



**International Co-operation on
Theories and Concepts in
Traffic Safety**

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on 20th and 21st October 2016**

on

**How to assess traffic safety? - Adapting
methods to future challenges**

Book of abstracts

The workshop will be organised in close co-operation with Lund University, Department of Technology and Society, Division of Traffic Engineering, Sweden.



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What is ICTCT?

ICTCT is an association developed out of an international working group of safety experts with the aim to identify and analyse dangerous situations in road traffic on the basis of criteria other than past accidents, analogous to the methods of air and industrial safety.

Our Goal

International co-operation in the identification and analysis of potentially dangerous situations in road traffic, and their causes, on the basis of relevant safety data derived from observations and surveys.

The aim of **ICTCT** is to achieve a deeper understanding of problems in the area, to harmonise future research activities, and to provide for means for an optimal utilisation of research results from different countries.

To fulfil these aims **ICTCT** has been involved in a number of co-operative research efforts (workshops, calibration studies, formulation of international guidelines, clearing house for reports, etc.).

**"WE DON'T NEED ACCIDENTS
IN ORDER TO PREVENT ACCIDENTS!"
because we are aware of "danger indicators"**

Danger indicators are, for example, traffic conflicts and near-accidents, as well as the behaviour and interaction patterns in which they are rooted. To improve knowledge about these events and behaviour patterns, which in the long run lead to accidents, is to be collocated within the **ICTCT's** sphere of activities.

Today's activities and future plans of ICTCT

- Information and co-ordination service for the international exchange of information
- Production and distribution of a regularly-published research journal ("Newsletter")
- Encouragement of international co-operation by the organisation of conferences and other events
- Development of research structure for the planning, realisation and implementation of projects
- Organisation and administration of an archive and a library ("Clearing house")
- Establishment of advisory centres for the identification, analysis, and solution of safety problems in line with the present state-of-the art
- Advice on the development of facilities for the training of safety experts in the identification of risk indicators in traffic
- Publishing of material (e.g. handbooks, brochures, guidelines...)
- Public relations work

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Keynote Sessions

Title: **How to assess traffic safety? - Adapting methods to future challenges**

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A common problem in traffic safety management is the low priority for assessment often demonstrated in traffic safety projects. A representative example is the Swedish Zebra Crossing. Existing for almost 100 years it took 50 years until a researcher undertook a study where he found that pedestrians were exposed to significantly higher risks at zebra crossings compared with locations without any facility for pedestrians. It took long time before the authorities accepted the results. When they finally did, the main result was adopting a new law making it obligatory to yield for pedestrians. The short term result was that pedestrian risks increased even more. The long term result, however, is that we have got a much more profound discussion about pedestrian risks, including the introduction of so called safe passages for pedestrians implying that to be safe for pedestrians maximum vehicle speeds must be 30 km/h.

This kind of missing – or delayed – safety analysis is to a great extent due to missing assessment techniques. We have relied on accident analysis, which have some quite important draw backs: Crashes are rare events and are therefore associated with random variation. Not all crashes are reported and the level of reporting is unevenly distributed. Besides the behavioural and/or situational aspects of the events are not covered by police accident data.

The main conclusion is that we need a link between accidents and behaviours. The link is **conflicts!** A conflict is defined as an observable situation in which two or more road users approach each other in space and time to such an extent that there is a risk of collision if their movements remain unchanged. The pioneers in this area were Perkins and Harris at the General Motors Laboratories in the end of the 1960-ies. They wanted to understand better how GM cars were operating from a safety point of view. They defined conflicts based on the initiation of brake lights. In the 1970-ies interest grew. However it became obvious that conflicts also needed a severity dimension. Spicer at TRRL in England produced the first subjective – 5 degree - severity scale. Hayward defined severity with the help of so called Time Measured till the Collision (TMTC). Other followed with similar time based criteria or other severity scales. Most definitions differed in theory, which led to an interest in finding out more about differences and similarities between different techniques. ICTCT was formed and 1983 a big Calibration Study was organised in Malmö, Sweden. Nine teams participated with simultaneous recordings at three intersections. Everything was video recorded for analysis afterwards. The main conclusion was that all teams follow one and one only common severity dimension. TTC was the main contributor.

Since then many efforts have been made to develop new techniques. However, reliability and validity issues have in large not been solved so as to produce "durable techniques", i.e. techniques that have been used in a larger scale. There are two main exceptions: 1/The Dutch technique DOCTOR, and 2/The Swedish Traffic Conflict Technique.

The main reason for lacking "durable techniques" is the cost of (manual) data collection. Image processing and other techniques are making much more reliable and – particularly – efficient data collection possible. This will open up for further development and use of operational conflict techniques in the future; thus hopefully improving safety assessment strategies significantly.

Title: **Traffic safety of tomorrow – a conflict-free system**

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Sweden has been successful in its road safety work where the number of deaths more than halved since 2003. The main success is connected to car occupants while unprotected road users' reducing injury trend has been more modest. To continue the work with Vision Zero and reducing the injury consequences, further measures are needed and a focus shift from deaths to long-term consequences, from protected to unprotected road users and thus from rural to urban areas.

Especially in the urban areas, there is a need to involve other aspects of liveability besides traffic safety. What makes safety in combination with liveability and sustainability so important is that new technologies and trends will change the transport system fundamentally. Self-driving vehicles, mobility as a service and shared economy together with electrification of vehicles will not only change our way of transport, it could also change our quality of life.

Research regarding the human factor will for instance be important in order to understand how we in a better way use new technology (self-driving vehicles and digitalisation) to release surface in the street space, increase the transport capacity and to distribute the space differently between protected and unprotected road users, in favour of pedestrians and cyclists but also for public transports. The interaction between human and self-driving vehicle is essential and we need to understand what is threatening or not and how technology read the intention of unprotected road users' movements. Furthermore, it is not self-driving vehicles that will drive as people, but people who will run as self-driving vehicles, since the rule of the game must be different in a conflict-free system.

Session I

SOCIAL STRUCTURES

Title: **Road user's behavior in Estonia: what has changed in 2001 – 2015**

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Author keywords: traffic behaviour, road user's behaviour, monitoring of traffic behaviour, Estonia, safety performance indicators, traffic study

It is well known that road safety is generally affected by the three main factors which are man, machine and environment. Estonia has improved road safety dramatically since the beginning of 1990's and it is obvious that all the mentioned factors have had their impact on this improvement. While there is a good idea of changes which have taken place in traffic environment and car industry, there is still not much information about trends in road users' behavior.

Changes in road users' behavior can be measured using safety performance indicators (hereafter "SPI") connected to compliance with Traffic Rules. Provided that these indicators are measured regularly, one can get a good idea about road users' behavior trends affecting inter alia traffic safety. It's necessary to understand these trends in order to plan future developments. Estonia is a unique place where traffic conditions have changed dramatically during the last 15 years and at the same time there were conducted annual studies aimed at estimating road users' behavior. There were used such SPI-s as percentage of road users who ignore red signal of traffic lights, who don't give way to pedestrians at non-regulated pedestrian crossings, who don't use seat belts and who don't use turn indicators. Respective data was collected by means of observations performed in the same places across the country. These places include rural roads and city streets as well as highways. Results were aggregated and analyzed annually and respective reports were made. Due to the fact that the first survey was conducted in 2001, it's became possible to study long-term trends in traffic behavior.

The present study aims at analyzing changes in road user's behavior which took place on Estonian roads in the past 15 years. Comparison analysis' results show that there are two groups of SPI-s. The first group is formed of those indicators which have changed dramatically during these years and show strong improvement trends. The other group consists of indicators which show weak trends or don't show improvement at all. Among the SPI-s in the first group are seat belt usage and giving way to pedestrians at non-regulated crossings. Improvement in some of the SPI-s such as usage of seat belts at rear seats has reached 60%. In the second group of indicators there are indicators connected to traffic lights and turn signals. The analysis' results correlate to the real work made in the field of traffic safety.

So, it can be concluded that in Estonia traffic behavior don't change on its own, for instance, because of increase of social awareness or better road infrastructure. Serious work should be done in order to reduce the risks coming from road users' behavior. The study showed what problems need to be prioritized in order to show improvement.

Title: **Impacts of connected and automated driving from the road operator perspective**

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keywords: Automation, connected vehicle, cooperative ITS, impact, assessment

Connectivity and automation are both advancing quickly, and highly automated driving will be reality in five years. The paper deals with the impacts of connected and automated driving especially from the road operator point of view.

The impacts are studied first on driver and traveller behaviour, then based on these on traffic flow and mode choice, and finally on policy objectives such as safety, efficiency, environment and accessibility.

Special focus is given on the impacts on traffic management and Network operation, and also here finally on the policy objectives. The analysis will also take on board the automation of road operators' own processes and systems, and the impacts of those.

Finally, the costs are also considered, and some tentative benefit-cost estimated will be discussed.

