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PRIMA
PRO-ACTIVE INCIDENT MANAGEMENT

Final Report

Deliverable D1.3
June 2016

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CEDR Call 2013: Traffic Management
PRIMA
Pro-Active Incident Management

Final Report
(D1.3)

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Executive summary

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.

This final report summarises all activities performed and the most relevant results of the project PRIMA (Pro-Active Incident Management), which constitutes a part of the CEDR Transnational Road Research Programme 2013 „Traffic Management“. 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.

To this end, existing and novel techniques applied to the phases of the TIM cycle (Discovery, Verification, Initial Response, Scene Management, Recovery and Restoration to Normality) were assessed in terms of their potential to optimize the overall incident duration, i.e. discovery, verification and response time, while maintaining the right balance of risks and costs for the road administrations. Based on the current best practice, as well as results from stakeholder consultations and a comprehensive literature review, a set of four representative incident scenarios has been determined to evaluate the performance, risks and costs of pro-active TIM.

PRIMA brings forward two pro-active techniques to assess incident management measures, developed within the project:

1. The model based short-term response planning tool can be useful to conduct quick comparisons of different incident management techniques for a real-time occurring incident.
2. On the other hand, the simulation-based incident response strategy planning tool can be useful to investigate the effect of different scene management techniques in more detail, as an anticipatory measure. This tool is best suited for more complex road networks with recurring incidents. The two tools can be an added support for incident management centres.

The assessment was followed up by the development of practical guidelines and recommendations for traffic managers of motorways and primary roads. The guidelines comprise a list of 14 pro-active TIM techniques that PRIMA finds most beneficial, described in a format that provides details on the benefits, cost elements, implementation steps and risks of applying a specific technique in the TIM cycle. In the longer term, the project outcomes are expected to lead to safer and more efficient and automated strategies for handling traffic incidents as well as optimal integration of innovative and novel methods with existing traffic management environments.

1 Introduction

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.

This report summarises all activities performed in the project duration from June 2014 to May 2016 and presents the most relevant results. For detailed results, it is referred to the technical project deliverables

- D2.1 (Stakeholder consultation report),
- D2.2 (Work package report including specification of incident scenarios),
- D3.1 (Assessment results of incident management techniques),
- D3.2 (Description and results of the CBA and risk assessment) and
- D4.1 (Guidelines and implementation steps for pro-active TIM).

The chapters 2 to 5 of this report are devoted to the respective work packages, before the report is concluded with an outlook on future implementation and open research questions.

2 Best practice and needs in incident management (WP2)

All activities of work package 2 were completed by February 2015 (see milestones and deliverables in Table 1). The objectives of WP2 were:

- Carry out a stakeholder consultation exercise to confirm the focus of the project and ensure the output is fit-for-purpose
- Review existing best practice in traffic incident management
- Identify and specify incident scenarios for the assessment in WP3

Table 1: Milestones and deliverables in WP2

No	Milestones/Deliverables
M2.1	Stakeholder needs obtained
M2.2.	Relevant scenarios specified
D2.1	Summary of stakeholder consultation
D2.2	WP report including specification of incident scenarios

2.1 Stakeholder consultation

A web-based survey was designed and offered to over 100 individuals with a professional interest in Traffic Incident Management (TIM) drawn from national and local governments, concessionaires, police and other professional bodies in 22 countries. In total, 18 responses (including one partial response) were received from 13 countries (59%), including all those represented in PEB (see Figure 1). Nearly all the responses are from NRAs (six being from or on behalf of the Rijkswaterstaat 'wearing two hats'). Because invitations were sent to several members of some organisations not all of whom were expected or needed to respond, the effective individual response rate is around 26%. The results are analysed in the deliverable D2.1 (Stakeholder Consultation Report, Taylor et al., 2015c).

Country responded	Number of responders
Sweden	2
Austria	1
Ireland	1
The Netherlands	5
Belgium	1
England	1
Norway	1
Finland	1
Denmark	1
Slovenia	1
Germany	1
Australia	1
USA	1
TOTAL	**18**

Figure 1: Number of responses from different EU countries, plus US and Australia

2.2 Definition and classification of incidents

Task 2.2 defined and classified incidents that represent the focus of the project. Starting with an initial list of incident types that resulted from the initial planning workshop, the work was continued by incorporating valuable feedback from the PEB meeting as well as by reviewing literature and TIM guidelines. The final list of incident types was concluded with results and input from the stakeholder consultations (see Figure 2) performed in Task 2.1.

