Conférence Européenne des Directeurs des Routes

Conference of European Directors of Roads

CEDR Contractor Report 2017-04

Call 2013: Traffic Management
METHOD, UNIETD and PRIMA projects

September 2017

CEDR Contractor Report 2017-04

Call 2013: Traffic Management METHOD, UNIETD and PRIMA projects

by

Jill Weekley – TRL
Ian Cornwell – Mott MacDonald
Philippe Nitsche – AIT

CEDR Contractor Report 2017-04 is an output from the CEDR Transnational Road Research Programme Call 2013: Traffic Management. The research was funded by the CEDR members of Belgium-Flanders, Denmark, Finland, Norway, UK and Netherlands.

The aim of the CEDR Transnational Road Research Programme is to promote cooperation between the various European road administrations in relation to road research activities. The topics covered by this Call were developed by TG Research to fulfil the common interests of the CEDR members.

Partners:

ISBN: 979-10-93321-35-6

Introduction

This report summarises the work undertaken within the CEDR Transnational Road Research Programme entitled “Traffic Management: Supporting the implementation of innovation in traffic management solutions” running from April 2014 to December 2016.

Through Call 2013 Traffic Management, CEDR members have funded research supporting implementation of innovation in traffic management solutions. The programme aimed to meet the research needs of European road authorities in three key areas:

- Incident Management: analysis of the risks and costs of handling incidents
- Implementation of innovation: development of usable solutions
- Human factors: investigation of human factors in order to achieve high compliance rates for traffic measures

The three projects in the programme are:

1. **METHOD: Managing European traffic using human-oriented design**
2. **UNIETD: Understanding new and improving existing traffic data**
3. **PRIMA: Proactive incident management**

This paper presents the methodology and outcomes of the three projects and provides an overview of the discussion on implementation from the final conference held in Dublin (on 25th October 2016).

At the end of this report, recommendations are given on how to disseminate and implement the outputs and outcomes of METHOD, UNIETD, PRIMA and CEDR research projects in general.

Abbreviations

Abbreviation	Meaning
ASM	Adaptive smoothing method
CEDR	Conference of European Directors of Roads (organisation)
CHARM	Common Highways Agency and Rijkswaterstaat Model (programme)
FCD	Floating car data
GUI	Graphical user interface
HUD	Head-up display
ICT	Information and Communications Technology
LOS	Level of service
NRA	National Road Authority or Administration
PCP	Pre-commercial procurement (project)
PEB	Programme Executive Board
QKZ, QFCD, Q-Bench, SIMPE, TTD	Methods for assessing traffic data quality (see Part 1: UNIETD)
TIM	Traffic Incident Management
TRA	Transport Research Arena
TT	Travel time

PART I

The projects

METHOD – Managing European traffic using human-oriented design

Project facts

DURATION: July 2014 – October 2016

COORDINATOR: TRL, UK

PARTNERS:
SWOV, Netherlands
TM Leuven, Belgium
TNO, Netherlands
VTT, Finland

DELIVERABLES

- D1.1 Comprehensive technical report
- D1.2 Concise Guidance booklet
- D2.1 Update to D1.1 (Comprehensive technical report)
- D2.2 Human factors framework
- D3.1 Final report on the results of the simulator studies

Background and objectives

The aim of the METHOD project was specifically to address the human factors involved in traffic management. The core motivation of the project was to improve working practices in a way that accounts for human factors. Good traffic management is becoming more and more important as road mobility continues to increase. Mobility demand is increasing faster than road capacity, leading to increased traffic density and congestion problems. Traffic management has a crucial role to play in minimising disruption to the road network as it continues to evolve. However, if designed and applied without accounting for human strengths and limitations, traffic management measures will not produce optimal or safe results. Hence, to achieve high compliance rates (and therefore success) for traffic management measures, human factors must be addressed. Successful traffic management will mean that road users perceive the signals placed by road authorities, understand the content of those signals, are able to act accordingly and are also willing to do so.

The project developed a detailed human factors perspective on traffic management measures through engagement with key stakeholders. The outcomes of the METHOD project aimed to improve existing and future measures taken by the national road administrations in terms of both higher throughput and traffic safety. Results from the project are being disseminated to traffic management professionals and the wider scientific community to ensure a lasting legacy and benefit from the project.

The team assembled to undertake this project was led by TRL (UK), in partnership with SWOV (Netherlands), VTT (Finland), TNO (Netherlands) and TML (Belgium-Flanders). The project team comprised research institutes and academic institutions with demonstrated expertise in the subject areas, including: Human Factors, traffic management and driving simulators.

Description and methodology of the project

The main objective of METHOD was to assist road operators in their current and future approach to human factors. This aim was supported by the development of a framework with recommendations based on the results of the project. To arrive at this objective the following activities were required:

- Analysing road user needs and behaviours in relation to traffic management measures
- Conducting an inventory of current practices and experiences in European countries
- Assessing the effectiveness of traffic management measures from a human factors perspective
- Producing a guidance booklet that presented key lessons learned, international tips and tricks (Europe-centric) and recommendations that will be practical and useful for Traffic Management operatives, all from the perspective of human factors
- Reviewing the results of the feed-in project to be conducted in response to Objective 1 of the Description of Research Needs: ‘Incident Management’
- Reviewing best practice in traffic management operations
- Creating a human factors framework for traffic management professionals that will assist in the introduction of human factors right from the start in future applications of traffic management
- Conducting two simulator studies (one in the Netherlands and one in the UK). These studies explored new or additional ways to communicate with road users in order to get more insight into human factors techniques for traffic management.

These activities were organised into 3 work packages, alongside the project management and dissemination activities. This was structured as follows:

- WP1: Human factors reflection on existing traffic management measures
- WP2: Human factors framework for traffic management operations
- WP3: Human factors in ‘in-car’ traffic management: Simulator studies
- WP4: Project management, quality assurance & dissemination

To fulfil the aims of the METHOD project it was necessary to identify current best practices as well as knowledge gaps in human factors considerations in traffic management. This was achieved through a literature review and traffic management personnel interviews. In this way the project built on current knowledge and distilled this into an up-to-date and relevant Human Factors guidance document (WP1). Building on this work the project produced a human factors framework for use by traffic management experts (WP2). This was supplemented with new data using state-of-the-art driving simulators to test new traffic management techniques that focus on in-vehicle information and the concept of gamification, an as yet relatively unexplored field of research in relation to traffic management (WP3).

Literature review

The literature review highlighted five key human factors which influence traffic behaviour and related choices:

1. Perception
2. Comprehensibility
3. Skills
4. Willingness
5. Behavioural adaptation

Four of these aspects are conditional for achieving the desired road user behaviour: perception, comprehensibility, skills and willingness. The fifth human factor aspect concerns behavioural adaptation: the collection of behaviours that occur following changes in the road traffic system which were not intended and negatively impact road safety.

Surveys and Operator Interviews

The understanding of the human factors involved was used to develop the questionnaire survey. This was disseminated amongst 11 traffic management and human factors experts across Belgium-Flanders, Denmark, Finland, the Netherlands, Norway and the United Kingdom gains insight into the deployment and effectiveness of current traffic management measures in practice, current use of human factors thinking as standard practice when designing traffic management and potential cultural differences in this respect.

The key content of the operator interviews was structured in four parts: i) Current practices, ii) Guidelines and instructions, iii) Human factors and iv) Future and new systems. The interviews were mostly telephone interviews and six operators from three countries participated. First, a use case approach was taken by picturing a typical situation and the actions taken in such a situation, e.g. an incident occurring. Next, the guidelines and instructions for traffic management operators were discussed, following by questions about human factors, their familiarity and presence in the daily work. The operators were also asked about their views of the future and what changes are expected both for the operators' work and the road users.

