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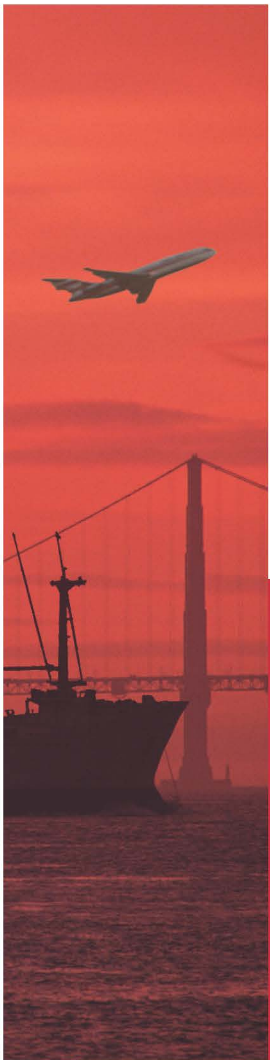

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EU ROAD SURFACES: ECONOMIC AND SAFETY IMPACT OF THE LACK OF REGULAR ROAD MAINTENANCE

STUDY

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TRANSPORT AND TOURISM

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STUDY

This document was requested by the European Parliament's Committee on Transport and Tourism.

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Abstract

This study looks at the condition and the quality of road surfaces in the EU and at the trends registered in the national budgets on the road maintenance activities in recent years, with the aim of reviewing the economic and safety consequences of the lack of regular road maintenance. The authors investigate the key causes behind the registered variations identified and the consequent impacts on road safety; they recommend therefore a series of actions and best practices to help preserve the safety and quality of the EU road surfaces.

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CONTENTS

LIST OF ABBREVIATIONS

AEC	Asociación Española de la Carretera (Spanish road Association)
ANAS	Azienda Nazionale Autonoma delle Strade (National Autonomous Roads Corporation)
ASFINAG	Autobahnen-und-Schnellstraßen-Finanzierungs-Aktiengesellschaft (Autobahn and high way financing stock corporation)
CADaS	Common Accident Data Set
CARE	European Centralised database on Road Accidents
CAGR	Compound annual growth rate
DARR	Digital Accident Data Recorders
DPA	Data Protection Act
EAPA	European Asphalt Pavement Association
ERF	European Union Road Federation
ERSAP	European Road Safety Action Programme
ETSC	European Road Safety Council
EU	European Union
EU13	The Member States which joined the EU after 2004
EU15	EU Member States before the 2004 enlargement
EU28	The current Member States
GM	General Motors
HI	Highways Agency
IRU	International Road Union
ITF	International Transport Forum
ITS	Intelligent Transport Systems

Km	Kilometre
MS	Member State
NHTSA	National Highway Traffic Safety Administration
NRA	National Road Authority
OECD	Organisation for Economic Co-operation and Development
RAC	Royal Automobile Club
RMPD	Road Maintenance and Development Programme
RSAs	Road Safety Audits
RSIs	Road Safety Inspections
TEN-T	Trans-European Road Network
USIRF	Union des Syndicats de l'Industrie Routière Française
VRU	Vulnerable Road Users

COUNTRY ABBREVIATIONS

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
HR	Croatia
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
UK	United Kingdom
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland

PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

This research study is intended to inform the parliamentary debate looking at the condition and the quality of road surfaces in the EU and at the trends registered in the budget assigned by EU Member States to road maintenance activities in recent years, with the aim of reviewing the economic and safety consequences of the lack of regular road maintenance.

To do so, the research study aims to give the reader, both an overview of the most recent developments of academic and policy discussion in this field and a tangible perception of the current situation regarding the status of road maintenance and level of expenditure in EU Member States. The study has a number of sections and is supported by evidence gathered through 11 national case studies. The analysis is supported, where possible, by quantitative information. As road maintenance standards, practices and monitoring tools are dissimilar within Europe, the volume of quantitative data that has been gathered in Member States is not always comparable.

ROAD SAFETY

Road Safety in Europe has been improving over recent decades. The number of fatalities in the EU-28 in 2010 was almost 31,500, or only 57% of the 54,949 fatalities registered in 2001. A significant step in this trend took place between 2008 and 2010, when road fatalities fell 10% per annum compared to 4% per annum between 2001 and 2007. Notwithstanding the substantial decline, the EU did not achieve the target, set in 2003, of a 50% decrease in road fatalities between 2001 and 2010.