Session II:

VULNERABLE ROAD USERS

Title: **Towards Developing a Bicycle Riding Behaviour Questionnaire**

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Cycling is considered as a health-promoting active mode of transport, consistent with the goals and policies of sustainable transport use. Cyclists are, however, a vulnerable group in terms of crash risk, and promoting safe cycling is a priority among policy makers and road planners. This presentation aims to investigate how self-reported cycling behaviours can be linked to self-reported crash records. This will be done through developing and validating a questionnaire for measuring the cycling behaviour. If construct validity and reliability is demonstrated, the questionnaire may be used as a tool for assessing traffic safety (as a surrogate to crash data) at a social level. The instrument can also be used further to expand on behavioural constructs with the aim to explain the precursors of aberrant behaviours. Policy makers can benefit a lot from such relationships (that are not achievable through the traditional safety assessment methods) in medium to long term planning for road safety improvements in the context of social interventions.

Research of this type originally owes to the work by Reason et al. (1990). Over the years this approach was further developed through other researchers' work. The research body, however, has mostly been concentrated on application of already validated instruments (e.g. Davey et al., 2007; Zhang et al., 2013; Sucha et al., 2014; Rowe et al., 2015), rather than validation studies. To date the studies have attempted to develop and validate behaviour questionnaires for driving (Lajunen, et al., 2004; Özkan et al. 2006), walking (Granié, Pannetier, and Guého 2013) and motorcycle riding (Motevalian et al. 2011). However, to date there have been few attempts at establishing a validated questionnaire for cyclists' behavior. This is an important approach because cyclists are amongst the most vulnerable road users.

An Internet survey has been launched to collect the data. A self-administered questionnaire (in Persian language) including aberrant cycling behaviours was linked to a web URL and distributed through different social networks (telegram channels, Facebook, LinkedIn, etc.) to ask the respondents to self-report the frequency of committing each behaviour in the past month, if they cycle a minimum of once a week. The measures used a Likert scale from 1: never to 5: almost always. The 39-item questionnaire was partly based on the Motorcycle Riding Behaviour Questionnaire (Elliott et al., 2007; Cheng and Ng, 2010; Özkan et al., 2012), but a number of modifications were conducted and items were also added.

The respondents have been further asked to report the number of crashes that they have experienced during cycling in the past three years, separated by crash type (bicycle damage only and crash including personal injury). From the reported crashes, the respondents were also asked to distinguish the number of crashes in which the respondent found him/herself at fault. Furthermore, the respondents were asked to report if they had been involved in a damage only or crash involving personal injury while cycling during a time period exceeding the last three years (a dichotomous scale of yes/no).

When a sufficient sample size (N=250 so far) has been achieved we will test the dimensionality (using exploratory and confirmatory factor analysis) and reliability (using Cronbach's alpha and inter-correlations) of the instrument. Further we will examine the construct validity of the instrument by testing the association between self-reported crashes and the behavioural cycling components. This will later help to construct behavioural models and could equip researchers with a reliable and valid tool, when the questionnaire has been translated to English, to conduct further studies on cycling behavior in different country settings.

Title: **The strength of the safety-in-numbers effect is inversely related to cyclist and pedestrian volume**

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Author keywords: Cyclist, Pedestrian, Safety-in-numbers, Interactions

A number of studies have found a so called safety-in-numbers effect for vulnerable road users. This means that when the number of pedestrians or cyclists increases, the number of accidents involving these road users and motor vehicles increases less than in proportion to the number of pedestrians or cyclists. In other words, travel becomes safer for each pedestrian or cyclist the more pedestrians or cyclists there are. This finding is highly consistent, but estimates of the strength of the safety-in-numbers effect vary considerably. This paper shows that the strength of the safety-in-numbers effect is inversely related to the number of pedestrians and cyclists. A stronger safety-in-numbers is found when there are few pedestrians or cyclists than when there are many. This finding is counterintuitive and one would expect the opposite relationship. Another interaction which is found is that the safety-in-numbers effect is inversely related to the ratio of the number of motor vehicles and the number of vulnerable road users. The larger the number of motor vehicles, compared to the number of pedestrians or cyclists, the stronger is the safety-in-numbers effect. It is suggested that behavioural adaptations underlie these relationships. When pedestrians or cyclists are few in number, and motor vehicles are many, pedestrians and cyclists know that they must take the primary responsibility for their own safety and cannot rely on drivers of motor vehicles to see them or give them the right of way. When there is a greater number of pedestrians or cyclists, their behaviour may be more varied and they may to a larger extent count on their number to protect them.

Title: **On elaborating best practise for traffic calming pedestrian crosswalks - Some considerations based on tests in Israel and Sweden**

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Author keywords: speed reducing devices, crosswalk, best practice, design, arterials, Israel, Sweden

Speed humps or speed cushions are often installed to traffic calm pedestrian crosswalks. The calming device can be located before the crossing point and/or the crosswalk itself can be elevated, a so called speed table. The aim of this article is to determine whether variations in distance between the speed reducing device (humps or cushions) and pedestrian crosswalks contribute differently to the safety and mobility of child, adult and elderly pedestrians, and if so, how. The conclusions are based on research from three test sites in Sweden and eight test sites in Israel. The site specific research included vehicle speed measurements and video filming. All three Swedish test sites were on two-lane arterials equipped with speed cushions at distances of about 5 m and 10 m from the pedestrian crosswalk. Vehicle speeds were somewhat lower at the pedestrian crosswalk when the distance between the speed reducing device and the pedestrian crosswalk was greater, and there were positive aspects on the mobility of the pedestrians. Pedestrians were more often given way by the first driver from the left if there was a greater distance between the crossing and the speed cushion, 50% at greater distances compared with 40% at shorter ($p < 0.05$). Children interviewed at one of the Swedish test sites stated that it is easier to cross in the crosswalk on the side of the traffic island where the speed cushion is located further away from the zebra stripes (about 10 meters) compared to the side where it is located closer (about 5 meters). This is probably due to the fact that it is easier for the children to judge if the driver will be braking for them or for the speed reducing device at the side where the device is located further away. In conclusion, a greater distance between the hump and the pedestrian crosswalk is suggested.

Two countermeasure settings were applied at the Israeli study sites: a 15 cm high trapezoidal hump combined with 8-10 cm high circular humps (Watt's hump), and a 10-12 cm high trapezoidal hump combined with 6-8 cm high circular humps. The circular speed hump was built 15-20 meters before the crosswalk, in each travel direction and lane approaching the crosswalk. Concerning the extent of the speed-reducing effect, the Israeli study showed that the first layout caused a greater reduction in travel speeds, compared with the second layout. The first layout was applied in most study sites, in three cities, where they led to a substantial reduction in speeds, achieving mean speeds below 30 km/h and 85-percentile speeds below 40 km/h. This was attained at sites with a wide range of initial mean speeds (42-58 km/h) and 85-percentile speeds (50-66 km/h), thus, demonstrating a speed-reducing effect of 20-30 km/h, in both speed indicators. Additional positive changes associated with the first setting concerned a remarkable increase in the share of vehicles yielding to pedestrians in the crosswalk zone. Both positive changes occurred instantly and remained in place after two months. It is also concluded that the treatment has a potential for reducing multiple threat conflicts occurring due to a vehicle overtaking a stopped car in the adjacent lane, which is a hazard especially to children crossing. It is suggested that this measure should be considered as the standard solution on multi-lane approaches to non-signalized crosswalks. Finally, it is discussed if the standard solution suggested can be seen as best practice defined as best design in terms of performance according to current knowledge, and if so if this requirement is fulfilled in the presented case.

Title: **Pedestrian Crossings near Elementary schools**

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Author keywords: pedestrian crossings, traffic safety, driver behaviour

Background. The study is based on the assumption that a suitable layout of the traffic infrastructure in the vicinity of pedestrian crossings near schools influences drivers' behaviour in terms of safety (lower speed and respect for pedestrians) and increases pedestrians' feeling of safety and comfort, while having a positive impact on the general traffic behaviour (reducing the traffic rate and the number of parents who drive rather than walk their children to school).

Aim. The present study aims to test the effect of adjustments to the traffic infrastructure (the road being narrowed into a single lane, additional traffic signalling being installed, and the signs for crossings being highlighted) in the vicinity of a pedestrian crossing in front of a school. In particular, the effects on drivers' behaviour (choice of speed, yielding to pedestrians on the crossing, etc.), pedestrians' behaviour (the place chosen to cross the road), pedestrians' needs and comfort (time spent waiting at the crossing, feeling of safety, and accompanying children to school), and traffic serviceability (driving children to school, traffic density at the location) will be investigated.