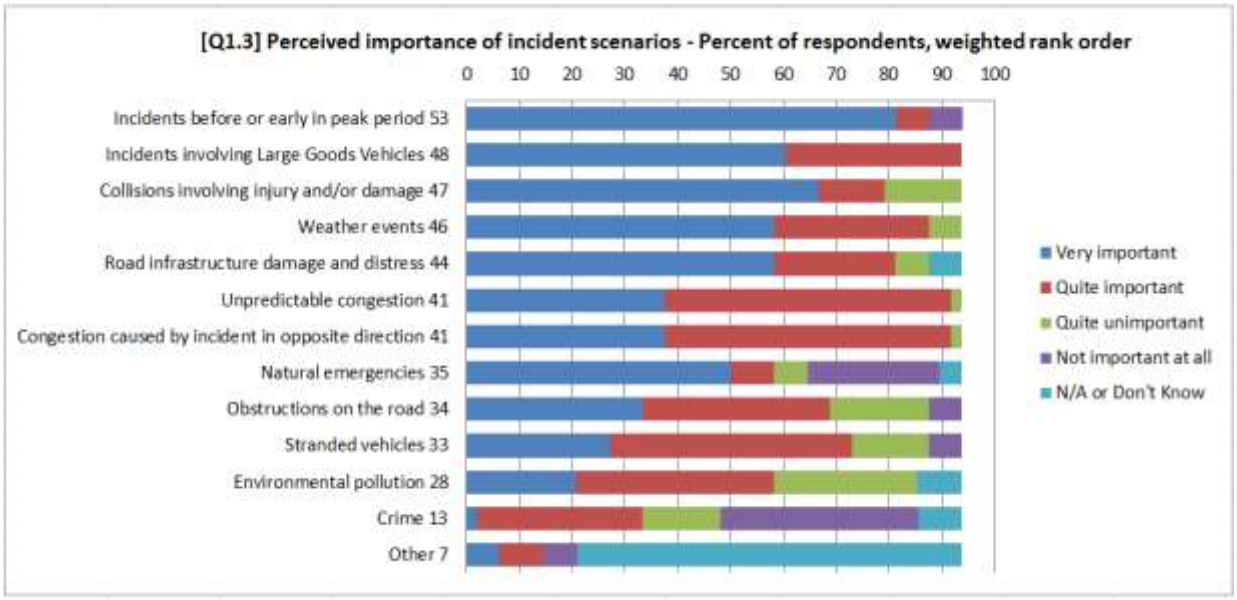


Figure 2: Relevant incident scenarios (ranked by weighted responses)

Based on the stakeholder response, literature and discussions within the project team, PRIMA defines a traffic incident as follows:

> A **traffic incident** is any unplanned event that may adversely affect the safety or the capacity of a road and hinder traffic flow.

In addition, two other definitions were developed and used as such in PRIMA:

> A **technique** is a way of conducting a series of traffic incident management actions (e.g. close lanes, secure workspace, tow vehicle and reopen lanes), eventually by applying a certain technology (e.g. Variable Message Signs, Probe Vehicle Data, etc.)

> A **scenario** is an internally consistent (verbal) picture of a situation or a sequence of events, based on certain assumption and factors (variables).

2.3 Review of existing best practice in incident management

It is acknowledged that there has previously been a significant number of reviews of best practices in traffic incident management and so this tasks looked to start with the recent CEDR publication 'Best practice in European traffic incident management' (CEDR, 2011) and other relevant documents such as the accompanying Aide Memoire for responders, the 'EasyWay Guidelines for the deployment of incident management' (EasyWay, 2010) and

similar guidance documents produced by individual national road administrations (e.g. ASFINAG, 2011; Austroads, 2007; FHWA, 2000; Highways England, 2009a and 2009b).

The existing documents and current operational best practice was reviewed in line with the definitions resulting from PRIMA's Task 2.2, taking into account the stakeholder opinions and information gathered in Task 2.1. The aim was also to widen the scope by investigating any relevant best practice from countries not covered by previous reviews. The PRIMA Deliverable 2.2 (Taylor at el., 2015a) reviews the previous CEDR projects Tasks 5, 12 and 13, national TIM experience and guidance documents (including outside Europe and FHWA initiatives), important aspects of best practice and features of pro-active TIM. Further sections deal with classification and costing incidents, specification of scenarios and cost-benefit analysis methods for the assessment, later in WP3. The deliverable concludes with summary lists of requirements, methods for taking PRIMA forward and proposed guidance outputs from the project. A summary is given in the following:

Needs for pro-active TIM:

- Realistic scenarios to be prepared for (examples in section 2.2)
- Identification of appropriate technologies and techniques
- Ability to assess incident risk by location, time, weather, traffic conditions etc.
- Ability to rapidly (re-)assess incident situations and their likely impact and duration
- Having necessary resources in readiness

Prioritization of incident types based on the best practice review and stakeholder consultation:

- Incidents before or early in peak period, especially with heavy traffic and/or few alternative routes
- Lane-blocking incidents
- Incidents with potentially long duration, e.g. involving LGVs, fires, oil spills
- Incidents affecting critical sites like bridges and tunnels

Tools and measures that may assist pro-active TIM:

- Novel techniques and technologies to be assessed (in WP3) including Probe Vehicle Data and other real-time data sources and traffic pattern recognition
- Other existing techniques identified in Stakeholder Consultation including:
  - Passive measures like incident screens (used to hide the incident scene to avoid distraction and rubbernecking by passing drivers), trucks with lane-closed or change-lane signs, cones etc.
  - Rapid clearance provided legal issues are resolved
- Risk analysis and decision support tools
- Scene recording to evidential standard, e.g. by laser scanning
- Specialized units in place where appropriate.

2.4 Identification and specification of incident scenarios

In Task 2.4, a plan for choosing incident scenarios was established. By using the information from the stakeholder consultation as base, a total of four different incident scenarios were developed during a comprehensive workshop held with the project team.

The main target was to obtain 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 according to the stakeholder consultation were covered in the developed scenarios, here stated below:

Scenario 1: Car to car collision involving injury, before traffic peak
Scenario 2: Unsafe road conditions due to adverse weather leading to congestion
Scenario 3: Large Goods Vehicle stranded on a motorway
Scenario 4: Unpredictable congestion due to obstruction on a motorway

