



Effective asset management meeting future challenges

Cross-border funded Joint Research Programme

by Belgium (Flanders), Denmark, Finland, France, Germany, Ireland, Lithuania, Netherlands, Norway, Slovenia, Sweden, Switzerland, and United Kingdom.

Description of Research Needs (DoRN)

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1 Introduction

“ERA-NET ROAD II – Coordination and implementation of Road Research in Europe” is a Coordination and Support Action funded by the 7th Framework Programme of the EC. The ERA-NET ROAD II (ENR2) partners are Austria, Belgium (Flanders), Denmark, Finland, France, Germany, Hungary, Ireland, Lithuania, Netherlands, Norway, Poland, Slovenia, Sweden, Switzerland, United Kingdom, with CEDR (Conference of European Directors of Roads) as an Associate Partner. These partners are committed to the goals of ENR2 which provides a platform for international cooperation and collaboration in research areas of common interest. Details can be viewed at the ENR2 website www.eranetroad.org.

This trans-national research programme, entitled “**Effective asset management meeting future challenges**” was drafted within the framework of ENR2. The participating National Road Administrations (NRA) in this Joint Research Programme are Belgium (Flanders), Denmark, Finland, France, Germany, Ireland, Lithuania, Netherlands, Norway, Slovenia, Sweden, Switzerland, and United Kingdom. As in previous ERA-NET ROAD programmes, they will establish a Programme Executive Board (PEB) and decide on a Programme Leader (PL).

The Common Obligation Programme Model from the ‘ENR-toolkit’ has been adopted for this joint research programme. This means that the Call for Proposals will be prepared and conducted by the PL in its country under its law and regulations and the budget will be jointly funded by all participants of the PEB.

To achieve the goals set by ENR2, it is essential that national research results, knowledge and experience be exchanged at all levels and this to develop a common approach and an increased acceptance of asset management principles and **benefit from the trans-national collaboration**.

The **aim** of the programme is to **improve the management of the European road network** by identifying and developing methods and procedures which optimise performance from a technical, economic and sustainability point of view. The management of a road network involves a wide range of areas including engineering, economics, social development, civil engineering, traffic management, safety, information technology, and many more. It is important that a **holistic approach** is adopted encompassing the whole service life “from cradle to grave” in order to maximise the potential benefits of these important national assets.

EU land transport policy recognises the importance of road transport through its stated aim of promoting “sustainable mobility that is efficient, safe and with reduced negative effects on the environment”. A cost-effective, reliable transport system is essential in developing and maintaining a thriving economy. According to ERTRAC, road transport contributed to 11% of total EU GDP in 2005. The available statistics indicate that inland freight transport across the EU totalled 2,595 billion tonne-kilometres in 2006, of which 73% was carried by road.

This economic success comes at a price. In the period 2000-2006, total investment by the EU member states in transport infrastructure amounted to some €859 billion. In 2006, the transport sector accounted for 23% of all CO₂ emissions, with road transport generating 73% of this total. These conflicting issues require that the road network be very carefully managed, particularly in light of the new challenges posed by the recent downturn of the European economy.

This Call focuses on the following main issues:

- The strategic management of the road network as a complete entity, rather than looking at each of its individual components (pavement, bridges, tunnels, gantries, signs, lighting systems, etc) separately, as is the traditional approach. Adopting such a holistic “cross-

asset” approach would enable a more rational way of distributing the available maintenance budgets to the different asset components on an objective basis, thus providing a more consistent and efficient management strategy.

- The development of advanced asset management procedures which take account of stakeholders’ requirements and expectations. Stakeholders in this sense include owners, operators, users and the general tax-payer who ultimately provides the funds. Such a management strategy would encompass key network operations such as maintaining efficient traffic flow, traffic safety, reliability of travel time, comfort, etc.
- The incorporation of environmental issues into the management process in order to minimise the negative effects on users, society in general, plant and animal habitat and biodiversity. Issues include utilisation of scarce natural resources, traffic noise, air quality, road run-off, congestion, disruption, etc.

The objectives to be considered in this Call for Proposals are described in more detail in Section 2.1.

2 Reasons for the Joint Research Programme

The main objective of this joint research programme is to recommend management processes and tools that Road Directors and Operators can use to manage the national road network in a safe, reliable, economic and sustainable way, in line with stakeholders’ expectations. The processes will incorporate a holistic approach to the management of all of the road components at all decision-making levels, from strategic level to operation level. They will enable Road Directors to identify where to target resources to obtain best value. The outputs from the programme will ensure that a **common framework** can be adopted by the different Road Authorities across Europe.