Methodology. A mixed qualitative-quantitative design was used to collect and analyse data. The study involves a pre/post approach. The first measurement was carried out before the infrastructural adjustment. The second measurement will be conducted one month after the adjustments. Study site: pedestrian crossing (see the figure) and its vicinity, an area outside the school. Measurement – in the morning before school (ca. 45 minutes), in the afternoon after school (in several time periods depending on the timetable) on two working days. Data collection methods and assumptions:

- changes in motorised traffic rate at the location (video). No change anticipated.
- changes in the rates and trajectories of cycling/pedestrian traffic (video). No change anticipated.
- car speed (measured by radar – during the other observations). 50 m before the crossing in both directions. Reductions in speed are anticipated.
- drivers' behaviour: yielding at the crossing in front of the school (direct observation). Improvement is anticipated.
- pedestrians: time spent waiting before crossing the road on the crossing (measurement of time). Reductions are anticipated.
- reasons for the use of a car – interviewing of drivers who pull up at the location.
- pedestrians' needs and attitudes (both adults and children): direct on-site interviewing (ca. 1-2 minutes) – questions about how safe they feel, what they find dangerous, what they would like to change, etc.
- number of cars dropping off children in front of the school (direct observation): Reductions are anticipated.
- number of children who walk to school by themselves (not being accompanied by their parents) (direct observation): Reductions are anticipated.

Results: This study is still in progress. The objective of the paper is to present the design of the study and baseline measurements (prior to the adjustment), as well as describing the infrastructural modifications to be made and the resulting changes. The authors of the study expect a general calming of the traffic (lower car speeds), a higher rate of drivers who yield to pedestrians, an increase in pedestrians' feeling of safety and a reduction in the time needed to cross the road, and a change in the way children travel to school – fewer parents who walk or drive children to school.

Session III

TRAFFIC CONFLICT TECHNIQUE

Title: **Can the Delphi method complement or replace time-based measuring of conflicts between vulnerable road users?**

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Author keywords: Traffic safety for vulnerable road users, Swedish Traffic Conflict Technique, Delphi method

Background: Experiences with the time-based Swedish Traffic Conflict Technique (STCT) show that measuring the severity of conflicts using a time span has a number of weaknesses - especially in conflicts between vulnerable road users. Cyclists and pedestrians can easily adapt to changes in speed and direction, and are often seen in close interaction. A number of studies show that a time-based measure may lead to an increased risk of including situations that – by visual assessment – simply expresses efficient traffic flow. (Christensen, 2015; Madsen & Lahrmann, 2016)

Aim: To counter this problem, this project also uses the Delphi method for assessing conflict severity based on the road users visible reactions. The purpose of this project is thus to clarify if the traditional Delphi method can complement or replace a time-based method for measuring conflict severity between vulnerable road users.

Method or methodological issues: The case of this project is to study whether it causes traffic safety issues in signalized T-junctions when cyclists are not required to respect the signal when driving through the upper bar. The project is a video based before and after study of conflict between cyclists (mopeds included) and pedestrians in four signalized T-junctions with separate bicycle paths.

Approximately 24,000 cyclists and 19,000 pedestrians were observed during 227 hours of video recordings. Furthermore 846 potential conflicts were registered. Potential conflicts are defined as situations where the distance in time between two or more road users is less than or equal to 3 seconds. The hypothesis is that these situations have a high potential of developing into serious conflicts. 50 of the 846 potential conflicts are further evaluated by:

- (1) a time-based measure of conflict severity, inspired by the Swedish and Dutch TCTs. Serious conflicts are defined as situations where the minimum Time-to-Collision (TTC_{min}) is less than or equal to 1.00 second or the remaining time for the second road user to adapt to any changes in speed or direction before arriving at the conflict zone (T_{2,min}) is less than or equal to 0.55 seconds;
- (2) an interaction study in which a group of Traffic Safety Experts assess the severity of these potential conflicts based on visible reactions, inspired by the Delphi method.

Results obtained or expected: The results show that (i) the time-based method includes more serious conflicts than the reaction-based Delphi method; (ii) overall consensus among the experts in measuring severity of conflicts is found after two rounds of the Delphi method; (iii) experts include other visible reactions such as gestures, attitude and body language i.e. when categorizing severity of conflicts.

Conclusions: It seems that there is a possible correlation between the results from both the time-based method and the Delphi method. However, the time-based measure may lead to an increased risk of including situations that simply expresses efficient traffic flow. Furthermore a time-based measure can be used for registering potential conflicts between vulnerable road users, but more detailed factors (e.g. gestures, attitude and body language) may have to be included when measuring the severity of these specific potential conflicts.

References: Christensen, 2015: Peter M. Christensen. Konfliktteknikmetoden: Belysning af sikkerhedsmæssige problemstillinger ved brug af cykelshunts i signalregulerede kryds. Master's Thesis, Department of Civil Engineering, Aalborg University, 2015.

Madsen & Lahrmann, 2016: Tanja K. O. Madsen & Harry Lahrmann. Comparison of five bicycle facility designs in signalized intersections using traffic conflict studies. Under review. Department of Civil Engineering, Aalborg University, 2016.

Title: **Understanding aberrant driving behaviour in Nigeria using the traffic conflict technique**

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Author keywords: Driving behaviour, Developing countries, Safety

This is the first phase of an ongoing study investigating the influence or “strength” of culture on driver behaviour. It tries to look at the extent to which driving behaviour is influenced by culture and environment, and what happens to drivers from developing countries with less disciplined driving environment when they move into developed countries with safer driving culture, stricter rules, polices and well defined enforcement strategies. Cross cultural mobility especially from developing countries known to have high accident rates because of many combined factors to developed countries with lower accident rates, may be a potential threat to road safety in the future if nothing is done about it.

Baseline information is needed to have an idea of the problem (bad driving behaviour) but this is very scarce in Nigeria and most developing countries. According to WHO (2013), data pertaining to road safety in the African region is still grossly inadequate for planning, implementing and evaluating road safety interventions and without data, it is difficult to improve safety. Data do exist but there is concern over the reliability resulting from both data collection methods and under-reporting issues. Accident data has been used over the years and have proved very beneficial in assessing traffic safety problems but does not provide enough information on behaviour and situational aspects of the processes leading to accident. Success could be achieved by emphasizing on the importance of research. This will help in the diagnoses of problems, identification of the best intervention measures to address specific problems and proper enforcement. And also by recommending solutions that would be achieved with the limited, available local resources and also help to investigate, describe and understand processes and events behind traffic safety problems in developing countries.

The aim is to compare road user behaviour (Motor vehicles, tricycles and pedestrians) across different road layouts at the same time and days of the week, to understand and draw a pattern on road accident causation with a specific focus on developing countries. Ownership and use of Tricycles gained popularity in Nigeria as a result of a ban placed on use of commercial motorcycles in some urban areas due to frequency of traffic crashes. This category of road users carry the highest volume of passengers in most parts of the country.

The methodology includes data collection using human observers and video recorders and will involve speed measurement, traffic count and traffic conflict studies. The traffic conflict technique will be adopted in this study as it offers an easy, safe, reliable and cost effective method of collecting data for road safety analysis. About 100 hours of observation will be carried out at different locations, times and days of the week in Nigeria by July, 2016.

This study will provide data on risky situations, and behaviour of drivers from developing countries, case study of Nigeria. It will give an insight into aberrant behaviours drivers’ exhibit considering their driving conditions, environment and mix of road users. The culture issue will be studied in the next phase.

Title: **Developing Evasive Action-Based Indicators for Identifying Pedestrian Conflicts in Less Organised Traffic Environments**

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There has been a growing interest in using surrogate safety measures such as traffic conflicts to analyze road safety from a broader perspective than collision data alone. This growing interest has been aided by recent advances in automated video-based traffic conflicts analysis. The automation enables accurate calculation of various conflict indicators such as Time-To-Collision (TTC) and Post-Encroachment-Time (PET). These indicators rely on road users getting within specific temporal and spatial proximity from each other and therefore assume that proximity is a surrogate for conflict severity. However, this assumption may not be valid in many driving environments where close interactions between road users are common. The objective of this paper is to investigate the applicability of time proximity conflict indicators for evaluating pedestrian safety in less-organized traffic environments with a high mix of road users. Several alternative behavioural conflict indicators based on detecting pedestrian evasive actions are recommended to better measure traffic conflicts in such traffic environments. These indicators represent variations in the spatio-temporal gait parameters (step length, step frequency and walk ratio) immediately before the conflict point. A highly congested shared intersection in Shanghai, China with frequent pedestrian conflicts is used as a case study. Traffic conflicts are analysed with the use of automated video-based analysis techniques. The results showed that evasive action-based indicators have higher potential to identify pedestrian conflicts and measure their severity in high mix less organized traffic environments than time proximity measures such as TTC and PET.