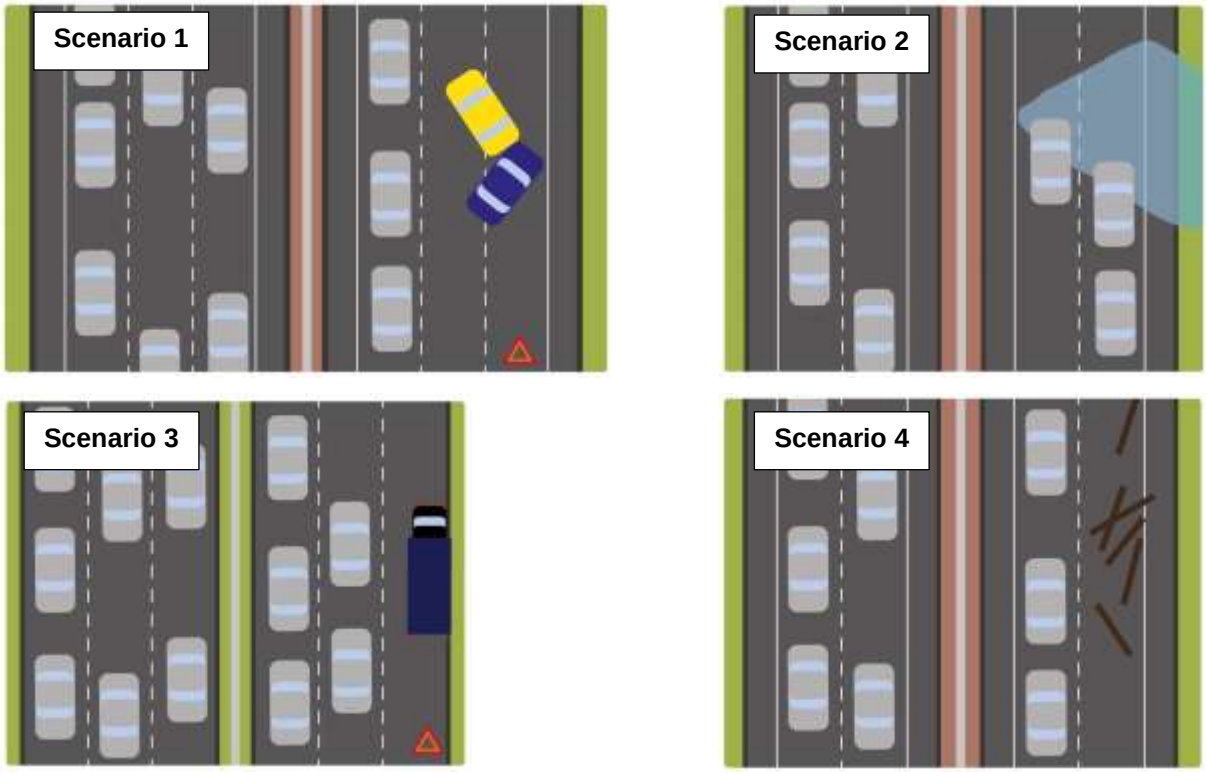


Figure 3: Illustrations of the four PRIMA incident scenarios

Variable factors were added to these basic scenarios (e.g. traffic flow, existing TIM infrastructure etc.), leading to a set of sub-scenarios, assessment of possible impacts and a list of potential TIM techniques to be applied. The scenarios and the TIM techniques that have been considered for each scenario are documented in Deliverable 2.2 - Report on best practice, needs and derived incident scenarios (Taylor et al., 2015a).

3 Assessment of existing and novel traffic incident management techniques (WP3)

Work package 3 started in January 2015, in connection with the first Progress Meeting, with aim of finalizing WP2 and handover from WP2 to WP3. WP3 looked to assess novel technologies and to estimate the risks and costs of the chosen combinations of incident scenarios and TIM techniques. An additional milestone has been added in WP3 (see Table 2). The milestone is for the handover of results from Task 3.2 to Task 3.1 with respect to assessment of potential time and cost savings in the Discovery and Verification phases (of the TIM cycle) when using novel technologies.

Table 2: Milestones and deliverables in WP3

No	Milestones/Deliverables
M3.1	Specifications of traffic model scenarios completed
M3.2	Assessed performance indicators transferred to Task 3.1
M3.3.	Traffic analysis of incident scenarios completed
M3.4	Cost-benefit and risk analysis completed
D3.1	Assessment results of incident management procedures
D3.2	Description and results of cost-benefit and risk assessment

The objectives of WP3 were:

- Estimate costs and risks of the representative set of combinations of incident scenarios and incident management techniques defined in WP2
- Investigate the feasibility of novel incident management methods

The assessment was conducted in three different steps according to the flow chart in Figure 4. The process of assessing the feasibility of novel technologies evaluated how much the response time can be reduced by using combinations of different novel technologies to shorten the discovery, verification and initial response phases. The length of these phases also depend on the type, quality and correctness of the information that these novel technologies provide, so in addition also quality indicators were investigated as well as the feasibility of automatic incident severity classification. The amount of saved time was fed into the process of modelling and simulating the incident scenarios, which estimated the traffic performance (e.g. travel time delay, queue length and incident duration) for different incident management techniques. 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. The analysis of the risk, cost and benefits were presented in a separate deliverable, namely PRIMA D3.2 – Description and results of the CBA and risk assessment (Taylor et al., 2015b). In the end the different assessments were used as input to the development of the PRIMA traffic incident management guidelines.

