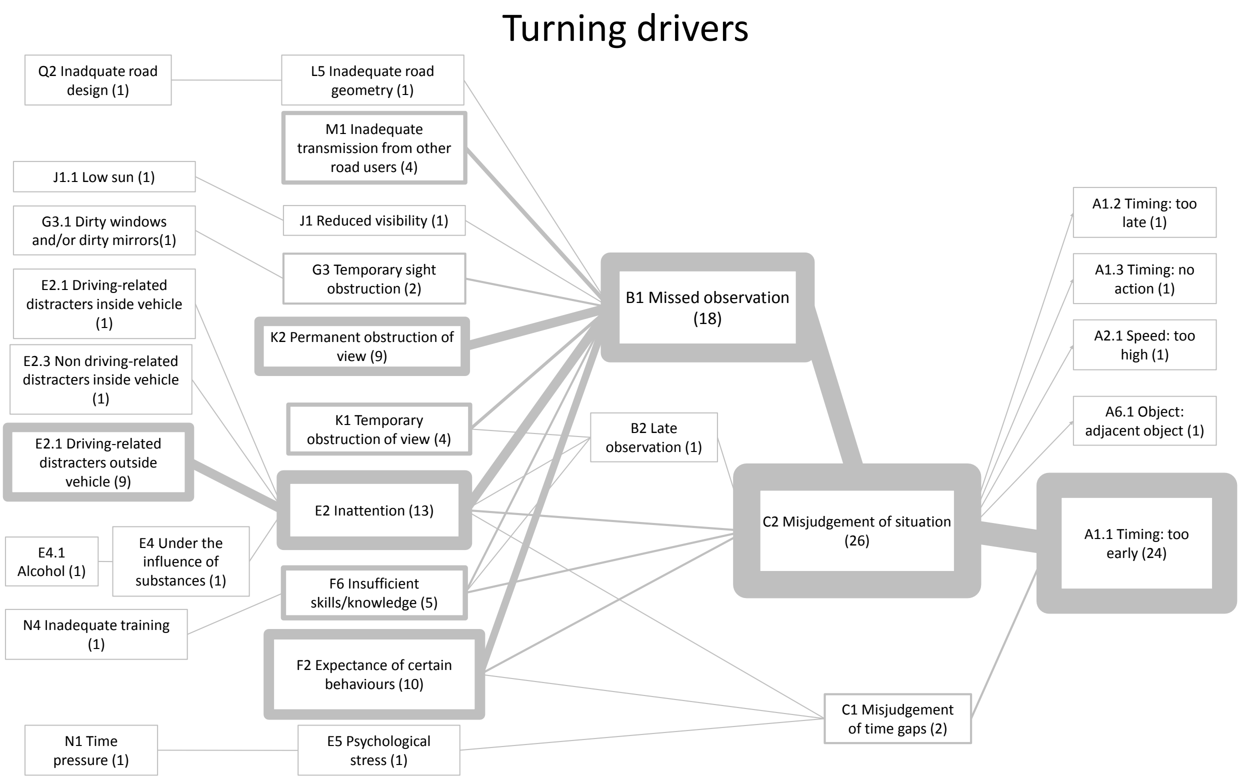


Figure 1.18. Aggregated causation chart for all 29 drivers who were performing a turning manoeuvre prior to the crash

The high frequency of *Missed observation* as a contributing factor most likely reflects the fact that drivers going straight more often have the right of way. The task of identifying and responding to a conflict vehicle therefore usually rests with the turning drivers. Because of that responsibility, sight limitations are more debilitating for turning driver performance, and hence more likely to be reported as a contributing factor.

The large portion of *Expectancy of certain behaviours* here mainly involve not adjusting the regular scanning pattern to accommodate vehicles travelling at speeds well above the speed limit. The fact that these vehicles invariably are motorcycles can be taken to indicate that either car drivers do not speed in the same way as motorcyclists do. However, a more plausible explanation has to do with human visual attention selection processes.

As discussed at length in recent research on attention, there are two main ways in which driver attention can be captured. One is the way in which a stimulus, such as another vehicle, can be said to stand out in relation to its surroundings, i.e. its *saliency*. When attention is directed towards an object because it somehow stands out, this is referred to as *bottom-up* driven attention selection. For example, the colour red if often used on warning signs and lights, because it normally stands out in relation to the surroundings. The other way a stimuli can capture attention is through *top-down* selection, meaning that a driver is proactively selecting, or being partial to, certain stimuli, not because they stand out from a sensual point of view (though they may of course do so), but because they provide important cues for how the traffic situation will develop[2]. For example, if a driver is about to turn left in an intersection, the turn indicator of a vehicle coming from the opposite direction may be less salient than its headlights. The turning driver will nonetheless focus on that turn indicator, to find out whether the other vehicle is turning or going straight (in which case the driver must yield right of way).

When a turning driver expects other vehicles to keep to the speed limit, while the other vehicle in fact is speeding, this in practice can be said to disable the top-down selection process. The threat object horizon which the driver thinks is relevant and therefore actively scans is in effect too small. This means that the only way for the conflict vehicle to capture the turning drivers attention is through bottom-up attention selection, i.e. by standing out in relation to its surroundings. Since a motorcycle is much less salient than a car (much smaller, less lighting) it will not stand out in relation to its surroundings the same way a car does. In the cases analysed here, it seems like the motorcycles simply do not not make it above the saliency threshold for bottom-up driven detection before it is too late. Several drivers describe their experience of the speeding motorcycles as "suddenly it was just there", which cannot be true from a physics point of view, but which matches quite well with this theory of attention selection.

In this overview it is noticeable that the contributing factor *Under the influence of substances* is almost entirely absent. Only in one instance has *Alcohol* contributed to the development of events. In terms of other "high profile" contributing factors for fatal accidents, speeding only occurs once (*Speed: too high*), driver fatigue is entirely absent, and *Inadequate training* occurs once. This can mean two things. Either the accident investigations have failed to identify instances where these factors have contributed, despite their assumed association with fatal crashes, or turning drivers are not drivers for whom these factors contribute. This will be further discussed below.

Other noticeable "missing" factors are *Time pressure* and *Psychological stress*, and indications of secondary task engagement, e.g. *Non-driving related*

[2] Note that this does not necessarily involve effort or conscious awareness. Routine driving, such as lead vehicle following, is often handled effortlessly, even if it involves some proactive and context-dependent attention selection, due to "implicit" expectations on how the situation will develop.

distracters inside vehicle occurs only in one instance. Again, this can either mean that the accident investigation has missed something, or that the turning drivers are not subject to these contributing factors. On the other hand, the frequency of *Driving related distracters outside vehicle* indicates that there is often some other traffic element involved in the traffic situation which the driver has to attend to, i.e. the task to manage for the turning driver is often relatively complex.

4.7.2 Drivers going straight

The aggregated causation patterns for drivers going straight are shown in Figure 1.19. Here, drugs and alcohol are more prominent contributing factors than they were for turning drivers. There are 5 instances where substance abuse has contributed to the accident (mainly *Alcohol*). In terms of the other "high profile" factors, speeding occurs in 8 instances (*Speed: too high*) and *Inadquate training* in 3 instances, while driver fatigue is again entirely absent.

In other words, for drivers going straight, the accident investigations show a larger display of contributing factors commonly referred to in literature as typical contributors to fatal crashes. In terms of numbers, a closer reading reveals that some of the factors overlap for particular accidents. All in all, high speed, drugs and/or alcohol and inadequate driver training played a role in 12 of 28 intersection accidents, where the affected driver in 10 of those 12 cases is the driver going straight.

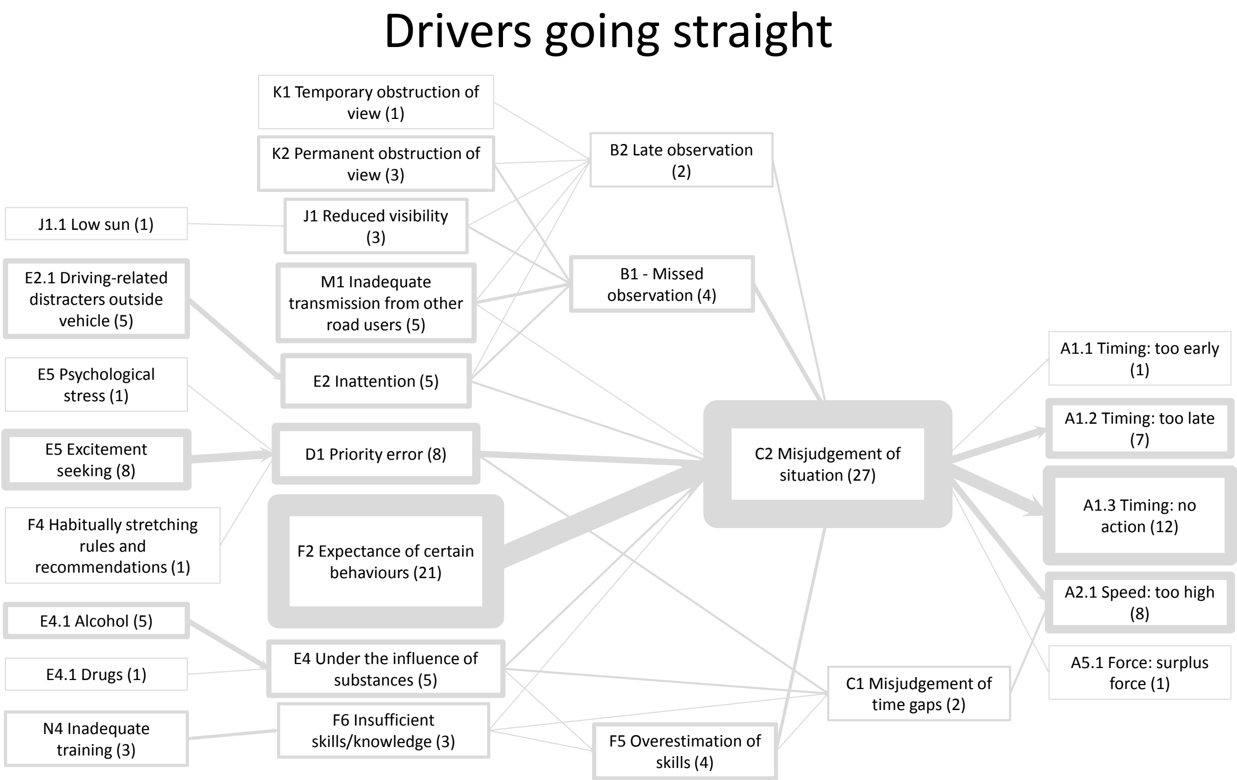


Figure 1.19. Aggregated causation chart for all 28 drivers who were planning to go straight through the intersection

A large number of planning related failures are also present for drivers going straight. Something which stands out is the high frequency of planning failures due to *Expectancy of certain behaviours*. This most likely reflects the fact that drivers going straight more often have the right of way. The task of identifying and responding to a conflict vehicle therefore in practice rests with the turning drivers. As discussed above, this assumption is supported by the fact that various obstructions to view are more often reported as a contributing factor for turning drivers than for drivers going straight.

It is worth noting that the group of drivers going straight exclusively contains the 17 MC drivers involved in the total 28 accidents. These MC drivers are also overly represented when it comes to contributing factors such as *Excitement seeking* and *Alcohol/Drugs,* as well as *Overestimation of skills* and *Insufficient skills/knowledge.* Their counterparts in turn have frequent difficulties in perceiving the MC drivers, both because they are not always very visible in terms of reflection and lighting, but also because the turning drivers are not scanning sufficiently far down the road in order to discover them, as they are not expecting speeding vehicles to be approaching the intersection.

4.8 Data quality

In Figure 1.20, the frequency of identified contributing factors for drivers going straight and turning are shown. This table provides some interesting general insights into how data has been collected in the 28 investigated accidents.

A general observation is that there are overall fewer contributing factors coded for drivers going straight than for turning drivers. This probably reflects an underlying but involuntary mechanism in the accident investigations, which is that the analysts are more likely to provide deeper and fuller explanations for why the turning driver gets into trouble, as compared to the driver going straight.

A very clear example which illustrates this asymmetry is the number of reported obstructions to view due to signposts and vegetation. Since they are part of the traffic environment, i.e. the infrastructure, one would assume that any blockage in lines of sight is reciprocal, i.e. if driver A cannot see driver B, the reverse should also be true. However, while such obstructions to view are frequently reported as contributing for turning drivers, they are rarely reported as contributing for their counterparts *in the same accidents*.

The reason why analysts have this focus on identifying contributing factors for turning drivers (albeit involuntary) is most likely connected to the fact that the turning driver is usually the one who is legally held liable for the accident. Since the driver going straight normally has the right of way, it is easy to conclude that it was not his/her fault. From that it is easy to come to think that the lions share of investigation effort should be put on the driver at fault, since that driver is the one who needs accident countermeasures the most.

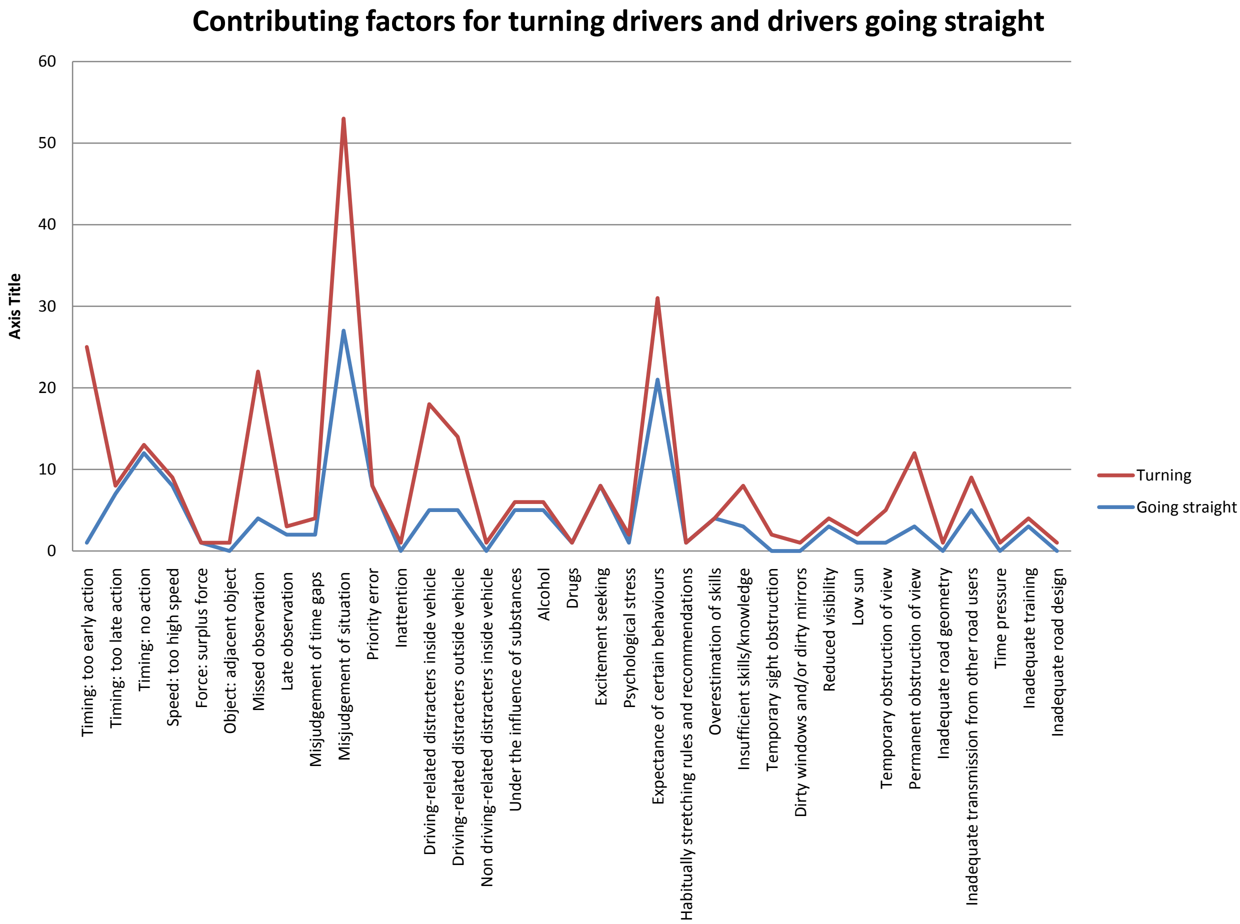


Figure 1.20. Frequency chart describing the number of times each contributing factor (of those applicable in the analysis) occurs for turning drivers and drivers going straight

Now, it is true from a physics standpoint that if two vehicles are on a colliding path, it will almost always be easier for one of the vehicles to perform the avoidance manoeuvre necessary to prevent a collision. However, it is far from clear that this vehicle necessarily contains the driver at fault; it is a kinematic relationship between moving masses rather than a moral relationship between operators. Put slightly differently, whom to blame is in a majority of cases irrelevant from a countermeasure development point of view. Underreporting of contributing factors for one of the parties involved based on moral reasoning about guilt thus hinders rather than helps countermeasure development. This underlying investigator mindset therefore needs addressing, to avoid future bias in the reported information.

It can also be seen that in the general perspective, the information on blunt end factors (those more distant in time/space, yet important for the development of events) contained in the accident reports is more limited than information on sharp end factors (those close in time/space to the crash). A likely explanation for this phenomenon is that the analysts, while certainly being professional crash investigators, not always reflect on the influence of blunt end factors on the event they are analysing. As there is no common methodology which explicitly describes the relevant scope of possible contributing factors, the analyst may view blunt end factors as part of the circumstances under which the event took place rather than contributing factors in themselves, and there is nothing and no one about there to correct it. This points to the importance of having an explicit, and in the analyst group anchored, analysis method which clearly defines the scope of possible contributing factors and influences to be controlled for in accident investigation. This in particular holds if the investigations are to yield results on blunt end factors.

On a more detailed level, there seem to be certain discrepancies between teams and investigators in terms of how data collection is managed and analysed. This observation has to be qualified somewhat, because during this project we have not had access to the complete background material from all accidents. For most accidents only the final report (usually a 5-10 page pdf document) has been available too us, whereas for other accidents we have also consulted the various protocols filled out by the investigators, such as Åstedsrapport, Kjøretøyskjema, etc. The extra information available through the protocols outside the main report sometimes (but not always) did hold valuable extra information for the analysis performed here. Valuable should here be taken not to mean that it brings new information to light which is unavailable in the main report. In that sense, the final reports overall are good at compiling the relevant information from the other documents. However, 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. In this regard, the extra information in the other protocols could sometimes be used to discard certain possible contributing factors, the established absence of which certainly make a difference in terms of how the accident causation process is viewed.

In the discussion above on noticeable “missing” factors such as driver fatigue and secondary task engagement, two possible explanations were offered. One was that the accident investigations have failed to identify instances where these factors have contributed despite their assumed association with traffic accidents, and the other was that these factors simply do not contribute. This dispute is not easy to settle, because it requires in-depth knowledge of the investigation procedure, which questions the analysts ask, and how systematic they are 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 genotypes which were not applicable to any of the 28 analysed accidents. Since DREAM has been put through extensive validation work and corroboration with other researchers’ findings on possible accident causes, there is reason to further investigate why many of the genotypes available in DREAM never get applied in the analysis. While the hoped for result of such a project would be that the accident analysis as currently being conducted is indeed sufficiently extensive, a more likely result is that there probably is room for improvement.

Finally, there is an unnecessary element of conjecture present in some of the accident reports. This seems to mainly be a confounding effect of either the

STEP[3] diagram nomenclature or the headlines used in the report templates. When the instructions say that the analyst should list possible contributing factors, some analysts have taken this as license to speculate. Rather than including only factors for which there is at least some empirical evidence (but all possible of those, naturally), the analysts at times make quite general speculations, regarding the capabilities of older drivers and other matters.

For example, in one accident the analyst says that the intersection may be difficult to negotiate for those unfamiliar with it. However, nowhere in the report is it stated whether the involved drivers had passed this intersection before. In other words, these conjectures are not corroborated by data in the report, they are just there as some sort of general possibilities. On a side note, for some accidents the extra accident information available could actually be used to discard some of these conjectures, which may otherwise have been necessary to include as contributing factors.

[3] STEP (”Sequentially Timed Events Plotting”; Hendrick and Benner, 1987) is a method used by most UAGs in order to generate a timeline showing crash-relevant actions and events occurring prior to, during, and immediately following the crash.

5 Intersection crashes - conclusions

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.

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; in 10 crashes these factors were found for the driver going straight. Five drivers were influenced by alcohol or drugs, four out of whom were going straight.

While this confirms the prevalence of these risk factors, it also indicates that most drivers end up in these situations due to combinations of less auspicious contributing factors.

The accidents have a certain stochastic element to them. While it certainly is true that any one of them could have been avoided, had at least one of the drivers been even more cautious, it is also clear that asking or demanding that level of caution in ordinary driving would severely hamper mobility. It is also quite contrary to driver expectations and previous experience, and basically amounts to staying continuously prepared for something extremely unlikely. Given swedish STRADA numbers on crash involved motor vehicle drivers (middle weight, i.e. excluding trucks and MC's, resulting in light, severe and fatal injuries) and the number of kilometres travelled per annum, a rough calculation gives that one has to drive for 300 hours a year (15 000 km/yr) in 211 years to end up with 1:1 accident odds ratio. For fatal accidents only, those 211 years become roughly 10 000 years.

In terms of countermeasures, this means that there is no simple remedy available, in case someone thought so. Rather, a host of measures have to be applied. A natural focus point to start with would be the MC drivers going straight, as they form a large part of the problem. Measures to increase MC driver visibility (reflex vests, automatic and more intense lighting, etc) may make a difference. For MC drivers who are less inclined to use such vests, the type of gap availability estimators on trial in certain US intersections (and elsewhere) are a promising option.

PART 2:

In-depth analyses of 15 fatal collisions between bicycle and motorized vehicle

6 Background and method

6.1 The primary data

Only final reports were used for our analysis. Out of a total of 26 fatal bicycle accidents, those 15 involving collision with a motorised vehicle were selected for analysis. The DREAM analysis was carried out only for the driver of the motorized vehicle.

6.2 Modification of DREAM: Estimating level of certainty when determining the genotypes

The 15 collisions were analysed using DREAM 3.0. An important modification of the method was made for these analyses to denote the varying levels of certainty associated with contributing factors. This implies that the analysis approach for the bicycle collisions differed slightly from the one that was used for the intersection crashes presented in Part 1.

DREAM forces the analyst to think through several stages of the accident and choose the most appropriate genotypes. The extent to which the analyst can be certain about this choice will depend on the information available. In some cases there will be gaps in the information about the pre-crash stage of an accident. This is more likely when one or more of the involved persons has been killed. In such cases the analyst has to employ deduction to a greater degree, and will be less certain about the choice of genotype.

To document the amount of certainty associated with each genotype, we decided to classify them in three categories, according to the level of direct evidence available from the available information. These categories are defined as follows:

Low certainty - conflicting records, no direct information or weak inference
Medium certainty - reasonable inference / inference from an objective source
High certainty - direct information/inference from an objective source.

7 Results of the DREAM analyses

In this section the results of the DREAM analyses are presented. For each crash we start with a brief description of surrounding events. A simplified drawing is then given to illustrate the crash situation. Each drawing is only meant to help the reader understand the description of the accident, rather than depict every detail of the event. The actual DREAM analysis and discussion of the results follows the event description. Methodological considerations are given together with any other points of note in Appendix 5.

7.1 Truck hitting two cyclists from behind

7.1.1 Short description of the accident

On a summer evening a trailer loaded with groceries (A) travelling on a narrow country road ran into two cyclists while overtaking them on a left hand curve with somewhat limited visibility. The cyclists were cycling in tandem at the edge of the road. They were headed in the same direction as the trailer. Instead of slowing down and waiting for a better opportunity, the trailer tried to overtake the cyclists with a clearance of 0.5 – 0.7 m. The requirement is 1.5 – 2.0 m. The trailer hit the first cyclist (B) such that that individual was thrown against the cyclist in front (C). Both cyclists ended up lying in a stone-filled trench. The first cyclist to be hit was killed on the scene, while the other was severely injured and transported to the hospital. A witness who had been driving an oncoming vehicle reported that the trailer first hit the first cyclist while attempting to overtake, and then hit the other with his trailer while turning back into the right-hand lane.

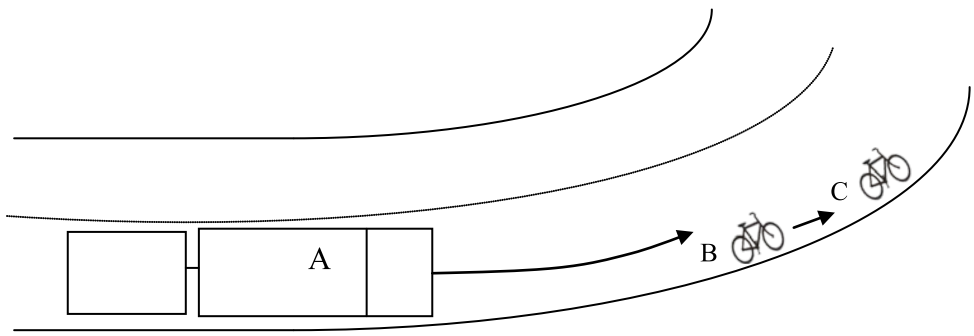


Figure 2.1: Sketch of accident 1.

7.1.2 Results of DREAM analysis

This accident is considered to be a “catching up accident” where the driver kept “too short distance” to the vehicle in front. The first genotype is “Misjudgement of situation”. The driver had clearly deemed it safe to overtake, while the records reveal that the view to the road ahead would have been somewhat limited and that the road was too narrow for such a manoeuvre. The genotype “Priority error” is chosen because the driver chose to overtake the cyclist instead of slowing down to 30 km/h and wait for a better opportunity. The genotype “Inadequate road geometry” was chosen because the road is clearly not suited to the heavy traffic that routinely uses it, with trailers barely fitting inside the lanes. The genotype “Expectancy of certain behaviour” is chosen because the driver most likely expected that the cyclists would keep to their side of the road, even though he tried to overtake them with a marginal distance. He may have done so under pressure from the road geometry.

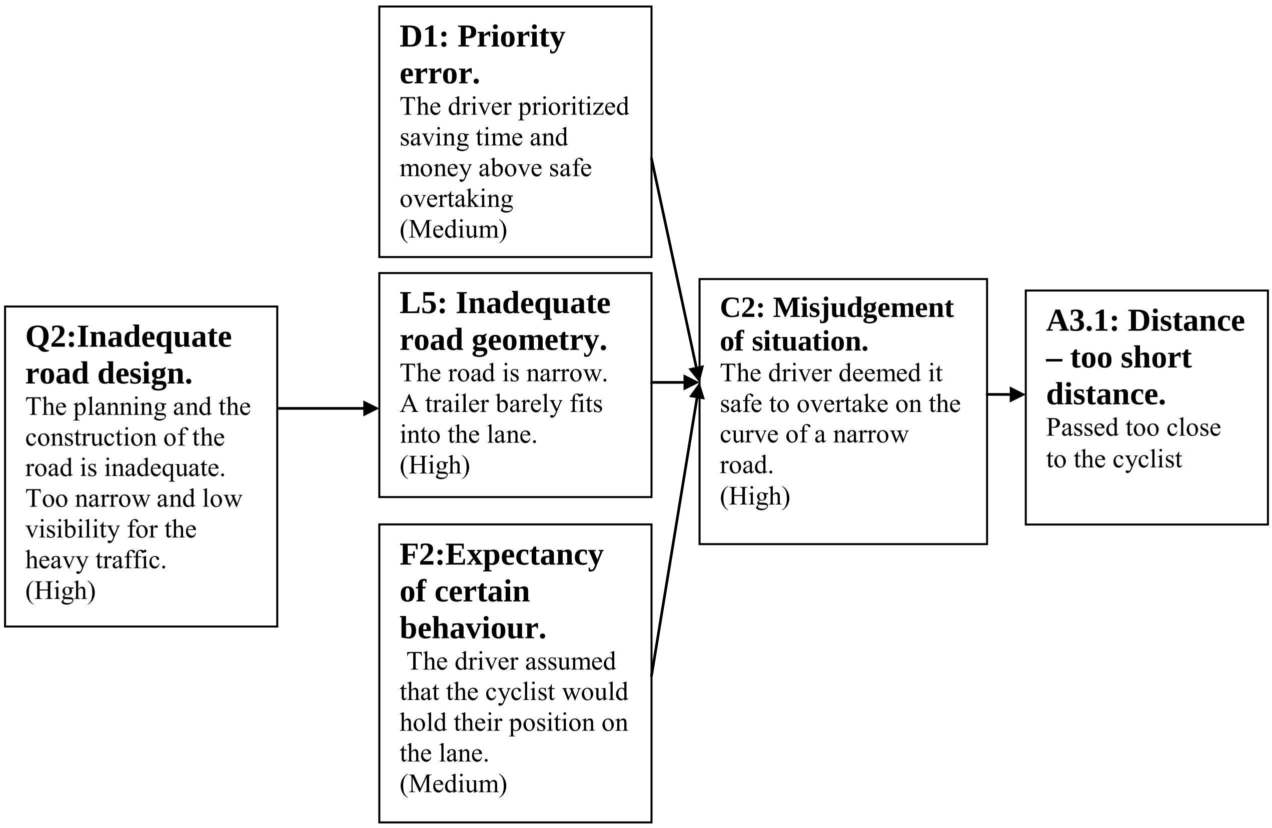


Figure 2.2. DREAM analysis of accident 1.