Simulator Studies

Two individual, independent simulator studies were undertaken as part of the METHOD project. These studies both investigated how two existing, near future concepts (gamification of driving behaviour and a head–up display (HUD)) could be applied to improve drivers' compliance with traffic management guidance. This has the potential to improve overall network efficiency; not only by improved compliance but also by giving national roads authorities better and more specific tools for managing the movements of vehicles on their networks.

The UK study was carried out by TRL and it investigated the use of gamification techniques on driving behaviour. A simple game design was created with the aim of encouraging drivers to adopt behaviours that were safe but also complied with traffic management guidance.

The second study was carried out in the Netherlands by TNO. It investigated the potential benefits of supplementing (or even replacing) existing driver-oriented traffic management information using spoken warnings or an in-vehicle HUD system.

Evaluation and outcomes of the project

The headline results from the METHOD project indicate that human factors are taken into account in traffic management, but not in a structured way. Some knowledge on human factors exists, but the information is fragmented and not integrated as a standard practice. It does not reach all operators and all levels in traffic management centres. Perception and comprehension seem to be the human factors which currently receive the most attention when traffic management measures are designed. When installing and setting signs care is usually taken to ensure that the signs are perceivable and the messages are readable and understandable. Conversely competence, motivation and behavioural adaptation are not that well covered. Motivation is identified as very important for compliance and efficiency of traffic management measures, but it is currently not easy to take into account.

Current Practice

The project discovered that many different practices and experiences of traffic management measures are applied in the six countries investigated. Of these measures dynamic speed management measures such as dynamic speed limits and variable message signs are the most common. The largest variety in traffic management measures are found in the Netherlands and the fewest in Finland. In the Netherlands traffic management measures are also most frequently applied.

According to the interviewed operators, the steps taken after incidents are quite similar in all three countries. Incident situations are perceived to work fairly well, as safety is ensured, necessary actions are taken and road users are informed. Guidelines for a number of different situations are available, but most of the learning is done on the job and through discussion with managers and colleagues. The emerging systems and services are seen as very positive by the interviewed operators. They expect their level of physical work to decrease and expect in the future to concentrate more on the actual traffic management. However, expected increases in the amount of incoming traffic data causes some concern.

Changes are underway in all three countries with current various systems being integrated under one interface. This is expected to ease the daily work of operators and improve their situational awareness.

Current Design Guidelines

Country experts indicated that the five key human factors are used as standard practice when designing traffic management in Belgium, Denmark and Finland. The Netherlands and the United Kingdom showed differences between the use of these human factor aspects as standard practice. Across the countries in this study traffic management operators most frequently used perception and comprehensibility as standard practice when designing traffic management measures.

Although most countries indicated (to a different degree) use of human factor aspects as standard practice when designing traffic management measures, the Netherlands was the only country that actually provided documentation on the specific framework used. The 10 Golden Rules[1] and the Human factors in Traffic Management framework[2] used in the Netherlands are the best practices found across the six European countries. Both documents were used as relevant input for Work Package 2.

[1] Kroon, E. C. M., Martens, M. H., Brookhuis, K. A., & Hagenzieker, M. P. (2014). Human factor guidelines for the design of safe in-car traffic information services. Delft: Ministry of Infrastructure and the Environment.

[2] Harms, I. (2012). *Het raamwerk van human factors in verkeersmanagement; aan de slag in de praktijk.* Rijkswaterstaat, Dienst Verkeer en Scheepvaart

There was a lack of relevant evaluation studies as a source for the assessment of traffic management effectiveness currently applied in the six countries. Additionally there was a lack of official documentation and frameworks on the use of human factors as standard practice for designing traffic management measures. The effectiveness assessments were dependent on the relatively small sample of experts that were interviewed. Carrying out more interviews with different experts is recommended in further research. This may also collect more relevant human factors documentation used for designing traffic management measures.

Simulator Results

The two simulator studies presented investigated how two different human factors techniques could support future traffic management. The use of simple gamification principles brought about changes in driving behaviour but the approach was not well liked by participants who felt that it made the driving task more difficult, suggesting that the creation of a better game could yield positive results for traffic management. The use of in-vehicle information for presenting traffic management information was found to be no better (but no worse) than traditional techniques but was found to be more satisfying for participants. It can be concluded that each study has therefore provided results that suggest each technique can be explored further. In particular, firstly, it would be of interest to work with game design specialists to create a specific game to encourage safe and compliant driving behaviour that builds upon the results of the UK study. Secondly, the use of in-vehicle information for traffic management was found to be non-detrimental to safe, compliant driving behaviour so further work should focus on how to gain further benefit from the flexibility of traffic management that can be achieved by this approach.

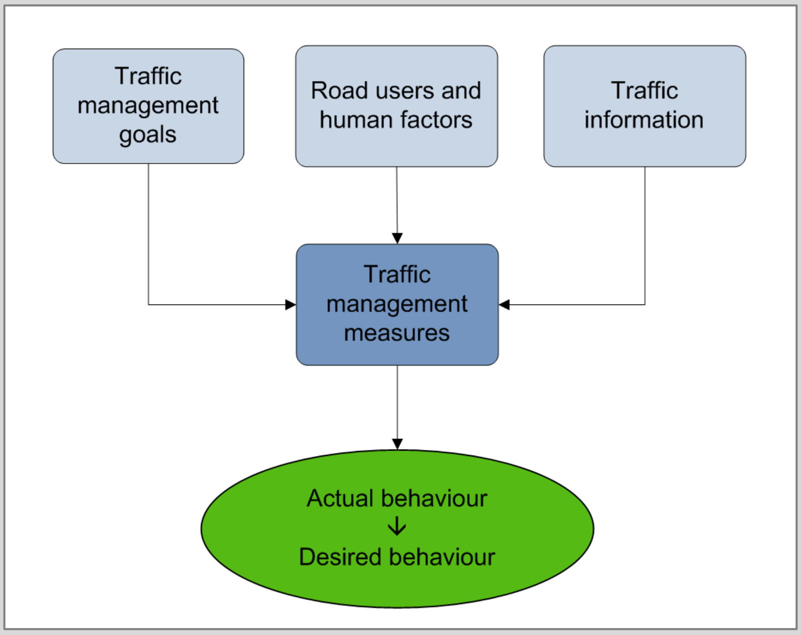
Recommendations

Recommendations for taking human factors into consideration in traffic management were formulated by examining the results of the literature review and operator interviews. In summary, the recommendations identified a need and possibility to better include road user motivation and take into account different individual factors by giving personalised feedback, ensuring sufficient situational awareness of operators and road users, and using common terms and practices. This can be achieved by closer cooperation within all levels of traffic management in each country and internationally.

Motivation was identified as an important issue in the human factors consideration steps (perception, comprehension, competence, motivation) because it has not been traditionally addressed that much and it can be influenced with new traffic management services. Basic knowledge about human factors in traffic management should be made available to all personnel involved in the traffic management process.

With findings of all information collected in mind, a recommended human factors framework was formed and is reproduced below.

Human factors framework for traffic management



Traffic management goals

The goals of traffic management measures aim to ensure safe, reliable and predictable travel. Traffic fluency and safety, emissions and efficient use of network capacity are sought to be optimised. The objectives or goals of traffic management measures consist of a set of measures to be applied for multiple purposes.