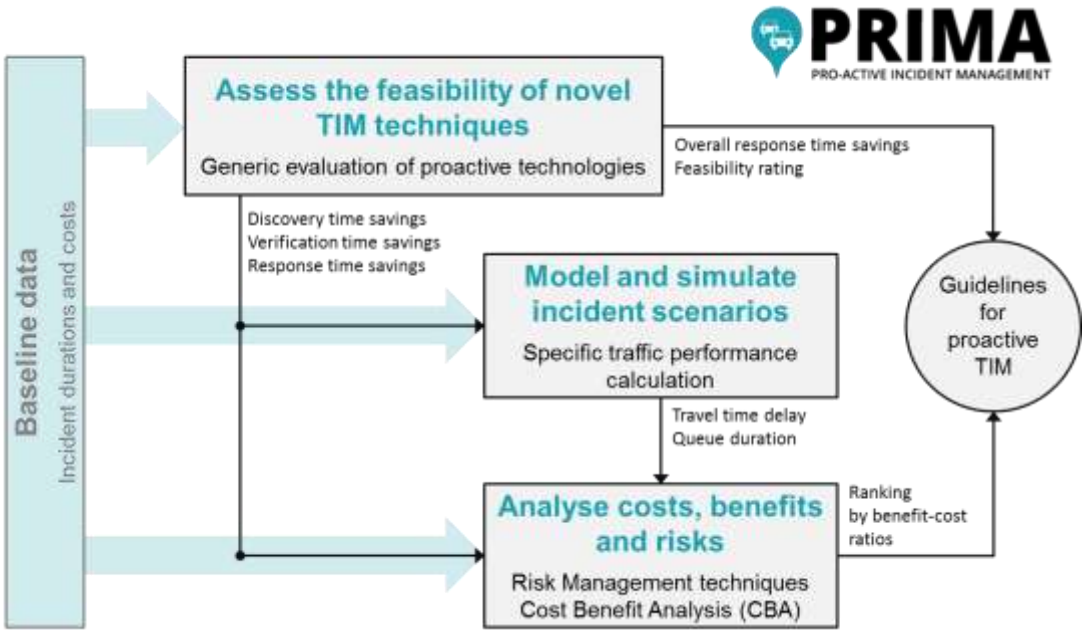


Figure 4: Methodology in PRIMA WP3

In the following, the activities in the different tasks are described. For detailed results, it is referred to the deliverables D3.1 (Olstam et al., 2015) and D3.2 (Taylor et al., 2015b).

3.1 Modelling and simulation of incident scenarios and scene management techniques

This task started with planning of the framework for assessment of costs of congestion for the combinations of incident scenarios and techniques chosen in Task 2.4. The work in this task was closely related to Task 3.2 and 3.3. The amount of saved incident management time by using innovative techniques, as estimated in Task 3.2, was fed into this task of modelling and simulating the incident scenarios in order to estimate the traffic performance (e.g. travel time delay, queue length 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 this task, the overall travel delay, queue length and incident duration were calculated for a high variety of incident management techniques and scenarios. Those numbers were fed into Task 3.3, where the cost-benefits were calculated.

The traffic performance assessment showed that alternative scene management techniques as quick clearance involving towing in off peak, contraflow, and closing a limited number of lanes can decrease delay and incident durations. However, the rank order of techniques depends on the start time of the incident in relation to the traffic peak, the assumptions for the duration of the different phases, the travel demand profiles, etc. The results show that there can be substantial differences between the total delay and the incident duration depending on which technique is applied for a given incident scenario, see for example Figure 5, which shows the results for the incident scene management techniques considered for scenario 1 given different travel demand profiles.

The time savings that can be achieved from novel technologies were assessed in Task 3.2 (see Section 3.2) and categorized into low, medium and high. The plot in Figure 5 depicts the results for the time category medium, assuming that novel technologies such as vehicle-based information reports (e.g. eCall) or Video Incident Detection Systems can reduce the detection phase duration by 80%, the verification phase duration by 70% and the initial response duration by 67%. Further explanations are given in deliverable D3.1 (Olstam et al., 2015).

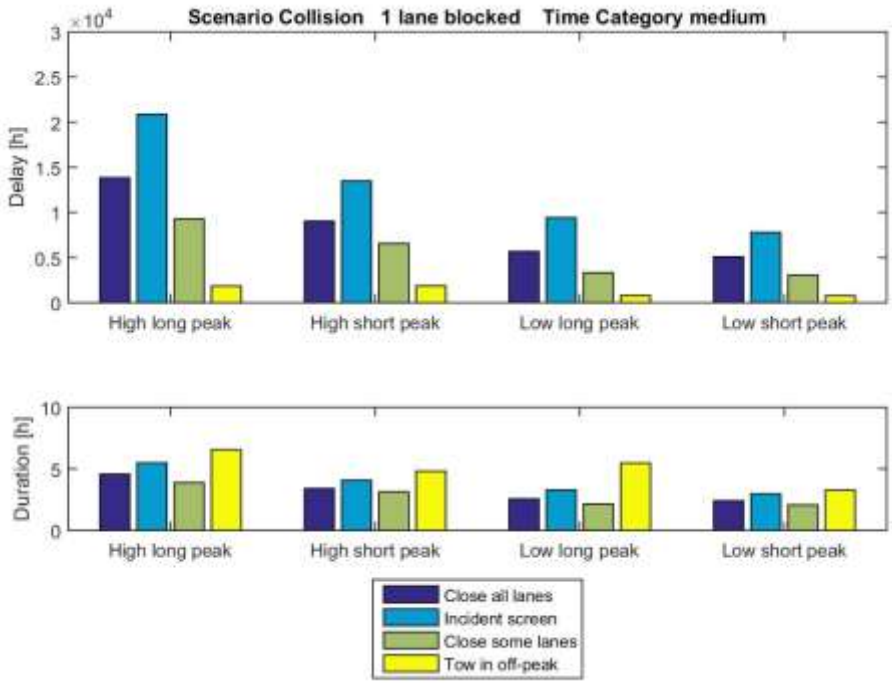


Figure 5: Results from incident scenario 1 (Collision) with one lane blocked and medium time savings due to novel technologies

3.2 Assessment of the feasibility of novel techniques

The objective of this task was to assess the feasibility of novel and innovative techniques for incident management. This involves solutions for detecting, classifying and verifying incidents based on promising technologies that are likely to be wide-spread in the near future, e.g. eCall or Probe Vehicle Data.