7.2 Truck running over a cyclist

7.2.1 Short description of the accident

On a dark December evening with poor lighting conditions a truck (A) ran over a cyclist waiting to turn left in a crossing. The truck had been waiting for the green signal to turn left from the left lane. The cyclist placed himself on the truck's right hand side, just in front of it, in the same lane. This position was in the truck driver`s blind spot, which was expanded by a console placed on the dashboard. The truck driver was not aware of the cyclist. The cyclist`s intention must have been to start off before the truck and get clear of it when the signal turned green. However, before the lights changed the truck driver decided to turn right instead, probably basing his decision on the congested traffic. So he signalled to the right, waited for all the vehicles to pass on his right hand lane, and turned right, running over the cyclist with his front right wheel. The cyclist died on the scene.

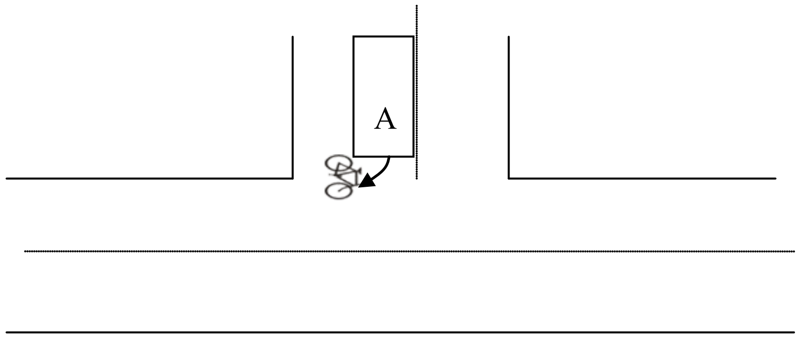


Figure 2.3. Sketch of accident 2.

7.2.2 Results of DREAM analysis

This is an intersection accident. "Wrong direction" is chosen as the phenotype because the driver initiates an illegal turn. "Misjudgement" of situation is chosen as the first genotype, as the driver assumed it was safe to proceed because the passage was clear. He "Misjudged the situation" because he had "missed observing" the cyclist's approach and its final position in front of the truck. This was due to "Inattention". The driver initially had his mind set on turning left, but on seeing the congested queue of cars he quickly calculated a new route and decided to turn right instead of left. During this process, missed the cyclist's approach to the truck. On the dashboard a shelf or a bracket was installed which contained different belongings. This obstructed the view and expanded the driver's blind spot. Thus "Permanent sight obstruction" and "inadequate design of driver environment" are chosen as genotypes.

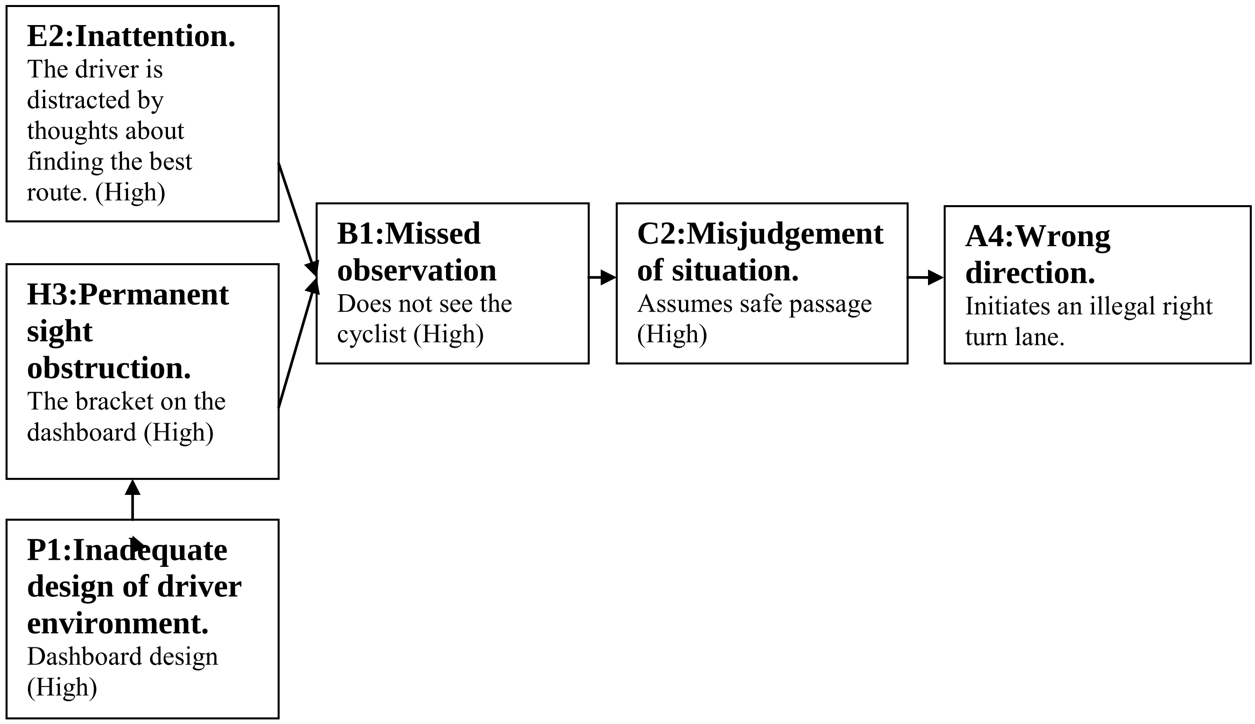


Figure 2.4 DREAM analysis of accident 2.

7.3 Truck hitting and then reversing back over a cyclist

7.3.1 Short description of the accident

On a January morning, about an hour after noon, a truck (A) ran over a cyclist and then reversed back over him. The cyclist died from the injuries. The driver was a 26-year-old professional truck driver who had started work only 14 days before the accident happened. Before the accident the driver had loaded the back of his vehicle with goods from a platform. After loading he drove the truck forwards to get clear of the platform so that he would be able to close the rear doors of the truck. The road was bumpy and not asphalted. The driver chose to drive further from the platform than he needed to because another truck was waiting to use the platform, and the driver wanted to give him access. While driving away, the driver called the company that was to receive the cargo, but he got no answer. He now discovered that a mechanical digger was blocking his access to the main road. At this point he decided to reverse so that he could use another exit in to get out of the loading area. While reversing his noticed that he hit something. He climbed out and saw that he had reversed the truck over a cyclist. The accident investigators believed that the driver must have first run over the cyclist while driving forwards, but he did not notice the crash because of the bumpy road, and that while reversing he must have run over the cyclist a second time.

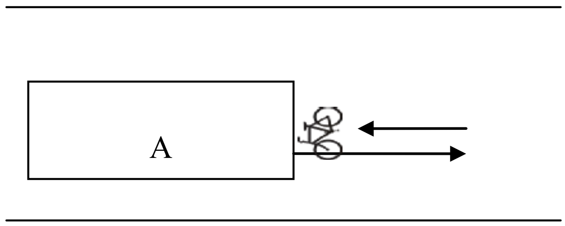


Figure 2.5. Sketch of accident 3.

7.3.2 Results of DREAM analysis

The phenotype “No action” is chosen since the driver did nothing to avoid an accident with another road user coming into his lane. The genotypes “Misjudgement of situation” and “Missed observation” are chosen since the driver did not see the cyclist. The driver was performing several tasks simultaneously. He was a new employee and inexperienced as a truck driver. It is likely that he was unable to perform the competing tasks adequately due to cognitive overload. Therefore the genotypes “Inattention” and “Non-driving distracters inside vehicle” are chosen. Since no mirror was installed in the truck to reduce the area of the driver’s blind spot (this was not obligatory), the genotypes “Permanent sight obstruction” and “Inadequate design of driver environment” are selected.

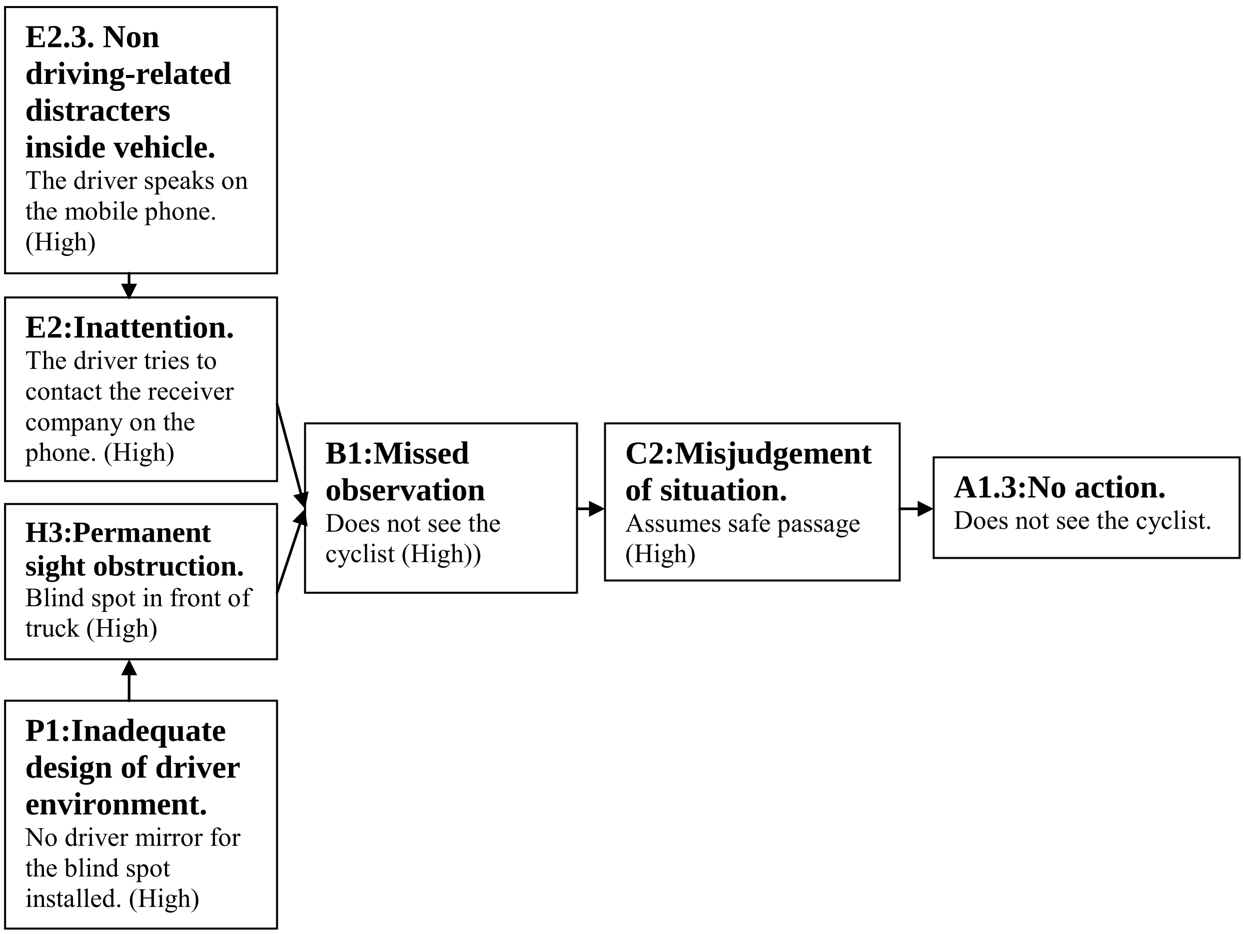


Figure 2.6 DREAM analysis of accident 3.

7.4 Passenger car colliding with cyclist

7.4.1 Short description of the accident

Early on a spring morning a passenger car (A) collided with a cyclist who had just exited a downhill slope that joined the main road. Visibility from the main road to the sloping side road was poor due to the layout of the road and a large amount of obstructing vegetation. The slope was not asphalted. The driver had not been exceeding the speed limit of 50 km/h, and only noticed the cyclist just before impact. The cyclist hit the windscreen and broke it, and then rolled over the roof of the car. The cyclist died from the injuries.

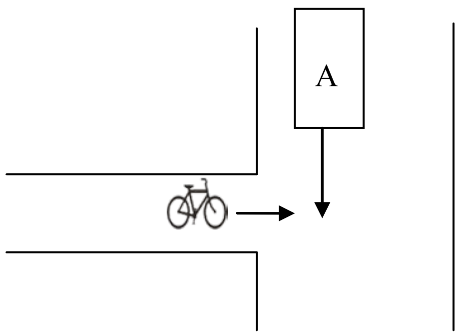


Figure 2.7. Sketch of accident 4

7.4.2 Results of DREAM analysis

The phenotype “No action” was chosen since the driver did notice the cyclist just before impact. “Misjudgement of situation” is chosen as genotype since the driver assumed safe passage past a junction with “Reduced visibility”. He “missed observing” the cyclist possibly because of “Inattention”.

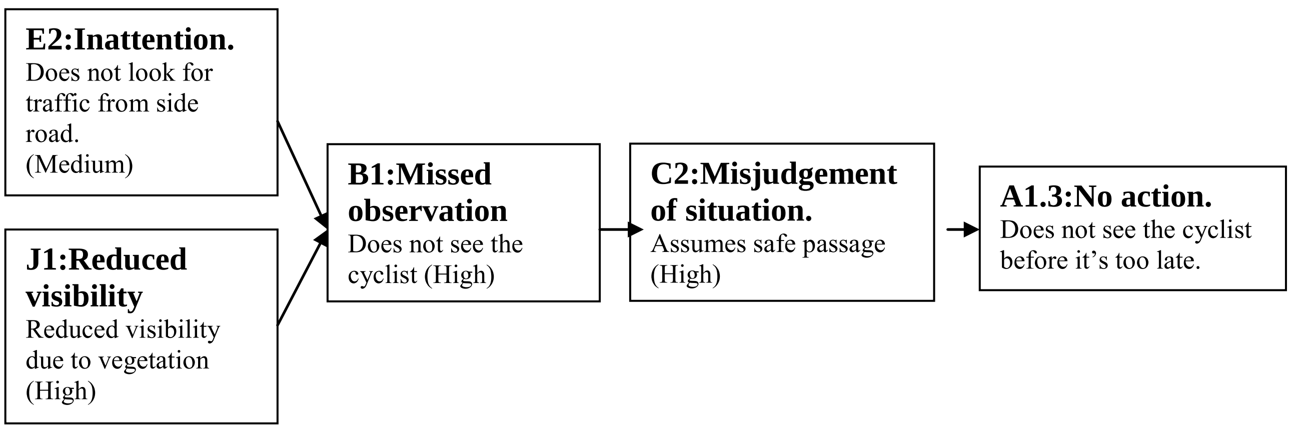


Figure 2.8. DREAM analysis of accident 4.

7.5 Passenger car colliding with cyclist while overtaking a truck

7.5.1 Short description of the accident

On an afternoon in February a ten-year-old boy was cycling home after football training (B). He had to cross a highway which had a speed limit of 80 km/h. A large truck (A) approached, travelling in the same direction as the cyclist when the cyclist decided to cross the road. The driver of the truck had noticed the cyclist and was wary that the boy might opt to pass into the truck's path in order to cross the road. This actually happened and so the driver slammed on the brakes. He managed to stop the truck a couple of metres in front of the cyclist. The cyclist proceeded to cross the road. The driver noticed in his side mirror that a passenger car (C) was approaching, with the intention of overtaking the truck. At this time the cyclist was concealed from the driver of the car. As the car was overtaking, the cyclist emerged, and the car hit and killed him at high speed.

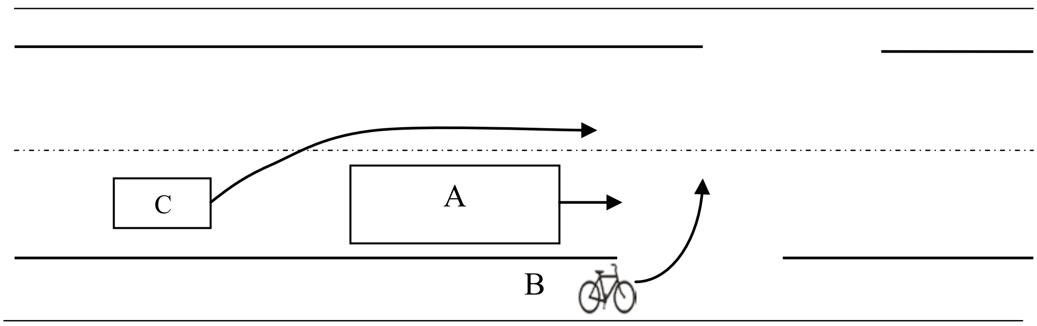


Figure 2.9. Sketch of accident 5.

7.5.2 Results of DREAM analysis

In deciding to overtake it is possible that the driver of the car did not notice the truck driver's sudden action, either believing that the truck had been standing still that it was continuing to proceed slowly. In either case "No action" is an appropriate phenotype since in the event the driver did not react to the truck's emergency braking. The car driver "Misjudged the situation" and deemed it safe to overtake the truck. He had had an appointment, and so probably experienced "Time pressure" and consequently "Psychological stress". From the available information it is reasonable to infer "Inattention" on the part of the car driver. It is known that the driver had previous records of speeding, which explains selection of the genotype "Stretching the rules and recommendations".

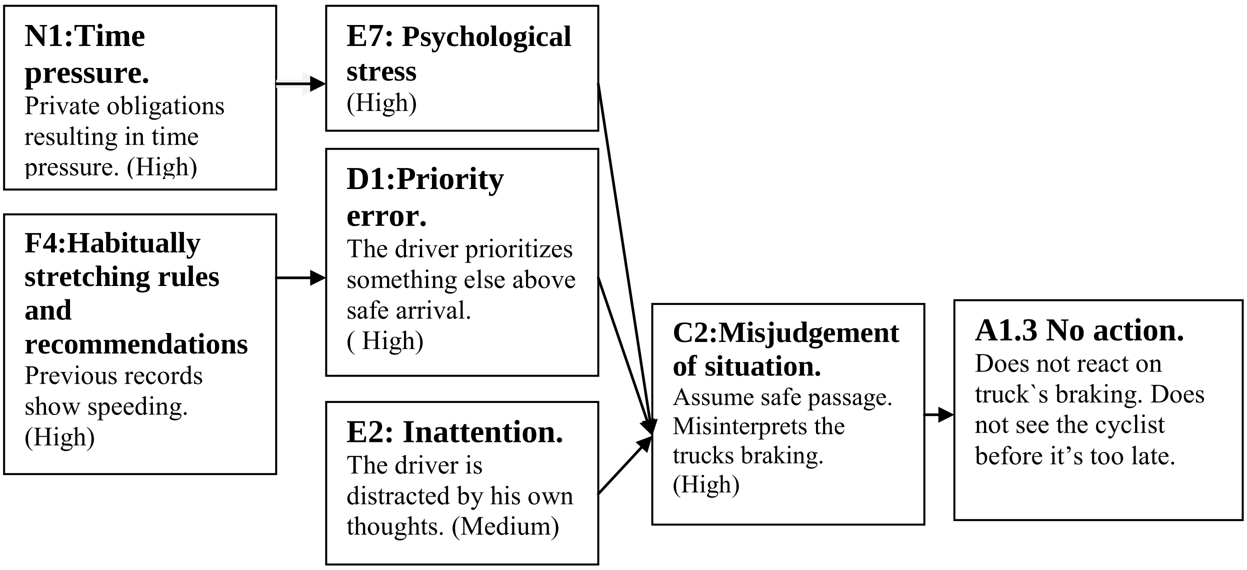


Figure 2.10. DREAM analysis of accident 5.

7.6 Passenger car colliding with two cyclists

7.6.1 Short description of the accident

On an October evening a 22-year-old man was speeding on a road with a speed limit of 60km/h (A). The investigation report shows that car collided with two cyclists at a speed of 80km/h, leaving a trail of skid marks measuring 65.8 m. Both cyclists were 15 years old. The accident happened on a relatively straight stretch of road. After an initial curve, it would have been possible for the driver to catch sight of the cyclists from a distance of 220 metres. The cyclists had been travelling in the same direction as the car on a sidewalk parallel to the road, and they had decided to cross the road at a pedestrian crossing. The crossing was not signposted. The cyclists had been aware of the oncoming car, but assumed they were at a safe distance with enough time to cross the road. The car driver had been aware of the cyclists, but did not anticipate that they would cross the road. On impact the trailing cyclist (B) received a blow to her head. She was not wearing a bicycle helmet. She died from the injuries two days after the crash. The other cyclist survived the crash (C).

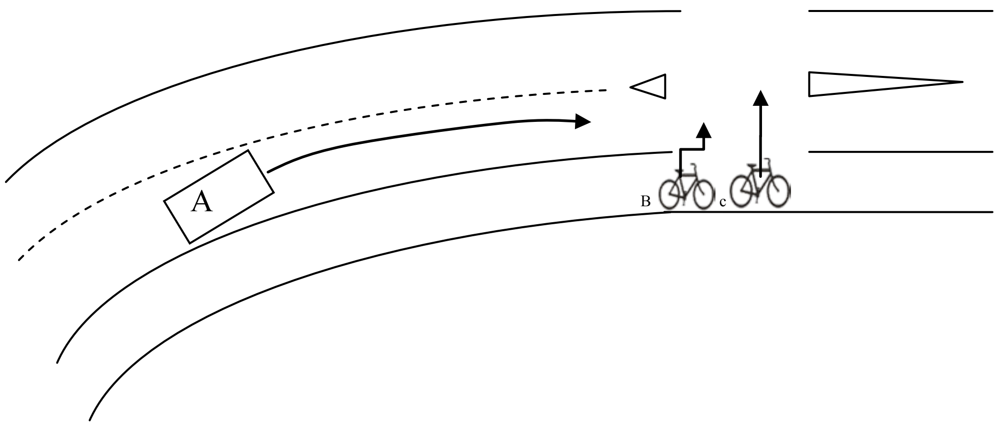


Figure 2.11. Sketch of accident 6.

7.6.2 Results of DREAM analysis

This is a crossing accident. “Too high speed” is selected as the phenotype. Alternatively “insufficient force” could have been chosen since the driver probably did not brake hard enough to stop in time. The driver “Misjudged the situation”, assuming that the cyclists would not cross the road (“Expectancy of certain behaviour”). He also had an appointment with some friends, which he “prioritized” over safety.

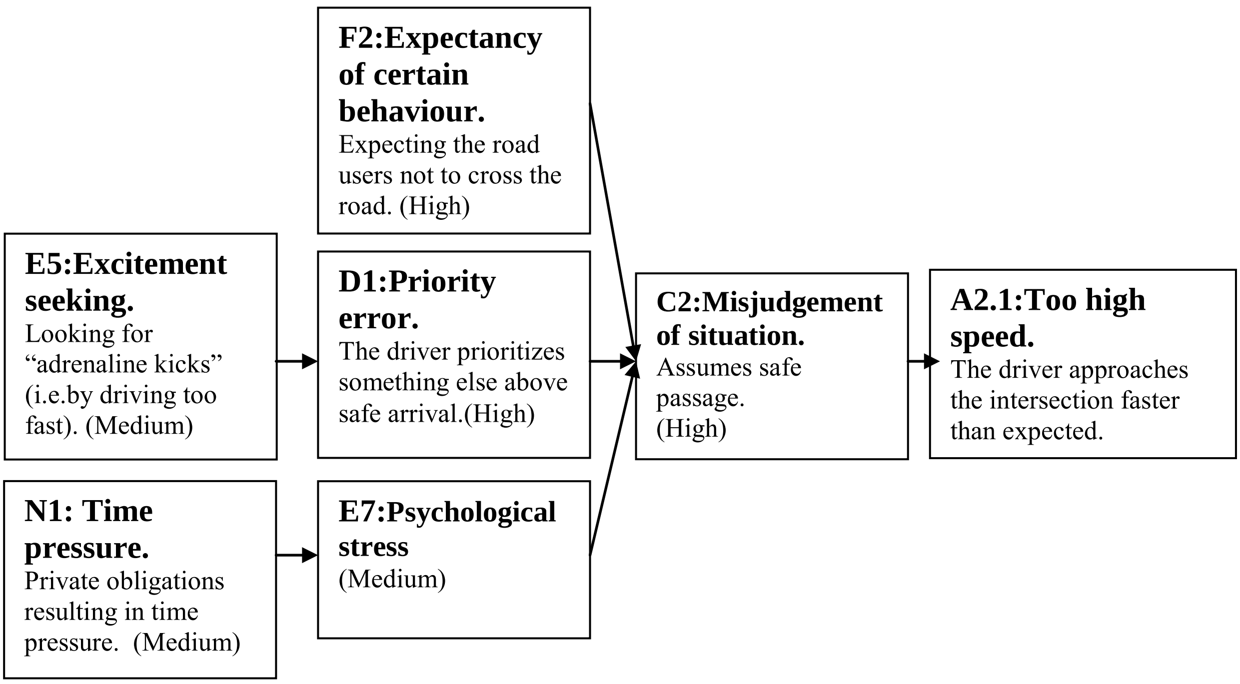


Figure 2.12. DREAM analysis of accident 6.

The appointment could also have led to “Time pressure” resulting in “Psychological stress”. Another reasonable inference from his surplus speed would be that the driver was “Excitement seeking” It is also noted that the traffic sign for pedestrian crossing had been removed, and this could have influenced the driver's expectations.

7.7 Truck running over cyclist

7.7.1 Short description of the accident

On a clear summer evening a truck carrying cement (A) ran over a ten- year-old cyclist at a construction site. The driver was experienced and 41 years old. He had to cross a cycle path to get to the main road. On his way down a small gravel road the truck driver had to pass a passenger car (B), which was parked with its driver sitting inside. Because of this car the truck driver manoeuvred his vehicle to the left of the gravel road, and then made a sharp turn to the right to get into the main road. Before crossing the cycle path and entering the road, the truck driver stopped to give way for an oncoming car from the left (C). He then crossed the cycle path, while making a sharp right-hand turn. In doing so he noticed that the truck hit something but did not take any notice of it before the driver in the parked car sounded his horn. By then the truck had already hit the cyclist with his right front wheel. The boy died on the scene. He had been wearing a helmet and reflectors and had been on his way home from school.

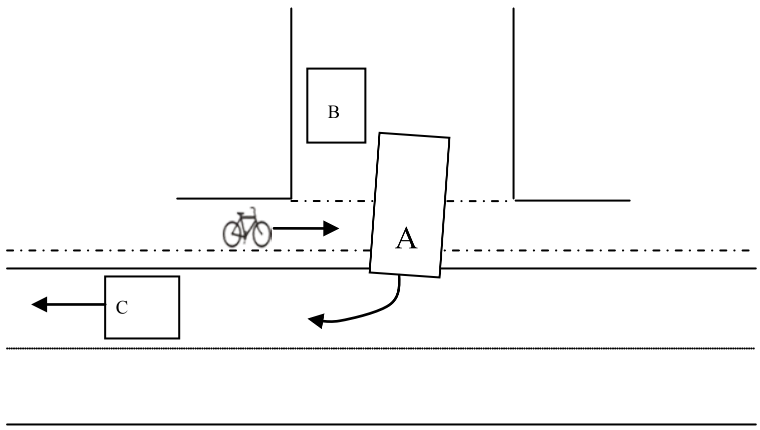


Figure 2.13. Sketch of accident 7.