Road users and human factors

The term human factors implies transferring knowledge about human abilities, limitations and other human characteristics to the design of equipment, tasks and jobs . The four main types of human factors in transport are defined as perception, comprehension, competence and motivation. In addition, standing apart from these four there are the concepts of behavioural adaptation and unconscious behaviour. Further, the physical and psychological characteristics as well as expectations of different road users are important. Physical characteristics include perception, comprehension and actual skills. Psychological characteristics are for example level of autonomy, perceived competence, relatedness or sense of community, and feedback. Expectations are important because road users base their behaviour on them and are prone to make mistakes if the design of a measure creates wrong expectations. This section also includes variable factors such as the current circumstances in the road environment (such as weather conditions or congestion), the type of trip and the state of the road user (such as personality, health, level of attentiveness).

Traffic information

Traffic information is the information on the current state of the transport system both for travellers and road operators. This information can be received from different sources. It includes for example loop data and information from cameras, police or rescue services and road users. It can be distributed to road users by variable signs or in-vehicle devices.

Traffic management measures

Traffic management measures are the measures applied to achieve desired goals of traffic management. Measures can be defined in different ways by technology clusters, desired effect or task of the road operator. Measures are for example to inform, advise, guide and steer road users with use of traffic information, traffic control, incident management, demand management, driver support and fleet and transport management. These measures can be carried out by dynamic speed management, local dynamic warnings, local traffic flow management or network wide traffic flow management.

Next steps

A key area which merits further study is the motivations for road users. This was identified throughout the METHOD project as being both important and also poorly understood. Further work should focus road user motivation and personal need, for example what is the users' motivation for using the road network and what is the logic behind their choice of vehicle. A better understanding of these factors would allow tailoring of traffic management measures to more effectively meet user needs.

It is also felt that re-running the simulator trial but using a redesigned app would add real value to the outcomes of this project. This new app should developed by a professional third party with industry experience in making engaging apps, and possibly working alongside a mapping company (such as HERE) to integrate the app into typical navigation system operation. This follow-on work could also further examine integration of in-vehicle information systems with traffic management, for instance and investigation into using such system to direct traffic around work zones in ways not previously possible.

UNIETD – Understanding new and improving existing traffic data

Project facts

DURATION: April 2014 - July 2016

COORDINATOR: Mott MacDonald, UK

PARTNERS:
TRANSVER, Germany
Institute for Transport Studies, University of Leeds, UK
nast consulting, Austria

DELIVERABLES

- D1 Review of traffic data for traffic management
- D2.1 Data quality evaluation: Description of methodologies
- D2.2 Data quality evaluation: Functional specification of software toolkit
- D2.3 Field tests and evaluation
- D3.1 Assessing the relevance of social media content
- D3.2 Estimating levels of social media content
- D3.3 Business models for social media data
- D4.1 Fusion of third party and existing traffic data
- D4.2 Updated guidance on short-term prediction
- D5 Factsheet
- D6 Waze traffic information

Background and objectives

The UNIETD project aimed to guide the national road administrations' use of third party data such as crowd sourced / social media and floating vehicle data in place of traditional infrastructure-based techniques.

The quantity, quality and potential of traffic data and information services based on mobile devices has increased, and road administrations are now facing the question whether to build and operate their own detection infrastructure, to buy external traffic data or information, or both. However, there are no standard methodologies or software tools available to allow the road administrations to efficiently check for themselves the quality of the traffic data and information based on mobile devices.

The project therefore aimed:

- to develop, implement and test methods for **quality assessment** of traffic data and services based on mobile devices;

- to understand the potential of **social media analysis** for traffic management, through assessing relevance, penetration rates and business models;
- to understand the implications of these new data sources and quality results for established techniques of **data fusion** and **short-term traffic prediction**, in order to support traffic management decision-making.

Description and methodology of the project

The UNIETD methodology was designed to address multiple sub-objectives listed in the road authorities' description of research needs. The project work package structure is shown in Figure 1.

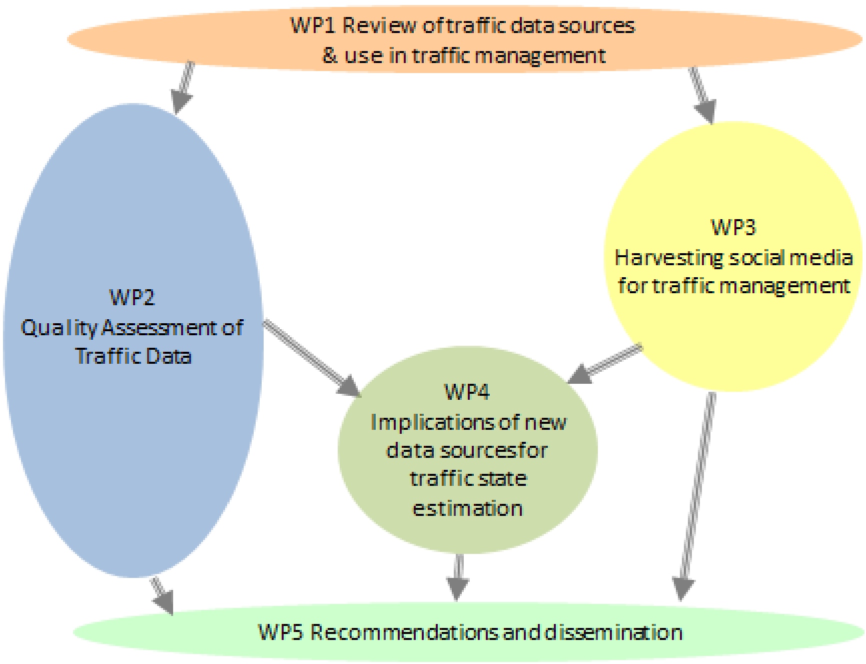


Figure 1: UNIETD top-level methodology

The project partners began by pooling their knowledge on traffic data for traffic management, considering (i) traffic management requirements (ii) current traffic data sources and (iii) current use of traffic data in traffic management. A set of limitations of current sources were observed when those sources are used for traffic management. This review set the context for analysis of mobile-derived traffic data quality, and research on the potential of harvesting social media for traffic management. Findings from those two major work packages were then used to update the state-of-the-art in data fusion, short-term prediction, and automated traffic management decision-making. Finally, the results from each activity were disseminated to roads administrations and the wider sector.

During the project an additional work package was added, with the agreement of the roads authorities – to examine the potential of Waze traffic data. The project therefore considered three different kinds of crowdsourced data as shown in Figure 2.