Title: **How to identify safety critical events in naturalistic datasets**

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Author keywords: naturalistic driving, crashes, triggers

Observing road users in their natural environment has become a popular approach to investigate crashes and potentially contributing factors. With the help of cameras and sensors installed in or on the road users' vehicles for a longer period of time researchers can gain valuable insight into their everyday behaviour in traffic. In recent years, a considerable number of studies has been conducted that utilised this methodology on cars, trucks, powered two-wheelers and bicycles. Some of these studies have collected data from more than 3000 road users, for more than one year. However, as crashes are rare events even in these massive datasets, researchers have to rely on crash surrogates such as safety critical events (SCEs) that occur in sufficient numbers to address factors that might have an influence on the occurrence of a crash. Unfortunately, aside of the question of what actually constitutes a SCE, the identification of such events in naturalistic data sets is not straightforward. Multiple approaches have been used in different studies, all with their advantages and drawbacks. Certainly the most time consuming approach is to review the collected data completely manually. Provided that there is clear definition of SCE, this should, in theory provide the most valid assessment of the data. However, the sole reliance on human raters, especially in ambiguous situations, has the potential for bias and mistakes. Also, for obvious reasons, a complete review of the material is only feasible for smaller datasets. A popular approach, especially for cars and trucks, is to rely on kinematic triggers, such as excessive deceleration, to identify candidates for safety critical events. Video material for these candidates is then reviewed, to verify if the trigger did indeed uncover a safety critical event. While this use of numerical values is certainly more objective than a purely manual review, it requires that all potential SCEs can indeed be described by such values. SCEs that do not fit such a description might go completely undetected. A third option is to use the road users' perception of a certain situation as a trigger. Through buttons installed on the vehicle, participants are asked to "tag" SCEs when they occur. This introduces a subjective perspective on SCEs, which is highly interesting especially in cases in which kinematic triggers are not readily available, or in domains in which a numerical description of SCEs is problematic. However, again, of course, the potential for biases to occur is obvious. Goal of this presentation is to review these different approaches, and stimulate a discussion about their validity, feasibility and usefulness.

Title: **Validation of surrogate traffic safety indicators**

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Author keywords: Surrogate traffic safety indicators, Validation, InDeV

When discussing surrogate traffic safety indicators their validity and reliability are of paramount importance. A surrogate safety indicator is supposed to measure traffic safety in a preferable way compared to using accident history. A validated indicator would reflect the expected number of accidents perfectly. In practice however, one can never know the true expected number of accidents which means that we have to have a more realistic ambition for validation. This paper will focus on how to validate surrogate safety indicators and present a number of different approaches found in literature.

It is possible to use accident history to estimate the expected number of accidents, using for example some safety performance function (SPF). These methods produce an estimation of the expected number of accidents and if a surrogate safety indicator can be demonstrated to have an equally "good" estimation this would provide a form of validation in that the surrogate indicator have the same prediction capabilities as accidents themselves.

This form of validation can be called product validity. The idea that the safety surrogate indicators can estimate safety with a similar accuracy as accident history. But there is also another form of validation which we can call process validation. This kind of validation proposes that the process that leads to an accident is the same process that leads to severe values of the traffic safety indicator. If this could be demonstrated it would indicate that the traffic safety indicator can be used as a surrogate for accidents.

Based on a literature review this study have identified a number of different validation approaches and some research focusing on the validation of surrogate indicators. Based on the review material, three different approaches of product validity have been identified and one attempt of process validity have been found.

One approach is to investigate the variance of the accident/conflict ratio. The assumption here is that a linear relationship exists between the expected number of conflicts and the expected number of accidents. If the ratio between these values are constant over a number of different locations one can demonstrate that the surrogate safety indicator can be used as a surrogate to estimate the expected number of accidents using the identified accident/conflict ratio. A good indicator would, using this approach, show a small variance.

A second approach is similar to the first and uses a safety performance function (often a negative binomial model) to investigate the correlation between conflicts and accidents. This approach uses the observed conflict rates and the accident history as inputs and calculates the relationship between them assuming that accidents follow a specific distribution and takes into consideration the variation of conflict counts. It is also possible to take other factors, such as exposure or infrastructural into account.

A third approach is based on before and after studies. The idea is to investigate a before and after study using both accidents history and observed surrogate safety indicators. If the conclusion from the different approaches is similar it would indicate that the surrogate indicator can be used as a surrogate.

A fourth approach is based on the idea of process validity. This approach used detailed police records to gain knowledge about the process leading up to an accident. The study gathered information regarding the type of road users, the type of evasive action, the speed and distance involved in the accident etc. for both accidents and observed conflicts and tried to compare the situation as thoroughly possible.

Based on these findings a validation study is being designed for the surrogate safety measure of Traffic Conflicts within the framework of the InDeV project.

Session IV

OBSERVATION TECHNIQUES

Title: **Observing observation of road user behaviour: A scoping review into current practices in scientific literature**

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Author keywords: Behavioral Observation, Road User Behavior, Scoping Review, Traffic Safety

Observation of road user behavior has been reported since the 1930s already, but especially during recent years the number of (peer-reviewed) studies and reports is increasing rapidly. Several methodologies have been used to study road user behavior (e.g., direct observation, driving simulator research and microsimulation), but an overview of the current extent, range and nature of this type of research is lacking. Therefore, a scoping review was performed in order to identify how road user behavior observation studies have been conducted, which topics have been covered and which research gaps still exist in literature. The aim of this paper is to a) provide an overview of conducted road user behavior observation studies, b) assess their usefulness, c) prevent duplicate research efforts, d) identify which indicators have been applied and e) indicate which areas of road user behavior research needs further examination.

The review team, consisting of two members, carefully created and tested a search protocol to systematically retrieve relevant literature from three major databases (ScienceDirect, Web of Knowledge and TRID). The search term "Traffic Behavior*" AND "Safety OR Observation" was utilized and yielded more than 21.000 results. After the removal of duplicates, the number of studies was further reduced to around 7500 papers (only including peer-reviewed journal articles were kept). After the first review round, in which the articles were screened for their relevance based on title and abstract, 698 papers remained. Studies were excluded if they were published in any other language than English, if it only contained stated behavior (e.g., questionnaires and focus groups) and if the data was collected in an obtrusive manner (e.g., naturalistic driving and driving simulator research). From the remaining records, around 15 papers were not retrievable and 89 papers were excluded because the content of the paper revealed it met one or more exclusion criteria. Based on subsamples of the 621 papers, a codebook was designed in order to extract relevant information from the included studies. Extracted information included research goals, data collection characteristics and behavioral indicators. The publication years ranged from 1949 till 2016 and the majority of the studies were carried out in the USA (38%), Canada (8%) and China (8%). The preliminary analysis revealed that road user behavior observation studies are used for four main goals: monitoring a traffic situation, test the effectiveness of a certain measure, calibrate and validate models (mostly used for microsimulation) or the calibration and validation of (semi-)automated video analysis tools.

At this moment, the data collection and analysis are still ongoing. Therefore, it is not yet possible to communicate results and conclusions.

Title: **Advantages and disadvantages of a video-based experiment to investigate drivers' speed choice at work zones**

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Author keywords: Speed choice, Video-based test, Roadworks

Work zones involve activity on the road or its surroundings that can influence safety of drivers and workers. Drivers need often to deal with new elements such as workers, work machinery and/or new traffic design. Therefore, some experimental methods to investigate safety measures at those sites can have side effects in form of increased information processing and disruption of drivers' expectations. This can, in turn, influence reaction times and, at worst case, increase crash risk. In order to avoid exposing drivers to potential dangerous situations, alternative methods to study drivers' behaviour at work zones may be useful. One possible method is the use of a video-based test.

This presentation reports part of the results of a study conducted in Norway that comprised four videos of real two-lane work zones. One work zone was located in an urban road and another in a rural road. The roads were filmed at two different moments - with and without visible roadwork activity. The videos were taken from the perspective of the driver and participants were encouraged to imagine themselves driving on the road depicted. Participants were randomly drawn from an existing panel and invited to participate by e-mail. A total of 815 drivers watched the videos and answered the online questionnaire. Each participant watched one video of the urban road and one of the rural road, in a randomized order. After watching the videos, they were asked to state their preferred speed and reasonable speed limit for each road.

The results showed that higher speeds were preferred for work zones without visible roadwork activity, for both road types. The work zones with visible roadwork activity had lower frequency of speeders and lower speed limits were evaluated as more reasonable. We concluded that visible roadwork activity had an effect on speed choice and that the use of videos can be a valuable tool to study drivers' speed choice at work zones. This presentation will focus on the advantages and disadvantages of video-based experiments and its implications for studies on drivers' behaviour at work zones.

Title: **What is going on here? - Exploring Interaction of Cyclists and Car drivers in Vienna with regard to perceived change and stagnation of cycling policies**

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Author keywords: data triangulation, interaction, changing resp stagnating cycling policy

In the current study a data triangulation strategy has been applied, in order to explore inter-actions from various perspectives. The questions raised are 1) what are the social functions of interactions in road traffic, which are considered as a constitutive element for the social order of traffic ("traffic climate") and 2) how do the processes of change and stagnation with regard to the altering conditions for cyclists influence the interactions. The focus especially is put on interactions of cyclists and car drivers. Vienna is the locale for the study: The share of cycling trips since 2009 was on a level of 6% and raised up only to 7% in 2014 [1]. Therefore it was of interest to investigate how the cyclists cope with other road users and with the conditions for cycling in order to develop policy recommendations how cyclists could be supported.