The research commissioned by this Call is underpinned by many years of research effort aimed at optimising road management from both a technical and economic point of view. This includes numerous projects into Pavement Management Systems, Bridge Management Systems and Asset Management generally, that have been funded nationally and by the EU. In discussions conducted at European level it has been found that road authorities have made substantial parallel investment and implementation in these fields. **It is not intended to duplicate this research.** What is needed is a comparison of the various systems and approaches that already exist or have been proposed and to identify what works and what does not. This will be used to take road management forward in a consistent and practical way. It will contribute to the developments of sets of appropriate service levels, highlight gaps and identify how the resources should be targeted. There is a general absence of cause and effect between the engineering performance parameters that are often built into these systems, the benefits provided to the users, the funding levels associated with each performance level and the achievement of high-level transport goals. The aim is to learn from this valuable experience to develop a harmonised holistic strategy that can be implemented across Europe.

The research conclusions and recommendations will be presented in such a way that they can be implemented across the EU even though Road Authorities will have different type of roads, and may already have embarked on a national asset management policy. The procedures will recognise that different management strategies may be required for different road classifications, depending on importance, traffic volumes, climate, sustainability, etc.

While the main focus of the programme is on the high level **strategic management** of the road network, the research will also include an examination of issues affecting **operational management**, with the end-products contributing to long-term road transport policy and the day-to-day management of roads.

2.1 Research Objectives of the Joint Call

The overall aim of the joint research programme “**Effective asset management meeting future challenges**” is to improve the management of the European road network. The research will focus on the development of efficient management tools using a **holistic approach** covering **all components** of the road network (pavement, bridges, tunnels, gantries, signs, lighting systems, etc) and encompassing the whole service life “from cradle to grave” in order to maximise the potential benefits of these important national assets.

The programme is based on the following **four objectives** which are described below together with the expected outcomes:

A: Meeting stakeholders’ requirements and expectations

B: Understanding asset performance

C: Development of suitable Key Performance Indicators (KPIs) for the future

D: Framework for optimised asset management

These objectives were developed following a series of workshop involving specialists from each of the partner Road Authorities. In these workshops, it was recognised that the traditional approach to managing roads, based primarily on the condition of the pavement and structures, is inadequate for today’s needs as they largely ignore the wider issues such as stakeholder expectations, whole life costing, sustainability and the environment. This research programme seeks to redress the problem by integrating these issues into an optimised management framework.

Applicants should ensure their project proposals are **clearly linked to one of the four objectives** listed above, although it is accepted that there is considerable overlap between them. Proposals should emphasise the **trans-national benefit** of the project outcomes for the participating Road Authorities in the context of effective road asset management.

A) Meeting stakeholders’ requirements and expectations

Managing and meeting the expectations of stakeholders is key to the successful delivery of a road network. The important issue to consider is whether the performance of the road network matches the stakeholders’ perceptions and expectations. The stakeholders to be considered are not simply the road owners, operators and users, but also operators of other modes of transport including public transport, local residents and all of the taxpayers who ultimately fund the network whether or not they use it.

Stakeholders’ expectations relate to the level of service provided, how and when maintenance works are performed, environmental impacts and costs. They will have conflicting expectations regarding costs, disruption, safety, noise, air quality, security and environmental impact. Network operators need to communicate decisions about road maintenance to the stakeholders, relating the technical measures and indicators that they use to plan and execute maintenance to the levels of service being considered and reassuring stakeholders that their needs are being considered and acted upon. There is a need to improve the effectiveness of the communications regarding maintenance works.

Levels of service are traditionally engineering based but the available funds for maintenance work and the impact on traffic will influence stakeholders’ expectations on the condition of roads and the acceptance of less frequent, cheaper and faster maintenance interventions.

The expected outcome of the research topic is the alignment of the use of resources and the expectations of the stakeholders. The research will identify how road users can be made aware of the challenges faced by road operators in providing the expected services including the levels of condition to be achieved. Similarly, the operators should appreciate the needs and concerns of the road users. Research needs to be undertaken to identify the most

appropriate way for all stakeholders to be effectively engaged and that appropriate techniques and technologies are available to help operators meet the identified needs and inform stakeholders. Balancing the needs and desires of the stakeholders against other factors is key, particularly where these may be inconsistent or conflicting.

Research proposals might include:

- Optimisation and analysis methods for identifying maintenance needs. Currently assets are generally selected using condition and traffic volume as the main criteria but this should be amended to consider other objectives such as user expectations, environment, safety, etc. One solution might be application of different multi-criteria decision making techniques.
- Study of stakeholder expectations and perceptions; most effective ways of engaging most effectively with these different sets of stakeholders; achieving a balance between high quality maintenance, the costs involved and delivering balanced outcomes for stakeholders; analysis of road users' willingness to accept lower maintenance standards in the knowledge that taxes will be lower; response of stakeholders to the implementation of green policies and the costs involved.
- Maintenance strategies for different road classifications: design of maintenance for the different road types with different traffic volumes and strategic importance to obtain overall network-wide best value.