7.7.2 Results of DREAM analysis

This is an intersection accident in which the driver enters the intersection "Too early" i.e. before the junction is free. The driver "Misjudged the situation" in that he thought that it was safe to cross the cycle path. He clearly did not see the cyclist approaching and entering his blind spot. This was a "Missed observation", caused by driver "Inattention", the large blind spots of the truck ("Permanent sight obstruction") or both.

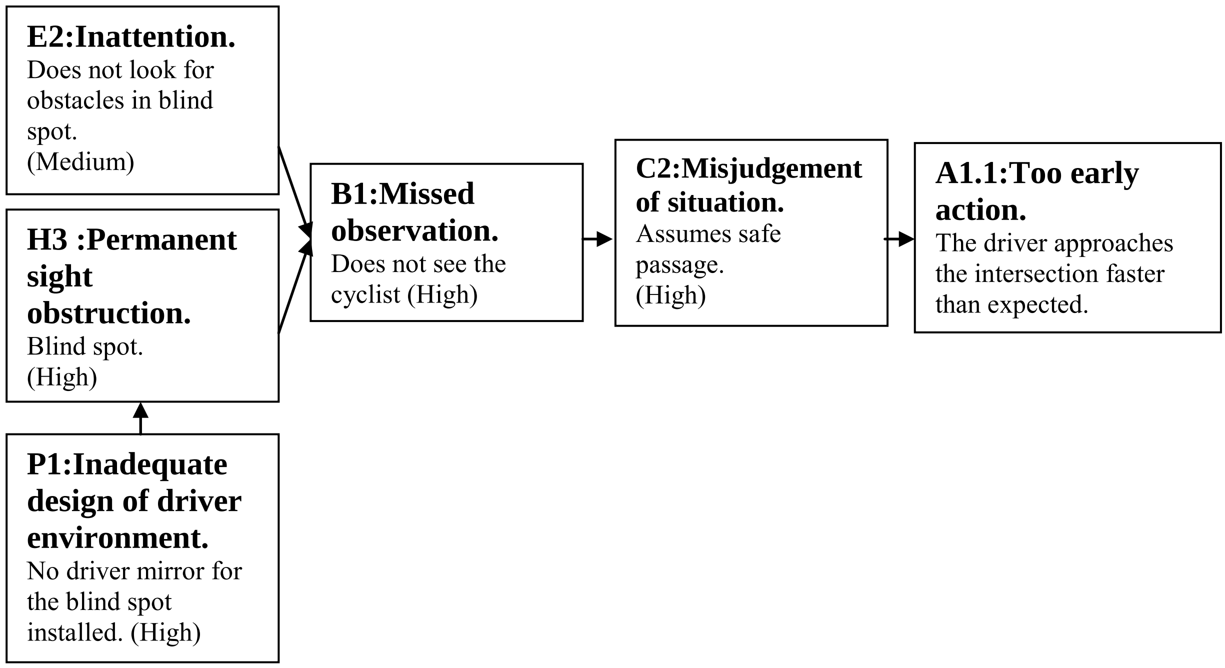


Figure 2.14. DREAM analysis of accident 7

7.8 Cyclist colliding with truck

7.8.1 Short description of the accident

On a morning in spring, a truck driver (A) was heading towards his destination after stopping at a stone-crushing plant to load his truck. He felt refreshed after having slept well the night before The sun was rising ahead of driver, making visibility difficult. He kept a low speed (30 km/h) as he approached a junction affording poor visibility to the roads entering from the left and right. He reduced his speed because he had to actually enter the intersection before he could look for traffic coming from the right. He was concentrating on this as he passed halfway over the crossing. He now heard something colliding with his truck. He stopped and looked in his rear view mirrors, first right then left. He saw a cyclist rolling on the road. The cyclist died from the injuries.

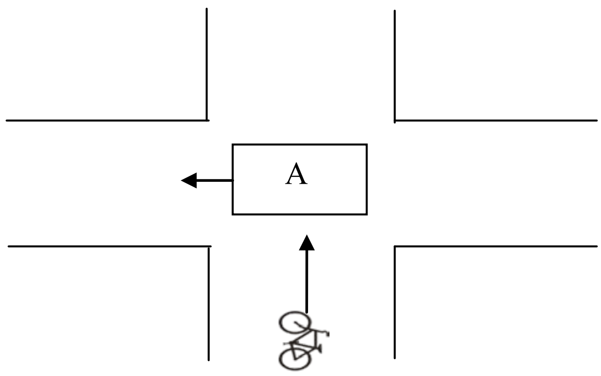


Figure 2.15. Sketch of accident 8.

7.8.2 Results of DREAM analysis

This is an intersection accident. Even though the driver did not see the cyclist approaching, "No action" is chosen as the phenotype because in the event he did not stop or give way to the cyclist. The driver "Misjudged the situation" because he assumed safe passage and because he "Missed observation" of the cyclist. Also there was "Inadequate road geometry", making him focus to his right. This has most certainly led to "Inattention" to his left. The low sun must have also contributed to "Reduced visibility". The truck driver used his mental resources to ascertain whether traffic was approaching from the right, thus "Driving related distracters outside the vehicle".

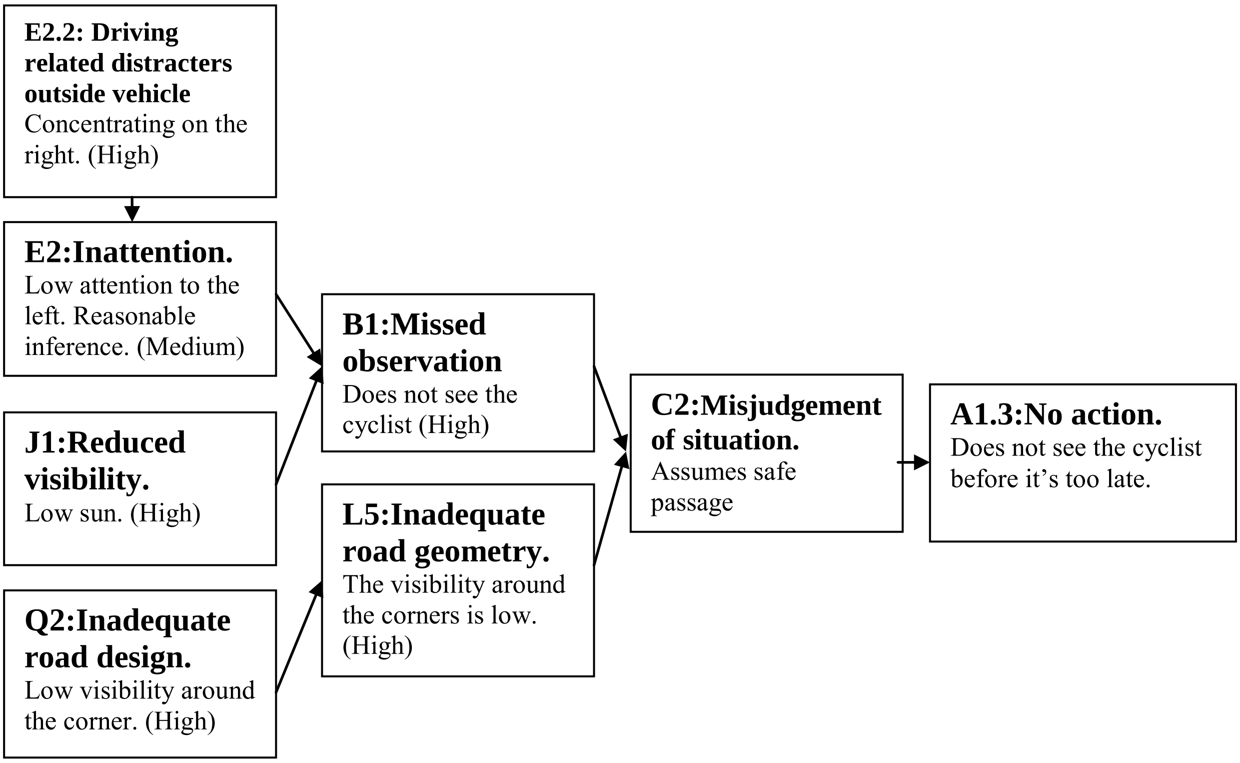


Figure 2.16. DREAM analysis of accident 8.

7.9 Truck running over and dragging cyclist over 200 metres

7.9.1 Short description of the accident

On a morning in November a truck driver (A) was pulling out from a petrol station. To do so, he had to cross a pavement. The driver intended to turn left into the road. He positioned the truck at an angle to the pavement for easy and quick access into the road. He waited for a pedestrian to walk past, and then pulled hastily out into the road in order to enter his lane before a passenger car (B) from the right arrived. He did not notice the cyclist coming from the right side on the pavement, an observation made more difficult by the angle of the truck in relation to the pavement. As the cyclist passed in front of the truck, and into the driver's blind spot, the truck accelerated into the road. The cyclist was hit by the truck, and became entangled behind the right front wheel, thus being dragged by the truck. The driver did not notice anything until after 200 m, where he stopped and realized what had happened. The cyclist died on the scene.

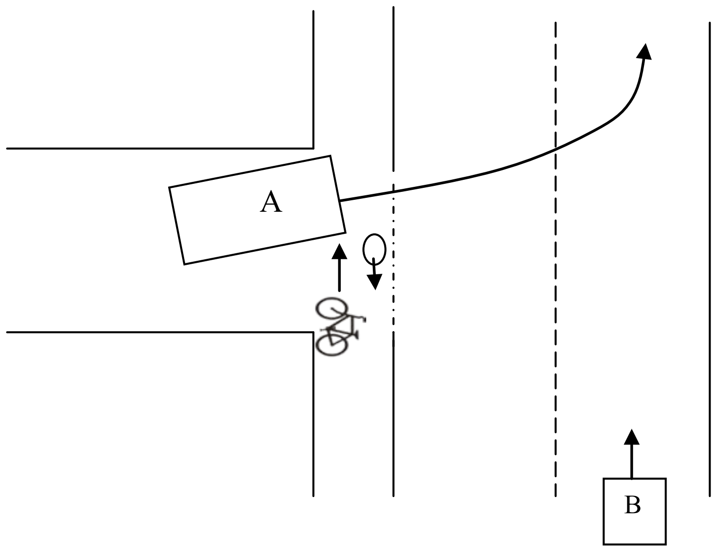


Figure 2.17. Sketch of accident 9.

7.9.2 Results of DREAM analysis

This is an intersection accident, in which the driver starting from a stand still enters the intersection too early i.e. before it is free. Thus the phenotype "Too early action" is chosen. The driver "Misjudged the situation" believing he had clear passage. From the report it seems he was in a hurry, and thus under "Time pressure leading to "Psychological stress". There was clearly "Missed observation" of the cyclist by the driver. The cyclist was wearing dark clothing ("Inadequate transmission from other road users"), which could have contributed to the missed observation. "Inattention" towards the footpath due to focus on the vehicles approaching on the road also seems likely. The truck driver used his mental resources on the vehicles coming from the right i.e. "Driving related distracters outside the vehicle". Also, the driver placed his truck at such an angle that the blind spot on his right was expanded. In addition there were raindrops on his side mirror which could have led to "Reduced visibility".

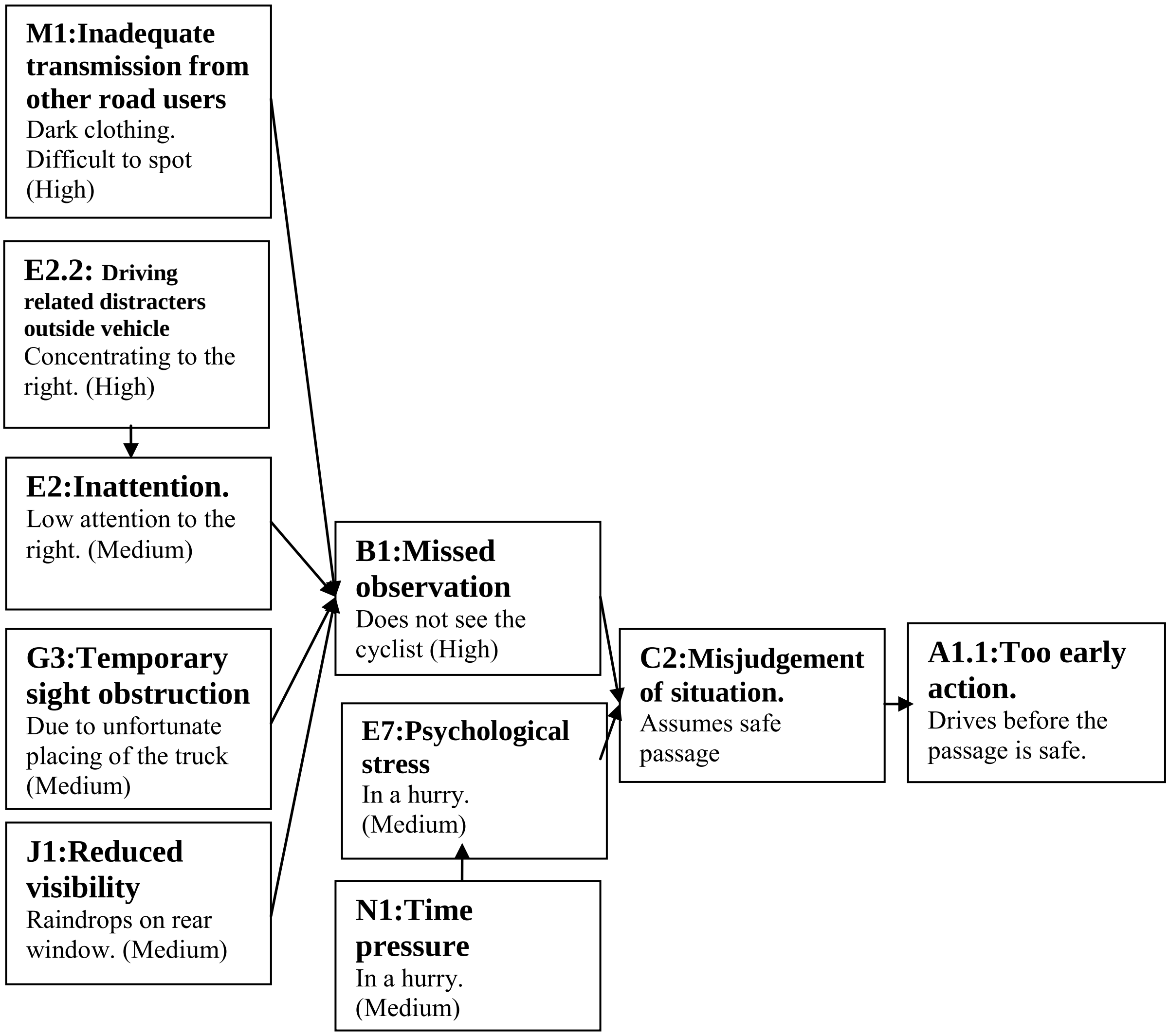


Figure 2.18. DREAM analysis of accident 9.

7.10 Taxi colliding with cyclist

7.10.1 Short description of the accident

Just after midnight on a Friday night, a minibus taxi (A) collided with a cyclist in an intersection. The roads leading to the junction were straight. However, while there was good visibility forward to the lights at the junction, high buildings reduced visibility to the sides of the crossing significantly. The speed limit was 50 km/h. The exact speed of the taxi as it approached the intersection was estimated to have been around 70 km/h. As it approached the intersection, the taxi driver slowed down to the speed limit. At this time the traffic lights were about to turn amber or red. The driver decided not to stop. It is not known whether or not he passed the lights while they were amber or red. As he was crossing, a cyclist entered the intersection at high speed from the taxi's left, and collided with the taxi. The taxi driver stopped his car at the crosswalk just some meters away from the point of impact. The cyclist died from the injuries six days after the incident.

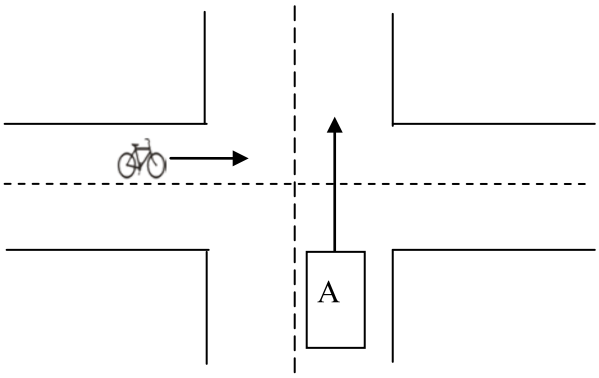


Figure 2.19. Sketch of accident 10.

7.10.2 Results of DREAM analysis

This intersection accident in which the driver entered the intersection without taking action (i.e. does not brake in order to avoid entering the intersection before it is free). The phenotype "No action" is therefore selected. The driver assumed safe passage and did not look to his left; thus there was "Misjudgement the situation" by the driver. There was also a "Missed observation" by the driver of the cyclist due to "Inattention". He also expected the crossing vehicles not to enter the junction because they were still on a red light ("Expectancy of certain behaviour"). In interviews the driver gave the impression that he may "Habitually have stretched the rules and recommendations". It is also reasonable to assume that the driver was under some pressure. It was Friday night and normally there is plenty of work for taxis at that time. This may have resulted in the driver feeling "Time pressure", leading to "Psychological stress".

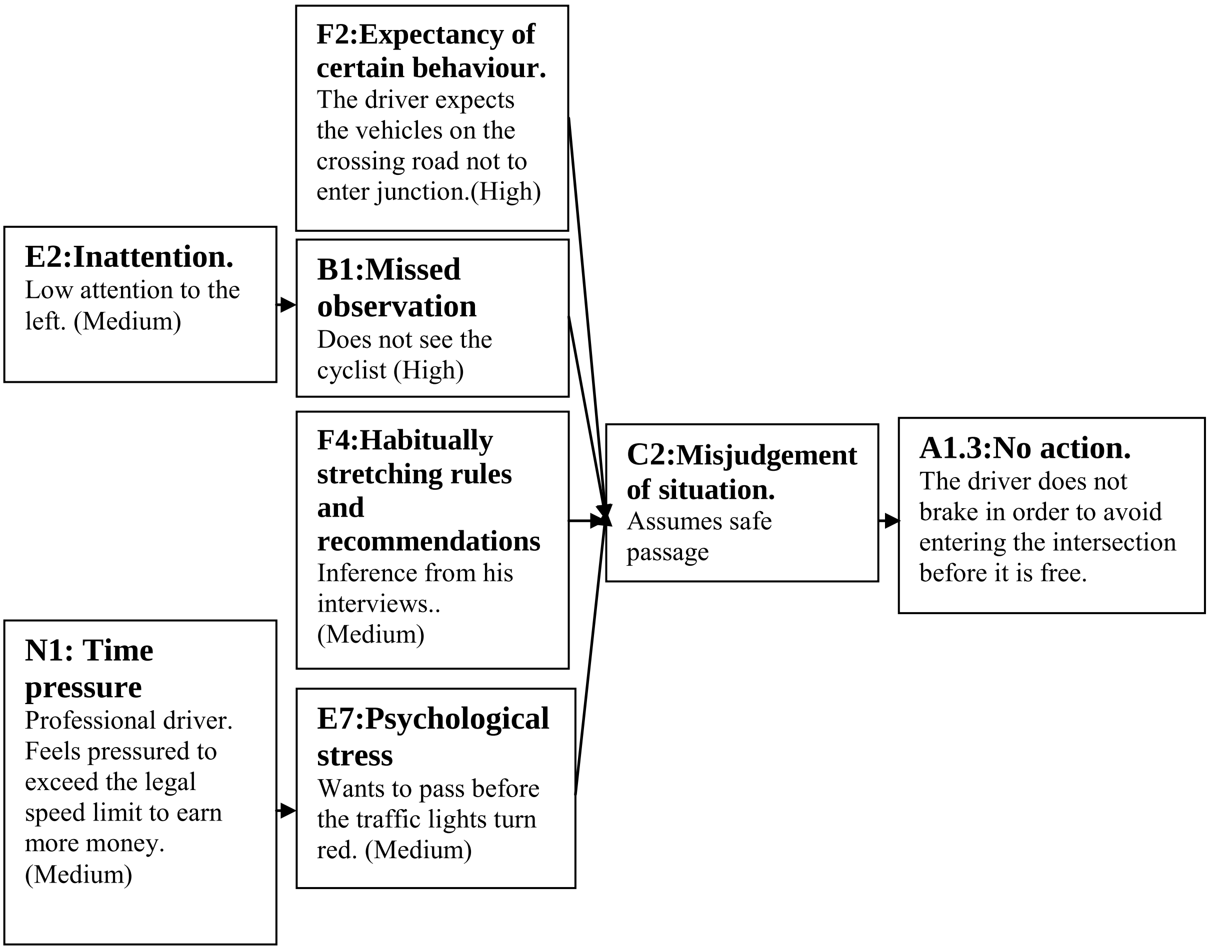


Figure 2.20. DREAM analysis of accident 10.

7.11 Cyclist colliding with passenger car at intersection

7.11.1 Short description of the accident

On an afternoon in December, a passenger car (A) collided with a cyclist at an intersection. For approaching road users, the view to the sides of the intersection was limited by buildings and fences. It was necessary to enter the intersection to get a clear view to the sides. The driver, a female aged 31 years, approached the intersection at low speed. On entering the crossing, a cyclist coming from the left at high speed collided with the car`s left front door. The cyclist did not stop pedalling before he crashed with the car. The cyclist was an elderly man, without a helmet. Later on, he died as a result of the injuries. Both parties lived near the accident scene, and were thus familiar with the roads.

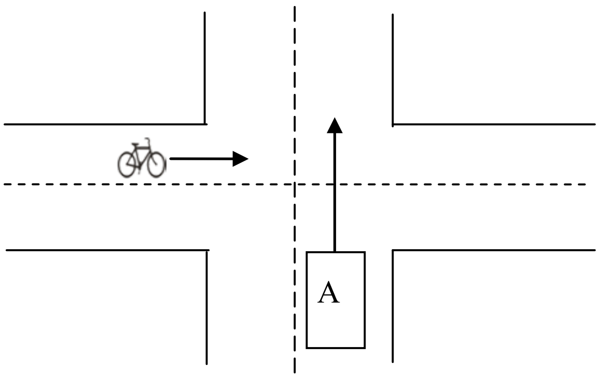


Figure 2.21. Sketch of accident 11.

7.11.2 Results of DREAM analysis

This is a crossing accident. The driver did not stop or give way to the cyclist, thus "No action" is chosen as the phenotype even though the driver did not see the cyclist approaching. The driver made a "Misjudgement of the situation" mainly because there was a "Missed observation" of the cyclist on her part. This was because there was "Inadequate road geometry" with low visibility to both sides. The driver was on a priority road and thus attention to the sides might have been lower than normal. The genotypes "Inattention" and "Expectancy of certain behaviour" are thus also chosen.

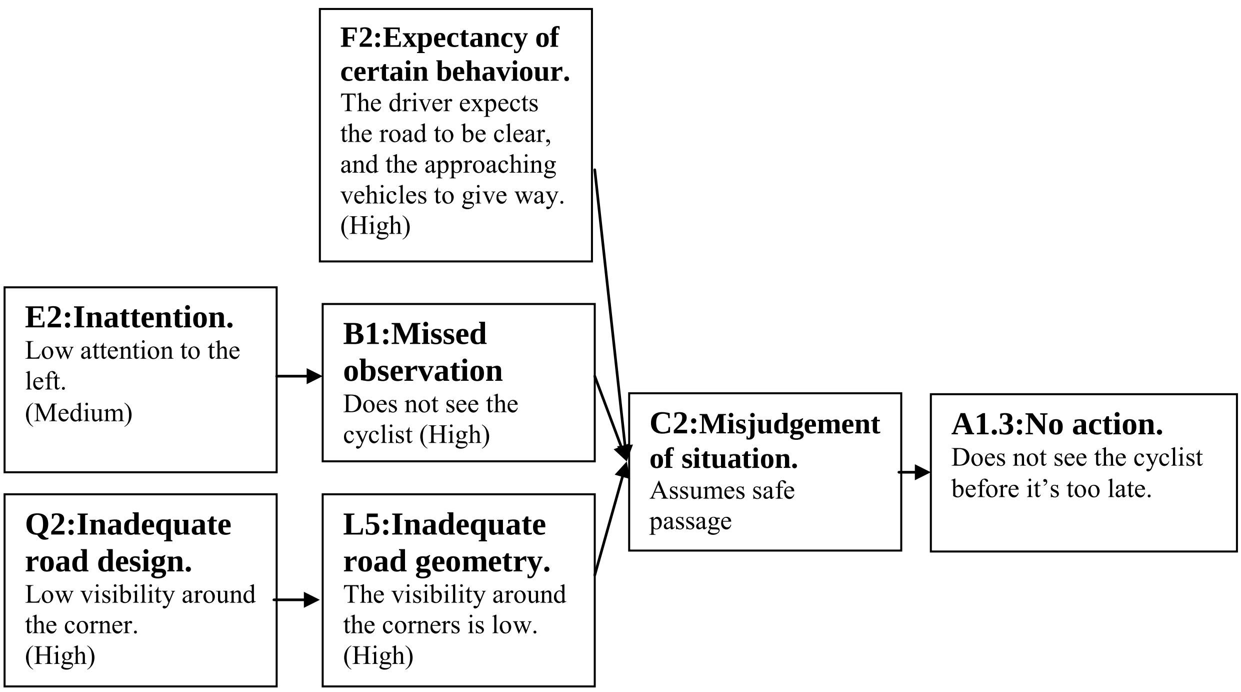


Figure 2.22. DREAM analysis of accident 11.

7.12 Taxi colliding with cyclist-and-passenger

7.12.1 Short description of the accident

On a late Friday night in October, a taxi driver (A) hoping for more customers, was driving back to the place he had collected his last passengers. The area was somewhat densely populated and the speed limit was 50 km/h. On approaching a junction, the driver noticed a dark shadow approaching on his right. He turned his head to look closer and noticed a cyclist carrying a passenger coming towards him. He tried to manoeuvre the car to the left, away from the cyclist hoping that the cyclist would get time to turn his cycle behind the car. The cyclist was cycling downhill at relatively high speed. The corner of the junction the cyclist passed through had low visibility because of an obstructing house and poor lighting. The cyclist did not manage to steer away and crashed straight into the car`s right front panel. The cyclist went through the car's windscreen and died from the injuries. The passenger flew through the air and landed several meters from the crash point, acquiring severe injuries but surviving the crash.

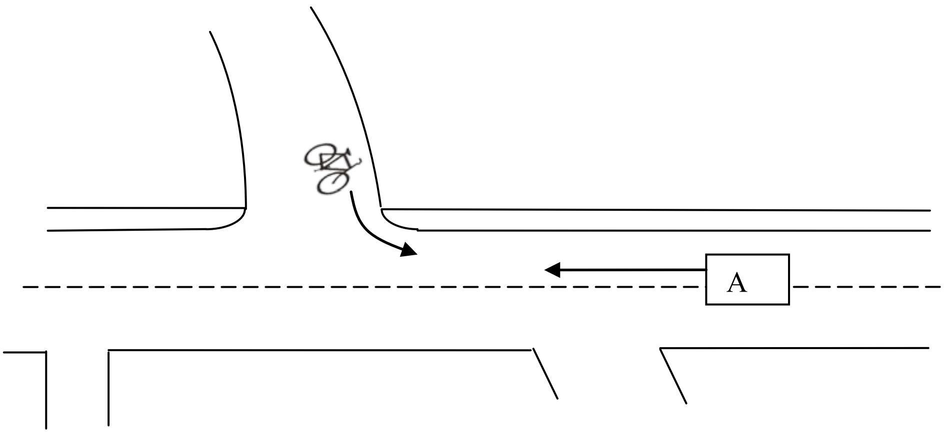


Figure 2.23. Sketch of accident 12.