For this aim interview data, observation data, data about infrastructure and crash data is used in this study to uncover the linkage between individual characteristics, societal aspects (traffic policy, images, law, common behavioural norms etc.), the environment (infrastructure, vehicles, traffic lights etc.) and interaction. The interview data brought information about applied interacting strategies which point out safety critical aspects for cyclists, which preliminary refer to shortcomings of infrastructure and resulting detriments for cyclists, e.g. being endangered by right turning cars on cycle path. Cyclist crash data [2] was integrated in the sampling strategy for identifying reasonable observation sites. The observation data from an intersection, where several cyclists have been injured in the last years, showed various forms of interactions, which cyclists use to cope with the infrastructural shortcomings, such as slowing down (rolling to a stop), scanning environment (turning the head and looking aside) or trusting in others (imitating (illegal) actions of other cyclists). By relating these forms of interaction with perceived change and stagnation of cycling policies, a number of areas have been identified, which should be targeted in the Viennese cycling policies more forcefully, such as increasing accessibility of cycling for children by reducing vehicle speed through infrastructural measures or providing more infrastructural capacities for faster driving utility cyclists.

Title: **The use of surrogate measures of safety in site-based observations of road traffic: a scoping review**

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Author keywords: Scoping review, traffic conflicts, surrogate measures of safety, near-accident, near-miss

Technical advances in sensor technology and techniques, in particular computer vision, in combination with the well-known limitations of traditional road safety analyses making use of accident data, have led to a strong increase in interest for the use of surrogate safety measures (measures based on observations of non-crash events in traffic) over the years. The literature in this domain is however vast and diverse, and due to the current technical advances the domain itself is rapidly evolving. Researchers new in the field of surrogate safety measures struggle to gain a clear overview of the current state of the field. Also more experienced researchers in the field risk to lose track of critical points of attention. This seems to lead to “reinventing the wheel”, and errors from the past that get repeated because researchers do not have a sufficient understanding of the literature in the field. The aims of the current study are therefore to provide a descriptive insight into the literature that is available, and to identify critical challenges and opportunities that should be central to future research in the field.

This paper presents a scoping review of the current state of the field. The focus is on studies that measure (in some way) the severity of individual traffic interactions through site-based observations (i.e. observations at fixed observation sites). This implies that studies that (only) make use of for instance instrumented vehicles, microsimulation models and observations of normal road user behaviour are beyond the scope of this paper.

Using a systematic search protocol and a predefined code book, relevant literature in the field is identified and structured as objectively as possible. The final database includes data from 229 unique publications from the period 1957-2016. This has allowed to provide an overview of the literature that is available by presenting quantitative analyses of different aspects of surrogate measures of safety, such as which indicators exist, how frequently they are used, what threshold values are applied to distinguish between ‘severe’ events and ‘non-severe’ events, the number of study sites included and the length of observations, techniques used to analyse the data, etc. The paper discusses methodological gaps and challenges that need to be addressed further in future research, such as the validity of surrogate safety measures, the need to make better use of the full continuum of traffic events, to better reflect the potential outcome severity in the event that an accident would have taken place, etc.

This paper is part of the InDeV project (In-Depth understanding of accident causation for Vulnerable road users). The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635895.

Title: **RUBA – video analysis software for road user behaviour analyses**

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Author keywords: Video analysis, Traffic conflicts, Watchdog, Road user behaviour analysis

Background

Although traffic conflicts occur more frequent than accidents, their occurrence is still rare. It is not unusual that several weeks or even months of data are needed to get enough traffic conflicts for a safety assessment. Looking through hundreds of hours of traffic video manually is very time consuming and present an obstacle to using traffic conflict studies for safety assessments.

Aim

To reduce the amount of video that has to be assessed manually, we have developed a video analysis program called RUBA - Road User Behaviour Analysis – and used it for traffic conflict studies and behavioural studies. A preliminary version of the software to use for research projects can be obtained from the authors.

Method or methodological issues

In RUBA we can automatically process traffic video and get timestamps when a particular type of road user behaviour occurs. Thus we avoid wasting time on looking through these parts of the video where nothing of interest happens – a watch dog function. In the software the user draws one or more fields on top of the video in the area(s) that he/she wants to analyse further. Each field detects when a road user passes the field. Three types of fields can be made: one detecting when a road user passes the field, one detecting when the road user passes in a specific direction, and one detecting when a road user stands still in the field. RUBA can for instance be used to detect when pedestrians cross the street or when a road user drives in the wrong direction. It is also possible to combine two fields in order to register when there are road users in both fields at the same time, e.g. detecting when a pedestrian crosses the road at the same time as a car approaches.

The latter is particularly useful for traffic conflict studies where it can be used to detect situations in with two road users passing the same area with short time distance, i.e. where a traffic conflict may have occurred.

Results obtained or expected

Results from a project comparing the safety of cyclists for different layouts of bicycle paths in signalized intersections (Madsen & Lahrmann, in press) showed that RUBA reduced the amount of video from 80 hours to 3-25 depending on the complexity of the recordings. In total, 400 hours of video was reduced to 64 hours, i.e. 16 % of its original length. Examples from other projects will also be shown.

Conclusions

There is a large potential of using video analysis software to reduce the amount of videos that has to be processed manually. This will make it more favourable to conduct traffic conflict studies based on several weeks of video recordings.

Acknowledgement

The development of RUBA was funded by The Danish Road Directorate. Further development of RUBA is done within the InDeV project (In-Depth understanding for accident causation of Vulnerable road users) which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 635895.

References

Madsen, T. K. O., & Lahrmann, H. S. (in press). Comparison of five bicycle facility designs in signalized intersections using traffic conflict studies. *Transportation Research Part F: Traffic Psychology and Behaviour*

Session V

BEHAVIOUR

Title: **Survival or deviance? A discussion of motives governing driver behaviour**

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Author Driver behaviour modelling, Motives, Monitoring of risks, Accident investigation

keywords: groups, Fatal accidents

Background: In 2003 a driver behaviour model was elaborated at the Institute of Transport Economics. The model - later named the "Risk Monitor Model" (RMM) –was published internationally for the first time in 2007, and in a slightly revised version in 2013. The model attempts to integrate different aspects that influence driver behaviour and is based on the axiom that man's deepest motive is survival, which in turn presumes that the organism is able to detect and deal with dangers in its surroundings. A risk monitor was proposed as the core of the model, which perceives, processes information and makes decisions, governed by motives, personality traits, and interaction patterns. Emotions and feelings play a key role in the monitor's handling of dangers where emotions are defined and allocated to unconscious, automated processes, while feelings are defined and allocated to conscious processes, thus pinpointing that neuroscience is an inevitable base for understanding driver behaviour.

Aim: New empirical evidence about accident risks, relative risks of illnesses, personality traits and other states, call for a further elaboration and extension of the RMM, with special focus on two diverging trends: One towards safe and secure driver behaviour with very low accident risk, the other towards maintaining deviant behaviour with high risk of accidents.

Methodological issues: The point of departure will be in-depth accident investigation of fatal accidents which has been mandatory since 2005 in Norway. One basic statement will be a resigned, but significant observation made by a team member of one of the accident investigation groups: "Why is it that we time after time observe almost the same type of accidents, behaviour and driver characteristics each time we are asked to investigate a fatal accidents"? With in-depth accident reports as base, this question will be considered and further elaborated in terms of behaviour and, hopefully, provide more insights into the extremes of "Survival" and "Deviance"

Expected results: A set of assertions and hypotheses will be stated and integrated in a revision of the RMM. One specific issue will be how these elaborations relate to the developments of autonomous vehicles.

Conclusions: Will be drawn in terms of how a revised RMM might satisfy the challenges of Vision Zero and expected effects of autonomous vehicles.

Title: **The effect of wind turbines alongside motorways on drivers' behaviour**

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Author keywords: Wind turbines, Motorways, Behavioral observations, Lateral position, Speed

This paper presents the results of an exploratory study aimed at investigating whether the presence of wind turbines in close proximity to motorways leads to behavioural adaptations among passing drivers. Empirical data from loop detectors and temporary video cameras were analysed in a study employing a before-and-after design at a site near Rotterdam, The Netherlands. Analyses of driving speed and standard deviation of speed (corrected for trend effects through the use of comparison sites) were performed as well as analyses of the lateral position and standard deviation of the lateral position and an observation of serious traffic conflicts.

The results showed that constructing wind turbines alongside a motorway led to some clearly observable effects on drivers' behaviour. The analyses of the speed data showed that the mean speed was lowered by 2.24km/h (corrected for trend effects) after the construction of the wind turbines while the standard deviation of the speed significantly increased. After the construction of the wind turbines, drivers took a lateral position somewhat more to the left-hand side in their driving lane. There was a nearly significant indication that the standard deviation of the lateral position slightly increased when the rotor blades were in transversal position. In the before period as well as in the after period, no serious traffic conflicts were registered.

The increase in standard deviation of speed and in lateral position are two factors that intrinsically can have an unfavourable effect on road safety. However, the observed order of magnitude of the change was shown to be quite limited. Earlier research suggests that negative effects on road safety are only expected for changes substantially greater than the ones that were observed in this study. On the other hand, there was a significant reduction in driving speed, which has a favourable effect on the expected number and severity of accidents. From these findings, it can be concluded that, based on the observed variables, no substantial negative effects for road safety were found in the present study. The authors recommend continuous monitoring and further research on the topic.