The assessment was carried out according to the following steps:

- Identification and definition of performance indicators, including time relevant and quality relevant indicators,
- Categorization and pre-selection of promising novel techniques
- Qualitative assessment to describe the feasibility of novel technologies for incident management

Techniques that can be used for discovering and verifying an incident range from basic 'low tech' reports to more 'high-tech' and automatized. The following techniques were considered in the PRIMA project:

- **Citizen reports:** This is the most basic type of detection and verification based on travellers calling the traffic management centre or a radio station, or based on dedicated smartphone apps.
- **Professional reports:** With their knowledge from trainings and experiences, professionals can support Incident Management with full and reliable information about the incident. (e.g. Police or Traffic Manager)
- **Sectional (and Network) Traffic Data Measurements:** technology based systems, e.g. ANPR, tolling systems, Bluetooth, WLAN) delivering traffic data for sections in (a) aggregated form, like number of vehicles per time or mean travel time for the section or (b) single vehicle data with more detailed information.
- **Vehicle-based (Trajectory) Data Measurements:** floating vehicle data, with accurate position and time information, typically GPS-based delivered in real-time via mobile phone network (UMTS/3G) or cooperative communication systems (c2x).
- **Video monitoring**: CCTV is often available in busier parts of networks monitored by a Traffic Management Centre, but may depend on detection by a human operator.
- **Vehicle-based Information Report:** eCall and 'advanced eCall' are considered especially in scenarios with collisions. eCall is designed to sense severe impacts in case of an accident and automatically call the nearest emergency centre and transmits the exact geographic location of the accident scene and other data.
- **Video Incident Detection System (VIDS):** the category involves algorithms for automatic incident detection based on image recognition in video data.

The assessment of the quality-related indicators (see Table 3) shows best capability of vehicle and video- based systems for incident discovery. Full and reliable verification of incidents can be expected by professional reports on the scene or via video. The assessment has also shown that good response performance is enabled by high quality in verification.

Table 3: Assessment Results for quality related indicators for discovery, verification and initial response

		Discovery		Verification				Initial Response
Nr	**Sub- Category**	**Detection Rate[1]**	**False Alarm Rate[1]**	**False Classif. Rate**	**Vehicle Class[1]**	**Nbr. of Vehicles**	**Injury Risk/ Injury Level**	**Response Performance**
1	Cross-sectional Traffic Data Measurements	NA	NA	NA	NA	NA	NA	NA
2	Citizen Report (partial and draft Information)	medium	medium[2]	low	yes	yes	partly (via direct communication link)	high (depends on verification quality)
3	Video Monitoring (visual , CCTV)	medium	low	low	yes	yes	partly (visual monitoring)	high (depends on verification quality)
4	Professional Report (full and reliable Information)	low	low	low	yes	Yes	yes (via direct communication link)	high (depends on verification quality)
5	Sectional Traffic Data Measurements – overall	NA	NA	NA	NA	NA	NA	NA (could be used for travel time estimation)
6	Sectional Traffic Data Measurements –single veh.	low	low	NA	NA	partly (indication by missing vehicles)	NA	NA (could be used for travel time estimation and routing)
7	Vehicle-based (Trajectory) Data Measurements	low	low	high	yes	No	NA	NA (could be used for travel time estimation)
8	Vehicle-based Information Report (eCall)	medium	low	low	yes	yes	partly (direct communication link to driver) yes (advanced eCall with in-car sensors)	medium (information from involved vehicles, but no scene overview)
9	Video Incident Detection System (VIDS)	high	high	low	yes	yes	partly (visual monitoring)	high (depends on verification quality)

Abbreviations: NA… not applicable; [1]derived from RAIDER project, [2]average False Alarm Rate for phone based and app based systems

Assuming the relevant requirements, such as available communication networks and appropriate penetration rates, vehicle-based systems provide good capability for the detection of incidents whereas video-based systems provide good capability for the verification of incidents. Potential time savings due to overlapping of phases may result from direct communication channels with involved or reporting persons.

Based on the idea to present a minimum resulting service level for stakeholders to estimate effects of implementing and/or using more advanced technologies, time categories were defined and potential achievable time savings were used as reference value for further tasks in PRIMA. The assessments indicate the feasibility of technologies to shorten incident detection and management documented within D3.1 (Assessment results of incident management procedures). The resulting time savings were further used in the traffic performance assessment. Complemented by the results of a CBA this results were used to conclude with recommendations to support decisions regarding the implementation or upgrade of novel technologies for incident management.

3.3 Analysis of costs, benefits and risks

The assessment results with respect to novel technologies and more traditional scene management techniques have been fed into a cost-benefit analysis, which is described in the separate PRIMA deliverable D3.2.

This task assessed incident scenarios identified in Task 2.4, the enhanced TIM techniques identified in Task 3.2, drawing on extensive recent data on incidents, as given in Table 4. Four incident scenarios were modelled assuming a range of traffic demand levels and initial response times, and applying different pro-active management techniques. Benefits of reduction of delay and secondary accidents were assessed in monetary terms and compared with the costs of interventions where available, with evidence-based assumptions about accident rates and value of time. Evidence on some technology and operational costs, including eCall, were presented, and risks that might be mitigated by the implementation of new procedures identified. While there is unavoidable uncertainty, there is evidence that pro-active techniques can deliver large absolute benefits.