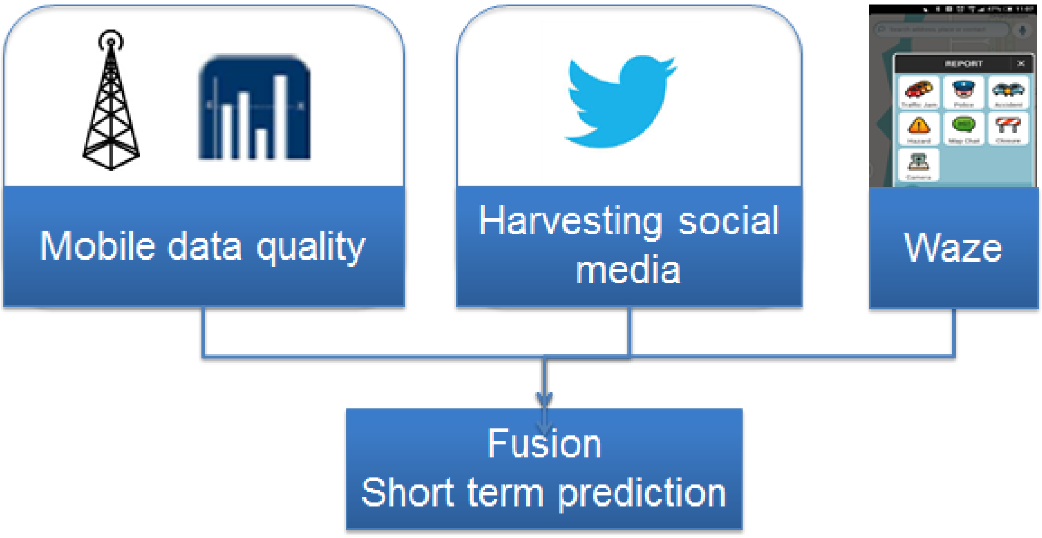


Figure 2: UNIETD considered three new sources of traffic data

Evaluation and outcomes of the project

Traffic data service quality evaluation

The UNIETD project used a simple organisational framework to categorise methods of quality assessment according to the kinds of reported data they assess and the kinds of data they use as the reference source of "ground truth". It also developed a new "UNIETD" method which can be used for the evaluation of reported speeds and travel times, and can distinguish between the ability to report real delays and the tendency to falsely report delays that do not exist. The method also:

- delivers quality indicators which are easy to comprehend and interpret and have a meaningful normalised scale (a proportion from 0 to 1);
- has only two parameters (congestion rate and tolerance rate), which are straightforward to comprehend.
- avoids problems that can arise with evaluations based on derived "level of service".

In order to assess the quality of different traffic data sources, UNIETD developed a flexible toolkit to enable comparison of the various methodologies for assessing traffic data quality, including the UNIETD method.

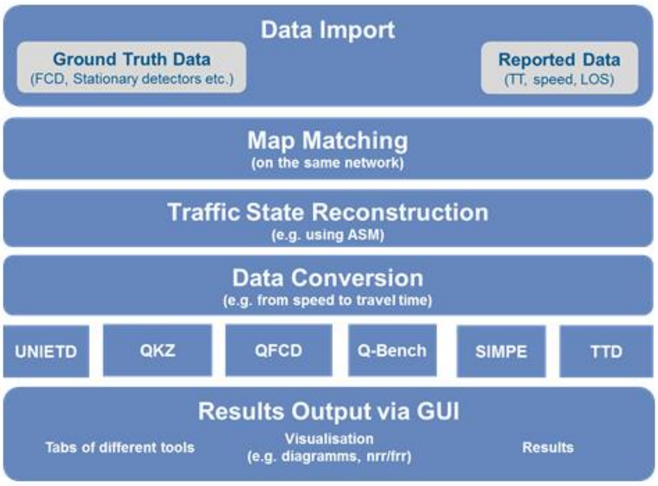


Figure 3: Processing steps of the UNIETD software toolkit

The UNIETD software toolkit was developed and then applied and evaluated in field testing. Results using 2016 data from two service providers showed a significant improvement in quality compared to similar tests undertaken by TRANSVER in previous years.

Social media for traffic management

UNIETD assessed the potential of social media analysis for traffic management, through studies of large Twitter data sets, research into the social media analysis market, and surveys.

The usefulness of tweets as a traffic data depends on the volume of relevant tweets relating to specific highways, and the relevance and quality of the textual content (such as the level of detail and timeliness). Manual assessment found that Twitter textual content includes relevant information for highways management. The figure shows a classification hierarchy with the proportions of messages in each category. A high proportion of tweets are concerned with traffic conditions, particularly routine congestion and unplanned incidents.

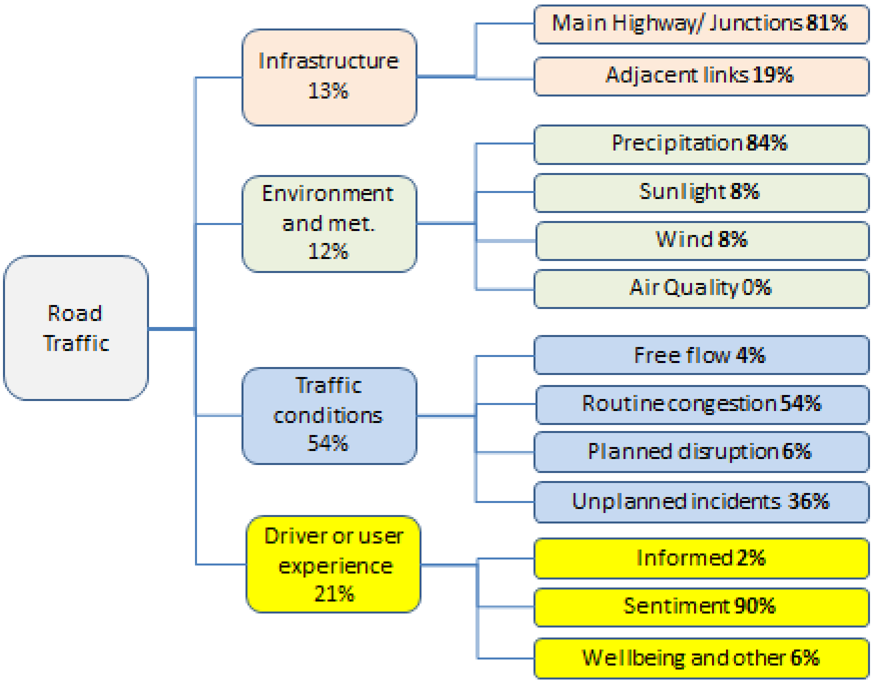


Figure 4 Classification of relevant tweets

Classifiers using machine learning algorithms were trained to detect the relevance and type of messages. Success rates of 70-85% were achieved, which do not support the idea of a fully automated traffic event detection service, but do suggest that a service could be built to produce a filtered stream of relevant tweets to present to a traffic manager for further interpretation.

UNIETD's surveys in England and in Austria confirm the likelihood of significant national differences in the perspectives, choices and behaviour of the general public. These may include trends in smartphone use, platform preferences, use by age groups and whether the user has permitted tweets to be geotagged. A striking national difference is the attitude to government access to personal location data, which was favoured in the UK, but disliked in Austria.

The prevailing view of surveyed social media experts is that over a five to six year time frame, Twitter amongst others will continue to be an increasingly useful source of information. There is very little evidence of expertise in social media analytics specifically for the transport management sector.

Business models for social media harvesting and analytics are highly dependent on the availability of social media data and the extent to which it is free. Travellers may become more aware of the commercial value and monetisation potential of their own data, or they may see it as a social virtue to contribute their data freely for the public good.

Harvesting traffic information from social media is challenging because it is not the result of a purposeful data collection design, but is contributed for a different purpose. The use of social media data within traffic management will require the development of new socio-technical skillsets.

Fusion of third-party and existing traffic data

Accuracy can be improved by fusing detector data with floating vehicle data. Floating vehicle data and data fusion can reduce but not remove the need for fixed detectors. There has been increasing focus on the use of traffic theory to fuse individual vehicle and detector measurements, but there is little or no published objective comparison of the results of different advanced methods.

Quality assessment could add value to data fusion in providing information about conditions, such as day or night, weather, and levels of congestion, in which different data sources become more or less reliable.

While data fusion could use information from social media data as corroboration for unconfirmed events, it is not yet possible to do this in an entirely automated process without any human consideration. However, other kinds of data could be fused with social media to make the process of human assessment of filtered social media more efficient.

UNIETD outlined the extended DVS method for fusing multiple data sets for automated traffic control using fuzzy logic.