Title: **Cyclist Behavior and Safety Assessment at Discontinuities in the Cycling Network: Adopting Surrogate Safety Analysis using Video Data**

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Author keywords: Surrogate safety, Motion pattern, Video analysis, Safety assessment, Discontinuity, Cycling network

The primary purpose of any transportation network is to provide connectivity between the origin and travel destination. However, given the vehicle oriented structure of the road network, there are interruptions in the later implemented cycling network. Discontinuities are interruptions in the cycling network where cyclists are faced with unexpected situations such as the end of a cycling facility or the change from one facility type to another that are perceived as inconvenient and less safe. Safety assessment at these points of discontinuity has been overlooked in literature. Given the uncertainty of cyclist behavior at discontinuities, our study aims to evaluate cyclist behavior and assess their safety at these interruptions in the cycling network and compare them with control sites for validation. Surrogate safety measures are used as a superior indicator of safety since abrupt changes in speed and movement can be monitored with respect to other road users. Our study proposes a methodology to apply motion pattern recognition, speed monitoring and conflict detection that can be applied to any location for safety assessment.

After proposing a set of discontinuity measures along Montreal's cycling network, video data was collected from a pole-mounted camera at locations with discontinuities and control locations to compare the difference in cyclist behavior and safety between areas with and without a discontinuity. Motion pattern analysis as well as surrogate safety measures such as speed and time to collision are extracted from the collected video data to evaluate whether or not there is a higher risk for cyclists at points of discontinuity. The various strategies adopted by cyclists when faced with discontinuities will be investigated. We expect that cyclists may have to undertake abrupt maneuvers, as well be involved in more severe or a higher frequency of dangerous interactions with other road users at points of discontinuity compared to their control sites.

Title: **GOGREEN – An Austrian national project to assess the influence of greenery on the behaviour of road users**

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To promote active mobility in a safe way, an attractive infrastructure, the design of open spaces in a human scale and accepted by the residents, also well designed open spaces are required.

The design measures include compound types of green structure in the streets, the creation of lounge areas in public open spaces, with all its societal, social, ethnic and microclimatic effect, which encourage numerous environmental aspects of a smart, liveable development of the town. The objective of GoGreen is, to set up a catalogue of criteria containing knowledge about “infrastructure & modern urban open spaces”. The project is funded by the Austrian ministry transport innovation and technology

Within the frame of a multidisciplinary approach there will be an investigation about how the mobility is affected by green infrastructure. Good practice analyses provide exemplary innovation and different possibilities of implementation. A requirement catalogue will provide a wide range of qualitative infrastructure needs of different target groups and will contain exemplary assessments of selected street sections. To achieve a participatory process, neighbours and experts will be integrated into a process of observations, surveying focus group discussions and interviews. The tools of the catalogue of criteria show, how the green infrastructure can be designed with the objective of stimulating active mobility in a safe way.

Results so far indicate that road users primarily connect a green infrastructure to fresh air, a place to sojourn and a possibility to experience nature. Green is a very important aspect of a high quality public space. Road users accept detours in order to walk in green areas and especially elderly people are hold of walking if the area is dominated by (parked) cars. In this context green also supports the feeling of subjective safety.

The following requirements were identified with respect to green infrastructure:

- Tidiness & cleanliness: a messy green infrastructure has a contrary effect – pedestrians avoid these places
- Aesthetic claims: it is a very big challenge to fulfil the aesthetic requirements of different road user with respect to green areas, implementing new green elements should consider various aesthetic claims
- Multifunctional areas: green infrastructure should be appealing to various target groups
- Participation and transparency: there is trend to urban gardening, active participation of the citizens to make the city greener, it is very important to make the various processes of participation transparent
- Safety: Green infrastructure has the power to increase the feeling of subjective safety on the one hand. On the other hand it might create the feeling of insecurity if it is not appropriately fostered.

Title: **General Traffic Safety Culture Model: Case Study of Estonia**

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keywords:

traffic culture, traffic safety culture, traffic accidents, traffic violations

Traffic Culture of a country is the sum of all external factors and practices concerning mobility and safety, which must cope with internal factors of traffic. External factors include following aspects: national, eco-cultural-socio-political, individual, etc. Practices consist of economy, education, engineering, enforcement and exposure. Road users, road engineering as well as road itself are elements of internal factors. Traffic Culture is divided into micro, meso, macro and magna levels based on cultural components. In simple phrase, Traffic Safety Culture is an amount of values, actions and behaviours, which show a commitment to safety in comparison to competitive goals and demands.

The main goal of this paper is to present and to describe a General Traffic (Safety) Culture Model, which was developed within the scope of the TraSaCu project. This model could be characterized from 3 different perspectives. The first aspect shows it as a general and comprehensive model, which includes all types of road users. The second perspective presents model as a framework, which help to explain the main reasons behind the vast differences between countries in road traffic safety of the world. The third and the last aspect describes it as a basic model to introduce a new age of safety – tools to reduce road traffic accidents and fatalities as minimum as possible within countries.

The research work of this paper includes also the results of the case study done in Estonia and based on the developed model application.

Session VI

SPEED

Title: **Roundabouts converted for road trains and the effect on vehicle speed**

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Author keywords: Road train, Roundabout, Speed, Redesign, Lane width

Road trains has been used internationally in many years, but it was first in 2008 the first trials with road trains (up to a length of 25.25m) on the Danish road network were initiated. The trial period was extended several times and is now prolonged to 2030, i.e. virtually as a permanent arrangement.

The state roads and selected municipal roads have ongoing been rebuild to ensure sufficient space for these road trains – design changes, which mainly have been concentrated in nodes. In total are around 150 locations, of which a considerable part are roundabouts, converted to ensure passage. In single lane roundabouts the central island is reduced and the area added to the lane.

All things being equal, it allows especially private cars to increase the speed in the roundabouts, as the turning radius will be bigger with an increasing width of the lane. The hypothesis is that the redesign will increase the speed through the roundabout considerably.

This study consists of two sub studies; a before/after study in one round about and a with/without study in two identical roundabouts with exception of the increased width of the lane in one of the roundabouts. In common for the studied roundabouts are a moderate traffic level (AADT of 6-8,000) and outside built up areas.

For each roundabout one week of video registration before and one after the redesign of it were recorded. Similarly, one week of data was recorded in the roundabout with and without the increased lane width, respectively.

Based on the measured time use between two location identified in the roundabout for private cars driving under free flow conditions, an estimation of the speed with/after compared to the speed without/before the redesign is made for in total 100 cars per week per location.

The very first tentative results show that the speed increases from about 28 kph to nearly 38 kph. It is therefore plausible that it resulted in increased accident risk and additionally increased speed variation, which is normally an outcome of an increased speed level.

The final results will be presented in the final paper.

Title: **Development of a speed-based surrogate roundabout safety measure**

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Author keywords: Speed, safety, surrogate measure, roundabout, floating car data

Roundabouts are one of the safest intersections. However, the need to fulfill the requirements of operation, capacity, traffic organization and surrounding development lead to variety of design solutions. The roundabout types (including single-lane/multi-lane, turbo roundabouts, solutions with various shapes of central island, urban/rural or high-speed) differ in their safety performance. Nevertheless it is difficult to assess the safety based on observed number of accidents due to their low occurrence and also small number of specific roundabout configurations. In order to estimate safety level, surrogate measure is needed.

Speed is known to be safety-related and may be collected in the field using various tools and methods. Therefore the aim of the study is assessment of impact of various roundabout geometry solutions on speed and development of a speed-based surrogate safety measure.

Speeds will be collected in selected positions (approach, entry, circulation, exit), but also in speed profiles, using floating car data, which is an emerging technology based on series of GPS points representing individual drives. It will allow statistical comparison of different speed collection methods. Analyses will reveal the relationships between trajectory, geometry (e.g. radii and/or deflections) and observed speeds, as well as driving behaviour (for example lane changes on circulatory roadway during through driving). Based on empirical research and geometrical parameters speed models will be also developed for various roundabout sections in order to assess speed changes in consecutive positions.

Developed surrogate safety measure will also enhance existing accident prediction models, which will help quantify the impact of different solutions roundabouts on road safety.

The final results will be applied to assess relative safety differences between various roundabout types.

A speed-based surrogate roundabout safety measure will be useful for proactive evaluations. As opposed to “waiting for accidents to happen”, it will allow preventive assessment mainly in the phase of roundabout design, especially for non-typical solutions or shortly after the construction.

Poster Sessions

Title: **Frequency and Severity of Pedestrian and Cyclist Accidents in Warsaw**

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Traffic safety situation of vulnerable road users (VRU) in Poland is one of the worst in the European Union. In 2015 on Polish roads 915 pedestrians were killed (31% of all traffic fatalities) and 8040 were injured (20% of all traffic injuries). Cyclist victims included 300 killed (10% of all traffic fatalities) and 4116 injured (10% of all traffic injuries). In the years 2009-2013 among all the victims of road accidents, some 27% of pedestrians and 37% of cyclists were killed or injured at intersections in built-up areas. Although road safety situation in Poland is generally improving, the number of pedestrian and cyclist accidents at intersections is not decreasing as fast as in other areas which raises serious concerns.