Table 4: Incident datasets with breakdown of attributes recommended and recorded

SOURCE	West Midlands	CIS	Carillion	NILO(M'ways)	Ireland NRA	Coverage	H/England
AREA	Midlands_2002	M25_2005	M25+_2005	M1-M6_2005	Ireland 2014-5	TOTAL	2013-5
NUMBER OF MONTHS	7(4-10)	12(1-12)	10(5-11)	2(10-11)	15(1-3)	27	29
Number of Incidents	1018	942	5277(*)	128	8322	15687	103359(#)
Of which Accidents	621	238	1059	112	1355	3385	21374
RECORDED ATTRIBUTES							
Road	✓	✓	✓	✓	✓	100%	✓
Date	✓	✓	✓	✓	✓	100%	✓
Start Time	✓	✓	✓	✓	✓	100%	✓
Response Time	☒	☒	✓	☒	☒	20%	☒
Cause	✓	✓	✓	✓	✓	100%	✓
Duration	✓	✓	✓	✓	✓	100%	✓
Severity	☒	✓	✓	✓	✓	60%	☒
Lanes Open	☒	✓	☒	☒	☒	20%	☒
Lanes Closed	✓	☒	☒	✓	☒	40%	☒
Heavy Vehicle Involved	✓	✓	✓	✓	☒	80%	☒
Delay/Effect on Traffic	☒	✓	☒	✓	☒	40%	(#)
No. of Vehicles Involved	☒	✓	☒	✓	☒	40%	☒
Number of Persons/Injuries	☒	✓	☒	✓	☒	40%	☒
Numerical Delay Estimate	☒	☒	☒	☒	☒	0%	✓
Directions Affected	✓	✓	☒	✓	☒	60%	☒
Diversion Information	☒	✓	☒	✓	☒	40%	☒
Keywords or Text	✓	✓	✓	✓	✓	100%	(#)

(*) This dataset actually contains 17937 records, but some incidents are represented by several record entries each with Receive, Start/Arrive and Stop times. This extra information complicates analysis but enables response time to be estimated.
(#) The Highways England 2013-5 dataset is excluded from the Coverage summary because it is much larger than the others and would bias the results. Effect on traffic is indicated for many events by estimated delay incurred by individuals to the nearest 5 minutes. Some records omit fields, and in some cases informal comments have been added, resulting in inconsistent format which complicates analysis.

The method and detailed results are documented in D3.2 (Description and results of cost-benefit and risk assessment).

4 Guidelines and future implementation (WP4)

The activities for WP4 have commenced in November 2015. The milestones and deliverables are listed in Table 5. The objectives were:

- Develop a guide with procedures on traffic incident management based on risks and costs
- Define implementation steps of procedures and business models for future traffic incident management

Table 5: Milestones and deliverables in WP4

No	Milestones/Deliverables
M4.1	Guidelines developed
M4.2.	Implementation steps developed
D4.1	Guidelines and implementation steps for pro-active TIM

4.1 Definition of recommendations for pro-active traffic incident management

This task started with an overview of current national guidelines across CEDR, as well as a review of the questions in the WP1 survey that were related to national or international guidelines that various NRAs use. The next steps included a further definition of the PRIMA Guidelines, by defining the end user, the format and the level of detail that were to be provided. WP3 results were transferred to recommendations for specific TIM techniques. With the inputs provided from previous WPs on incident scenarios, existing and novel enhanced TIM techniques as well as risks and costs analyses, the guide conveys in a comprehensive approach how to deal with different types of incidents in a proficient manner.

Figure 6 shows an overview of the PRIMA recommended techniques for traffic incident management, grouped into the four PRIMA phases that were defined in the project's commencement:

Monitor & Anticipate:

In these phases, incident management techniques can be utilised to monitor and recognise changes in the traffic state, as well as to identify certain high risk locations on the road network. This can facilitate the anticipation of potential incident scenarios.

In these phases, pre-incident management techniques based on novel technologies are used, such as video incident detection systems, Probe Vehicle Data (e.g. Vehicle to Infrastructure communication – V2I, Floating Car Data – FCD) or the Simulation-based incident response strategy planning tool.

Prepare & Respond:

In these phases, incident management techniques can be utilised to best prepare and respond to an incident, thus minimising costs and risks as well as potential secondary effects. In these phases, incident management techniques such as Advanced eCall, redirection strategy or the Model-based short term response planning tool can be used.