7.12.2 Results of DREAM analysis

The driver approached the intersection at "Too high speed", which did not allow him to stop in time to avoid the cyclist coming from the right. He must have assumed safe passage and thus made a "Misjudgement of the situation". There was also "Late observation" of the cyclist by the driver which meant that he could not stop or to steer clear of the cyclist. This in turn could have a range of causes. Three genotypes have been chosen in our DREAM analysis. "Inattention" is one. If the driver had paid enough attention to his right, he probably would have driven more slowly and seen the cyclist directly instead of out of the corner of his eye. There was also "Reduced visibility" at the intersection, not least because of the poor lighting in the area. A house very near the crossing ("Inadequate road geometry") also contributed to the reduced visibility.

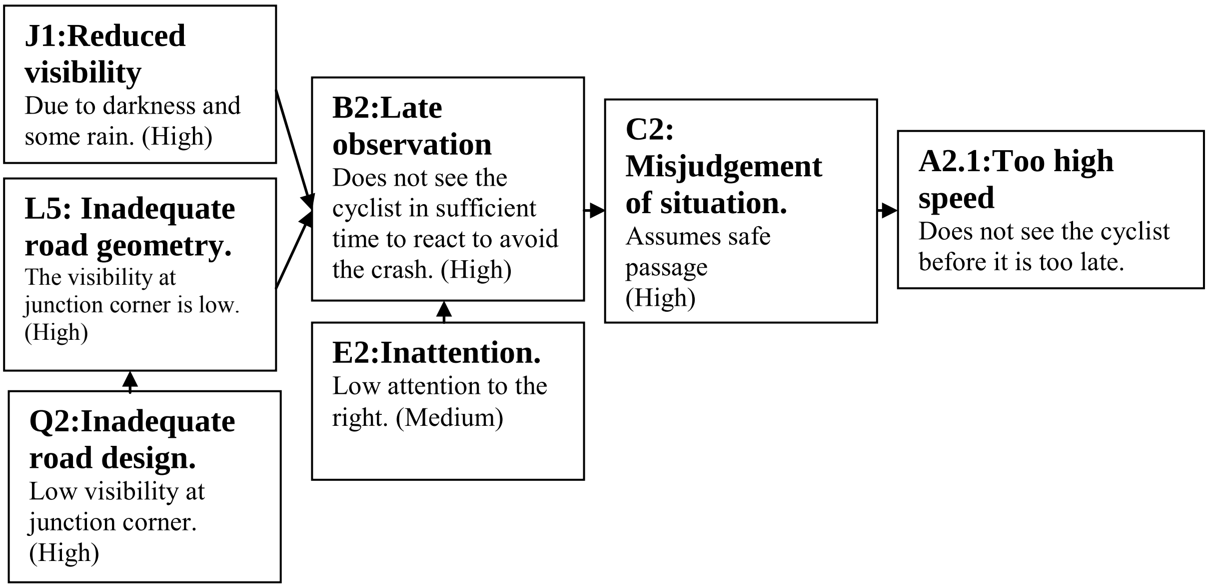


Figure 2.24. DREAM analysis of accident 12.

7.13 Passenger car hitting cyclist from behind

7.13.1 Short description of the accident

On a summer afternoon on a country road, a passenger car (A) hit a cyclist while attempting to overtake it. The cyclist, an 83-years-old woman, died from the injuries. The driver, in by her sixties, maintained low speed (30-40 km/h) around a corner at which the road ran alongside an old wall with surrounding vegetation. The speed limit was 50 km/h. There was no pavement along the road. The driver did not notice the cyclist until just before the accident happened. The cyclist was hit by the car`s side mirror. Two pedestrians remember seeing the cyclist cycling unsteadily before the accident, as if she had been indecisive. The pedestrians had walked by; the actual accident happened behind their back. The cyclist died from the injuries she received when she fell from her bike.

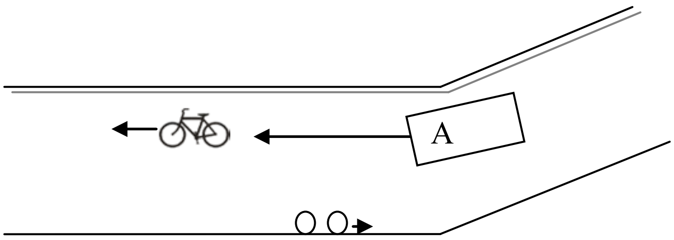


Figure 2.25. Sketch of accident 13.

7.13.2 Results of DREAM analysis

This is a catching up accident where the driver keeps "Too short distance" to the cyclist and strikes her from behind. The driver assumes safe passage, thus making a "Misjudgement of the situation". This genotype is chosen even though the driver did not see the cyclist in time ("Late observation"). The wall alongside the road was built close to the road, reducing the view of approaching drivers around the corner. In addition much vegetation was growing on top of the wall, suggesting poor maintenance. No cycle path or pavement was built along the road. Thus the genotypes "Inadequate road geometry" and "Inadequate road design" are chosen. In addition there had to be some "Inattention" on the part of the driver, since despite the obstruction she had kept sufficiently low speed to be able to see the cyclist form a resonable distance on exiting the corner.

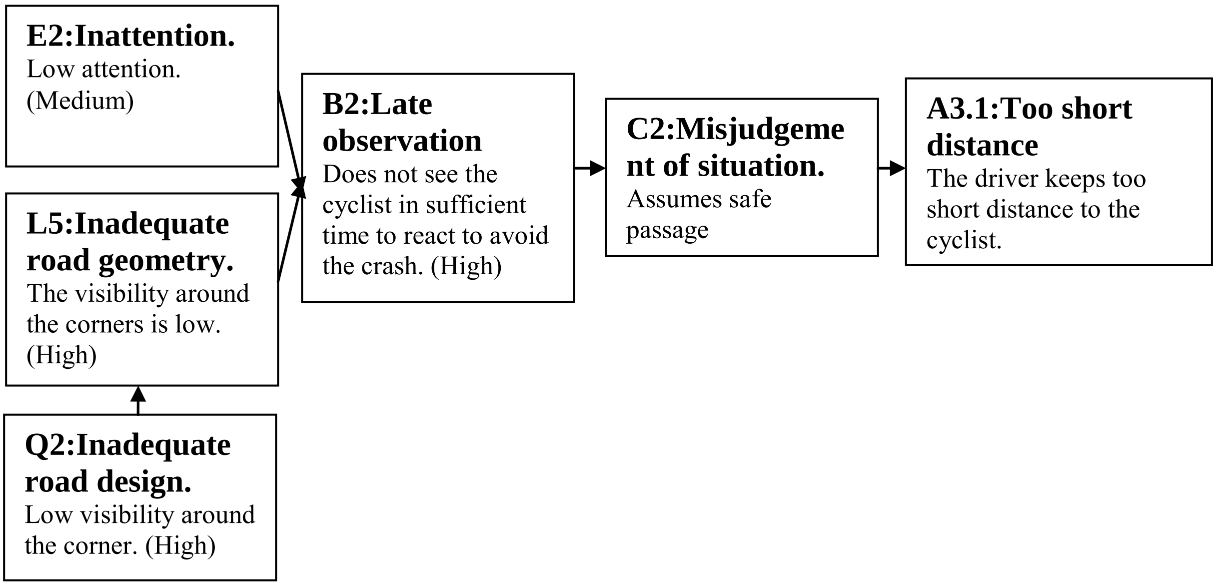


Figure 2.26. DREAM analysis of accident 13.

7.14 Pursued car hitting two cyclists

7.14.1 Short description of the accident

An unregistered car (A) was being chased by the police as it approached an intersection. On the other side of the intersection another car was travelling at a speed of 40-45 km/h (B) around a curve. It was heading away from the intersection, in the same direction as car A. The driver of car A may have first tried to overtake car B, or may have observed the car too late. He skidded to the left on driving around the right-hand curve, to overtake car B in front. The driver of car B was taken by surprise as the speeding car passed on his left. Meanwhile, two cyclists were approaching car B in the opposite lane, in the direction of the intersection. Driver A may not have seen them, as they may have been concealed by car B. Car A hit the first cyclist (C) and continued to skid forward crashing into a stone wall. A ski-box on the roof of car A then became detached and fell down, hitting the other cyclist (D), before the car finally stopped with two of its wheels on top of the stone wall. Cyclist D had seen the car coming and had tried to manoeuvre away. The first cyclist (C) was thrown up into the air by the impact. She died from the injuries.

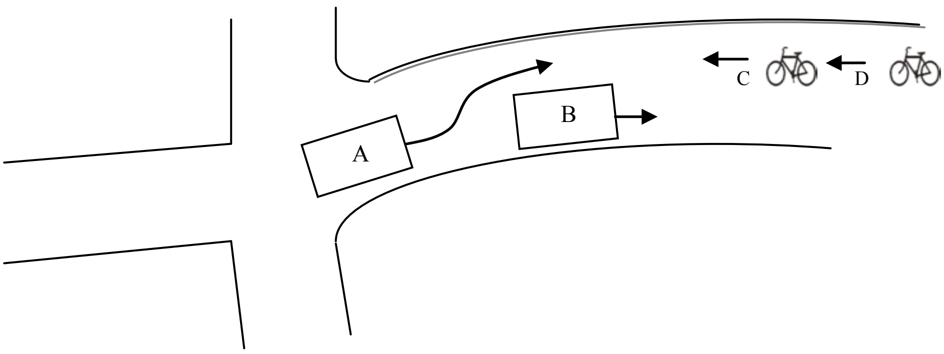


Figure 2.27. Sketch of accident 14.

7.14.2 Results of DREAM analysis

The driver of car D approached car B and changed lane faster than other road users would have expected. “Too high speed” is therefore chosen as the phenotype. An alternative phenotype is “Wrong direction”, since the driver left his own lane in a curve, hitting the oncoming traffic. He clearly made a “Misjudgement of the situation“ in terms of his speed in relation to the curve and the traffic. There was a “Missed observation” of the cyclist by the driver of car D. But the main reason for misjudgement of the situation was a “Priority error”. He prioritized his escape from the police above safety. It is thus reasonable include the genotypes “Habitually stretching rules and recommendations”, “Psychological stress” and “Overestimation of skills”.

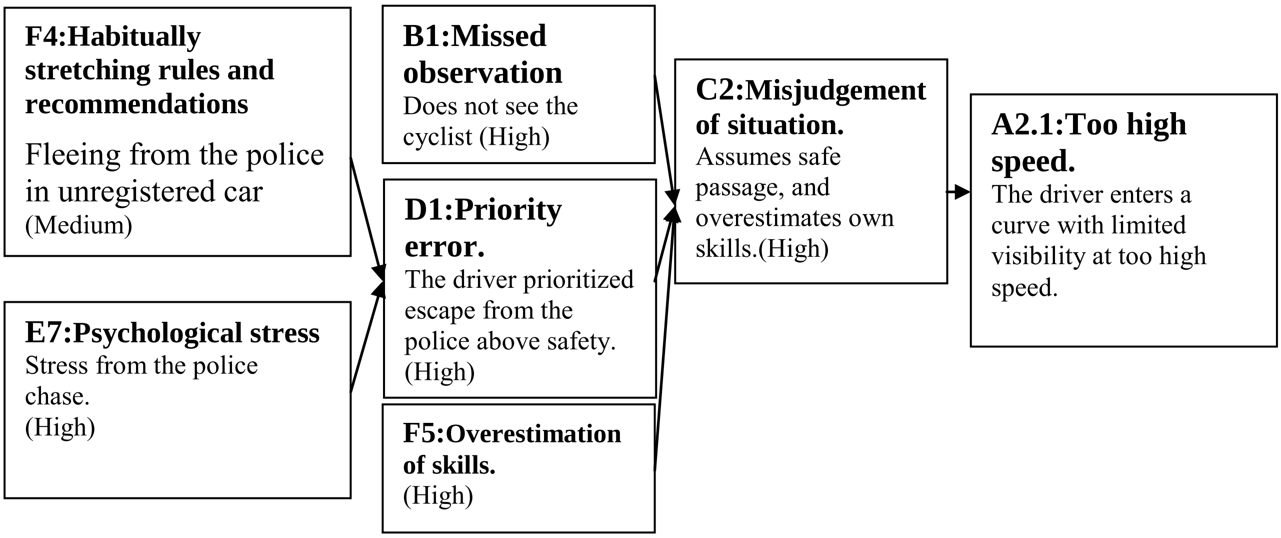


Figure 2.28. DREAM analysis of accident 14.

7.15 Passenger car hitting cyclist at an intersection

7.15.1 Short description of the accident

On a late summer Saturday afternoon, a passenger car (A) crashed with a cyclist on a country road. The cyclist was coming from a driveway, which led into the country road. The road had a gentle curve which gave the impression of good visibility, but the visibility from the road to the driveway was limited to 60 – 130 meters. The cyclist entered the main road, probably intending to cross it to reach the pavement on the other side. There was no pedestrian crossing. The driver of the car maintained the speed limit of 60 km/h, but still did not manage to stop in time for the cyclist. They crashed and the cyclist died on the scene.

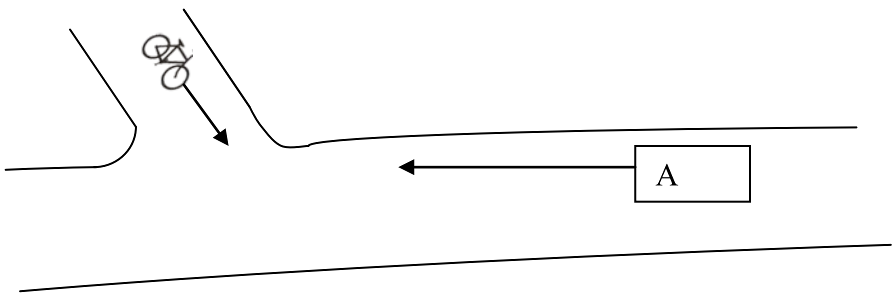


Figure 2.29. Sketch of accident 15.

7.15.2 Results of DREAM analysis

This a crossing accident in which the driver started to brake and/or made an avoidance manoeuvre too late to avoid an accident. We do not know whether or not the driver actually braked. There are no skid marks apparent in pictures from the scene, but there is a report from the driver which says that he did not manage to brake in time; thus the phenotype "Too late action" was chosen. "No action" would have also been a valid choice based on the limited information we have. The driver made a "Misjudgement of the situation" as he anticipated free passage. He "observed the cyclist too late" to be able to stop in time. The reason for this is not given directly in the accident report, but it is reasonable to infer the genotypes "Inattention" and "Temporary sight obstruction" from the Wunderbaum hanging on the windscreen.

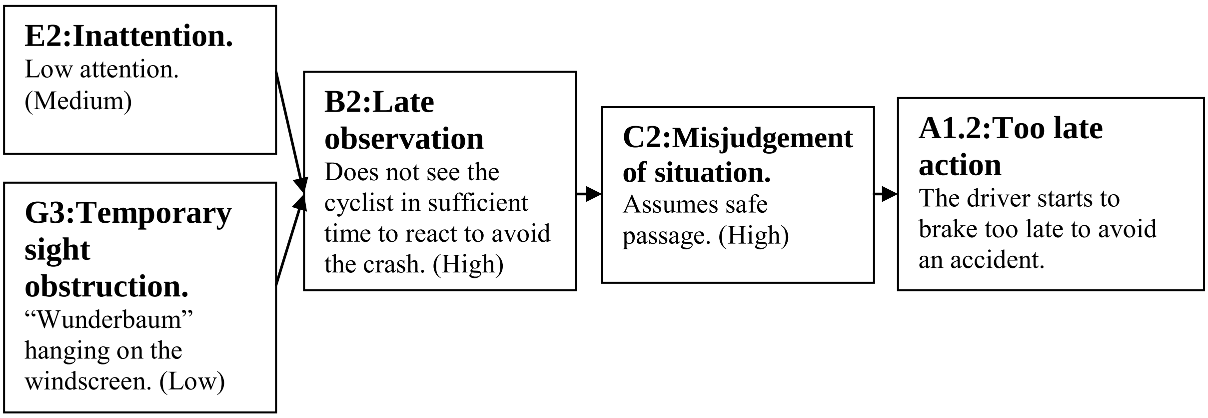


Figure 2.30. DREAM analysis of accident 15.

8 Aggregating DREAM charts

8.1 Common causation patterns

The purpose of aggregating causation charts is to find common causation patterns. The fifteen accidents studied in this report have been studied with the same tool and the same methodology. We therefore have a consistency and we may aggregate the results.

We have analyzed 15 accidents involving at least one cyclist and at least one automobile. Using these analyses we have aggregated three charts. Chart A show all the genotypes and the connections between them regardless of their occurrence or frequencies. Chart B include only those genotypes and connections which appear at least twice, and chart C includes only those genotypes and their corresponding connections which are deemed “High - certainty” by the analyst.

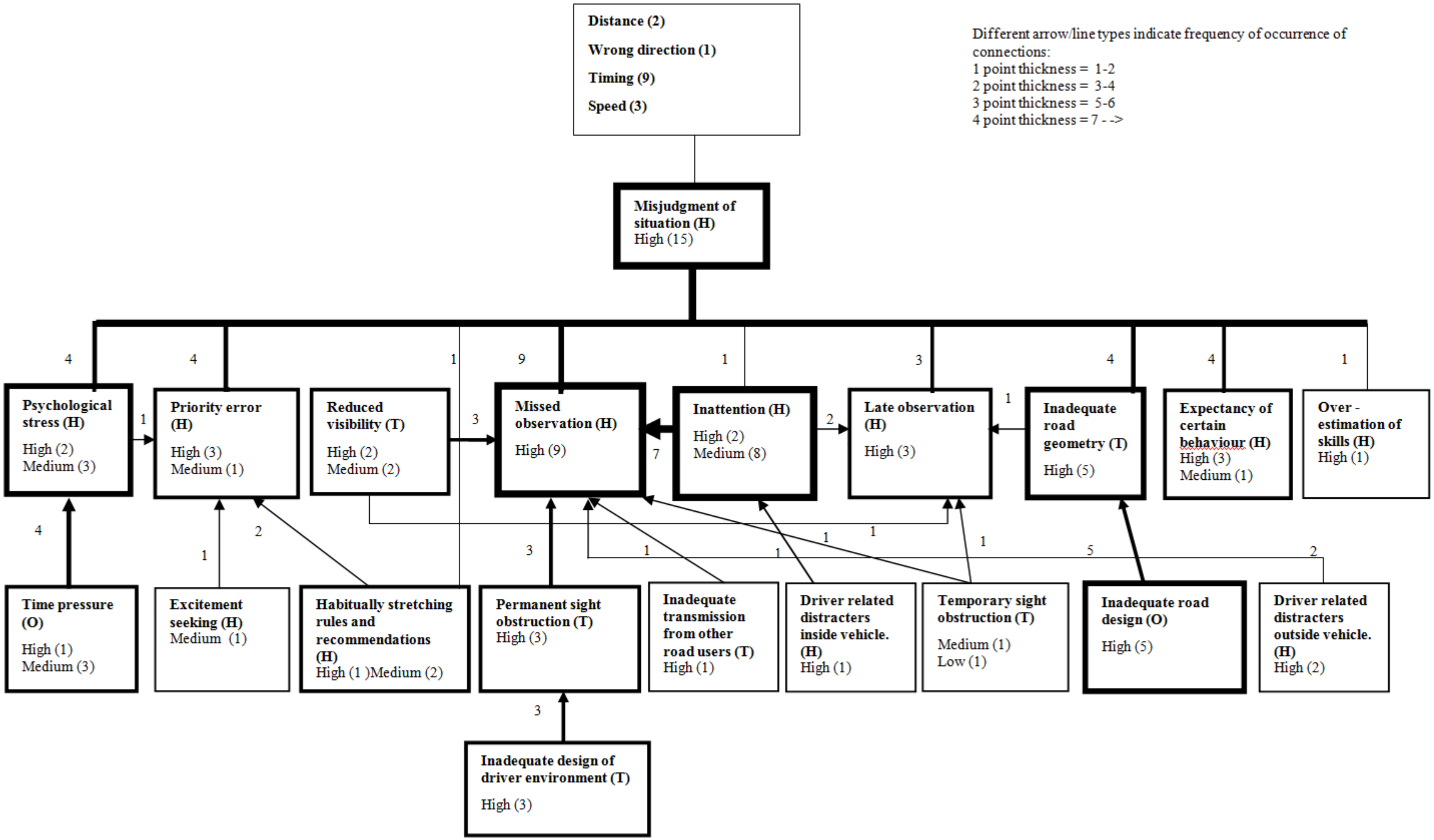


Figure 2.31. Aggregated DREAM chart including connections and genotypes for collisions between bicycles and motorized vehicles.

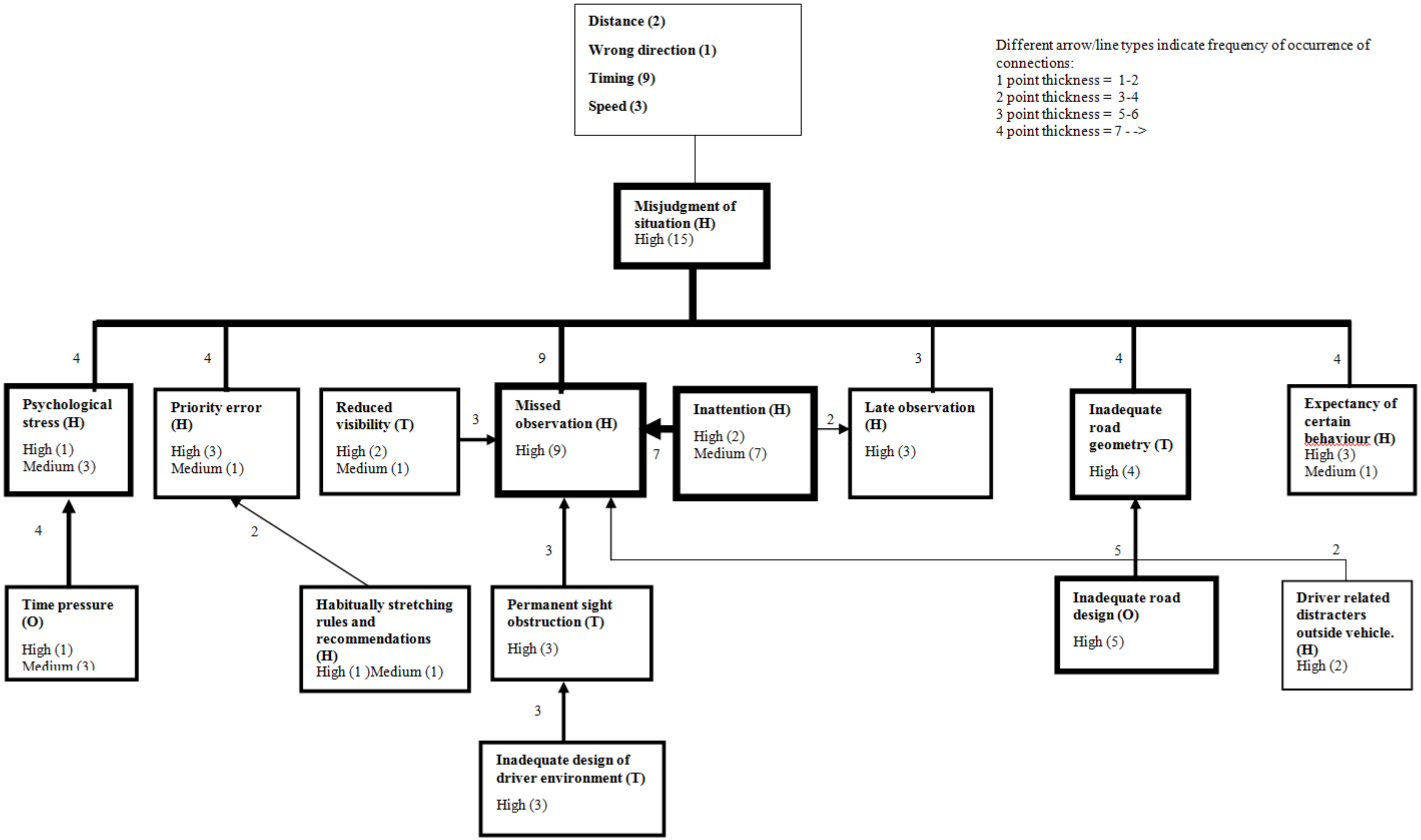


Figure 2.32. Aggregated DREAM chart for collisions between bicycles and motorized vehicles, including connections and genotypes which occur at least twice.

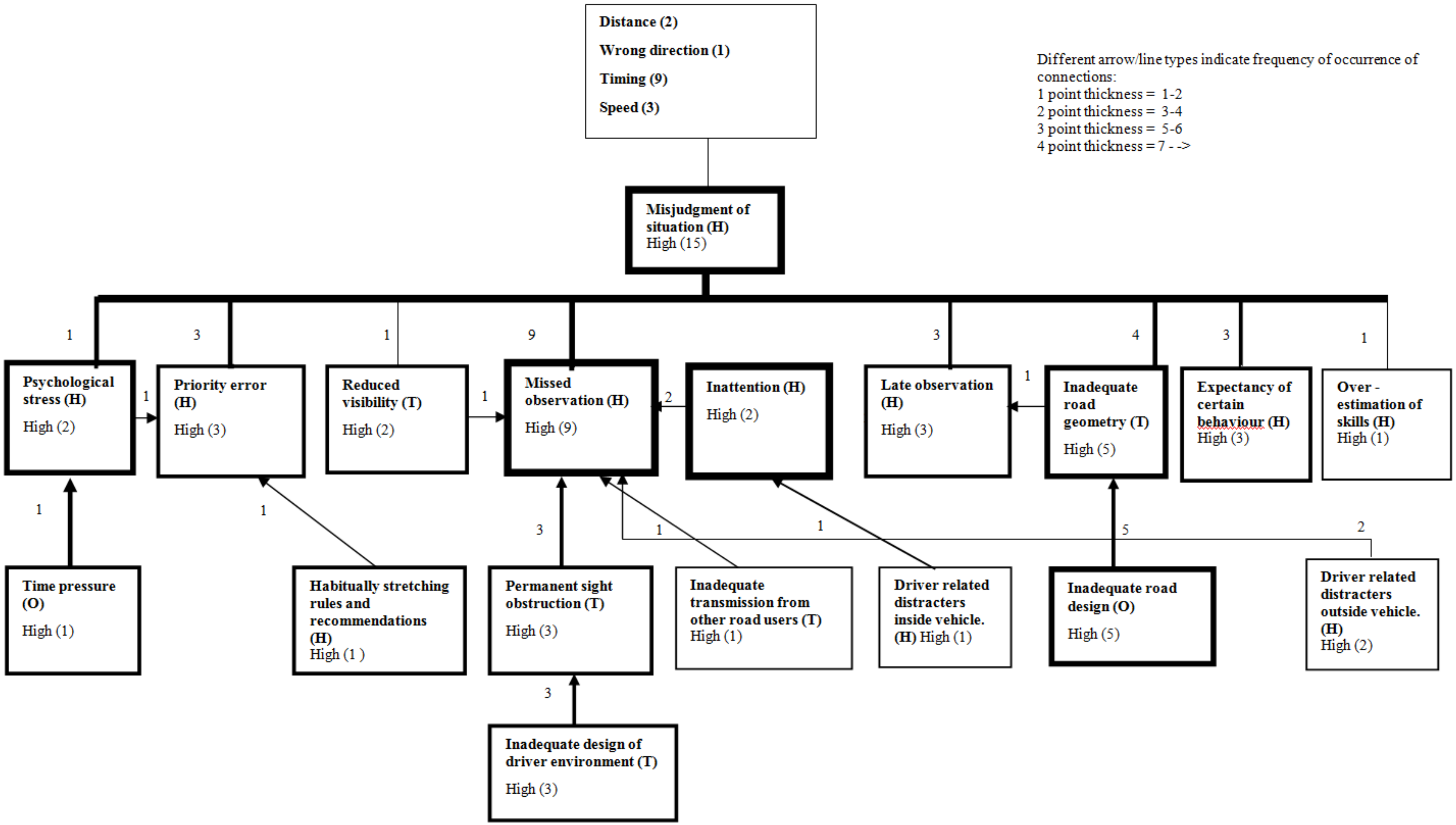


Figure 2.33. Aggregated DREAM chart for collisions between bicycles and motorized vehicles, including only genotypes with high certainty level.