The paper presents preliminary results of analyses conducted as part of research project InDeV. One of the aims of the project was to identify situations and circumstances critical for VRU safety. To this end, pedestrian and cyclist accident records in InDeV partner countries were examined. Of particular interest is accident database in Warsaw where police accident records are enhanced with additional information like exact accident location and data on behaviour and movements of accident participants.

This paper attempts to examine and analyse injury severity and risk factors for pedestrian at cyclist injuries in accidents located at intersections in Warsaw. The dataset examined includes police records of 1379 accidents from the years 2009-2013, in which 115 pedestrians were killed and 1349 injured. During the same period, there were also 281 accidents with cyclists in which 9 cyclists were killed and 272 injured.

One group of factors examined relates to physical environment (road type, road width, exact location of the accident, lighting conditions), traffic control (signal presence) and vehicle characteristics (vehicle type, type of manoeuvre before the accident). Another group of factors relates to road user characteristics (age, gender) and behaviour contributing to the accident (red running).

A great majority of accidents with pedestrians involved vehicles going straight (70% for signalised and 85% for unsignalised intersections), while for accidents with cyclists the corresponding percentages were very similar. More accidents occurred at intersection exit roadways than at approach roadways – the ratio for pedestrians was 2.7:1 for signalized and 1.5:1 for unsignalized intersections.

Preliminary analysis conducted using logistic regression shows that the most important factors affecting injury severity are: type of intersection control (signalised or not) and the type of vehicle involved in the accident. The highest probability of fatal or serious injury occurs for pedestrians or cyclists hit by trams, buses or trucks. The impact of the type of vehicle manoeuvre is not statistically significant.

Road user behaviour plays an important part: in 27% of accidents examined pedestrians were crossing on red while in 9% of cases vehicles were crossing on red. Reasons of committing violations of traffic rules could be not pedestrian-friendly traffic signal settings. This could mean long waiting times for pedestrian at signalized crossing. It is hoped that more data on pedestrian crossing behaviour will be collected during filming which will be carried out within project InDeV.

Title: **Learning of Mannered Driving by Knowing own Cognitive Style of Empathizing-Systemizing**

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Author keywords: Empathizing-Systemizing, hazard perception, active learning, lecture, education

Danno & Taniguchi (2015) analyzed relationship between individual cognitive style and traffic accident/incident experiences and it was suggested that those drivers who had higher Empathy quotient (EQ) experienced less accidents/incidents. Systemizing quotient (SQ) had no main effect to those experiences. However, those experiences of drivers with high SQ were increased when their EQ was low. Based on the result above, it was suggested that those drivers who have stronger Empathizing function could have stronger capability of hazard perception. On the other hand, Systemizing function could weaken capability of hazard perception when Empathizing is weak, although it doesn't have its independent effect. The result means basically that Empathizing could yield stronger cognition of a person/agent than just a car/non-agent in looking other road users and Systemizing would interfere with that kind of recognition when Empathizing is weak.

While driving a car in a public road, they are likely to behave rather selfishly against other road users than they walk among peoples on a pavement. The main reason of the behavior could be 'anonymousness'. If people feel they are watched, as when they can see other person's face and eyes directly, they behave with well-manner against others. However, a person inside another car could not be viewed easily, and drivers also feel they themselves are not watched directly. Therefore they are likely to behave selfishly or not considering others. However the Empathizing function promotes understanding other persons' needs and predicting their behaviors. This strengthens hazard perception capability. The 'transient' would be another characteristic of behavior on road. A car moves quickly besides others and they are likely to become free from responsibility against others. These conditions tend to release the innate drives as aggression which causes dangerous driving as over speeding. However, encouraging drivers to recognize other road users to be human being, i.e. empathizing, would possibly remind drivers to drive manneredly on public roads.

In a general traffic safety education, this knowledge could be used in a traffic safety lecture with Psychological test of Empathizing-Sytemizing model. It should be interesting for audience to know their own cognitive style. Answering a Psychological test and scoring by themselves is a kind of active learning process and the result could offer valuable opportunity to know the self. Explanation of the relationship between Empathizing-Systemizing and hazard detecting should be main issue of the lecture. The most important point must be to encourage the recognition that another car is not a machine but a human being 'wearing a car'. This recognition will produce consideration for others which originates in empathizing. This educational method is constructed of active self-testing and learning knowledge on traffic safety by lecture. The effect of this method is not validated yet but this kind of lecture is needed widely in Japan and the effect of cognitive modification could be expected especially with regard to interpersonal relationships, i.e. traffic behavior.

Title: **Autonomous Cars: Benefits, Risks and Perspectives**

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Author Keywords: autonomous cars, driverless, ITS, accidents risk

According to European experience, intelligent transportation systems (ITS) could create clear advantages for transport systems: ITS increase its effectivity, sustainability and safety as well as support the development of EU domestic market and the improvement of competitive power. As noted in the European Commission documents, there is a number of efforts, which were carried out in this field starting from the 1980s. Unfortunately, these efforts were often uncoordinated and had fragmentary nature. Furthermore, they were traditionally directed to decide separate problems such as to support environmental friendliness and energy efficiency of transport, road congestions, traffic management, road safety, operational safety of commercial carriers, etc. At the present time geographical continuity, systems and services compatibility as well as standardization are the main actual tasks of ITS development.

One of the main ITS focus areas, which is promoted during the last 15 years, is a realization of intelligent vehicle concept. The first experience to use on-board intelligent systems showed that they could reduce a total amount of accidents by 40% while an amount of accidents with fatal by 50%. Moving from a creation of driver support systems to a development of semiautonomous and driverless cars is the world trend and is explained by desire to ensure sustainability and safety of transport systems. However, it should be clear that entry of new technical and technological solutions is connected with appearance of new problems, which decision could require new methods and tools.

This paper describes problems and ways to increase safety, reliability and sustainability of transport systems by organization of the interaction between all road-users. The main focus of research is critical situations caused by uncoordinated actions of transport process participants. Possible ways to solve these problems are also considered. As a result, it is shown that for reliability management of autonomous cars it is necessary to improve service system as well as algorithm of big data processing. Use of the common information space to form a massive of operational data about vehicle state as well as codification of defects to form fault statistics and to analyze it allow to determine service strategy and to carry out its correction in case of need. The article includes also examples of control algorithms and models, which gives a possibility to assess risks of accidents appearance on the urban roads.

Title: **Social media and Traffic safety in India**

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Author keywords: Social Media, Traffic Safety, India

Social media is about sociology not technology. It's about making a connection-one person at a time. It's a conversation, a digital dialogue and a word-of-mouth on steroids. When you engage in social media on matters of personal and social concern like traffic accidents and related pains, you can notice everyone talk like a friend, sharing their personal experiences of conscience of their eye and not pushing the agenda of shameless self-promotion. Since one can also choose with whom to interact, the credibility of social message is very high.

Social media is a broad term that refers to multiple digital communication platforms used for networking and social interaction. Human relationships are still more powerful than the technology utilized to facilitate online communities. Since Social media provides a web of interconnected minds, it becomes a perfect place for exchanging personal and social messages to affect change. In many parts of the world, traffic safety advocates integrated Social media into their strategies, target audiences live, work and play online. Even in India, Social media plays an important part in traffic safety and here, I will share some positive experiences from Bangalore, an Indian city.

India is still relatively poor economy at \$1500 per capita and to wipe the tear from every eye of the 1.2 billion persons living here, one would at least want to be middle income around \$6-7000 which if reasonably distributed, will have dealt with extreme poverty. And that is two decade worth of work to be even moderately satisfied.

With about half a million reported traffic accidents, of which about 25% fatal accidents with 150,000 persons dying every year, have earned India a dubious distinction. India has the worst traffic accident rate worldwide. Bangalore is the third largest city in south of India. Thanks to Social media, Bangalore is today as popular for its potholed roads as it is for its IT industry. It is a home of some 4000 potholes with varying degrees of hazards associated with them. When people interacted via social media whenever potholes claimed lives young men and women became victims due to traffic accidents, citizens start asking very valid questions of who is responsible for fixing bad roads, costs, corruptions in the workings of municipal and other governmental organization etc. which were only bothering so far the minds of researchers or so called elites, became a talk of the town.

School children started writing essays on Potholes of Bangalore, artists and those of kindred spirit letting out their creativity on the roads and concerned citizen in city wide protest were submitting Memorandum to Municipal and other governmental agencies to do something for the traffic safety of people living in the city.

As a result, the municipal officials ensured that roads of Bangalore are free of potholes and many roads are well asphalted for safe and smooth traffic conditions of Bangalore roads. And some promises were also realized in practice. Personal Note: Since my eyes were opened to people getting killed in accidents (ca 1982) and was suffering myself emotionally to save them somehow, driven me in search of ways of better accident reporting or recording methods, video techniques, capacity methods etc., It is good to know now that social media does alert people that might affect their lives from getting back home safe!