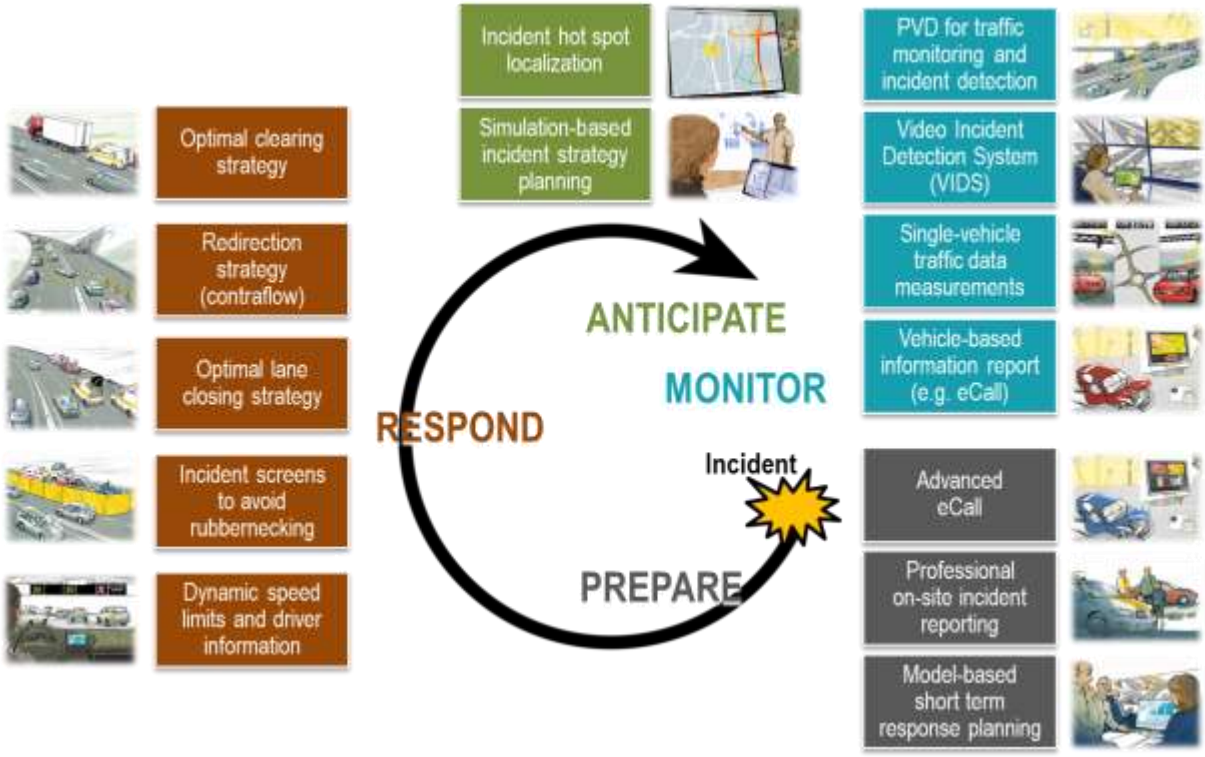


Figure 6: Recommended pro-active incident management techniques in PRIMA

4.2 Design and production of guideline document

Based on the data analysed in Task 4.1 as well as consultations with the Project Officer, the general framework of the PRIMA guidelines was defined. The guidelines aim at Regional/National traffic managers and National Road Authorities; however they do not replace national TIM guidelines. The scope is to guide authorities for new investments into pro-active incident management, by providing the added value of novel techniques in terms of costs, benefits and risks. It is envisioned that the guidelines are applicable to a wider target group, rather than to serve the specific requirements of a single road authority.

Therefore the guideline presents the recommended PRIMA techniques in a simple and efficient profile format that contains a small description of the technique and technologies involved, the main benefits for TIM, an overview of the cost components along with an estimation of the cost value size and an overview of the risks involved when applying a specific technique. Moreover, implementation steps are presented for the most novel techniques. See the PRIMA deliverable D4.1 (Mocanu et al., 2016).

4.3 Definition of implementation steps for future traffic incident management

The activities of this task commenced in January 2016. The objective was to identify the key control parameters that are essential in defining the business models for implementing future TIM techniques. These parameters define who utilizes which resources and who does which activities and influences the distribution of cost, risks and benefits in a value network.

The scenarios and novel techniques selected in WP2 and WP3 led to the development of multiple business models for implementing future TIM techniques. Several applicable

business models were investigated, which covered public, private or mixed partnerships. However, based on the assessment of risks and costs performed in Task 3.3, selected business models were defined for the most promising technologies. The models were visualised in value networks, which depict the flows of services, money and other gains between the main stakeholders involved in a service, whether as a provider, users or beneficiary. In PRIMA, value networks describe how organisations (roles) collaborate in creating value for TIM, while also taking into consideration input from the stakeholders. See example in Figure 7 for the technique "Simulation-based incident response strategy planning", which can be seen as a prevention technique used to anticipate the best scene management techniques for different types of incidents at specific hot spot locations and traffic conditions.

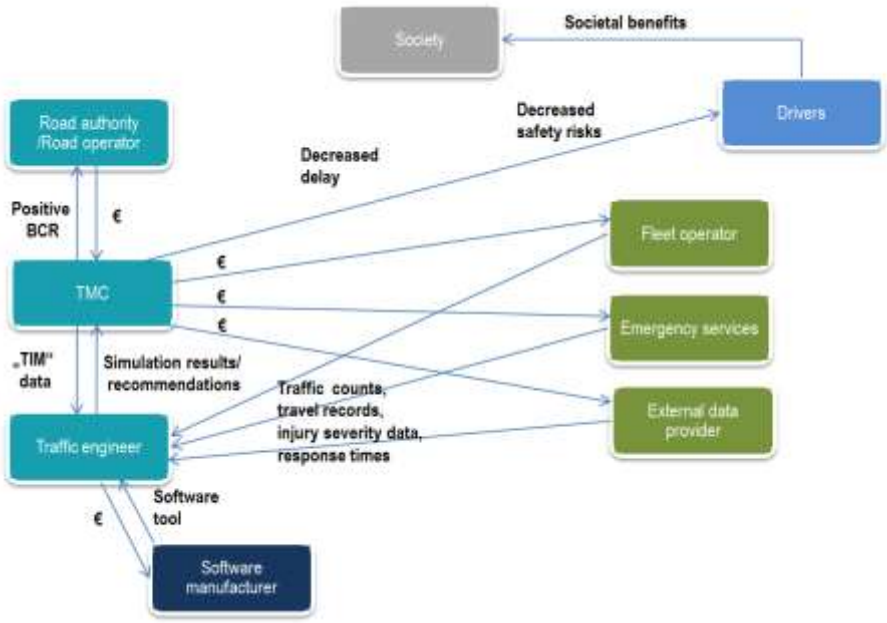


Figure 7: Value network for the simulation-based incident response strategy planning