Short-term traffic prediction

Following on from the ERA-NET Road Mobility project STEP (2011-13), UNIETD surveyed the state-of-the-art of short-term traffic prediction for traffic management.

Research using data-driven and model-based techniques continues, and hybrid techniques which combine both approaches have also emerged. There are several commercial products and services on the market, and an increasing set of deployments for trial or operational purposes. Floating vehicle data is seen by leading providers of traffic prediction as a very useful source. The accuracy of predictions has been assessed by various methods, but there is no standard, and comparison of the results of multiple advanced techniques has been limited. Further research should focus on evaluation to inform business cases for national roads authorities.

Crowd-sourcing initiatives for traffic data

UNIETD considered “Waze” as one example of the potential of crowd-sourcing initiatives as additional data feeds. The content has been demonstrated to potentially support use cases relevant to traffic management, such as detecting stationary vehicles, detecting congestion, detecting accident-prone locations, analysing network performance, analysing user experience, analysing the effect of police speed checkpoints, weather information and improving road works information. Initial analysis of the distribution and number of Waze users (in 2015) indicates that these numbers look promising in some European countries. However, UNIETD’s work on quality and social media shows that along with operational use of any crowd-sourced data there must be ongoing monitoring of its penetration and quality, due to the variation and volatility in public uptake across locations and time.

Dissemination

The project results were disseminated through several channels including the following publications:

- “Increasing understand of the quality of new sources of traffic data”, I Cornwell, S Grant-Muller, P Cross, M Clarke, T Heinrich, D Elias, B Catchesides; ITS World Congress 2015. Selected as one of the “best” 66 papers (750 presented).
- “UNIETD – Assessment of Third Party Data as Information Source for Drivers and Road Operators”, D Elias, F Nadler, I Cornwell, S Grant-Muller, T Heinrich; TRA 2016
- “UNIETD we stand” [titled by magazine editor], Thinking Highways, August 2016
- UNIETD results included in wider University of Leeds paper at TRB 2016 and submission (currently under review) to IET.
- Factsheet and summary article submissions to multiple industry newsletters

PRIMA – Proactive incident management

Project facts

DURATION: June 2014 – May 2016

COORDINATOR: AIT, Austria

PARTNERS:
TNO, Netherlands
TRL, UK
VTI, Sweden

DELIVERABLES

- D1.1 Inception report
- D1.2a Progress report 1
- D1.2b Progress report 2
- D1.3 Final project report
- D2.1 Summary of stakeholder consultation
- D2.2 WP report including specification of incident scenarios
- D3.1 Assessment results of incident management procedures
- D3.2 Description and results of cost-benefit and risk assessment
- D4.1 Guidelines and implementation steps for pro-active TIM

Background and objectives

Non-recurrent events such as road accidents, vehicle breakdowns and extraordinary congestion – henceforth referred to as traffic incidents – affect travel times, safety and the environment, and also generate costs associated with these impacts. Therefore, road administrations must manage incidents in a safe and efficient manner. Typically, every country has its own traffic incident management regulations and strategies, but there is a need for transnational practical guidance to achieve an optimal balance of cost and risk factors. Furthermore, increased mobility and promising developments in information and communication technologies (ICT) open up new opportunities for handling traffic incidents.

The aim of the CEDR Transnational Road Research Programme 2013 "Traffic Management" is to realise the benefit of implementing innovation in traffic management solutions for National Road Administrations (NRAs). In this context, the project PRIMA targets the enhancement of current state-of-the-art Traffic Incident Management (TIM) techniques by introducing the idea of Pro-Active Incident Management with the following essential features: Anticipate, Prepare, Respond, and Monitor - anticipate that something may happen, be prepared to respond efficiently when the situation requires it, and monitor developments to minimize secondary effects.

The project work has built upon previous regulations, specifications and assessment studies regarding TIM. The objectives can be summarized as follows:

1. Provide clear guidance and recommendations for handling incidents and monitoring management performance and benefits, based on the assessment of risks and costs
2. Assess the technical, economical and organisational feasibility of innovative incident management based on novel technologies
3. Provide implementable solutions to facilitate pro-active incident management for high-level road networks, at a transnational level.

Description and methodology of the project

The project was structured into three technical work packages, as shown in Figure 5. In WP2, a stakeholder consultation survey was carried out alongside with a literature review to collect existing best practice and promising novel technologies as well as to confirm the focus of the project. Furthermore, incident data was from NRAs was analysed to further identify and specify incident scenarios for the assessment in WP3.

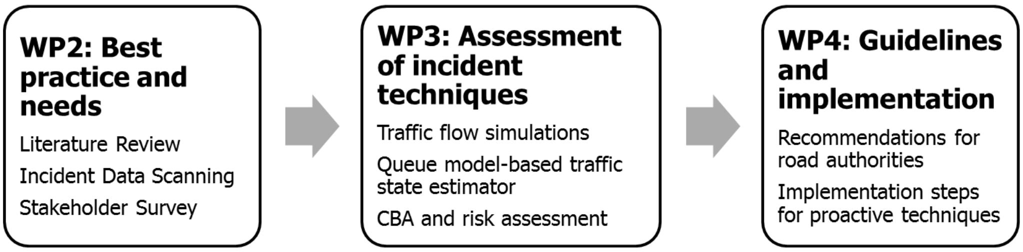


Figure 5: Methodology of PRIMA

By using the information acquired in WP2 as basis, a total of four different incident scenarios were developed during a comprehensive workshop held with the project team. The main target was to get a large variety of scenarios and at the same time satisfy the desired requests from the stakeholder consultation. Most of the highest ranked incidents and technologies were covered in the developed scenarios. The four traffic incident scenarios (all considering motorways) are depicted in Figure 6.

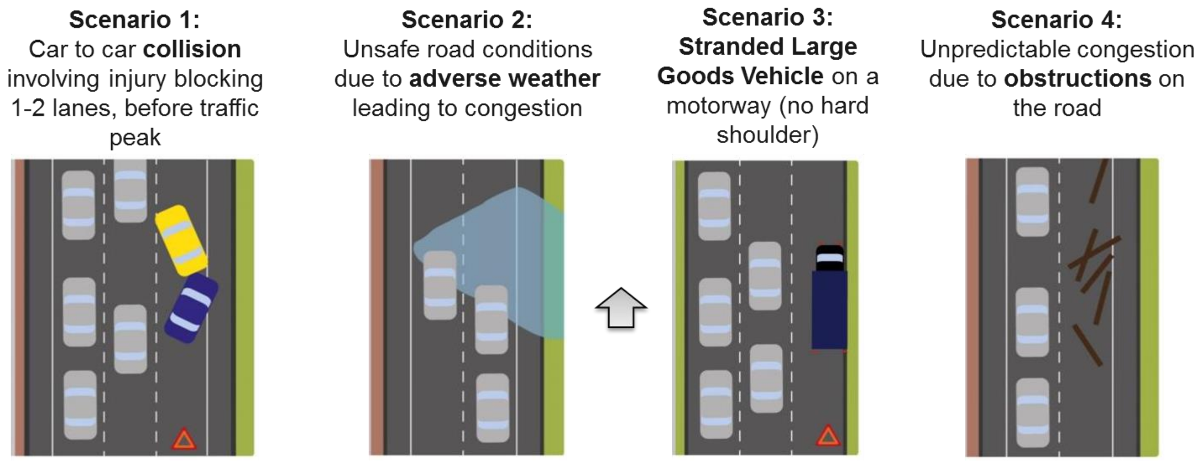


Figure 6: Four traffic incident scenarios in PRIMA

Each Scenario definition is an internally consistent description of a phenomenon, sequence of events, or situation, based on certain assumptions and variables (factors). The use of the scenarios was in estimating the probable effects of one or more of the variables. Variable factors were added to these basic scenario definitions (e.g. traffic volume, operating speed), leading to a set of sub-scenarios, assessment of possible impacts, and a list of potential TIM techniques to be applied (e.g. quick clearance, use of incident screens, eCall etc.).