8.2 The aggregation

Looking at chart A, the picture is complicated. There are many genotypes, some with multiple connections between them. While some genotypes and connections clearly stand out in terms of the number of times they appear in the 15 analyses conducted, chart A does not distinguish between levels of certainties. We refined chart A in an attempt to highlight the most common and reliable causal patterns, resulting in charts B and C.

The most frequent phenotype is “Timing”, followed by “Speed” and then “Distance” and finally “Wrong direction”.

From chart B, we see that “Misjudgement of situation” is the immediate cause of each of these phenotypes.

“Misjudgement of situation” is often preceded by “Missed observation”, which has a high frequency in the chart and a high level of certainty attached.

“Missed observation” is highly linked to its antecedents “Inattention” and “Permanent sight obstruction”, the latter often preceded by “Inadequate design of driver environment” in the causal chain suggested.

“Physiological stress” and “Priority error” are also often linked with “Misjudgement of situation” in the run up to accidents. “Psychological stress” is often caused by “Time pressure”. “Priority error” is a product of both “Time pressure” and “Habitually stretching rules and recommendations”.

Also “Inadequate road geometry” is a significant of “Misjudgement of situation”. And the cause of “Inadequate road geometry” is almost always “Inadequate road design”

If we only consider genotypes with “high” certainty (chart C) we see that the frequencies for most genotypes is reduced, especially in the case of “Inattention”. “Missed observation” however still has high frequency, the other genotypes being much less frequent in comparison. The second most common cause is “Inadequate road geometry” and “Inadequate road design”.

9 Bicycle accidents – discussion and conclusions

The overall conclusion from our study of 15 fatal collisions between a motorized vehicle and one or more bicycles is that poor driver perception of cyclists is often key in the run-up to the accident. This applies especially for those accidents occurring at junctions affording the driver limited views, or in situations where the driver is being distracted by either the traffic outside or by something inside the vehicle.

Sight obstruction, Inadequate driver environment and Poor road design also contribute significantly to perception difficulties. The first two genotypes lead to the driver failing to notice the cyclist, while the latter often leads 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 Priority error are other factors that stood out in our aggregation charts leading to misjudgement of the situation.

The investigated accidents were limited in number and collected from only one country. General conclusions should therefore be drawn with caution and even more caution is required when proposing concrete countermeasures. Nevertheless on the ground of the many “Missed observations” in our study, it is reasonable to suggest general measures targeted at increasing bicyclist visibility, helping drivers to observe the bicyclist in time, and consequently avoiding collision.

PART 3:

General discussion and conclusions

10 Causal factors in crashes

The analyses of both intersection crashes and collisions involving bicycles share the common feature of inattention or distraction as important causal factors, thus confirming the notable role of those factors shown also in previous crash studies.

Concerning the intersection crashes, those perceptual difficulties were most notable primarily for turning drivers. This seemed to be related to a large extent to being faced with 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.

Contributing factors often pointed to in literature, e.g. high speed, drugs and/or alcohol and inadequate driver training, played a role in 12 out of 43 crashes. While this confirms their prevalence, it also indicates that most drivers end up in these situations due to combinations of less auspicious contributing factors. It was also notable that 10 of the 12 drivers under influence were going straight, motorcyclists were over-represented and high speed was also a frequent factor.

It is difficult to point to practical implications in terms of specific countermeasures. Rather, a host of measures have to be applied. A natural focus point to start with would be the MC drivers going straight, as they form a large part of the problem. Measures to increase MC driver visibility (reflex vests, automatic and more intense lighting, etc) may make a difference. For MC drivers who are less inclined to use such vests, the type of gap availability estimators on trial in certain US intersections (and elsewhere) are a promising option.

Concerning the collisions between bicycle and motorized the perceptual problems of drivers were found especially in crossing with limited view or in situations where the driver is being distracted by either the traffic outside or by something inside the vehicle.

The many occurrences of “missed observations” as a causal factor points to the importance of any measures chat could increase the bicyclists’ visibility, thus helping drivers to observe the bicyclist in time and consequently avoiding a collision.

11 Implications for data collection and analyses by NPRA investigation teams

Only final reports from the crash investigation teams were used for our analyses. The content and structure of the accident investigation reports which were used for the DREAM analysis varied in content and quality. Ideally the reports should have been in one template. Also, in order to minimize the need for guesswork on the part of the analyst, the accidents report should contain thorough interviews from all surviving parties, including witnesses. The interview should include detailed questions about their state of mind, health and what the experienced before the accident.

Comprehensive interviewing may even reveal organizational factors. For example, factors like stress and fatigue could possibly be traced back to organizational background factors. It can be questioned whether a DREAM analysis add much to the knowledge when based on reports with poor background data.

A general observation is that there are overall fewer contributing factors coded for drivers assumed not to be the party "at fault" for the crash. However, from a countermeasures point of view, information from both parties may in many cases be equally relevant. Underreporting of contributing factors for one of the parties involved based on moral reasoning about guilt thus hinders rather than helps countermeasure development. This underlying investigator mindset therefore needs addressing, to avoid future bias in the reported information.

In can also be seen that in the general perspective, the information on blunt end factors (those more distant in time/space, yet important for the development of events) contained in the accident reports is more limited than information on sharp end factors (those close in time/space to the crash). A likely explanation for this phenomenon is that the analysts not always reflect on the influence of blunt end factors on the event they are analysing. This points to the importance of having an explicit, and in the analyst group anchored, analysis method which clearly defines the scope of possible contributing factors and influences to be controlled for in accident investigation. This in particular holds if the investigations are to yield results on blunt end factors.

For several crashes some frequent risk factors, such as e.g. driver fatigue or secondary task engagement, were not mentioned in the reports. 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 was that these factors simply do not contribute. It is important that the reports include information showing whether a given factor was investigated or not, and not only mention when the factor was shown to be present.

The DREAM methodology used here contains a number of genotypes which were not applicable to any of the analysed accidents. Since DREAM has been put through extensive validation work and corroboration with other researchers' findings on possible accident causes, there is reason to further investigate why many of the genotypes available in DREAM never get applied in the analysis. While the hoped for result of such a project would be that the accident analysis as currently being conducted is indeed sufficiently extensive, a more likely result is that there probably is room for improvement.

Finally, there is an unnecessary element of conjecture present in some of the accident reports. When the instructions say that the analyst should list possible contributing factors, some analysts have taken this as license to speculate. Rather than including only factors for which there is at least some empirical evidence, the analysts at times make quite general speculations, regarding the capabilities of older drivers and other matters.

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APPENDIX 1
Genotypes, phenotypes and links used in the analysis of intersection crashes

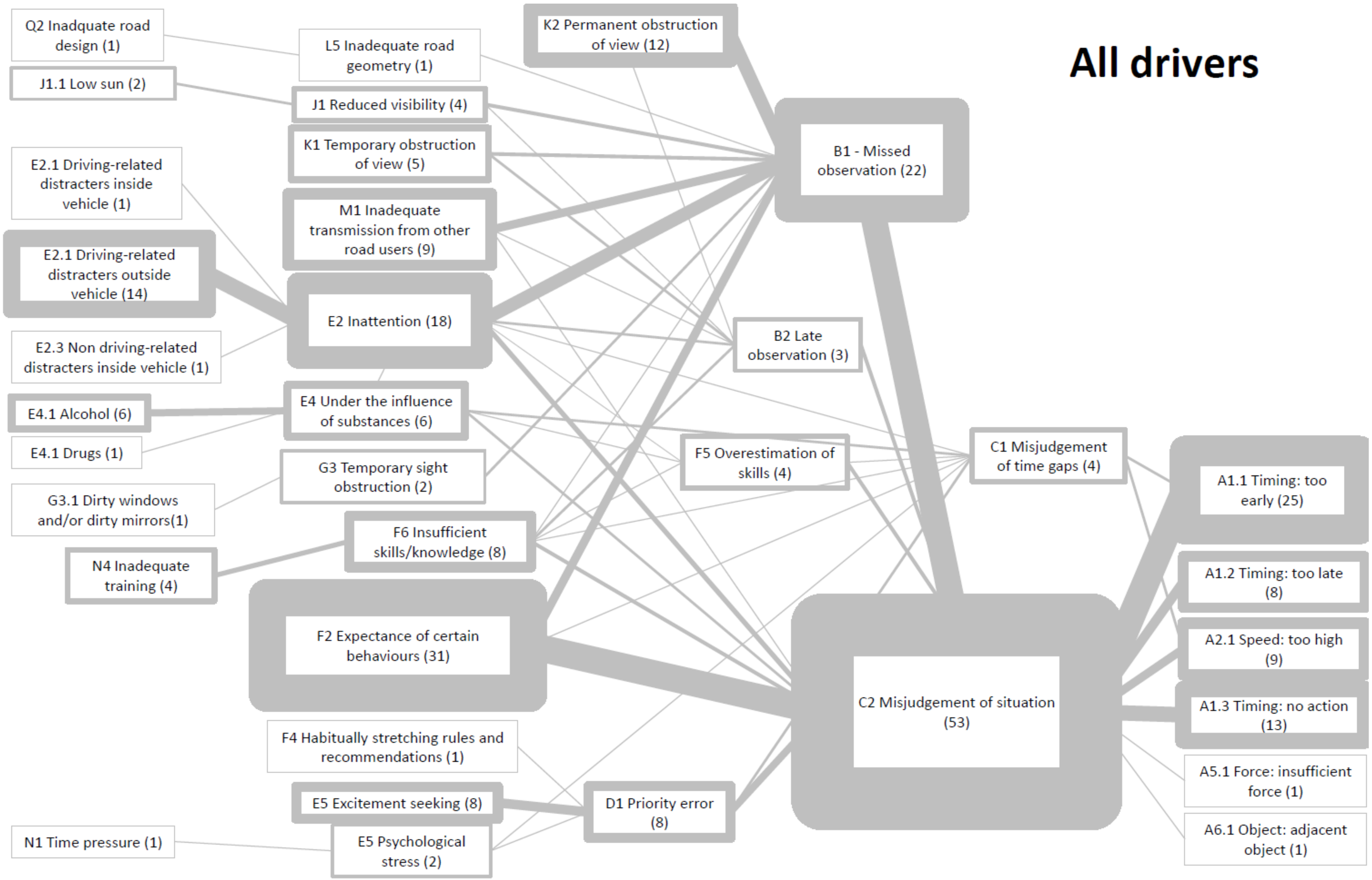
Table A.1.1: All phenotypes and genotypes in the 28 accidents

				SCP	LTIP			RTIP			LTAP-OD			LTAP-LD		
	ALL	Straight	Turning	SCP	ALLA	LD	LTIP	Alla	LD	RTIP	ALLA	OD	LTAP	ALLA	LD	LTAP
A1.1	25	0	25	0	2	0	2	1	0	1	13	0	13	9	0	9
A1.2	8	8	0	0	0	0	0	1	1	0	4	4	0	3	3	0
A1.3	13	12	1	2	0	0	0	1	0	1	5	5	0	5	5	0
A2.1	9	8	1	0	2	2	0	1	1	0	4	3	1	2	2	0
A5.1	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
A6.1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1
B1	22	4	18	1	2	0	2	1	0	1	9	1	8	9	2	7
B2	3	2	1	1	1	1	0	0	0	0	1	0	1	0	0	0
C1	4	2	2	0	0	0	0	0	0	0	3	1	2	1	1	0
C2	53	27	26	2	4	2	2	4	2	2	24	12	12	19	9	10
D1	8	8	0	1	2	2	0	1	1	0	2	2	0	2	2	0
E2.1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1
E2	18	4	14	1	1	1	0	0	0	0	10	2	8	6	0	6
E2.2	14	4	10	1	1	1	0	0	0	0	8	2	6	4	0	4
E2.3	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0
E4	6	5	1	0	0	0	0	0	0	0	3	3	0	3	2	1
E4.1	6	5	1	0	0	0	0	0	0	0	3	3	0	3	2	1
E4.2	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
E5	8	8	0	1	2	2	0	1	1	0	2	2	0	2	2	0
E7	2	1	1	0	1	1	0	0	0	0	1	0	1	0	0	0
F2	31	22	9	1	3	1	2	3	2	1	14	10	4	10	8	2
F4	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0
F5	4	4	0	0	1	1	0	0	0	0	3	3	0	0	0	0
F6	8	3	5	0	0	0	0	0	0	0	5	3	2	3	0	3
G3	2	0	2	0	0	0	0	0	0	0	2	0	2	0	0	0
G3.1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0
J1	4	3	1	2	0	0	0	0	0	0	2	1	1	0	0	0
J1.1	2	1	1	0	0	0	0	0	0	0	2	1	1	0	0	0
K1	5	1	4	0	2	1	1	0	0	0	2	0	2	1	0	1
K2	12	3	9	2	0	0	0	0	0	0	2	0	2	8	1	7
L5	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1
M1	9	5	4	2	0	0	0	0	0	0	6	2	4	1	1	0
N1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0
N4	4	3	1	0	0	0	0	0	0	0	4	3	1	0	0	0
Q2	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1
	290	146	144	17	24	15	9	14	8	6	139	66	73	96	41	55

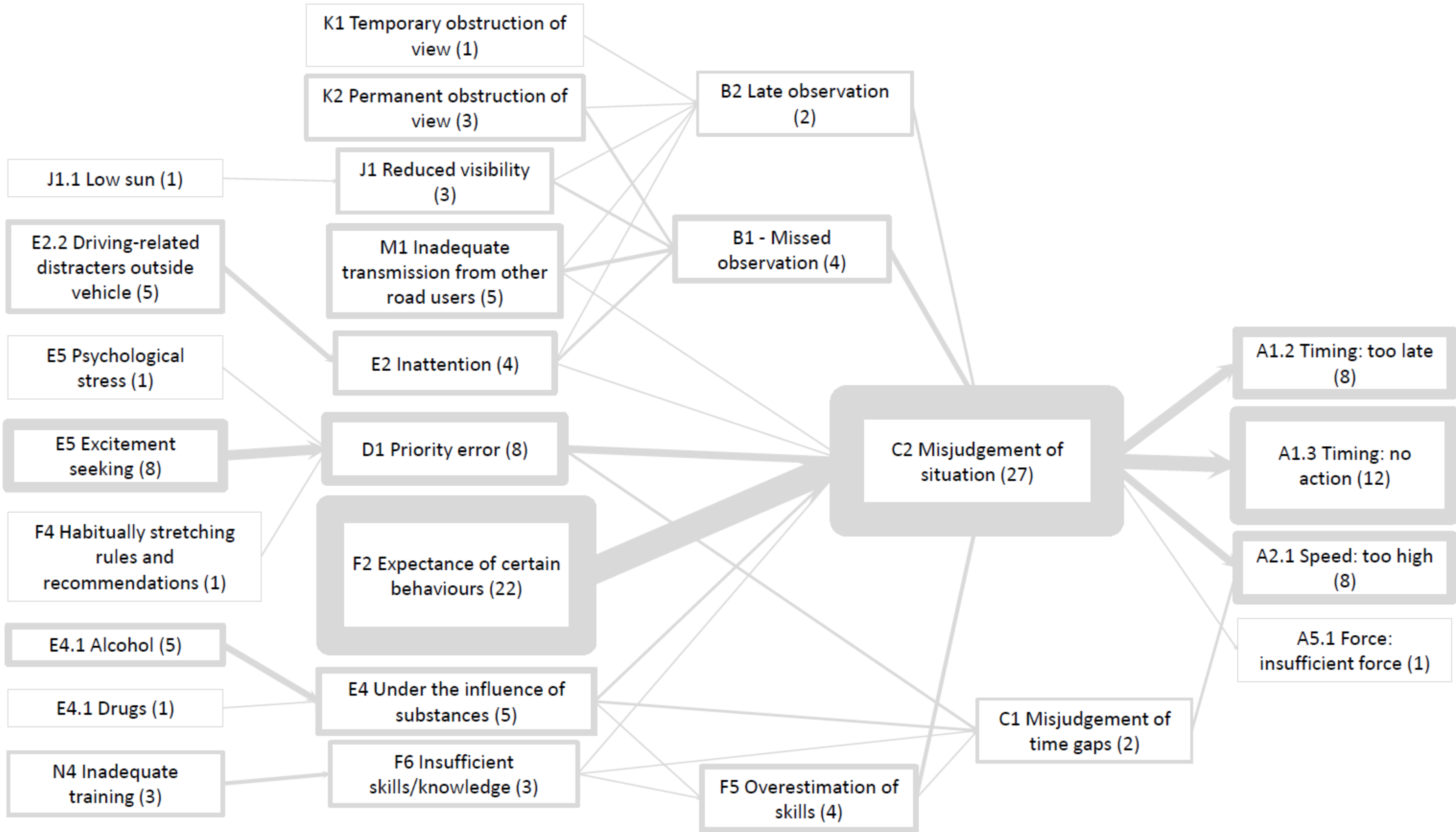
Table A.1.2: All links between genotypes and phenotypes in the 28 accidents

					LTAP-OD		LTAP-LD		LTIP		RTIP		SCP
		All	Straight	Turning	OD	LTAP	LD	LTAP	LTIP	LD	RTIP	LD	SCP
B1	C2	22	4	18	1	8	2	7	2		1		1
B2	C2	3	2	1		1				1			1
C1	A1.1	2	0	2	0	2							
C1	A2.1	2	2	0	1	0	1						
C2	A1.1	23	0	23	0	11		9	2		1		
C2	A1.2	8	8	0	4	0	3					1	
C2	A1.3	13	12	1	5	0	5				1		2
C2	A2.1	7	6	1	2	1	1			2		1	
C2	A5.1	1	1	0	1	0							
C2	A6.1	1	0	1	0	0		1					
D1	C1	2	2	0	1		1						
D1	C2	6	6	0	1		1			2		1	1
E2	B1	11	2	9	1	4		5					1
E2	B2	2	1	1		1				1			
E2	C1	1	0	1		1							
E2	C2	4	1	3	1	2		1					
E2.1	E2	1	0	1				1					
E2.2	E2	14	5	9	3	5		4		1			1
E2.3	E2	1	0	1		1							
E4	C1	2	2	0	1		1						
E4	C2	2	2	0	1		1						
E4	E2	1	0	1				1					
E4	F5	1	1	0	1								
E4.1	E4	6	5	1	3		2	1					
E4.2	E4	1	1	0	1								
E5	D1	8	8	0	2		2			2		1	1
E7	C1	1	0	1		1							
E7	D1	1	1	0						1			
F2	B1	7	0	7		2		2	2		1		
F2	C1	1	0	1		1							
F2	C2	23	22	1	10	1	8			1		2	1
F4	D1	1	1	0			1						
F5	C1	1	1	0	1								
F5	C2	3	3	0	2					1			
F6	B1	2	0	2				2					
F6	B2	1	0	1		1							
F6	C1	1	1	0	1								
F6	C2	3	1	2	1	1		1					
F6	F5	1	1	0	1								
G3	B1	2	0	2		2							
G3.1	G3	1	0	1		1							
J1	B1	3	2	1	1	1							1
J1	B2	1	1	0									1
J1.1	J1	2	1	1	1	1							
K1	B1	3	0	3		1		1	1				
K1	B2	2	1	1		1				1			
K2	B1	11	2	9		2	1	7					1
K2	B2	1	1	0									1
L5	B1	1	0	1				1					
M1	B1	7	3	4	1	4	1						1
M1	B2	1	1	0									1
M1	C2	1	1	0	1								
N1	E7	1	0	1		1							
N4	F6	4	3	1	3	1							
Q2	L5	1	0	1				1					
TOT		**233**	**118**	**115**	**53**	**59**	**31**	**45**	**7**	**13**	**4**	**6**	**15**

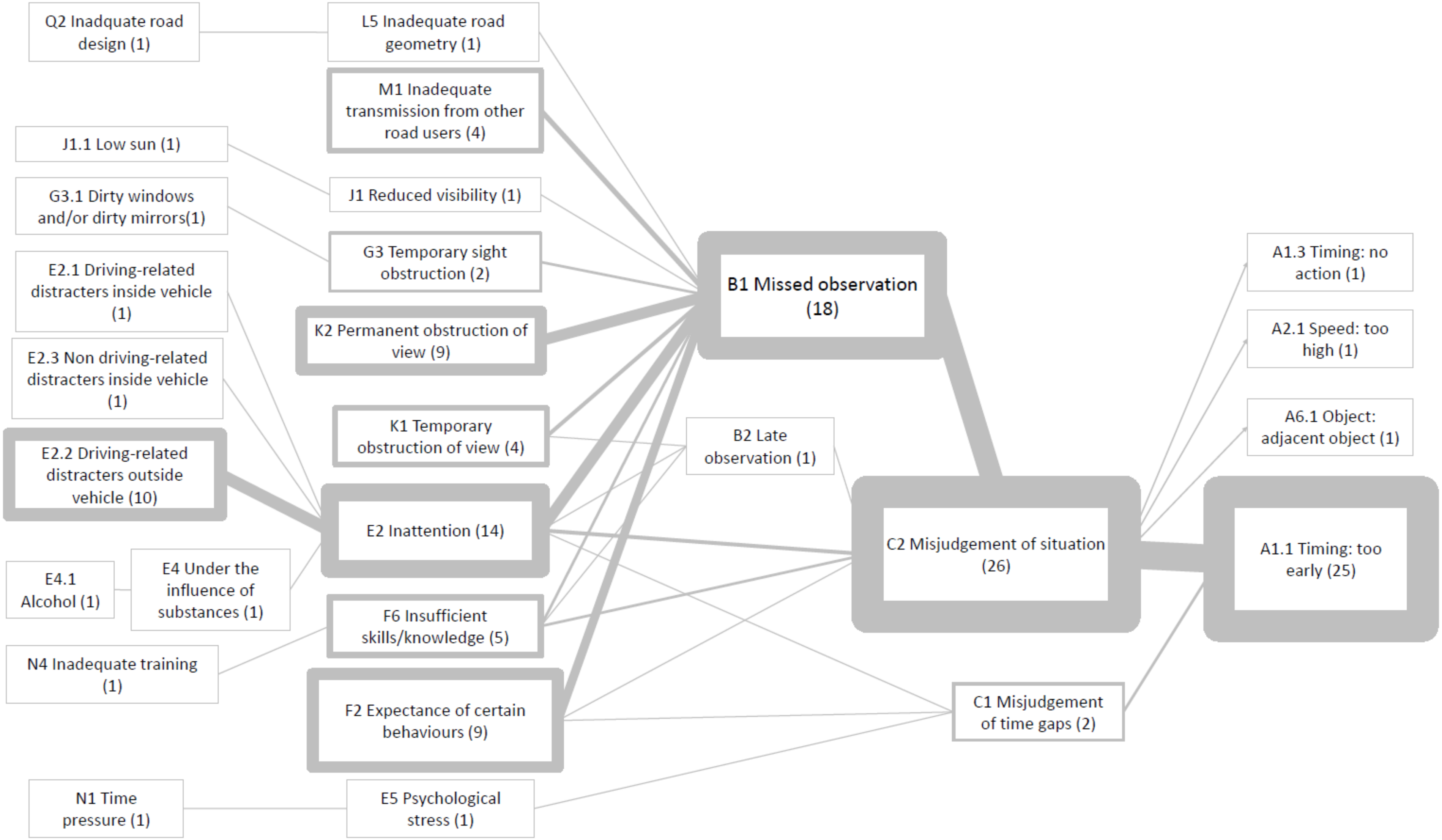
APPENDIX 2
All aggregations of intersection crashes


All drivers
Q2 Inadquate road design (1)
L5 Inadequate road geometry (1)
K2 Permanent obstruction of view (12)
J1.1 Low sun (2)
J1 Reduced visibility (4)
K1 Temporary obstruction of view (5)
B1 - Missed observation (22)
E2.1 Driving-related distracters inside vehicle (1)
M1 Inadequate transmission from other road users (9)
E2.1 Driving-related distracters outside vehicle (14)
E2 Inattention (18)
B2 Late observation (3)
E2.3 Non driving-related distracters inside vehicle (1)
E4 Under the influence of substances (6)
E4.1 Alcohol (6)
E4.1 Drugs (1)
C1 Misjudgement of time gaps (4)
F5 Overestimation of skills (4)
G3 Temporary sight obstruction (2)
G3.1 Dirty windows and/or dirty mirrors(1)
A1.1 Timing: too early (25)
F6 Insufficient skills/knowledge (8)
N4 Inadequate training (4)
A1.2 Timing: too late (8)
F2 Expectance of certain behaviours (31)
A2.1 Speed: too high (9)
C2 Misjudgement of situation (53)
A1.3 Timing: no action (13)
F4 Habitually stretching rules and recommendations (1)
A5.1 Force: insufficient force (1)
E5 Excitement seeking (8)
D1 Priority error (8)
N1 Time pressure (1)
E5 Psychological stress (2)
A6.1 Object: adjacent object (1)