Title: **The role of fines and rewards in the self-regulation of young drivers: methodological and conceptual issues**

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Author keywords: Fines, rewards, self-regulation, young-drivers

Traffic safety interventions often aim to modify driving behavior using deterrence, especially among young drivers. The use of rewards to motivate such modifications, for example by re-structuring insurance schemes, remains understudied. We acquired both subjective and objective data on driving behaviors in a sample of 114 young student drivers in Israel's Southern region. We used a survey to acquire data on the participants' history of violations, self-reported driving behavior, and subjective attitudes towards risks and fines. We then examined the participants' objective driving behaviors, including violations, using a specifically designed smartphone application developed. The results show a significant gap between self-reported and objective driving patterns. The magnitude of rewards necessary to motivate self-regulation was significantly smaller than fines. We discuss the implications of our findings on self-reported behavioral data and the potential use of rewards in motivating changes in driving behavior.

Title: **Are weather parameters suitable predictors of road safety outcomes ?**

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Background: Inclement weather conditions associated to road risk are known, and coded by police on the spot of the accident: precipitation (rain, snow), slippery pavement (frost), and fog increase the risk of accident and its severity. These inclement weather conditions also reduce the presence on the road, in other words exposure to risk. The number of injury accidents and resulting casualties, measured at an aggregate level (whether local, regional, or national, can be seen as the product of risk (number of accidents/casualties by unit of exposure to risk) and exposure to risk (number of units on the road, number of units multiplied by their distance travelled), and are thus impacted by two opposite inclement weather effects which may, or may not, compensate one another. In addition, disaggregating this analysis according to the type of road user will most likely provide specific results, and will enrich the results of a single analysis applied to the total of road users.

Aim: This presentation aims at highlighting significant correlations between specific weather parameters and aggregate fatality frequencies, at country-level in Europe. The road users are either aggregated at national level, or disaggregated according to their vulnerability: pedestrians, bicycles, power-two wheelers and motorized vehicles' users.

Method: Structural (or state-space) time series analysis techniques are applied to the monthly number of fatalities for a group of 7 European countries (Austria, Belgium, France, Germany, the Netherlands, Slovenia, UK) and for the long-time period 2000-2014. Road safety data was extracted from the IRTAD database. The meteorological information was extracted from the European Commission Agri4cast database under the form of 5 types of inclement weather days, aggregated at monthly level.

Results obtained or expected: The applications performed for a single country aim at an explanatory analysis, while those performed for the group of 7 countries aim at a comparative analysis among them. In general, inclement weather effects on the total of road users are consistent among countries with similar geographical characteristics. As regards the road user's disaggregation, a substitution effect between vulnerable and other users appears, and this is strongly dependent on the country.

Conclusions: The results are significant, and highlight the relevance of accounting for inclement weather configurations in road safety trend analysis. Rain and heat on the one hand, snow and frost on the other hand, appropriately aggregated at national level and at the scale of the month, enrich the short-term trend analysis performed at the monthly level. These results could serve to improve road safety management (alert levels by inclement weather are to be set), and road safety trend assessment as well (short-term changes in the trend, due to meteorological factors are to be corrected for, which highlights the changes imputable to other factors such as road safety policies).

Title: **Is there any connection between road classification and driving speed in Slovenia?**

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Author keywords: traffic safety, speed, geometric design of roads, national road classification

The analysis of traffic accidents showed that speed is one of the main causes for road traffic accidents. Speed is directly related to the degree of impact and with consequences of traffic accidents. Furthermore, depending on the actual speed the room for manoeuvres is decreased, which consequently influence reaction time of individual and the associated stop distance and that means, the higher is speed the less time is for reaction and inversely. The driving speed in road traffic is highly depended on a man (driver). From the point of view of the system driver, environment and vehicle the speed can be influenced by a variety of measures that are either infrastructure or psychological, but certainly this also includes improvements in the means of transport.

Main goal of the research was to find any connection between national road classification and driving speed choice in Slovenia. Firstly there was literature review followed by practical part of research.

Slovenia has on national road network 650 automatic traffic counters which work is not only to count traffic but also to measure driving speed of vehicles. For analysis of input data (March, October 2014 and 2015) were observed 134 traffic counters from which were 67% (90 traffic counters) located outside of settlements and 33% inside (44 traffic counters). All of observed traffic count locations have been classified in categories according to Slovenian national road classification and then furthermore with some adjustments in so-called SafetyNet categorization. There were performed calculations for three main parameters: average speed, 85th percentile of speed and percentage of vehicles which speed was greater than 10 km/h above the speed limit. From each SafetyNet category we chose four traffic count locations, three of them were chosen in dependence of maximal values of two parameters (85th percentile of speed and percentage of vehicles which speed was greater than 10 km/h above speed limit) and one of them was chosen in dependence of minimal values of the same two parameters. Then we obtained data for geometric design elements of exposed road segments (exposed traffic count locations) and data for traffic accidents and its consequences on these locations. At the end of the practical part (after the data analysis) statistical tests between speeds in different national road classifications were made for purposes of finding connection between national road classification and driving speed choice in Slovenia.

Title: **Speed Choice and Curve Radius on Rural Roads**

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In most developed countries the majority of serious injured and fatalities in traffic accidents can be associated with driving in rural areas. A significant part of these incidents can be connected to the alignment of the road and an inappropriate speed choice.

Often are curved alignments marked with informative speed-calming measures as traffic signs, reflectors or surface painting. However, it has been the hypothesis that people are reducing their speed insufficiently and are driving too fast in most curved alignments – especially when they are driving there frequently.

By knowing the speed near and in the curved alignments compared to the geometry of the curved alignments, it can be clarified, if and which speed-calming measures that are required. Using GNSS-based floating car data (FCD) from driving cars the speed near and in curved alignments is found. Single observation of FCD are connected to trips and these are summed in order to find the mean speed in the curved alignments. Data in the paper are partly based on FCD from the Intelligent Speed Adaptation (ISA) project, “Pay As You Speed” (PAYS) (<http://www.sparpaafarten.dk/>) and from the more present and big FCD project “ITS Platform” (<http://www.itsplatform.dk/index.php/en.html>). An initial result based on the data from PAYS only including 18 curved alignments with radiuses spanning from 15 to 350 m show that the coherence between speed and radiuses reveal a correlation that can be explained by the following logarithmic function where v is speed and R is radius.

$$V=14*\ln(R)$$

The tentative results based alone on the “Pay As You Speed” project show an expected positive connection between speed and radius, and that speed is virtually unchanged with a radius higher than 225m. In the final paper, a much bigger data sample from ITS Platform will be used to underpin the results presented here, but also to avoid any bias from PAYS data due to the speed reducing effect from the ISA.

Title: **Impact analysis of additional ambulance vehicle beacons**

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Author keywords: road user behaviour, impact assessment, rescue vehicle, traffic safety, computer vision

This work is a preliminary study on behalf of the Bavarian Red Cross (BRK) and examines if and what effect on traffic safety can be measured when BRK ambulance vehicles are equipped with additional beacons on the front fender next to the front lights. Several studies document the high crash risk particular during emergency drives [1][2]. The BRK endeavors to decrease the crash frequency of their ambulance vehicles by improving their visibility especially at intersections and narrow gateways. Therefore, the additional beacons need to be evaluated, which is the purpose of this study.

In order to evaluate the effect of additional beacons, emergency drives conducted with equipped and unequipped ambulance vehicles were compared. More precisely, the exit of a BRK station and the surrounding road segment was observed for 14 days by a video camera, which enables computer-vision aided analysis of the traffic. Within this time frame, 38 traffic situations of unequipped and 13 situations of equipped ambulance vehicles could be observed. The trajectories of interacting road users in these situations were analyzed. The use of Surrogate Safety measures appeared to be not practicable to obtain statistical significant results due to few interacting trajectories and no critical situations. Instead indicators like maximum deceleration, position and time of braking and reaching walking speed etc. of single trajectories were used.

The indicators showed, that road users entered the observation area slower encountering equipped ambulance vehicles—probably due to prior braking—than was measured at emergency drives without additional beacons. Furthermore, road users on average braked 3.5 m earlier, less intensely and reached walking speed 4 m earlier when ambulance vehicles were equipped with additional beacons. .

A follow-up study will examine video material of longer time frames and different locations to enlarge the samples size and thus to gain more significant results. Particular attention will be paid to urban intersections, which are the most critical spots for ambulance vehicles. Moreover, the use of Surrogate Safety Measures will be examined.

[1] Berufsgenossenschaft für Gesundheitsdienst und Wohlfahrtspflege (2007): Verkehrsunfallanalyse bei der Nutzung von Sonder- und Wegerechten gemäß StVO: Konzeptionelle Vorschläge zur Verbesserung der Aus- und Fortbildung

[2] Berliner Feuerwehr: Jahresbericht 2015.