Expected outputs would include:

- Strategies for engaging with stakeholders.
- Optimised maintenance strategies that include stakeholders' expectations and standard system of defining level of service.
- Maintenance strategies that meet financial, environmental and social requirements.

B) Understanding asset performance

The European road network encompasses a wide range of different assets, each of which has its own unique challenges in terms of the measurement, monitoring and modelling of performance. Understanding asset performance under changing conditions, such as increasing traffic volumes, stricter environmental constraints and a more aggressive climate, has become a major challenge. There is a need to assess how the factors considered above might need to be further adapted in order to give the optimum results for the asset. There are now considerable sustainability and environmental pressures being imposed at both national and EU level. Road Directors and Operators need to know how to best respond to legislation and targets on climate change and environmental factors, and specifically how these affect the information about the different asset types and the network performance that needs to be obtained.

The focus of this research topic is to obtain a better understanding of how the road network performs, how the different components interact and the impact of this interaction on the scheduling and delivery of service. Currently, the different road components (pavements, structures, tunnels, signs and other road equipment) are assessed separately and only brought together after finding individual optimum solutions. "Cross-asset management" is a management strategy that focuses on a holistic approach which aims to achieve greater efficiency of budget allocation between the different components. There is a need to consider this issue at programming level, where separate work programmes e.g. for bridges and pavements are co-ordinated in order to minimise costs and disruption.

The research would focus on existing asset management systems for the different road components (pavements, bridges, etc) and attempt to extract best practice from these for

general application. This would include an evaluation of the parameters used in the different asset groups and how they are used for effective management. These parameters would then be examined to determine their effect in a cross-asset management system.

The expected outcome of the research in this topic will enable Road Directors to decide which parameters have to be considered and how the information needed could be obtained, assessed and utilised in a cost-effective way in order to deliver a safe, serviceable and satisfactory network.

Research proposals might include:

- Objective criteria for road performance: study of what parameters are currently being monitored, how they are valued, whether they are appropriate for assessing condition and performance and whether these reflect owner, operator, and user requirements; development of improved condition assessment techniques.
- Identification and evaluation of parameters to describe the whole asset from the financial, social-economic, engineering and environmental point of view. Ranking of the parameters and sensitivity study to determine the main parameters that need to be included and identify those of lesser importance.
- A study of the interactions between different road components in the management process, including everything from routine maintenance to capital investments.
- Effective use of life cycle cost: Use of historic maintenance information to develop case studies that can be used to calibrate or verify assumptions made at the design stage relating to whole life cost.
- Optimisation of maintenance: adoption of different maintenance strategies for different lengths of road on the same route in order to optimise maintenance.
- Study of existing management systems and identification of best practice; identification of the main objectives and target functions of management tools for different assets as a basis for the development of a holistic cross-asset management approach and the evaluation of the potential benefits.
- Methods and procedures for cross-asset optimisation; study on how a cross-asset management system would function in terms of allocating resources to the different road components and the potential benefits that could be derived; optimisation of intervention timing in a holistic maintenance strategy.

Expected outputs would include:

- Optimised cross-asset maintenance strategies including technique for determining the optimum allocation of resources to different road components and justifying maintenance needs; decision support system for allocation of budgets to individual road components from an objective and holistic point of view.
- Framework for including life cycle cost into the management system.
- Management strategies based on measured performance.
- Common evaluation tools across EU countries; harmonised approach to management at strategic level including asset valuation.
- Maintenance strategies that cater for different road classifications.
- Management strategies for the different components of a road network and for the adjustment of maintenance works.

C) Development of suitable Key Performance Indicators (KPIs) for the future

This topic focuses on the development of Key Performance Indicators (KPIs) in order to manage Europe's strategic road network to meet society's needs generally and stakeholder's perceptions and expectations in particular. These KPIs would be used within an advanced management process to monitor the performance of the management strategy and indicate success or otherwise. A transparent common set of KPIs across different road components would be required which can be implemented across the different road network components, for different road classifications and in the different countries.

A methodology for implementation needs to be developed which would include optimisation tools for long and short term management strategies focussing on both strategic and operational levels. Information is required on service level KPIs and their evolution over time, the development of environmental and socio-economic KPIs and interaction between different KPIs.