The feasibility of novel technologies for incident management was assessed in terms of how much the duration of discovery, verification and initial response can be shortened. The amount of saved time was fed into the process of modelling and simulating the incident scenarios, which estimates the traffic performance (e.g. travel time delay and incident duration) for different incident management techniques. Two different assessment methods were developed, namely

1. one more advanced based on macroscopic traffic simulation using the Cell Transmission Model (CTM) and
2. one simpler but quicker based on a deterministic queue model implemented in MS Excel.

The latter queue model was proven to be useful to conduct quick comparisons for different techniques given the start time of the incident, the travel demand profile, speed limit, number of lanes, etc. In addition, the macroscopic cell transmission simulation model was applied to investigate the effect of different scene management techniques in more detail. The cell transmission model has longer execution times and requires more calibration work, but gives a more detailed description of changes in the traffic state due to an incident and different incident management techniques. The simulation model takes on- and off ramps into consideration and can capture variations in the travel demand at a higher level of detail. Hence, for more complex motorway sites with recurrent incidents, a local calibrated macroscopic traffic simulation model would be a more preferable decision support tool for scene management.

As a result of the assessment task, the overall travel delay, queue length and incident duration were calculated for a high variety of incident management techniques and scenarios. The effect on traffic performance and the estimated time savings were then used to estimate the risks and costs of the different incident management techniques given a specific incident scenario. For detailed results of the assessment, it is referred to the PRIMA deliverables D3.1 and D3.2.

A further analysis was conducted with regard to the severity of incidents, especially in case of accidents, where information on casualties and injuries is essential. In Advanced eCall, injury risk information is added to the eCall message. This has the potential to further improve emergency response, both in quality and time. A prerequisite for adding injury risk information to eCall is that a real time injury risk estimator is available, which can be used to estimate the risk of injury based on sensor input from the vehicle. In WP3, a first step towards Advanced eCall was made by performing a feasibility study on the use of TNO's Human State Estimator to predict injury risk on a real time basis.

Evaluation and outcomes of the project

The objectives of PRIMA were to develop a guide with recommended TIM techniques based on risks and costs and to define implementation steps and business models for the most innovative ones, providing clear guidance on pro-active incident management to road authorities. This was achieved by synthesizing all inputs provided by the stakeholder consultation and best practice review, by assessing techniques using simulations and by presenting the most effective techniques for handling different types of incidents, across the whole TIM cycle.

Figure 7 shows example results for the car-to-car collision scenario (nr. 1) with time-space diagrams for three different TIM strategies. The coloured triangles depict the results from the macroscopic traffic simulation (with green being free flow and red or black being low or zero velocity), while the white triangles stem from the calculations of the deterministic queue model. It can be seen that the results for this case are quite similar and that towing away later would dramatically decrease the queue duration and length.

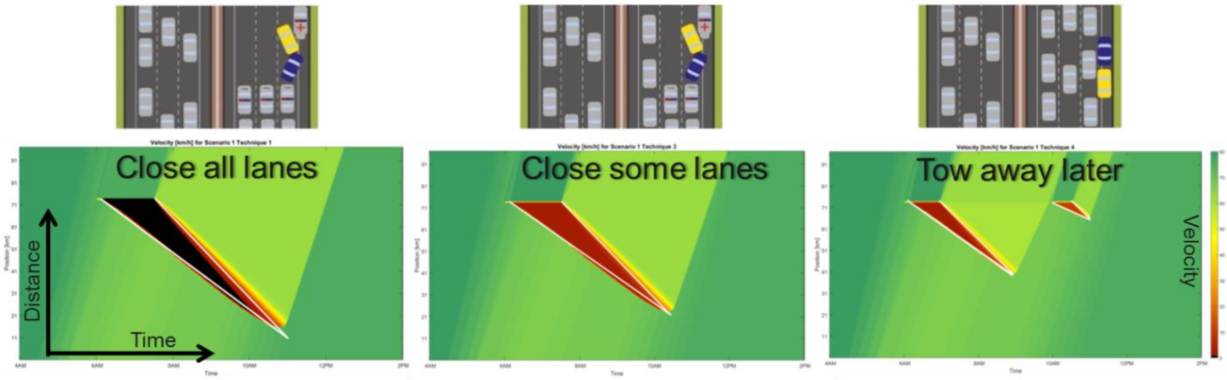


Figure 7: Results of the assessment of three different TIM strategies for the car-to-car collision scenario

Calculations like the one above were conducted for many variations of scenarios, also considering the expected impacts of novel technologies. Alongside with an assessment of risks and costs, this led to a total of 14 recommended TIM techniques as depicted in Figure 8 and described in the PRIMA guidelines (D4.1).

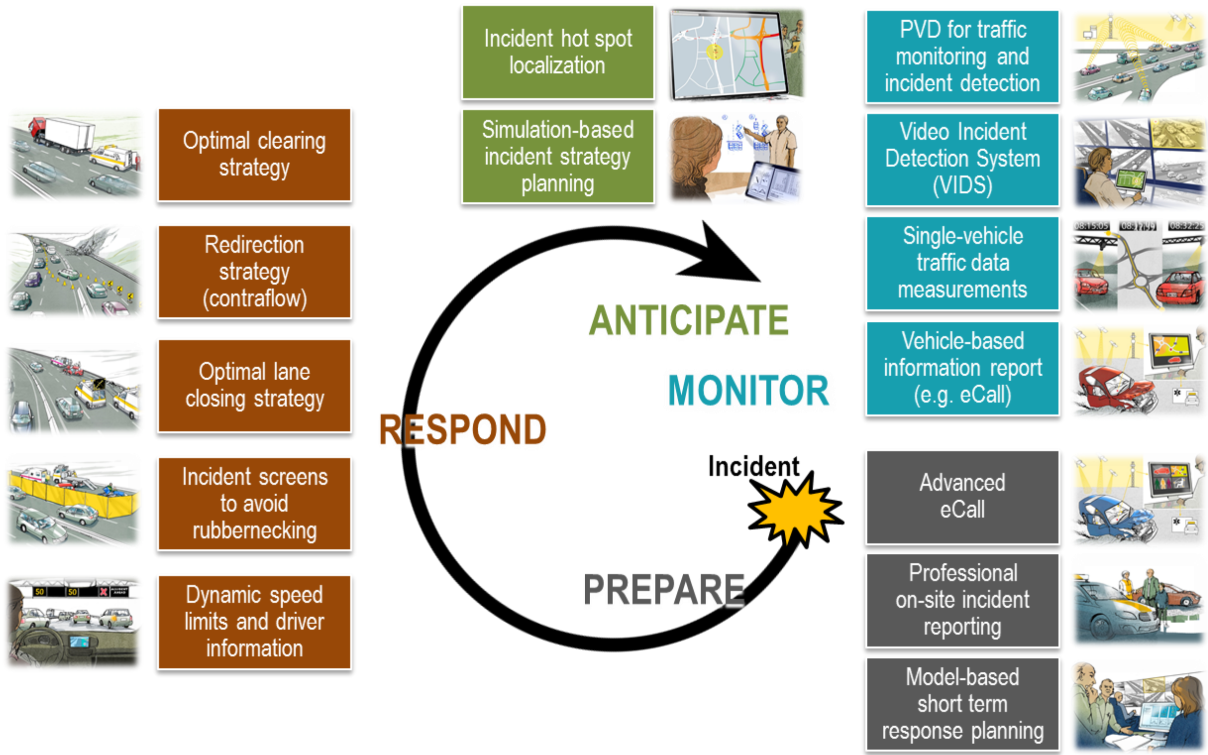


Figure 8: Recommended pro-active incident management techniques in PRIMA

In summary, PRIMA produced the following four outputs, which could be taken further:

1. PRIMA guidelines incl. recommended TIM techniques
2. Experimental tool #1: Simulation-based incident response strategy planning tool

3. Experimental tool #2: Model-based short-term incident response planning tool
4. A model for injury estimation for "Advanced eCall"

Further development in terms of refining the models (i.e. the simulation-based model (2) and the deterministic queue model (3), respectively) as well as enhancing and developing the user interfaces would make each an attractive decision support tool for traffic incident management.