Drivers going straight

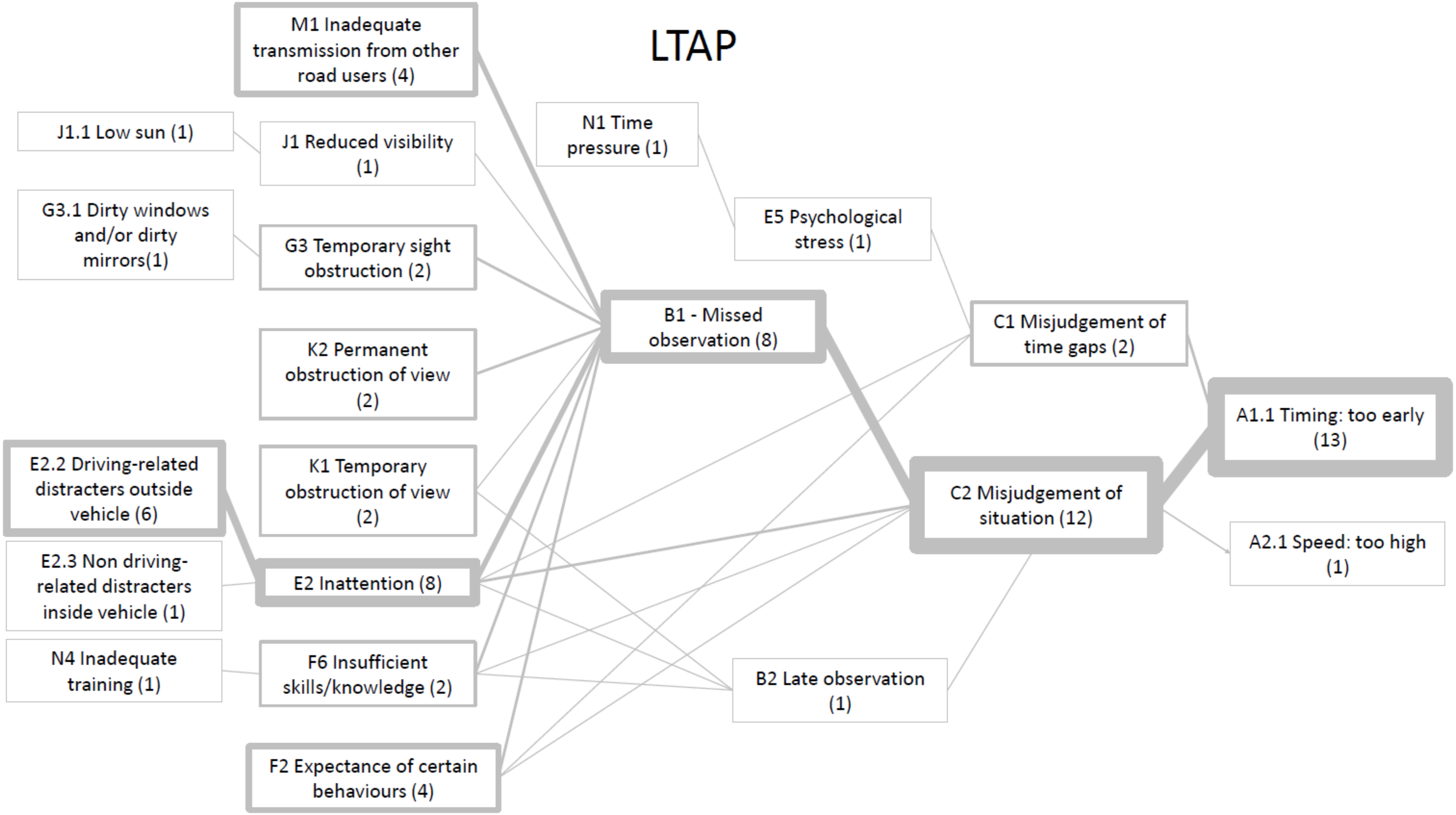


Turning drivers



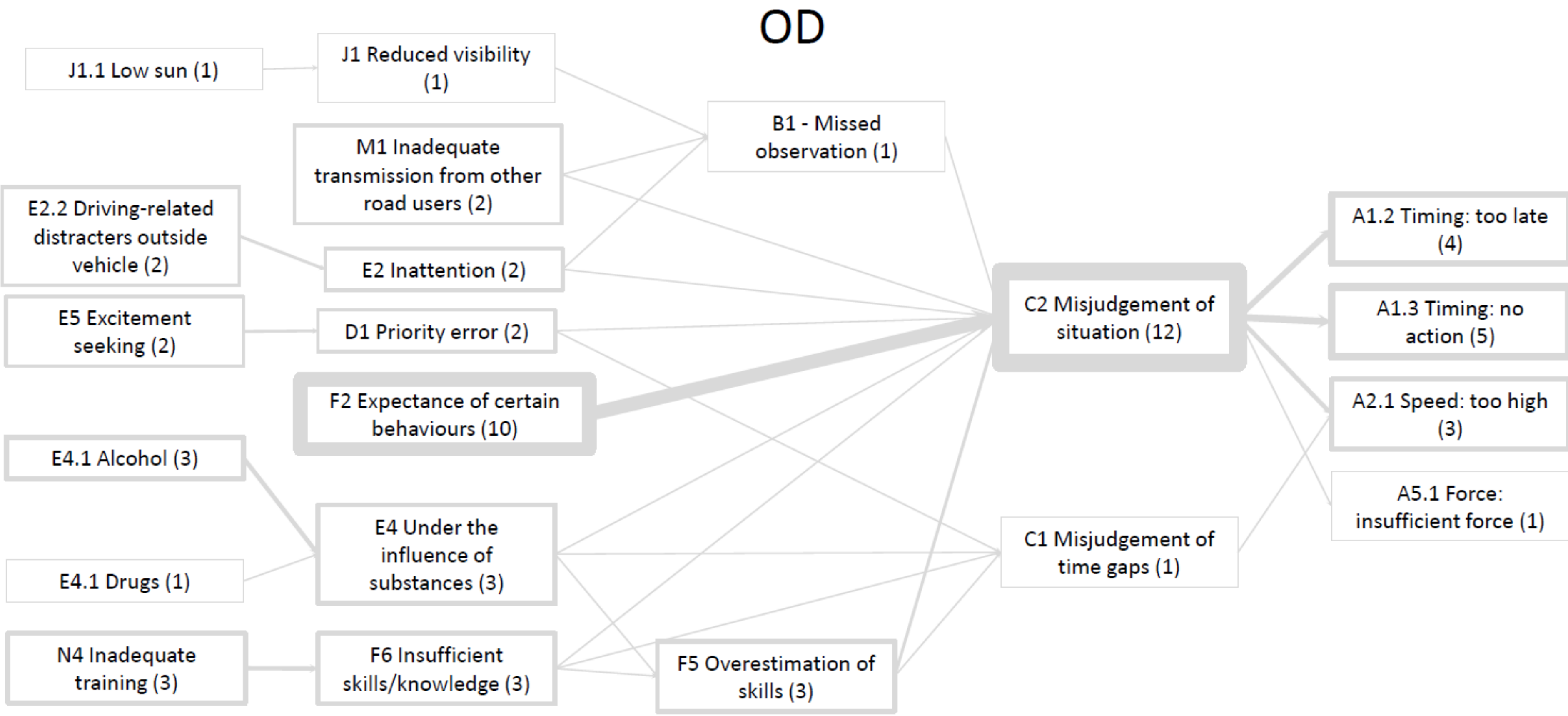
LTAP- OD

LTAP



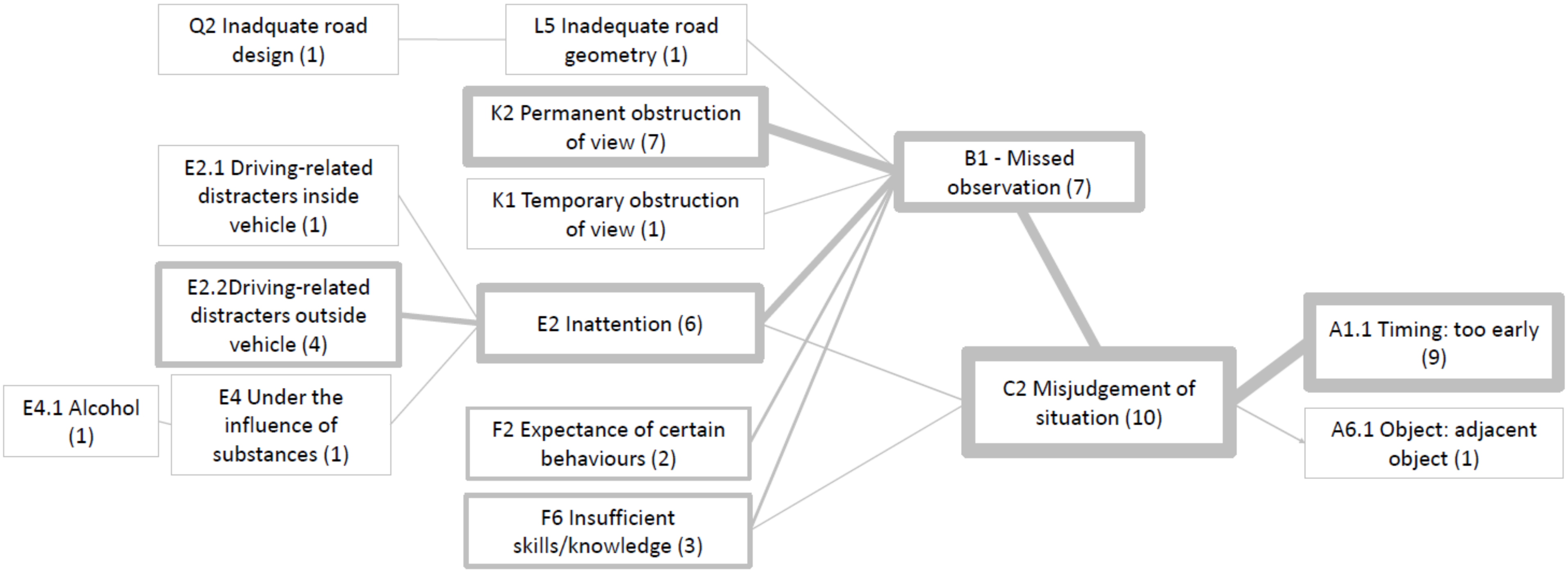
M1 Inadequate transmission from other road users (4)
J1.1 Low sun (1)
J1 Reduced visibility (1)
N1 Time pressure (1)
G3.1 Dirty windows and/or dirty mirrors(1)
G3 Temporary sight obstruction (2)
E5 Psychological stress (1)
B1 - Missed observation (8)
C1 Misjudgement of time gaps (2)
K2 Permanent obstruction of view (2)
A1.1 Timing: too early (13)
E2.2 Driving-related distracters outside vehicle (6)
K1 Temporary obstruction of view (2)
C2 Misjudgement of situation (12)
A2.1 Speed: too high (1)
E2.3 Non driving-related distracters inside vehicle (1)
E2 Inattention (8)
N4 Inadequate training (1)
F6 Insufficient skills/knowledge (2)
B2 Late observation (1)
F2 Expectance of certain behaviours (4)

LTAP- OD


OD
J1.1 Low sun (1)
J1 Reduced visibility (1)
B1 - Missed observation (1)
M1 Inadequate transmission from other road users (2)
E2.2 Driving-related distracters outside vehicle (2)
E2 Inattention (2)
E5 Excitement seeking (2)
D1 Priority error (2)
F2 Expectance of certain behaviours (10)
C2 Misjudgement of situation (12)
A1.2 Timing: too late (4)
A1.3 Timing: no action (5)
A2.1 Speed: too high (3)
A5.1 Force: insufficient force (1)
E4.1 Alcohol (3)
E4 Under the influence of substances (3)
E4.1 Drugs (1)
C1 Misjudgement of time gaps (1)
N4 Inadequate training (3)
F6 Insufficient skills/knowledge (3)
F5 Overestimation of skills (3)

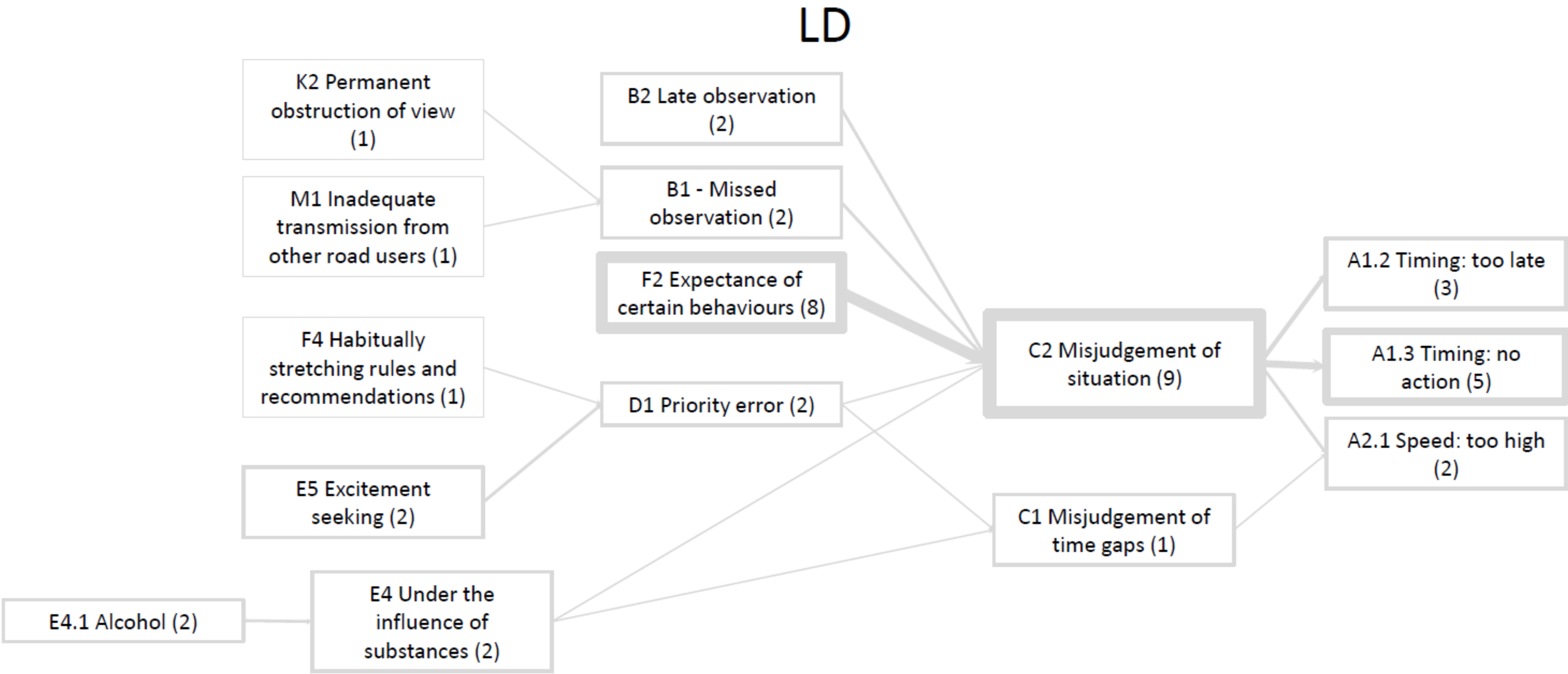
LTAP- LD

LTAP



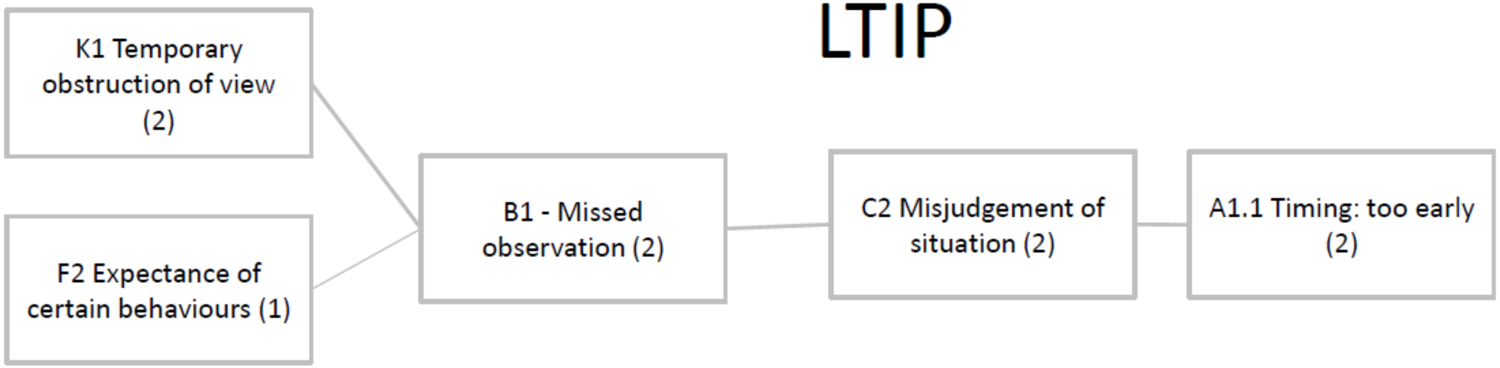
Q2 Inadquate road design (1)
L5 Inadequate road geometry (1)
K2 Permanent obstruction of view (7)
E2.1 Driving-related distracters inside vehicle (1)
K1 Temporary obstruction of view (1)
B1 - Missed observation (7)
E2.2Driving-related distracters outside vehicle (4)
E2 Inattention (6)
A1.1 Timing: too early (9)
E4.1 Alcohol (1)
E4 Under the influence of substances (1)
C2 Misjudgement of situation (10)
F2 Expectance of certain behaviours (2)
A6.1 Object: adjacent object (1)
F6 Insufficient skills/knowledge (3)

LTAP- LD


LD
K2 Permanent obstruction of view (1)
M1 Inadequate transmission from other road users (1)
F4 Habitually stretching rules and recommendations (1)
E5 Excitement seeking (2)
E4.1 Alcohol (2)
E4 Under the influence of substances (2)
B2 Late observation (2)
B1 - Missed observation (2)
F2 Expectance of certain behaviours (8)
D1 Priority error (2)
C2 Misjudgement of situation (9)
C1 Misjudgement of time gaps (1)
A1.2 Timing: too late (3)
A1.3 Timing: no action (5)
A2.1 Speed: too high (2)

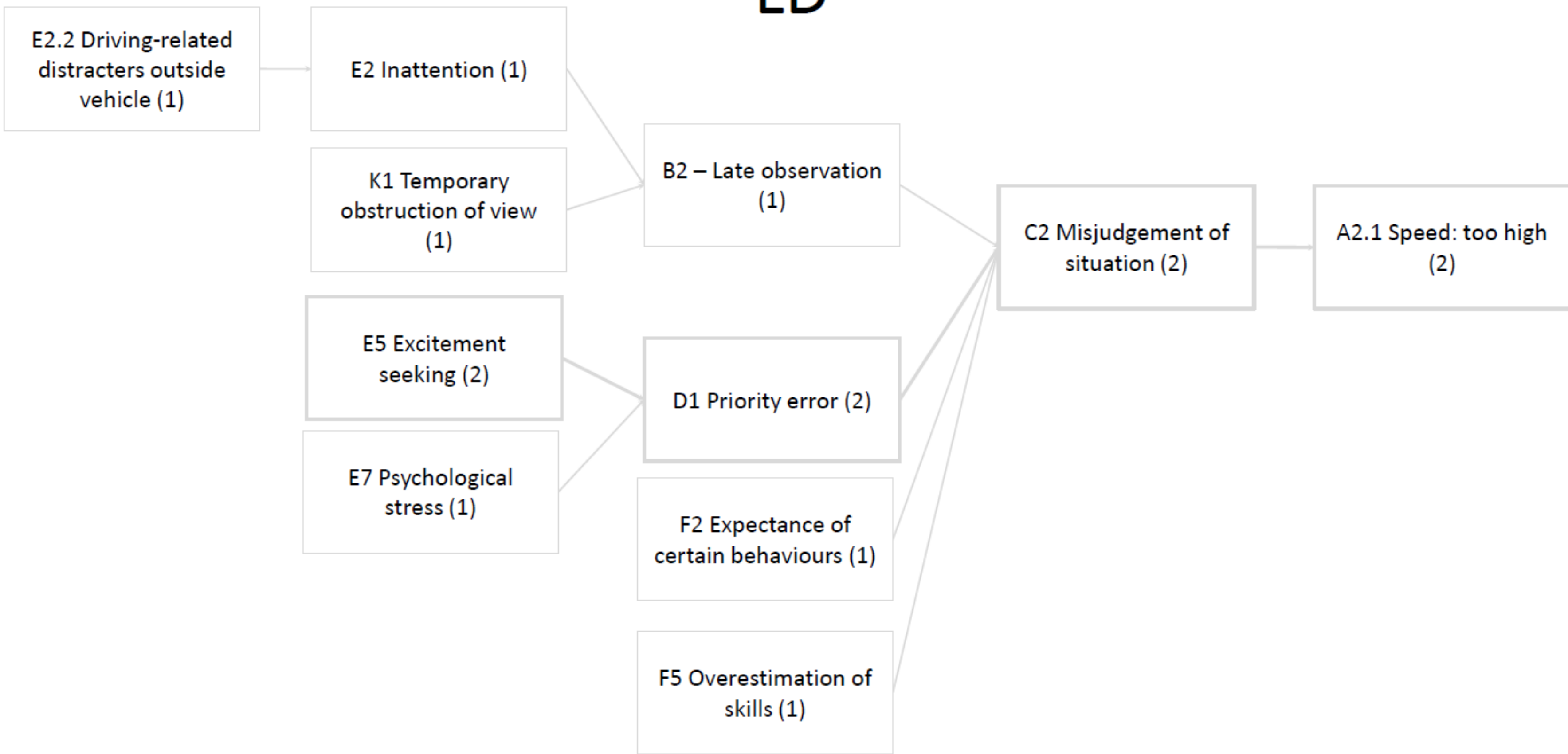
LTIP

LTIP


K1 Temporary obstruction of view (2)
F2 Expectance of certain behaviours (1)
B1 - Missed observation (2)
C2 Misjudgement of situation (2)
A1.1 Timing: too early (2)

LTIP

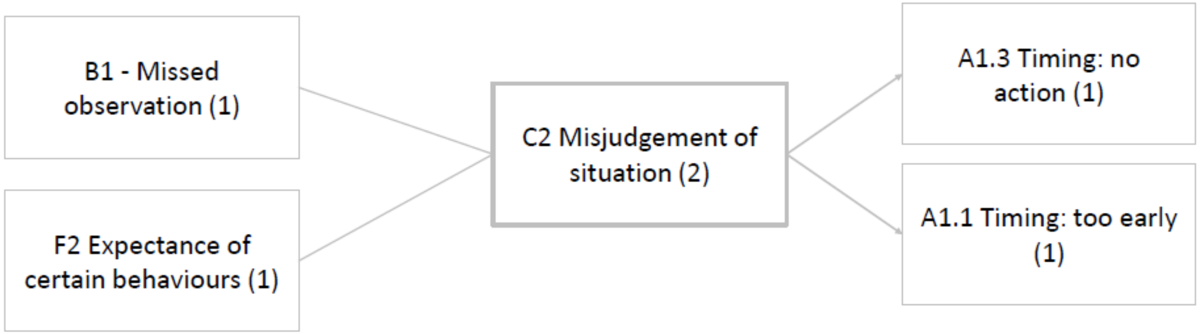
LD



E2.2 Driving-related distracters outside vehicle (1)
E2 Inattention (1)
K1 Temporary obstruction of view (1)
B2 – Late observation (1)
E5 Excitement seeking (2)
E7 Psychological stress (1)
D1 Priority error (2)
F2 Expectance of certain behaviours (1)
F5 Overestimation of skills (1)
C2 Misjudgement of situation (2)
A2.1 Speed: too high (2)

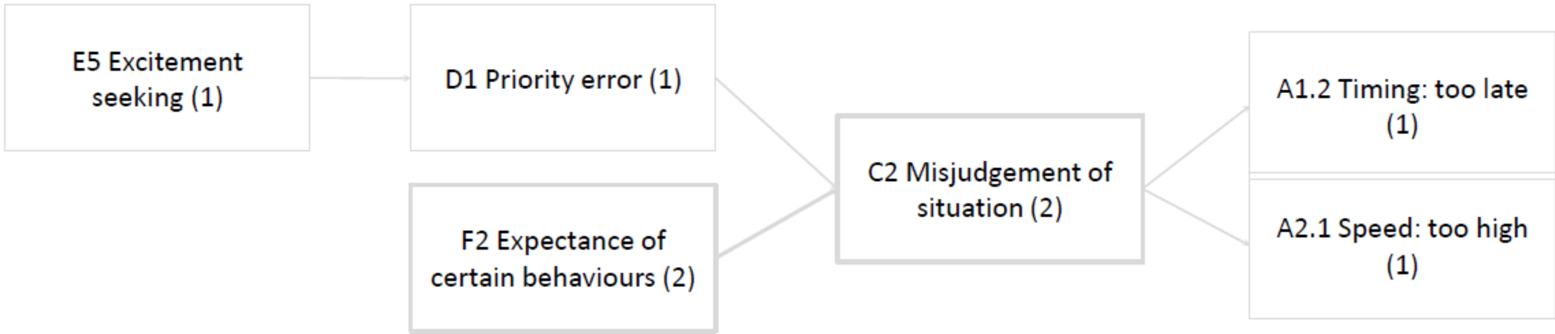
RTIP

RTIP


B1 - Missed observation (1)
F2 Expectance of certain behaviours (1)
C2 Misjudgement of situation (2)
A1.3 Timing: no action (1)
A1.1 Timing: too early (1)

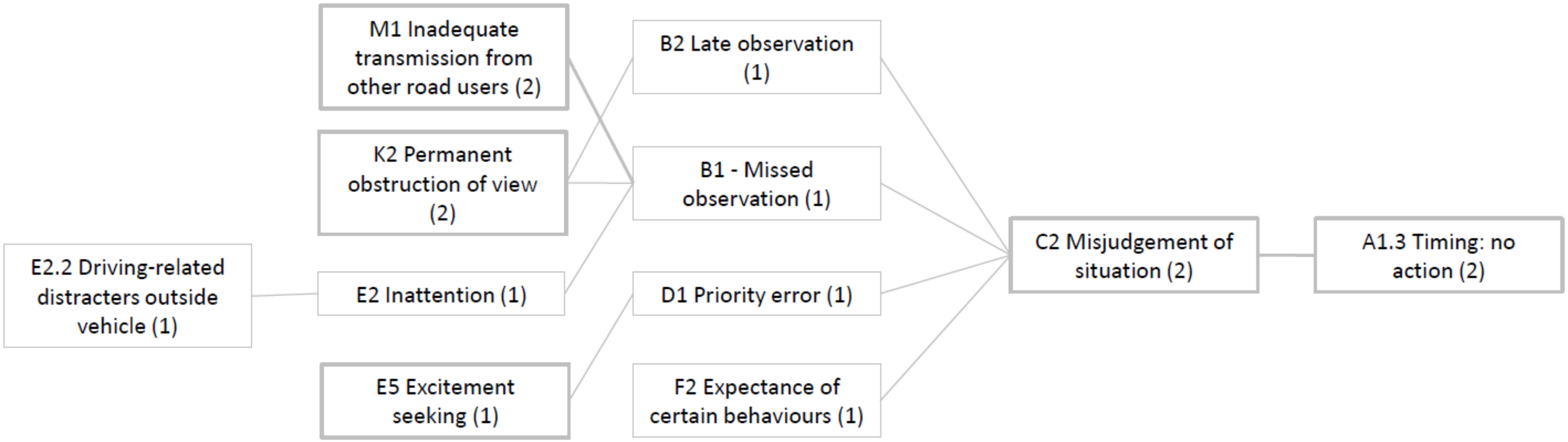
RTIP

LD


E5 Excitement seeking (1)
D1 Priority error (1)
F2 Expectance of certain behaviours (2)
C2 Misjudgement of situation (2)
A1.2 Timing: too late (1)
A2.1 Speed: too high (1)

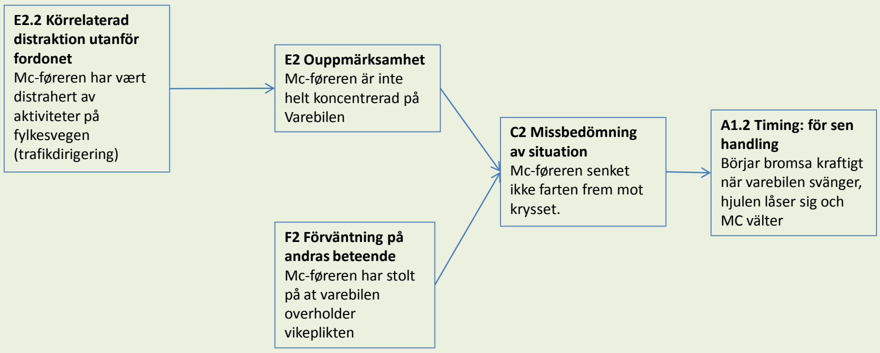
SCP

ONE ACCIDENT - BOTH DRIVERS



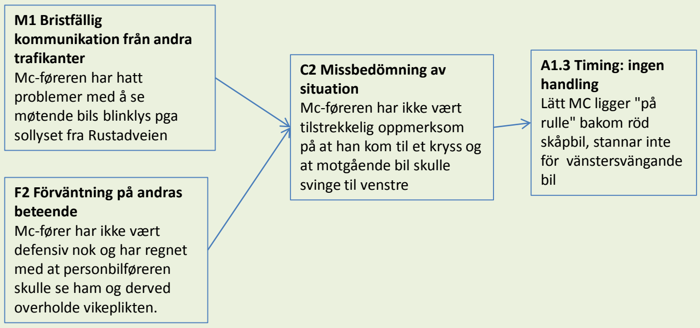
APPENDIX 3
DREAM charts for all intersection crashes

1 LTAP-OD
MC OD

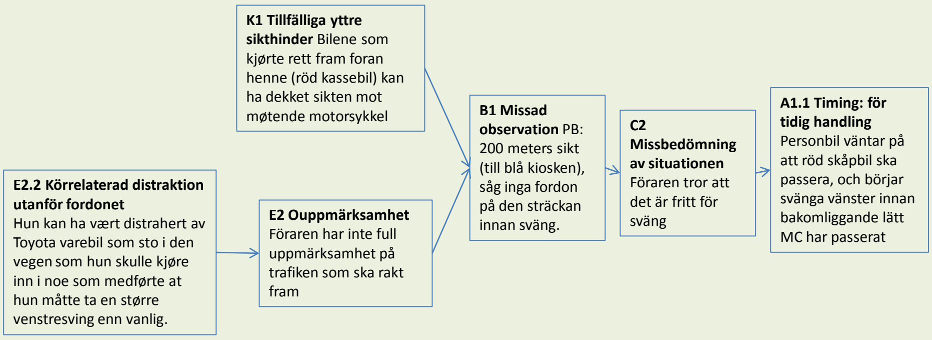


1 LTAP-OD
Varebil LTAP

2 LTAP-OD
MC OD



2 LTAP-OD
personbil LTAP



3 LTAP-OD
MC OD

F2 Förväntning på andras beteende Överraskad av att lastbilen inte lämnar företräde (lastbilen har väjningsplikt)

F5 Överskattning av färdigheter Har ikke hatt unormalt høy hastighet, men har feilvurdert den bromskraft som behövs för att få stopp på den tillgängliga sträckan. Föraren tror förmodligen att han kan utnyttja motorcykelns fulla bromskapacitet (vilket ger ungefär samma bromssträcka som en bil), men klarar i verkligheten inte av detta i en kritisk situation.