Research proposals might include:

- Identification of KPIs to be included in an advanced management strategy including environmental, socio-economic KPIs and their evolution with time; study of how KPIs would be used to reflect stakeholders' expectations and perceptions in a proactive management strategy.
- Implementation of KPIs consistently across different road components and in different countries with different road types.

Expected outputs would include:

- Definition of easily understood KPIs and how they would be monitored.
- Implementation strategy for KPIs in different countries with different road types.
- Framework for incorporating KPIs in an optimised asset management system.

D) Framework for optimised asset management

The traditional approach incorporated into most pavement management systems involved measuring condition which then triggers maintenance activities once a particular threshold is reached. One way in which management strategies could be advanced is to adopt a more proactive approach in which maintenance is carried out before structural deterioration becomes evident. Such an approach would require more detailed models for deterioration and a clear definition of "end of service life". The concept of risk could also be introduced to quantify the reliability of the management strategy as well as taking on board the interaction between the different road components. Development of a proactive asset management strategy could be used to manage the different components of a road in a more efficient way and could be used to meet the demands of a high-level strategic management process. It might, for example, include the concept of asset value which could be based on construction cost, replacement cost or value to the local/national economy. The predicted changes in asset value in response to different budgetary constraints could provide the basis for justifying increases or decreases in annual maintenance budgets. Such an approach would require different monitoring parameters to be developed for the different road components, as well as information on the efficiency of maintenance activities. This could include assessment of the impact of the condition of different asset types on the overall network value (e.g. poor drainage condition will affect the value of the whole road infrastructure, not just the drainage). If part of a link is in very poor condition and deters the use of the link then the reduced value of that link should be identifiable.

Research proposals might include:

- Study of the principles of proactive asset management and the potential benefits of such an approach; sensitivity study to determine the effect of different management strategies on whole life cost. This should include identifying and managing the likely risks.
- Development of methods for predicting future asset performance, condition or value for different investment strategies and how this might be used to justify maintenance allocations.

Expected outputs would include:

- Framework for a proactive asset management and monitoring requirements.
- Principles and methods of asset controlling on public and private roads.

2.2 Possible outcomes

Outcomes from the research programme are expected to include:

- Best practice guidelines.
- Detailed description of stakeholders' needs and expectations.
- Detailed description of infrastructure performance (for all different asset types).
- Improved communication with stakeholders.

The research proposals need to address the above issues in the following ways:

- At a strategic level – how might these affect the overall maintenance strategy, its funding, and the risk profiles that would need to be addressed.
- At an operational level – how might these affect the maintenance interventions that are planned, or the adopted planning process for developing the maintenance programme.
- Requirements for the definition of sustainable and environmentally-friendly maintenance treatments, measures and strategies.

3 Overview of current European activities and results

A general overview of the present research results and activities in Europe is outlined below. Applicants must not duplicate existing results, but submitted projects can be based on the outcomes and state-of-the-art identified in the projects listed below.

4th Framework Programme

- i) BRIME: Bridge management in Europe <http://www.trl.co.uk/BRIME>

CEDR Technical Group Road Maintenance

- i) Strategic Plan 2009-2013, October 2008
<http://www.cedr.eu>

COST – European Cooperation in Science and Technology

<http://www.cost.esf.org>

- i) COST 354 – Performance Indicators for road pavements
<http://cost354.zag.si/>

ERA-NET ROAD

- i) [Maintenance backlog, estimation and use](#)
- ii) [Road users getting to grip with Climate Change \(ongoing\)](#)
- iii) [Safety at the heart of road design \(ongoing\)](#)

ERTRAC – European Road Transport Research Advisory Council

<http://www.ertrac.org>

- i) Structured Research Recommendations 2007-2015.

FEHRL – Europe’s road research centres

- i) The Strategic European Road Research Programme 2006-2011.
<http://www.fehrl.org>

OECD – International Transport Forum

<http://www.internationaltransportforum.org>

- i) OECD (2001). Asset management for the road sector.
<http://www.internationaltransportforum.org/Pub/pdf/01AssetE.pdf>
- ii) OECD (2001). Performance Indicators for the road sector.
<http://www.internationaltransportforum.org/Pub/pdf/01PerformIndicE.pdf>

PIARC – Technical Committee D.1 Management of road infrastructure assets

<http://www.piarc.org>

- i) [Asset Management for Roads - An Overview](#)
- ii) [Asset Management in relation to Bridge Management](#)
- iii) [Asset management practice](#)
- iv) [Integration of performance indicators](#)
- v) [Towards Performance Management of Bridges \(and other Structures\)](#)

Transportation Research Board (TRB), US

<http://www.trb.org>

- i) An asset-management framework for the Interstate Highway system. NCHRP Report 632, 2009.
- ii) Asset Management Guidance for Transportation Agencies. NHCRP Digest 266, March 2002.