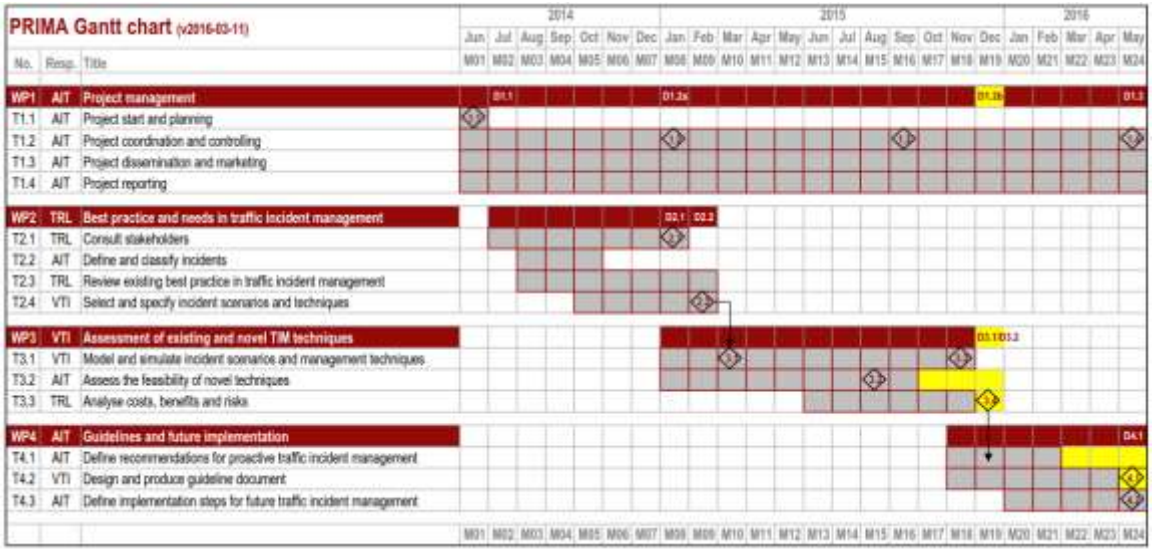
5 Project management (WP1)

WP1 involves the overall consortium management, dissemination and reporting activities. Table 6 lists the milestones and deliverables.

Table 6: Milestones/Deliverables of WP1

No	Milestones/Deliverables
M1.1	Inception meeting held
M1.2.	First interim meeting held
M1.3	Second interim meeting held
M1.4	Final meeting held
D1.1	Inception report
D1.2a	Progress report 1
D1.2b	Progress report 2
D1.3	Final project report

In addition to the physical meetings, monthly teleconferences were held, during which the project coordinator along with the WP leaders gave updates on the work progress in the project. The updated Gantt chart is given in Figure 8. A new milestone (M3.2) has been added to WP3, since this was found to be a crucial step towards the assessment. In consultation with the project officer, the second progress report D1.2b was moved to month 19, when WP3 was finished.



No.	Milestone	Deadline
1.1	Inception meeting held	M01
1.2	First interim meeting held	M08
1.3	Second interim meeting held	M16
1.4	Final meeting held, project ready for closure	M24
2.1	Stakeholder needs obtained	M08
2.2	Relevant incident scenarios specified	M09
3.1	Specification of traffic model scenarios completed	M10
3.2	**NEW:** Assessed performance indicators transferred to Task 3.1	M15
3.3	Traffic analysis of incident scenarios completed	M18
3.4	Cost-benefit and risk analysis completed	M19
4.1	Guidelines developed	M24
4.2	Implementation steps defined	M24

No.	Deliverable	Deadline
D1.1	Inception report (DoW)	M02
D1.2a	Progress report 1	M08
D1.2b	Progress report 2	M19
D1.3	Final project report	M24
D2.1	Summary of stakeholder consultation	M08
D2.2	WP report including specification of incident scenarios	M09
D3.1	Assessment results of incident management procedures	M19
D3.2	Description and results of the CBA and risk assessment	M19
D4.1	The PRIMA guidelines and implementation steps	M24
D4.2	~~Description of implementation steps for future TIM~~	~~M24~~

Figure 8: Gantt chart, milestones and deliverables. Changes/delays are highlighted in yellow.

6 Conclusions

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 previous project work and presenting the most effective techniques for handling different types of incidents, across the whole TIM cycle.

This final report summarises all activities performed and the most relevant results of the project PRIMA. Existing and novel techniques applied to the phases of the TIM cycle (Discovery, Verification, Initial Response, Scene Management, Recovery and Restoration to Normality) were assessed in terms of their potential to optimize the overall incident duration, i.e. discovery, verification and response time, while maintaining the right balance of risks and costs for the road administrations.

Besides the PRIMA guidelines on pro-active TIM, a major result of PRIMA is that it brings forward two pro-active incident management techniques developed within the project. The model based short term response planning tool can be useful to conduct quick comparisons of different incident management techniques for a real-time occurring incident. On the other hand, the simulation based incident response strategy planning tool can be useful to investigate the effect of different scene management techniques in more detail, as an anticipatory measure. This tool is best suited for more complex road networks with recurring incidents. The two tools can be an added support for incident management centres.

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

7 Acknowledgement

The work presented in this report was carried out as part of the CEDR Transnational Road Research Programme Call 2013. The funding for the research was provided by the national road administrations of Belgium-Flanders, Denmark, Finland, Norway, UK and Netherlands.

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List of abbreviations

ANPR	Automatic Number Plate Recognition
bCall	Breakdown Call
BCR	Benefit Cost Ratio
CCTV	Closed Circuit Television
CEDR	Conference of European Directors of Roads
C-ITS	Cooperative Intelligent Transport Systems
eCall	Emergency Call
FCD	Floating Car Data
GUI	Graphical User Interface
I2V	Infrastructure to Vehicle Communication
ITS	Intelligent Transport Systems
NRA	National Road Authorities
PEB	Programme Executive Board
PRIMA	Pro-Active Incident Management
PSAP	Public Safety Answering Point
PVD	Probe Vehicle Data
TIM	Traffic Incident Management
TMC	Traffic Management Centre
V2I	Vehicle to Infrastructure Communication
VIDS	Video Incident Detection System
VMS	Variable Message Signs
VSL	Variable Speed Limits

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