C2 Missbedömning av situationen
Det er lange, svake bremsespor etter MC. Først de siste 10 m av sporet bremses det kraftig.

A5.1 Kraft: för lite kraft
Föraren bromsar för lite för att kunna stanna för den svängande lastbilen.

3 LTAP-OD
Vogntog LTAP

K2 Permanenta yttre sikthinder
Var på stedet senere (i mørket sammen med datter) og la merke til at lys på møtende biler fra brua forsvant fra tid til annet pga stort skilt og vegetasjon.(avstand ca 200 m). Kan bli problem med en Mc som kommer från bron även i normal fart om föraren gör sin scanning och fattar svängbeslut väldigt tidigt (3-4 sek innan sväng påböras)

B1 Missad observation
Vid den tidpunkt då föraren scannar av framåt för att se om det är annan trafik så är motorcykeln inte synlig.

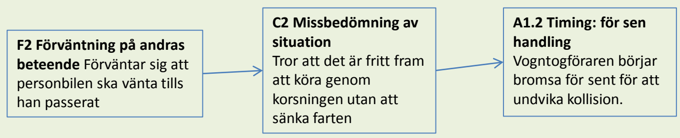
C2 Missbedömning av situationen
Föraren tror att det är fritt för sväng

A1.1 Timing: för tidig handling
Vogntog börjar svänga vänster innan MC har passerat

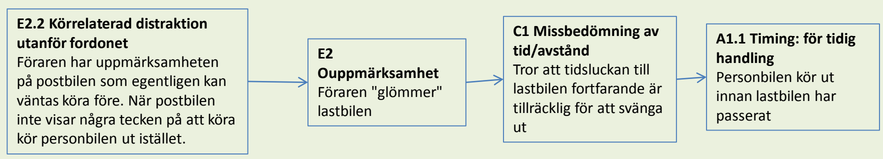
E2.2 Körrelaterad distraktion utanför fordonet
Har inte kört här förut. Måste pga vogntogets størrelse litt langt fram pga øyspissen. Fokuserad på manövreringen.

E2 Ouppmärksamhet
Föraren har inte full uppmärksamhet på vägen där MC:n kommer

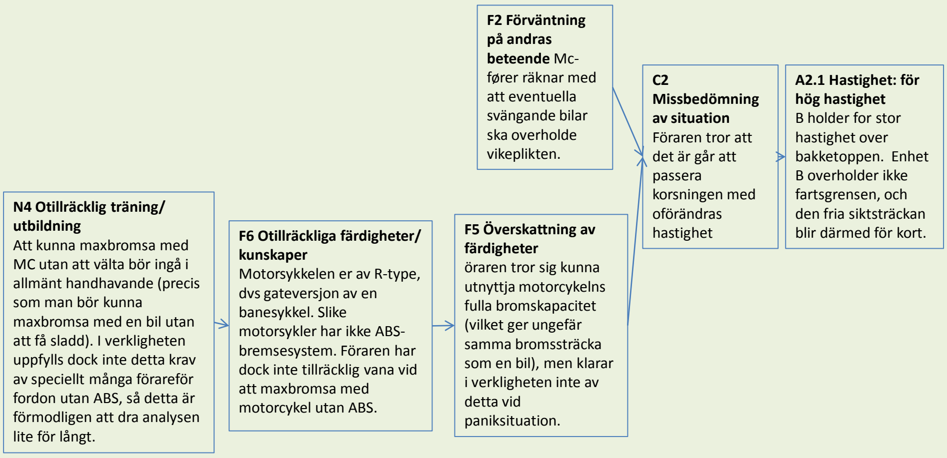
4 LTAP-OD
Vogntog OD



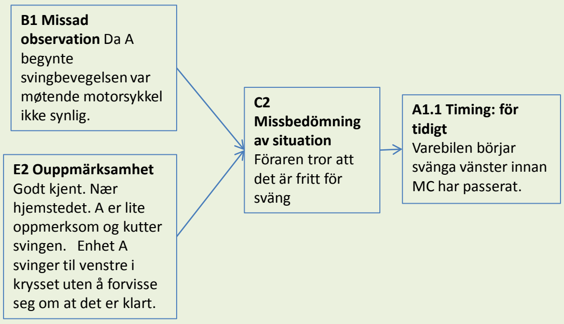
4 LTAP-OD
personbil LTAP



5 LTAP-OD
MC OD



5 LTAP-OD
Varebil LTAP



6 LTAP-OD
minibuss OD

F2 Förväntning på andras beteende
Sjåføren av minibussen var helt sikker på at den røde personbilen ville overholde vikeplikten

→

C2 Missbedömning av situation Föraren tror att det är fritt fram att köra genom korsningen utan att sänka farten

→

A1.2 Timing: för sen handling
Minibussföraren börjar bromsa för sent för att undvika kollision.

6 LTAP-OD
personbil LTAP

E2.2 Körrelaterad distraktion utanför fordonet
Efter en första kontroll av att avståndet till minibussen är tillräckligt för hinna svänga har föraren uppmärksamheten riktad på Mercedesen som står stilla och ska svänga vänster ut på samma väg som personbilen kommer ifrån.
Kan ha vært opptatt av ventende kjøretøy til venstre i vikepliktsituasjon

→

E2 Ouppmärksamhet
Föraren "glömmer" minibussen som är på väg mot korsningen

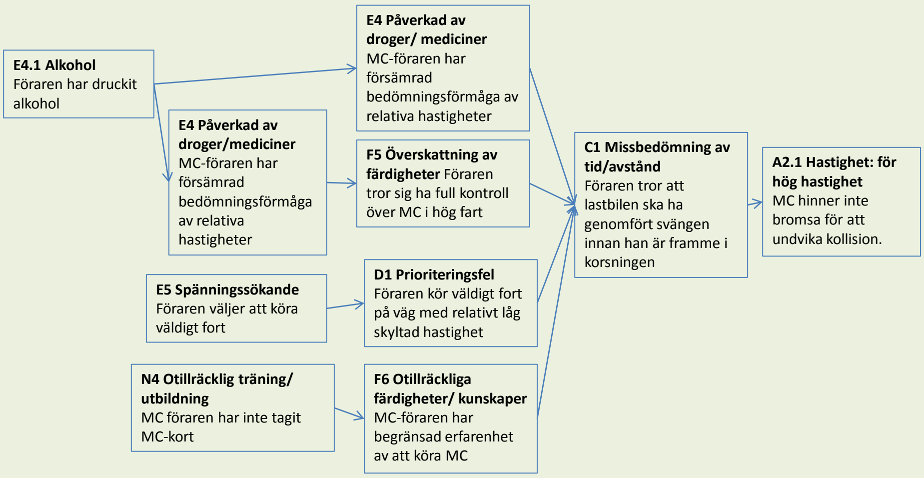
→

C2 Missbedömning av situation
Föraren gör ingen extra kontroll, tror att tidsluckan till minibussen fortfarande är tillräcklig för att hinna svänga innan den kommer fram?
Kombinasjon av fart og avstand til møtende trafikk, sett i forhold til eldre personers tidsbruk for selve handling?

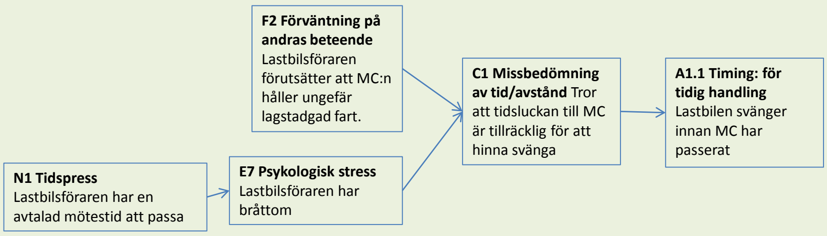
→

A1.1 Timing: för tidigt
Personbilen börjar svänga vänster innan minibussen har passerat

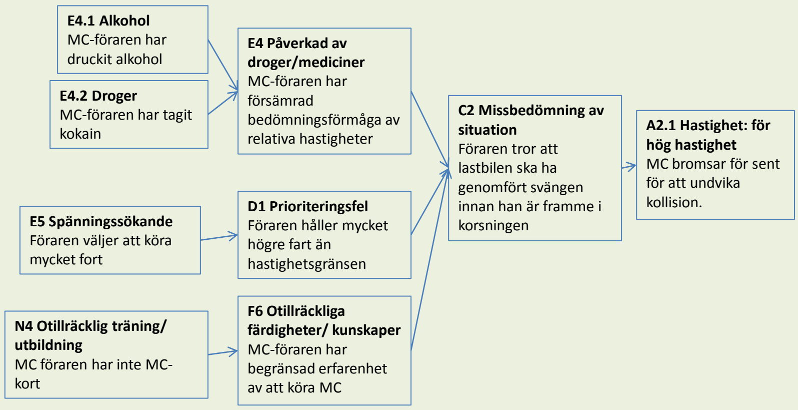
7 LTAP-OD
MC OD



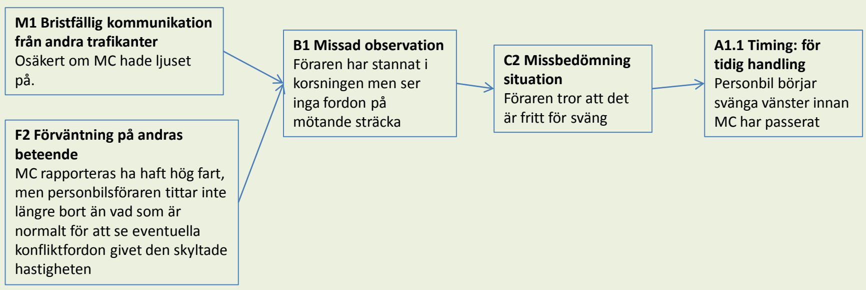
7 LTAP-OD
Lastebil LTAP



8 LTAP-OD
MC OD

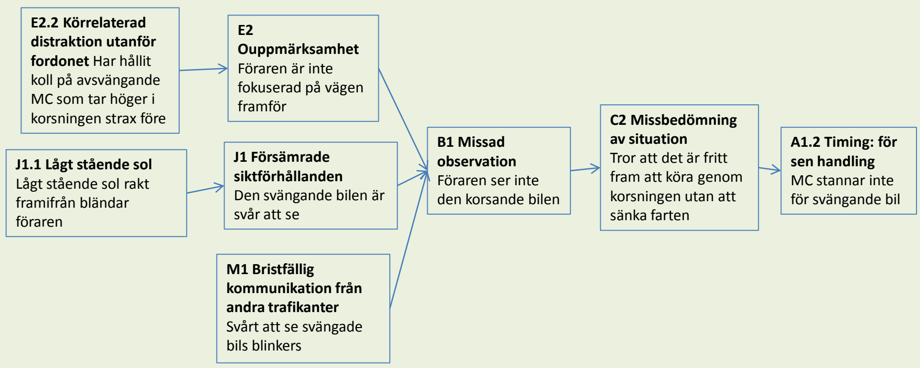


8 LTAP-OD
personbil LTAP



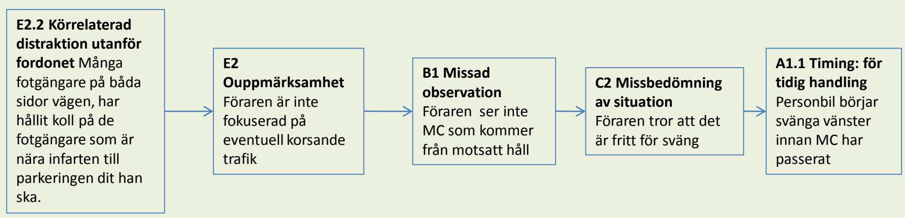
9 LTAP-OD

MC OD

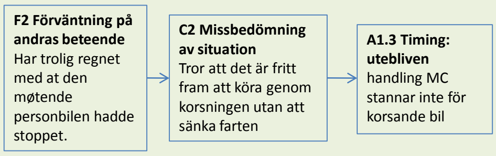


9 LTAP-OD

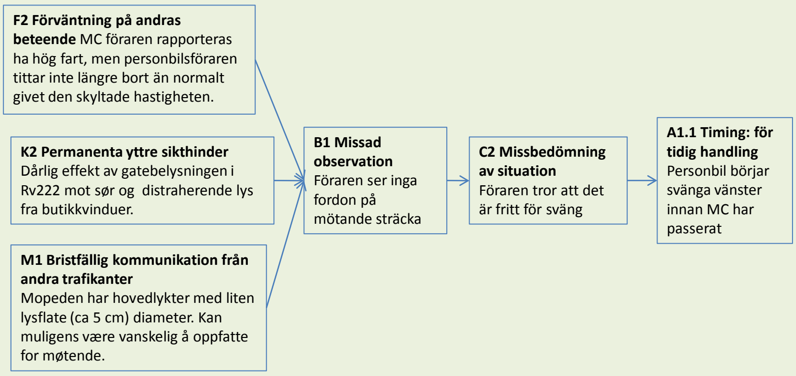
personbil LTAP



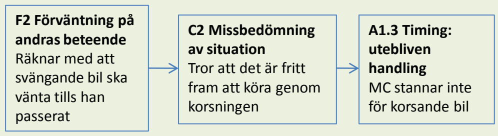
10 LTAP-OD
MC OD



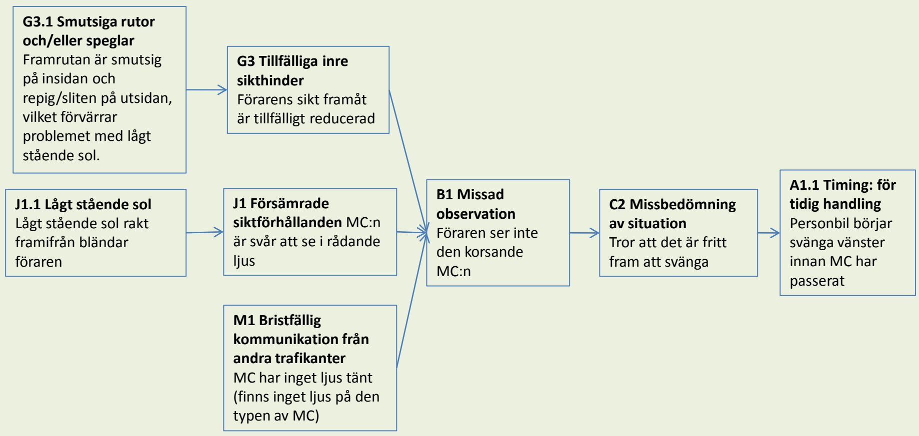
10 LTAP-OD
personbil LTAP



11 LTAP-OD
MC OD



11 LTAP-OD
personbil LTAP



12 LTAP-OD
personbil LTAP

N4 Otillräcklig träning/ utbildning
Föraren har bara haft körkort i 11 dagar, och kuggat 3 gånger innan han tog det. Vissa moment i utbildningen måste dock ändå ha gått honom förbi.

→

F6 Otillräckliga färdigheter/ kunskaper
Föraren tror att MC ska stanna för honom när han svänger vänster, trots att det är han som egentligen har väjningsplikt.

→

C2 Missbedömning av situation
Föraren tror att det är fritt för sväng

→

A1.1 Timing: för tidig handling
Personbil börjar svänga vänster innan MC har passerat

12 LTAP-OD
MC OD

F2 Förväntning på andras beteende
Räknar med att svängande bil ska vänta tills han passerat

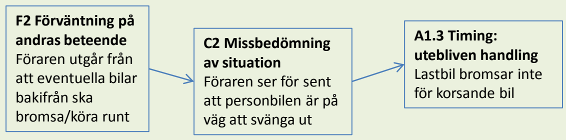
→

C2 Missbedömning av situation
Tror att det är fritt fram att köra genom korsningen

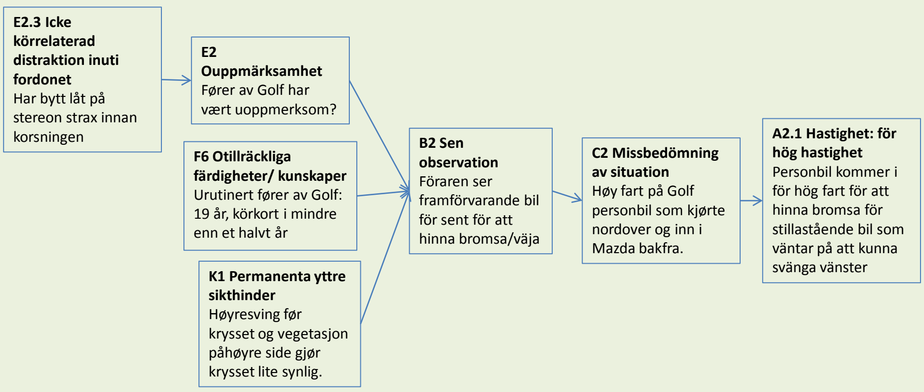
→

A1.3 Timing: utebliven handling
MC stannar inte för korsande bil

13 LTAP-OD
Lastbil - OD

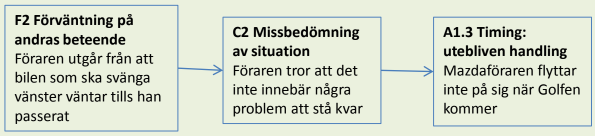


13 LTAP-OD
Personbil1 - OD

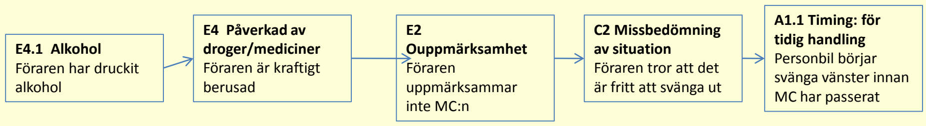


13 LTAP-OD

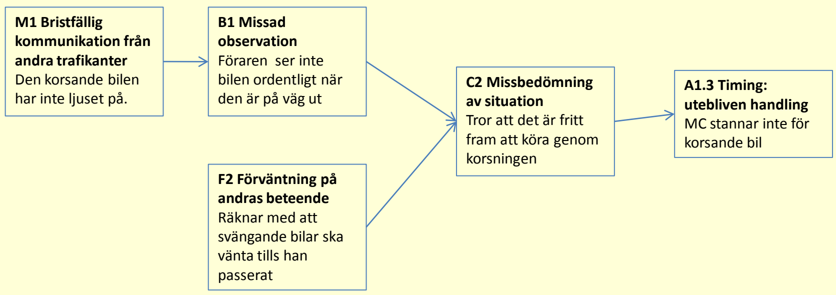
Personbil 2 – LTAP



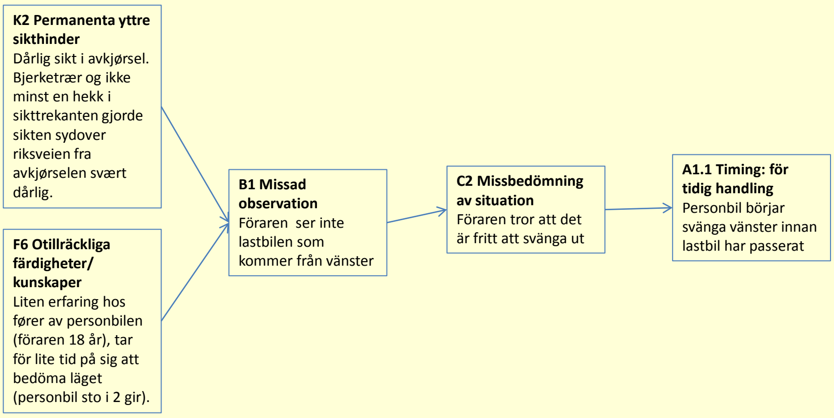
1 LTAP-LD
personbil LTAP



1 LTAP-LD
MC LD

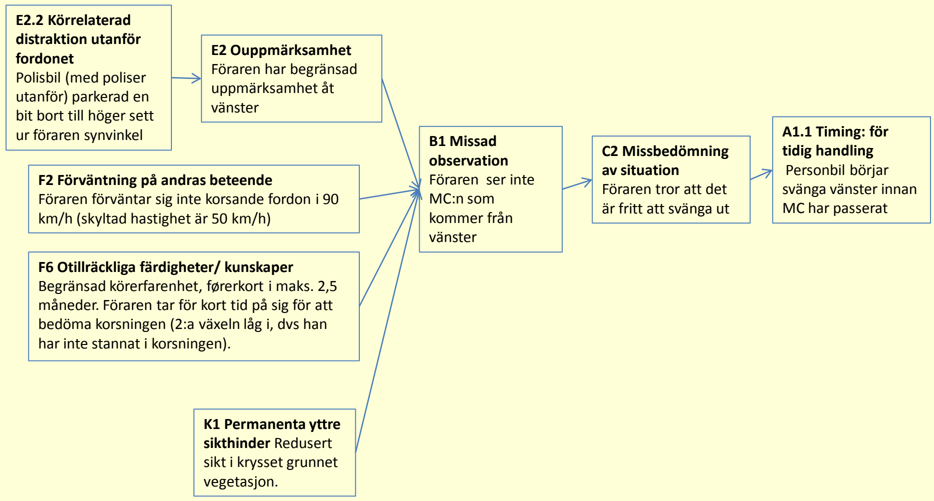


2 LTAP-LD
personbil LTAP

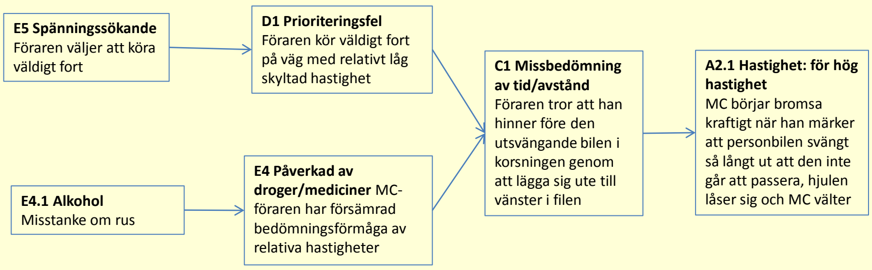


2 LTAP-LD
Lastbil OD

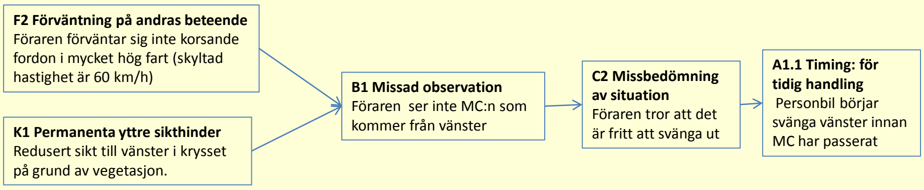
3 LTAP-LD
personbil LTAP



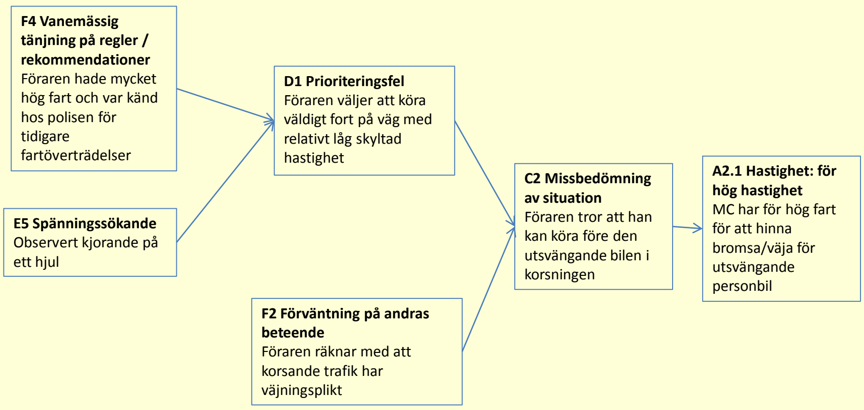
3 LTAP-LD
MC LD



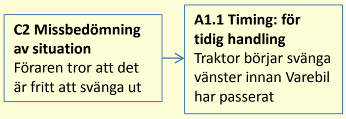
4 LTAP-LD
personbil LTAP



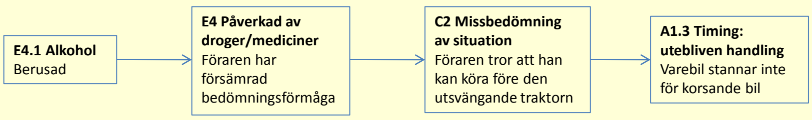
4 LTAP-LD
MC LD



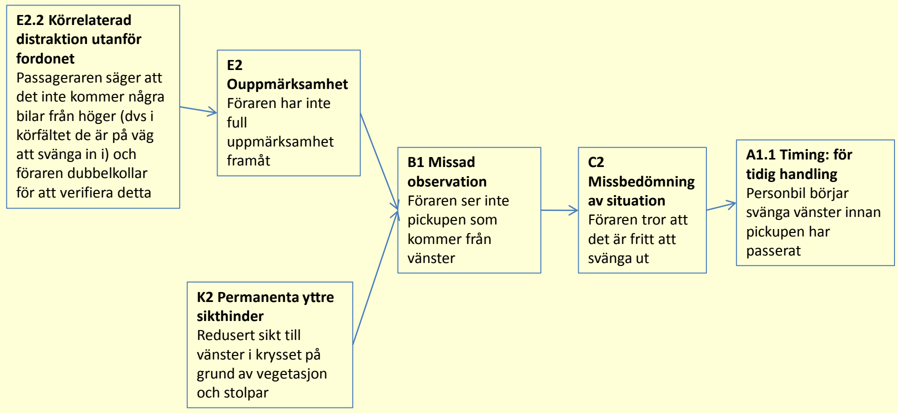
5 LTAP-LD
Traktor LTAP



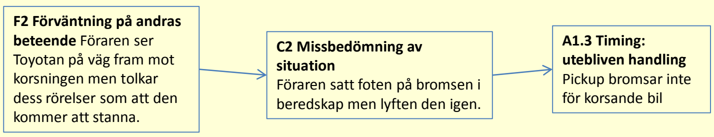
5 LTAP-LD
Varebil LD



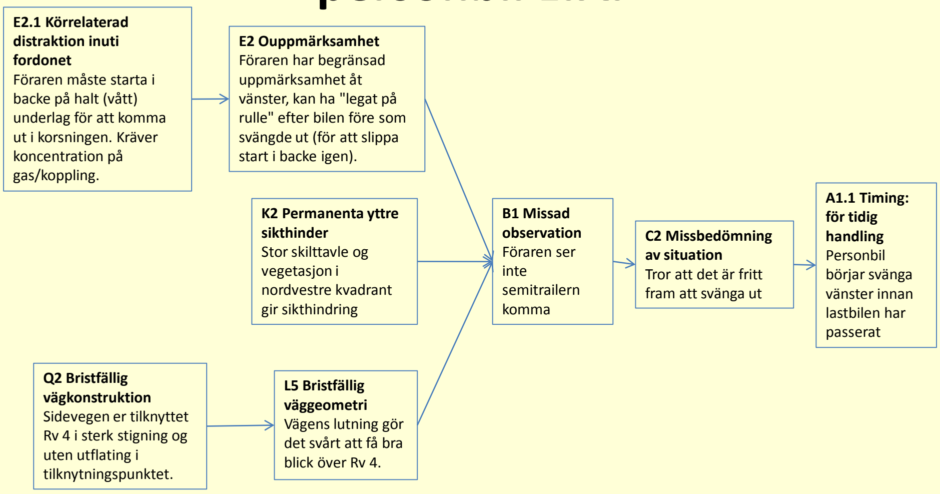
6 LTAP-LD
personbil LTAP



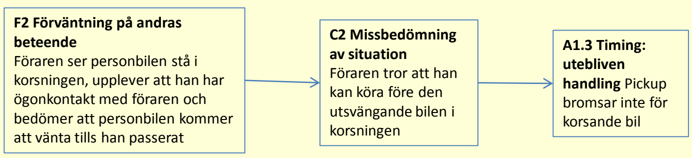
6 LTAP-LD
pickup LD



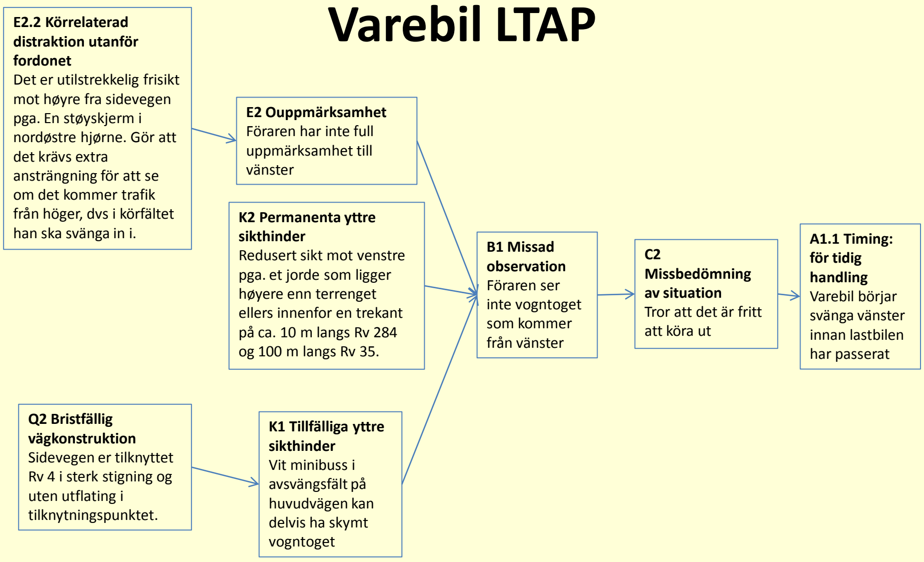
7 LTAP-LD
personbil LTAP



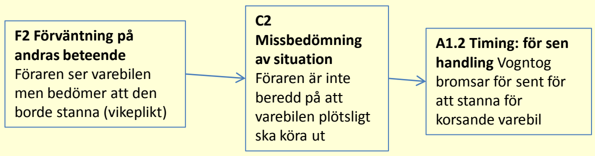
7 LTAP-LD
Semitrailer LD



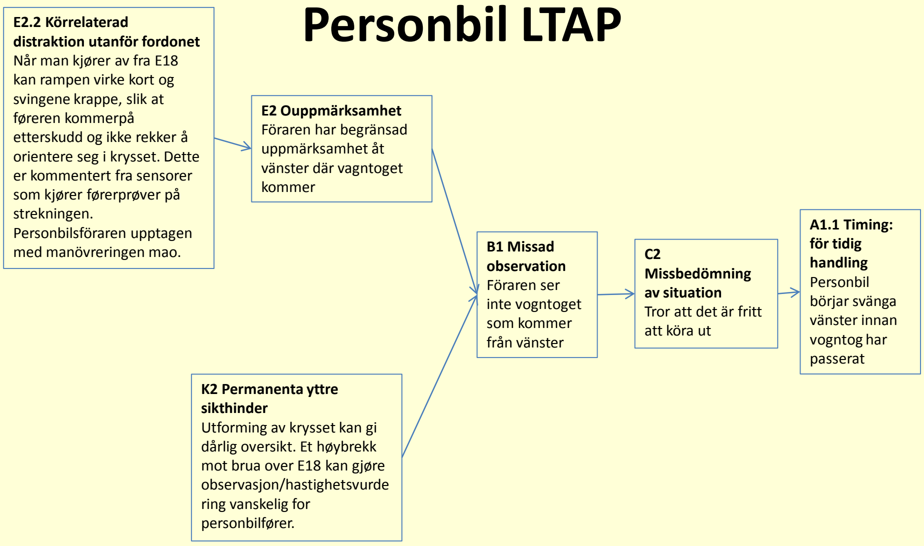
8 LTAP-LD
Varebil LTAP



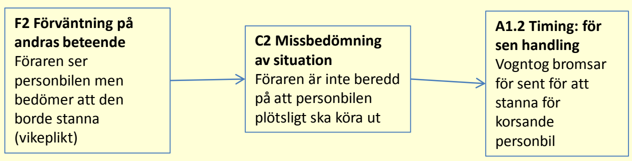
8 LTAP-LD
Vogntog LD



9 LTAP-LD
Personbil LTAP



9 LTAP-LD
Vogntog LD



10 LTAP-LD
Personbil LTAP

F6 Otillräckliga färdigheter/ kunskaper
Föraren kör hyrbil med manuell växel, fast han är van vid automatväxel på sin egen bil