National programmes – Finnish Road Administration

- i) Road Asset Management Research Program (http://alk.tiehallinto.fi/voh/voh/voh_etus_e.htm)
- ii) Economics of the Traffic System in Finland (ongoing project)

National guidelines – Germany

- i) ASB Anweisung Straßeninformationsbank Teilsysteme Netzdaten und Bestandsdaten, Stand: Juni 2007, Bundesministerium für Verkehr Bau und Stadtentwicklung, Bonn 2007 www.bmvbs.de
- ii) Zusätzliche Technische Vertragsbedingungen und Richtlinien zur Zustandserfassung und -bewertung von Straßen ZTV ZEB-StB, Ausgabe 2006, FGSV-Nr. 998, Forschungsgesellschaft für Straßen- und Verkehrswesen, Köln 2006, www.fgsv-verlag.de
- iii) Richtlinien für die Planung von Erhaltungsmaßnahmen an Straßenbefestigungen RPE-Str 01, Ausgabe 2001, FGSV-Nr. 988, Forschungsgesellschaft für Straßen- und Verkehrswesen, Köln 2001, www.fgsv-verlag.de
- iv) Arbeitspapiere zur Systematischen Straßenerhaltung, FGSV AP 9, Forschungsgesellschaft für Straßen- und Verkehrswesen, www.fgsv-verlag.de
- v) Zusätzliche Technische Vertragsbedingungen und Richtlinien für die bauliche Erhaltung von Verkehrsflächen-Asphaltbauweisen ZTV BEA-StB 98, Ausgabe 1998/2003, FGSV-Nr. 798, Forschungsgesellschaft für Straßen- und Verkehrswesen, Köln 2003, www.fgsv-verlag.de
- vi) Zusätzliche Technische Vertragsbedingungen und Richtlinien für die bauliche Erhaltung von Verkehrsflächen-Betonbauweisen ZTV BEB-StB 02, Ausgabe 2002, FGSV-Nr. 898/1, Forschungsgesellschaft für Straßen- und Verkehrswesen, Köln 2002, www.fgsv-verlag.de
- vii) Richtlinien für die Standardisierung des Oberbaus von Verkehrsflächen RStO 01, Ausgabe 2001, FGSV-Nr. 499, FGSV-Nr. 798, Forschungsgesellschaft für Straßen- und Verkehrswesen, Köln 2003, www.fgsv-verlag.de
- viii) Empfehlungen für Wirtschaftlichkeitsuntersuchungen an Straßen EWS, Ausgabe 2002, FGSV-Nr. 132/2, Forschungsgesellschaft für Straßen- und Verkehrswesen, Köln 2002, www.fgsv-verlag.de

National programmes – Ireland

<http://www.nra.ie>

- i) Development of pavement cost models for the Irish National Road network (ongoing project)
- ii) Development of bridge network life-cycle cost model (ongoing project)

National programmes – UK Highways Agency

<http://www.ha-research.gov.uk/>

- i) Design Manual For Roads and Bridges
www.standardsforhighways.co.uk/dmrb/
 - ii) Integrated Asset Management – the Blue Print
 - iii) County Surveyors' Society – Maintaining Vital Assets
 - iv) Value Management Guidance – Roads Renewal/ Bridges Renewal
 - v) National Programme – National Framework
 - vi) Whole Government Accounting – Asset Valuation
 - vii) Roads Board – Asset Valuation
 - viii) Network Management Manual
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http://www.ukroadsliaisongroup.org/roads/well_maintained.htm
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www.ukroadsliaisongroup.org/pdfs/p02_management_of_highway_structures.pdf
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http://www.ukroadsliaisongroup.org/lighting/code_of_practice.htm
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www.ukroadsliaisongroup.org.
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10. Maerschalk, G., Krause, G (2004). Erstanwendung der vorliegenden Algorithmen für die Erhaltungsplanung in ausgewählten Bauämtern. Forschung Straßenbau und Straßenverkehrstechnik, Heft 878, Bonn.
11. FE 09.139/2005/MRB (2008). Auswertung von Forschungsarbeiten zur Verbesserung eines Informationssystems für das Management der Straßenerhaltung. SEP-Maerschalk, München.
12. Mild, Pekka and Salo, Ahti (2009), Combining a multiattribute value function with an optimization model: An application to dynamic resource allocation for infrastructure maintenance. Decision Analysis, Vol. 6, No. 3, September 2009, pp 139–152.