PART II

Implementation

Outcomes from the workshop

A workshop was held to present the outcomes of the three projects and discuss implementation with interested parties. This workshop was held in Dublin on 25th October 2016 and was attended by representatives of CEDR, the National Road Authorities of England, Ireland, Belgium-Flanders and the Netherlands, research organisations, consultancies and maintenance contractors.

Discussion and implementation of METHOD, UNIETD and PRIMA

METHOD

Although the project did not cover commercial service providers explicitly, the results of the METHOD project could be very relevant to them. A potential next step would be a wider use case looking at the human factors elements related to service providers and the commercial aspects.

It was mentioned that Highways England have created a role called Human Factors Champion to help with the implementation of new technologies. The aim is to keep the user at the heart of the design process and to include human factors considerations from as early as possible. This is an idea that could be picked up by other national road authorities. It is important to get buy-in from stakeholders as early as possible in the process, although this is difficult when the target audience is “all road users”.

One of the main findings from the project is the need to treat people like individuals. However there is a high-level conflict that needs to be considered between treating people like individuals and standardisation (such as standard road signs).

There is an opportunity for a new type of traffic management which is tailored to the individual and to reconsider whether the status quo is actually the best way of doing things or whether users have merely adapted to the situation. For example – the ‘Queue Ahead’ sign is a standard UK road sign, however it is not that useful to an individual – users would prefer to know details such as whether the queue is forming or dispersing, or its cause. The desired information given in any situation will depend heavily on familiarity with the road in question, amongst many other things. However, care must be taken to not design for the “weakest link”.

There is a need to create new expectations in the design process and the user must be central. The aim is to somehow strive for standardisation and uniformity but also tailor for the individual.

A possible avenue may be through new in-car technology. The project has shown the potential in gamification as a method of influencing driver behaviour. The concept was well-received by participants, and compliance improved, however the extra workload was found to make the driving experience more stressful and the game not fun enough to compensate.

Existing signs and signals in the most part provide a “negative” message, in that they are directing users not to do things, or warning them of hazards. The concept of positive feedback in-vehicle, demonstrated through gamification, may be useful in providing reward rather than punishment. Another example of this would be a model such as supermarket loyalty systems – in this case, rewarding drivers for driving well.

UNIETD

There is difficulty getting reliable information from social media. Human judgement is still needed to understand subtlety; for example identifying sarcasm is a challenge. A significant proportion of relevant tweets have been found to come from a small number of people. Geotagging is usually needed in order to confirm the subject location, but geotagged data represent a small proportion of the overall data set. Nevertheless, the size of the data set does suggest real promise in these data. Automated classifiers are nowhere near accurate enough yet but they can be used to filter down to make the dataset manageable.

Waze was noted as one specific offering whose data shows potential for traffic management applications. The project was not able to establish a clear process for agreeing operational access to Waze data [but since the event, Waze and its new UK operation appears open to talk to large organisations on this matter].

Although out of scope of the current project, social media is already being used actively by roads operators to inform travellers; further research could explore to what extent existing platforms and expertise of social media processing specialists could be adapted to support social media conversations between roads operators and road users.

The volatility of social media platforms is also a risk to manage when considering investment, for example Twitter use has been reported to have declined in one country over one particular time period, and it is difficult to predict longevity. Processing systems should be developed to be as generic as possible and then tailored to fit to specific social media platforms. Dashboard reports of the volumes of relevant messages should accompany such systems.

PRIMA

The outcomes of PRIMA, in particular the incident response modelling tools, are seen as very useful and promising support for incident managers. The PRIMA guidelines will be distributed via CEDR and complement the existing CEDR guidelines on TIM. For an implementation and a roll-out of the models within NRAs, they need to be further developed in terms of user-friendliness and interfaces. An issue that came up during the workshop was the country-specific differences in incident management practice. While some countries already use advanced incident management methods such as hot spot maps and simulations, other rely on more traditional techniques. Hence, the models may have to be tailored to country-specific needs.

The speed of incident detection is crucial. Highways England have carried out a trial started of (almost instantaneous) radar detection, where control centre operators have been able to respond within 12 seconds. The event is detected by radar and control centre operators can then rapidly identify closest CCTV. The eCall system, currently scheduled for 2018, is another method of reducing the detection time and increasing the flow of information.

The PRIMA project has identified the risks of systems causing too many false alarms, leading to lack of credibility, and also the risk of operators having too much reliance on the systems. It is felt however that many operators have extensive camera networks which are expensive to run and sometimes not used a great deal - therefore anything that uses data and sensors to work more efficiently is desirable.

Operators such as Highways England often have performance targets for lane availability and journey time; the "tow away later" option in PRIMA directly benefits both of these. Safety aspects must still be considered of course, but PRIMA provides a useful tool for illustrating such options. There was a question about how the increasing use of smart motorways (i.e. no hard shoulder) would impact the “tow away later” option. It was proposed that perhaps the Emergency Refuge Areas could be used for this. Another option may be pre-positioned recovery vehicles at identified hot spots. Again, it is important however to avoid designing for the weakest link and providing services to badly-prepared drivers and inadvertently failing to discourage the behaviour.

There is often a conflict when multiple agencies dealing with incidents have different objectives, e.g. the Police, the road operators etc. There is a balance between efficiency and safety. Any incident response strategy needs to consider how to engage all agencies and to consider how to align procedures and processes so that everyone has buy-in. Currently in many countries these procedures are very separate. In Highways England there are shared control centres for the road operators and the emergency services and the alignment is quite successful. Clear lines are drawn between the two agencies within the control centres but it does provide the opportunity for collaboration.

There will be an increasing requirement for the kind of network modelling demonstrated in PRIMA, for example, airports are starting to use these techniques. This provides an opportunity to extend the knowledge developed in the project into new areas.

Implementation of CEDR projects

Past Projects – COBRA, Seamless and STEP

The three specific projects discussed were all from the ERANET ROAD 2011 Traffic Management call and have been implemented in different ways. The COBRA project developed a cost-benefit assessment tool for road authorities, which has been used but also further developed in a subsequent follow-on CEDR project (ANACONDA).

This project has increased understanding of the importance of bundling of C-ITS services. COBRA has contributed to the assessment of pilots and deployments led by Highways England, including the ongoing A2/M2 corridor pilot in the UK.