→

C2 Missbedömning av situation
Föraren är klarar inte av att stanna vid stopplinjen

→

A6.1 Objekt: näraliggande objekt
Personbilen kör ut framför Vogntoget

10 LTAP-LD
Vogntog LD

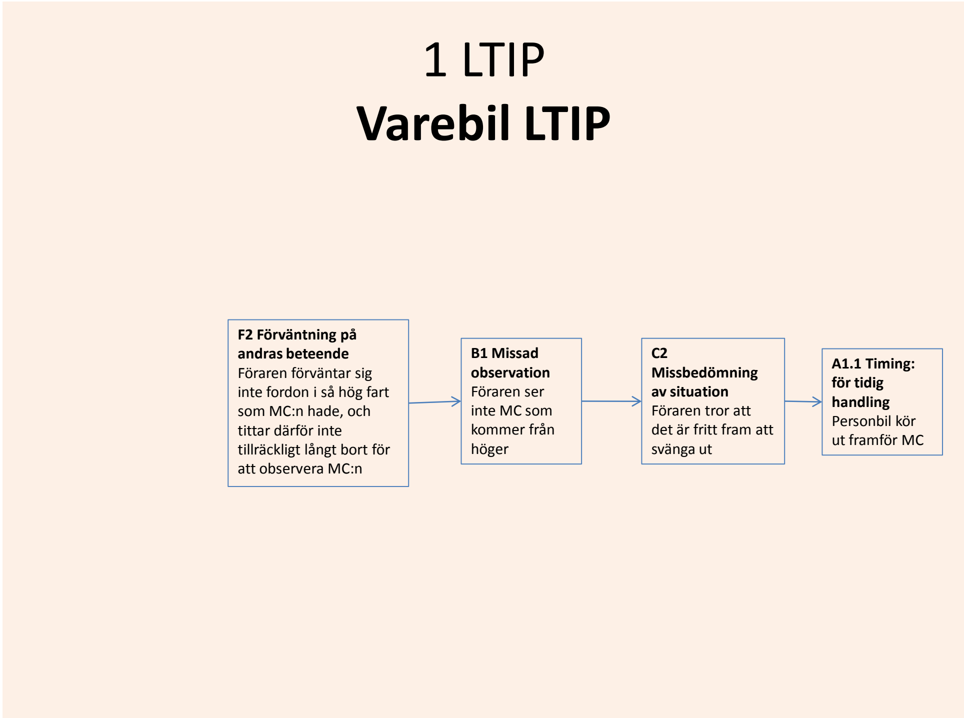
F2 Förväntning på andras beteende
Föraren ser personbilen men bedömer att den borde stanna (vikeplikt)

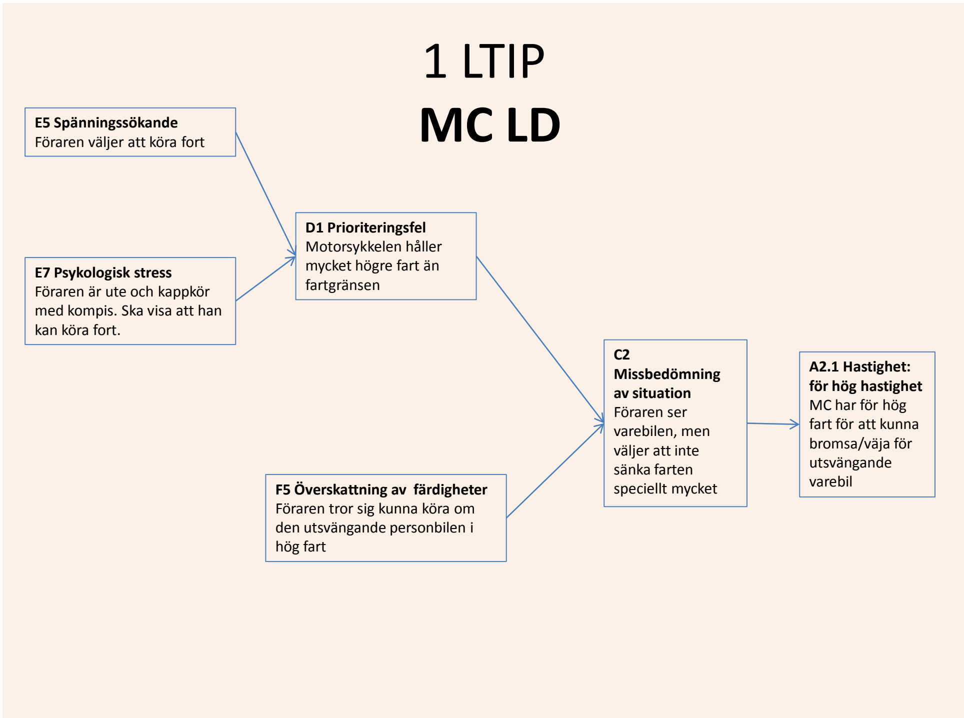
→

C2 Missbedömning av situation
Föraren är inte beredd på att personbilen plötsligt ska köra ut

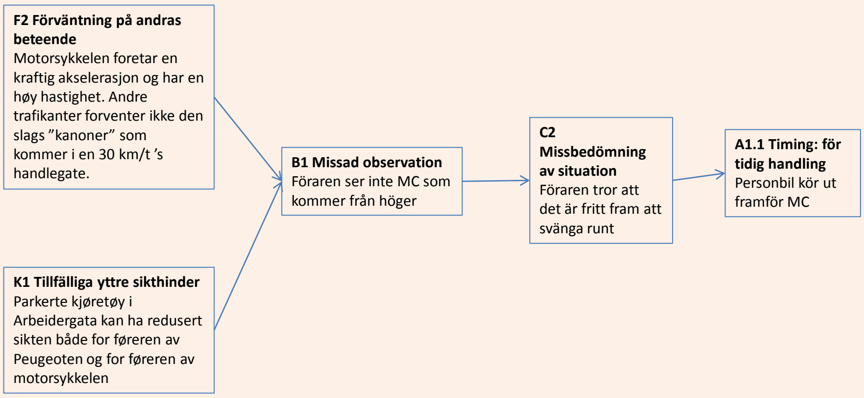
→

A1.2 Timing: för sen handling
Vogntog bromsar för sent för att stanna för korsande personbil

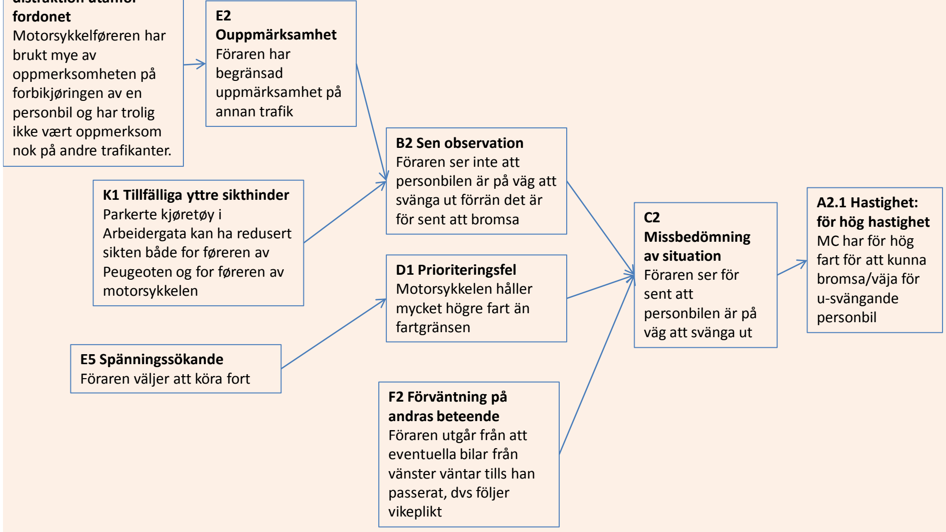

1 LTIP
Varebil LTIP
F2 Förväntning på andras beteende
Föraren förväntar sig inte fordon i så hög fart som MC:n hade, och tittar därför inte tillräckligt långt bort för att observera MC:n
B1 Missad observation
Föraren ser inte MC som kommer från höger
C2 Missbedömning av situation
Föraren tror att det är fritt fram att svänga ut
A1.1 Timing: för tidig handling
Personbil kör ut framför MC


1 LTIP
MC LD
E5 Spänningssökande
Föraren väljer att köra fort
E7 Psykologisk stress
Föraren är ute och kappkör med kompis. Ska visa att han kan köra fort.
D1 Prioriteringsfel
Motorsykkelen håller mycket högre fart än fartgränsen
F5 Överskattning av färdigheter
Föraren tror sig kunna köra om den utsvängande personbilen i hög fart
C2 Missbedömning av situation
Föraren ser varebilen, men väljer att inte sänka farten speciellt mycket
A2.1 Hastighet: för hög hastighet
MC har för hög fart för att kunna bromsa/väja för utsvängande varebil

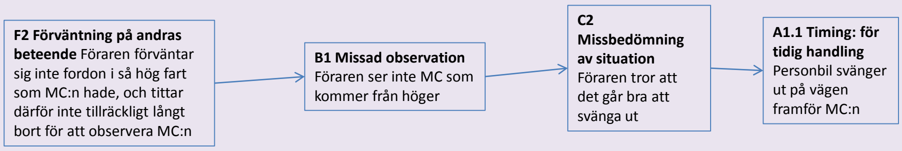
2 LTIP
Personbil LTIP



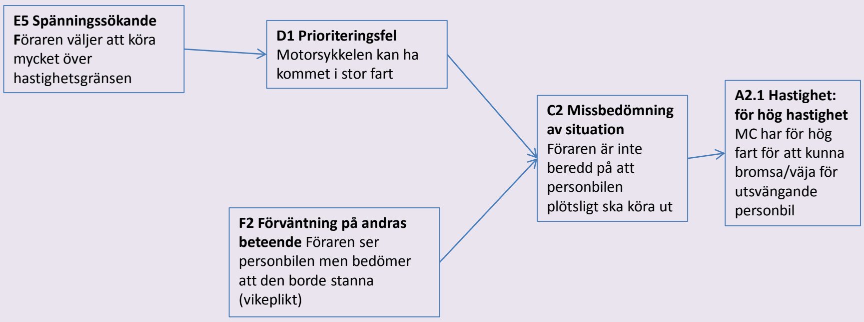
2 LTIP
MC LD



1 RTIP
Personbil RTIP

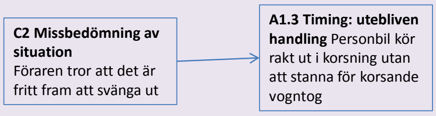


1 RTIP
MC LD



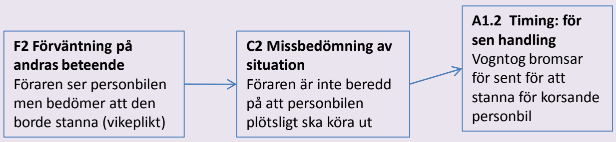
2 RTIP

Personbil RTIP

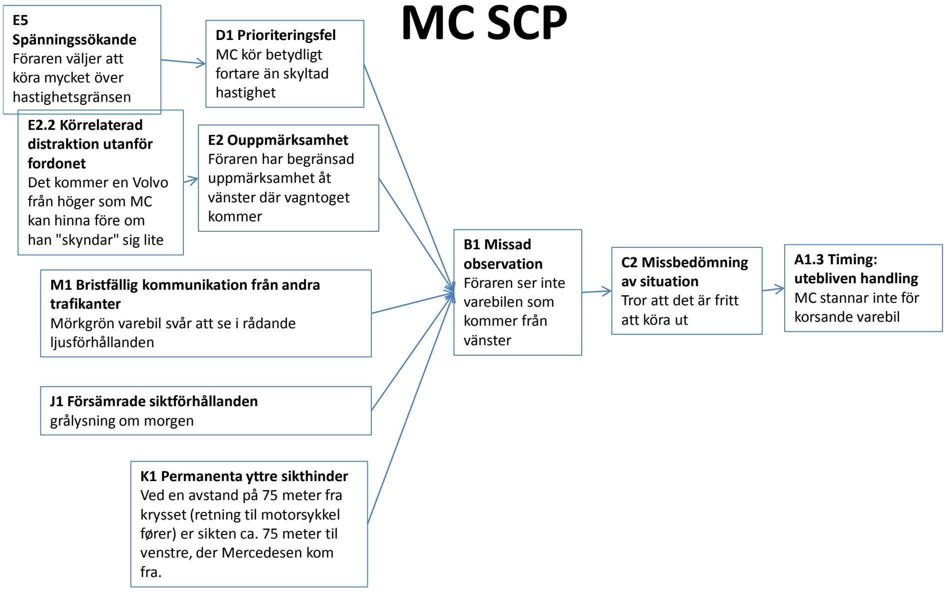


2 RTIP

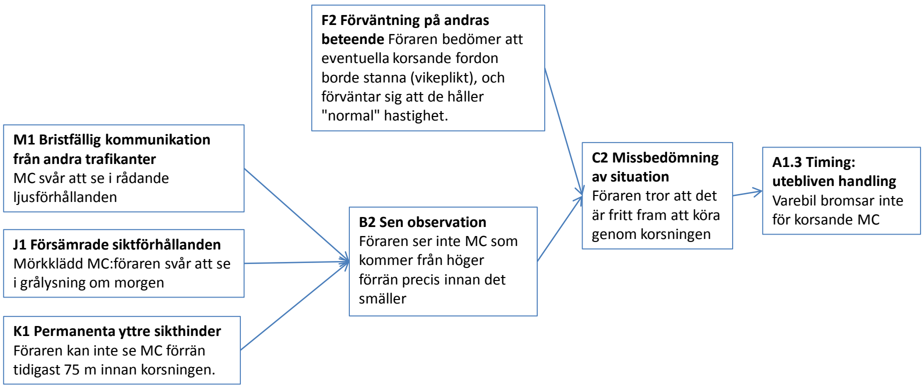
Vogntog LD



1 SCP
MC SCP



1 SCP
Varebil SCP



APPENDIX 4
Some methodological considerations on DREAM 3.0 based on the bicycle case studies

DREAM - Phenotypes

Several phenotypes could be explanatory to one accident. The analyst has to choose only one phenotype. The choice does however not affect the rest of the analysis as all genotypes link to all of the phenotypes. The kind of accident is therefore less important in our version of DREAM. Supporting this statement, we saw that two completely different kind of accident had exactly the same genotypes. Nevertheless we have chosen not to regard this as a problem since DREAM`s area of interest is primarily focused on the pre-crash stage.

DREAM - Genotypes

Genotype “misjudgement of situation” suits a range of different situations. The choice of this genotype could sometimes seem unsuitable for the reader. However the definition of the genotype in the manual is much clearer and demonstrative than the actual name. The name should perhaps be considered revised. All our wide ranging accidents had “misjudgement of situation” as their first genotype. This indicates the need for further breaking down this genotype into categories.

DREAM - New version for cyclists?

DREAM is developed for accidents involving cars. An accident is a result of several factors coming together simultaneously or in the right sequence. The genotypes and phenotypes are design especially for motorized vehicles. To analyze an accident with regards to a bicycle a version of DREAM would have to be developed. This may be a task for future research and development.

DREAM - Driver – Technology – Organization

The genotypes are organized according to the driver – technology – organization triad. Sometimes there is an influence of one type of genotypes on another type which does not appear in the outcome. For instance, “temporary sight obstruction” was chosen as a genotype which is grouped under “technology”. But the reason for sight obstruction was a human fault, which does not appear directly in the analysis, and in lack of other genotypes to choose, technology is given a part of the fault of the driver missing to observe a cyclist.

We see from diagram A.4.1 that the majority of genotypes are from the "Human" category. The DREAM method seems to have little focus on the "O" and "T" part of the M-T-O triangle. In the figure below we can clearly see that "H" dominate the picture totally. "T" take up about 20% of total, and "O" only 10%.

One main reason for the huge dominance of the "H" types is the genotype "Misjudgement of situation". Because of the structure of the DREAM 3.0 all the accident ended up having this genotype.

However, in chart C where only genotypes with high level of certainty are listed, we see that "H" decreases somewhat. This could indicates that "H" genotypes are more easily included in the DREAM analysis and classified with "medium" or "low" certainty, while there is a higher threshold to include "T" or "O" in the analysis.

An explanation of this could be that the Human – genotypes are more noticeable for the accident investigation team and for the DREAM analyst and thus more easily included. While O – genotypes only are included when there is high certainty of their influence.

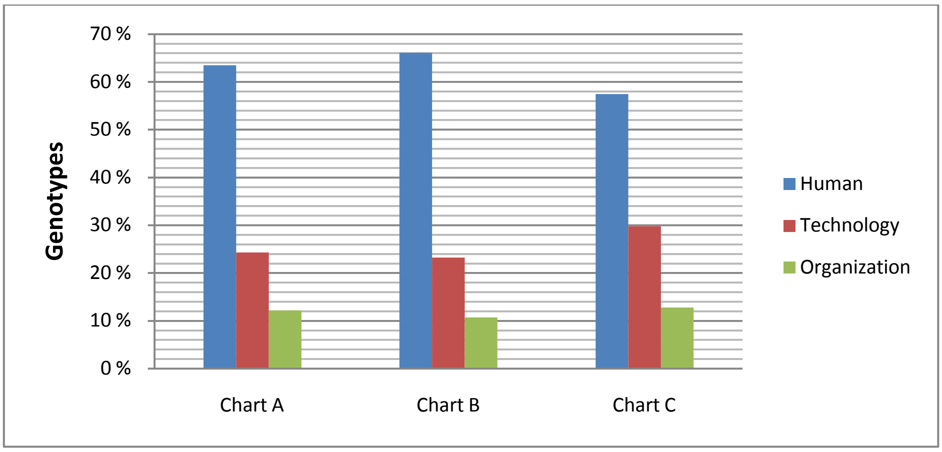


Figure A.4.1: Distribution of genotypes in the various aggregations.

Uncertainty of causal factors

In our report we have graded the genotypes with a certainty level; high, medium or low. This turned out to be valuable when aggregating the results. To include this grading in the DREAM method with clear definitions of the levels and guidelines would increase the quality of the method.

High competence among the analyst may be necessary

In some cases it may be difficult to choose among the available antecedents for a given genotype, and to decide which factor is most "correct" or "suitable". The DREAM manual gives guidelines, but the analyst has to be familiar with the concepts to choose correctly. The understanding of the accident may also vary somewhat from analyst to analyst. In any case a good understanding of the theoretical models and the cognitive concepts used in the taxonomy are necessary requirement for a consistent and effective use of the DREAM analysis.

APPENDIX 5
Various notes on the bicycle accident analyses

Accident nr 1.

We see from this analysis that two different phenotypes can be used to describe the accident description. Nevertheless it is only allowed to choose one phenotype. However all phenotypes have the same genotypes. This decreases the importance of the phenotype, making them less interesting to the analysis.

Accident nr 2.

The report this analysis was based upon did not contain any information on whether or not the cyclist tried to avoid the truck, or if the truck hit him completely by surprise. There is neither any information on exactly when the other road users alarmed the driver, weather it was before or after the truck crashed with the cyclist. It would also be interesting to have information about exactly when the cyclist arrived, his speed etc.

Accident nr 3

DREAM 3.0 contains rather limited number of phenotypes. The analyst could sometimes be confused about which one to choose. Interesting to note, that accident 2 and 3 have exactly the same genotypes, but the accident have different phenotypes.

Accident nr 4

The DREAM analysis was based upon a report which lacked many details about the accident. There were no records from witnesses, no mention about any brake tracks, the clothing of the cyclist, use of helmet, whether or not the involved parties where familiar with the road and the position of the cycle and the car after the collision.

Information about the parties involved in the accident, like age, background, sex etc. are not considered directly by DREAM, but nevertheless they are vital for the analyst to be able to draw a full picture and chose the most accurate genotype with somewhat high level of certainty. But regardless, it is important that the accident investigation reports cover the background information. After covering several accidents, this information can be accumulated to give interesting results or at least indications about vulnerability.

Accident nr 5

DREAM does take into account previous records of stretching rules and recommendation, which is regarded as a “human factor”. However DREAM does not directly intercept similar problems on “technology factors”. For instance number of previous accidents on the road. This information is often easy available in the accident reports. In this case the driver could have misjudged the situation because of the truck in front was obstructing the view to the cyclist. However in DREAM 3.0 there is no link between “misjudgement of situation” and “temporary obstruction of view”

Accident nr 6

There were few pictures in the report the DREAM analysis was based upon. Pictures and sketches are useful tools for the analyst to understand and analyze the accident. It helps to liberate the analyst from the conclusions drawn in the report and re-analyze the accident using DREAM method.

Accident nr 7

Genotype “misjudgement of situation” suits a range of different situations. The choice of this genotype could sometimes seem unsuitable for the reader. However the definition of the genotype in the manual is much clearer and demonstrative than the actual name. The name should perhaps be considered revised.

Accident nr 8

Reports of the accidents are written in different templates, and not all matters are discussed similarly or even mentioned in all of the reports. DREAM considers the drivers state in regards to freshness, drowsiness etc. However information about this is not included in all reports. A need of a common template for accident reports is highly present.

Accident nr 9

The genotype “Temporary sight obstruction” which is grouped as a “Technology” genotype was chosen for the driver placing his truck in a way that his view was obstructed. No extra mirror was installed to help the driver with this situation, but strictly speaking this was a human error and not a technological fault. No other genotype suited this incident.

The report mentioned that the driver wanted to enter the road before the approaching vehicles from his right arrived. However, there is no mention in the reports about why he wanted to do this. Was he under time pressure? And if so, why? Was the act a pure excitement seeking stunt? And if so, does the driver have any previous records of doing so? And so on. The analysis could have shifted to emphasize organizational matters more than what emerges if such information was made available.

Accident nr 10

Reconstruction of the event in pictures and drawings helps the analyst to better understand the situation, and analyze the event independently of the analysis made by the writer of the crash reports. Pictures from the drivers direction`s approach, the placing of the involved parties pre crash and post crash are important pictures for the analyst to have access to. Thorough description of the parties involved, like for instance information about the clothing, used of reflexes, helmet and a description of the that day`s activity are also essential to the DREAM analysis.

The genotype “Misjudgement of situation” has applied all the accidents. Situations where the driver is hit by a surprise because of some sudden behaviour from the other party are most likely classified as misjudgement by the driver. Even though the driver probably is free from any misjudgement, the genotype would be chosen in lack of other more suitable genotypes.

Accident nr 11

As stressed in accident 6, pictures from a reconstruction of the accident are important for the analyst to grasp the whole situation, and perform a DREAM analysis independently of the conclusions drawn in the report. In this report only one picture was given, without the placement of the vehicles, neither before nor after the accident.

The interviews from the driver and witnesses were very limited and did not include particulars of for instance their alertness, health and mind states and so on. There were no account on which direction the driver was concentrating on, weather to her left or to her right when the accident happened.

Accident nr 12

DREAM is developed for accidents involving cars. An accident is a result of several factors coming together simultaneously or in the right sequence. In this and other accidents much information available is not used because the analysis is not preformed for the other party involved in the accident. This is not done because, as mentioned earlier, the DREAM is strictly speaking not applicable for cyclist.

To fully grasp all the genotypes in an accident, the DREAM analysis should ideally be preformed for all parties involved in the accident. In our report however, at least one of the parties involved is a cyclist. As the tool DREAM is developed for the motorized vehicles, we have not performed a separate analysis for the cyclists.

Accident nr 13

Many a time the crash scene investigation group is not alerted. This was also the case in this accident, and thus many details have been lost. Information from the crash scene is important for an accurate DREAM analysis.

Accident nr 14

There was no interview with the driver in the accident investigation report. Nor was there any interview with the surviving cyclist. Seeing an accident from the view point from all the parties involved helps the analyst to draw a more complete picture and pick the right genotypes with higher level of certainty. Again more pictures would have been useful.

Accident nr 15

A thorough interview with the driver was not given in the accident report. Information about what the driver was doing, where he was going, did he have time pressure etc. was not available in the accident report. A DREAM analysis based merely on visual facts has minor benefits.

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