The STEP project developed a short-term traffic prediction system; a successor to this system has been installed in a control centres in Rotterdam and is helping operators. The accuracy of predictions in the system is continually improving and the project has helped to generally develop better prediction technology. The use of the system in practice has also helped refine what operators want and need to see in front of them. As part of the joint procurement process for renewal of the Traffic Management Centre (TMC) operational systems with Highways England and Rijkswaterstaat, the CHARM PCP programmes Lots 1 and 2 are both using prediction technology that was shaped by the experience of STEP, and which are providing new capabilities that may be deployed after fruition of the CHARM PCP programme to complement the capability of the main CHARM ATMS. The experience of STEP really had a big influence on how these predictors are being developed now for CHARM.

The Seamless project contributed not just research reports but a large number of updates and proposed improvements to standards and specifications in accordance with architectural principles that the project established. The DATEX II model and profile for traffic management plans was deployed in Germany and it has been used within the CHARM PCP programme to publish location-specific driver advice to service providers for dissemination to in-vehicle devices. This particular development supports improved driver information.

There are also proposed improvements to the DATEX II protocol – due to the pace of CEN and DATEX development, these are being approved gradually: some have been approved already and others are expected to form part of DATEX v3, which is to be finalised in 2017, and to be part of CHARM DATEX services in future. They should make it more cost-effective to realise successful DATEX II communications of travel time and other processed traffic data.

General discussion on the CEDR research programme

In the traffic management area there have been some really strong examples of CEDR projects demonstrating innovation. In terms of aspirations going forward there is a need for a road map for how best to implement the valuable output from projects.. This doesn't always mean outputs are directly implemented into operational practice. Project outputs have different levels of maturity; some require more research and some require dissemination. It is ideal if the distribution of outputs can be built into the original project or another project can be commissioned for implementation.

A key concept is that the conclusion of the projects should not be considered the end of the programme, merely the end of the research element. For example the floating vehicle quality evaluation research in UNIETD is ready for uptake in assessments to inform procurements.

Before considering ways to improve implementation of outputs, one key conclusion is the need to be more vocal about the outputs that are already used, and the impact they have. In many cases, outputs are in operational use but this information does not get through to relevant stakeholders, such as the directors of funding road authorities. May be a change of mindset to become more sales-oriented; in order to demonstrate the value of the programmes, information about what has been done and the associated benefits needs to be communicated with those responsible for the continuation of the programmes. It may be useful to consider tailoring outputs such as reports for different audiences – e.g. requesting projects to provide a short summary and impact statement to accompany project reports.

There is a need to improve the communications interface with the road authority directors and be more forceful with regards to disseminating the many benefits of the programmes (as well as sharing knowledge of aspects that have not been successful).

All CEDR calls start with thematic workshops with national road authorities in order to identify problems common to all. These thematic workshops are useful in themselves as, in many cases, identifying the problem is an achievement as well. As the funds invested from road authorities is pooled to tackle these common problems, the return on investment is greatly increased, even though the output may not be as tailored to individuals as ideally it would be. It must be made clear however that there can be a long timeline associated with some of the research; the element of visualising the future can be a useful input for authorities also.

All participants benefit from the sharing of best practice and of the open-source outputs. Pan-European road authorities share many problems and the increasing collaboration and collective-thinking enabled through the programmes is of great benefit. There are parallel benefits of collaboration between suppliers as well as between the NRAs. There have been many occasions where suppliers have subsequently worked together. It can be very useful for suppliers to understand from the programmes the problems facing the NRAs and may lead to further opportunities for collaboration.

These projects can be useful for securing additional funding within national authorities, for example the COBRA tool was used to develop the methodology for the impact assessment and business case for the A2-M2 connected corridor in the UK. They can be a tool for demonstrating and ensuring national funding is allocated where it can be most cost-effective.

As discussed above, it can sometime be difficult for outputs to be adapted for use more widely. For example, in Belgium there is no traffic officer service, and therefore this element of the PRIMA outputs is redundant unless directed to other government departments. As well as consideration within the projects, there needs to be effort directed towards this after project conclusion. An important role for tackling this would be the product development champion or similar; for ideas and outputs that show promise during the research phase, the role would then take on responsibility for carrying them forward from knowledge to implementation and aligning with the objectives of the organisation.

The success of implementing systems in the STEP project shows the value of getting users involved as early in the process as possible, in order to optimise the ability to take outputs forward into an operational context. This links to the importance of incorporating the human factors element as discussed in METHOD. As well as the need to communicate and disseminate to management level as discussed above, there is as strong a requirement to communicate also with those interacting with the outputs in operation, for example control centre operators. This is because there is a potential conflict between the “top-down” view and “bottom-up” view. If an idea or a tool is identified as having promise through the research, it needs to be taken to operators for input. Ideally there would be an EU-wide working group or similar forum of operators for consultation. The question therefore becomes how best to facilitate such engagement; one example that is being tried in the Netherlands is to hold dissemination events in control centres. It may be that funding from these programmes can be used to target dissemination in this way.

It is important to note however that CEDR as an entity cannot mandate national road authorities to act; any implementation needs to be driven at a national level.

One potential way of encouraging better engagement between different agencies and operators is to identify the common objectives. Existing working groups could establish their priorities and specific areas of interest and then identify which other organisations share them. This already happens at the thematic workshops discussed above, but with narrow participation. It is worth noting that members of supply chains can be included in project board meetings, however there is usually a resource constraint as well as financial restraint that precludes this.

Recommendations

Following the conclusion of the projects in the programme and the discussion around the CEDR research programme, the following recommendations are proposed for CEDR and / or the National Road Authorities as appropriate:

- Consider establishing and / or promoting the role of ‘Human Factors Champion’ within national road authorities. The purpose of this role is to ensure human factors elements are taken into account (as early as possible) when designing and implementing new services using new and emerging technologies

- Distribute basic knowledge regarding human factors to all personnel involved in traffic management at all levels, through dissemination and promotion of the METHOD 'Human Factors in Traffic Management' booklet within national road authorities and their supply chains.
- Promote and encourage close cooperation between traffic management centres, emergency services and other actors involved in traffic and incident management, in particular when designing strategies. Good practice can be shared through Highways England joint control centres.
- Disseminate the PRIMA guidelines for use by NRAs. An option for this would be to incorporate into the CEDR Traffic Incident Manual – either as a supplement or as part of a re-publication.
- Refinement of the experimental tools developed in PRIMA (both the underlying models and the user interface) with the aim of producing professional decision support tools for traffic incident management.
- Dissemination and use of the UNIETD toolkit; this enables comparison of the various methodologies for assessing traffic data quality, including the UNIETD method. Good practice can be shared through prior successful operational use.
- Carry out or promote further research into the evaluation of short-term traffic prediction techniques for traffic management to inform business cases for national roads authorities.
- Promote and encourage further development towards the operational use of social media conversation in traffic management. Establish best practice for processes and tools and assess the potential of existing platform products.
- Consider requesting all CEDR projects to provide a short summary and impact statement (aimed specifically at NRA directors) to accompany final project reports.
- Consider establishing a development role in NRA that, for ideas and outputs from projects that show promise, would take on responsibility for progressing them from knowledge to implementation and aligning with the objectives of the organisation.
- Consider ways to facilitate engagement with operators on an EU-wide basis. This could include holding events in different locations, targeting funding specifically towards such dissemination, establishing a forum or working group, using the existing working groups to identify common objectives.

CEDR Contractor Report 2017-04 (September 2017)

Call 2013: Traffic Management
METHOD, UNIETD and PRIMA projects

Conférence Européenne
des Directeurs des Routes
Conference of European
Directors of Roads

Conference of European Directors of Roads (CEDR)
Avenue d'Auderghem 22-28
1040 Brussels, Belgium
Tel: +32 2771 2478
Email: information@cedr.eu
Website: http://www.cedr.eu

ISBN 979-10-93321-35-6