In addition to this general decline in road fatalities it is worth noting that:

- The decline has been achieved despite a general growth in road passenger transport: between 1995 and 2011 road transport demand, measured in passenger-kilometres, grew by an average of 1.1% per annum across the EU.
- The situation varies substantially across the different Member States. Southern and eastern Member States tend to have fatality rates higher than the EU average.
- The decline in fatalities varies according to road users: the number of fatalities has fallen steadily for cars (-45%), goods vehicles (-40%), cyclists (-33%) and pedestrians (-34%), while the number of fatalities in accidents involving motorcycles has remained constant.
- Provisional data for 2013 indicate that road fatalities are still decreasing, as an overall number of 26,000 fatalities has been registered in the EU. According to the EC press-release "Second good year in a row puts Europe firmly on track towards target"[1], 2013 is the second year in a row that saw an impressive decrease in the number of people killed on Europe’s roads. Based on preliminary figures, the number of road fatalities has decreased by 8% compared to 2012, following the 9% decrease between 2011 and 2012.

[1] EC press-release IP/14/341 published on 31/03/2014.

- For the coming years, the European Commission has renewed its objective of halving fatalities by 2020 through an increased focus on the enforcement of road rules.

Data on road accidents at European level are collected in CARE, the European centralised database on road accidents, which provides information on deaths or injuries across the EU, collating non-confidential data from EU Member States into one central database. Although significant steps have been made to improve the quality of the statistical information provided, the CARE database has limitations regarding both the reliability of data and the lack of information about accident causation factors.

Since the adoption of the 3rd ERSAP, the EU has recognized that human error is the most recurring cause of road accidents, but the impact of road condition and maintenance is not negligible. In many circumstances, it is difficult to disentangle causality: there are accidents caused directly by the poor condition of the road, but there are also accidents caused by drivers' behaviour in reaction to the condition or the design of the road. As drivers can, and inevitably do, make mistakes, infrastructure conditions should be gradually improved to protect users more effectively against their own shortcomings.

ROAD MAINTENANCE EXPENDITURE IN THE EU

The collection of homogeneous and accurate information on road maintenance and investment expenditure across the different Member States is difficult as the degree of homogeneity of data is minimal. Roads are administered differently in different MS, thus the responsibility for keeping the different sections of the road network at acceptable standards is assigned to numerous bodies, such as national ministries, regional or local authorities. In addition to this the definition of road maintenance and investment activities is not always clear comparing different national contexts, making it problematic to detect exactly what needs to be recorded in each of the two categories, creating discrepancies in the way data is reported across the different MS.

To assess the evolution of maintenance activities on road works in the EU in recent years this study has brought together the road expenditure dataset produced by the OECD/ITF, the asphalt production data reported by EAPA and specific country information.

Data collected shows that road investment levels remained relatively stable in the EU between 2006 and 2011. Road investment was at its highest in 2009, but had fallen by 7.1% by 2011. Country-specific data shows that there is a great deal of variation across EU countries in road investment expenditure registered in the 2008-2011 period. As an example Bulgaria and Poland both increased their investment expenditure over these years, whilst Slovenia, Austria and Ireland drastically reduced theirs. Road investment expenditure of the largest economies in this sample – Germany, France and the UK – did not vary substantially between 2008 and 2011.

Regarding the maintenance expenditure levels, the analysis suggests the presence of a significant reduction of maintenance activities in Italy, Ireland, Slovenia and Spain in recent years and a likely downward trend also in Slovakia, Finland, Czech Republic, the UK, Portugal and Hungary. At the same time, an increase in maintenance expenditure seems to have been recorded in a number of EU MS over the same period: this is the case for Austria, Germany, France, Croatia, Lithuania, Luxemburg, and Poland.

The extent to which the crisis has affected road investment and maintenance activities depends on the structure of the funding mechanism adopted in the different countries and on the political choices made by decision makers. The impact of the crisis has been higher where the funding of road infrastructure is highly dependent on government spending rather than from other sources of financing (e.g. toll roads). The status of public finance of different MS and the fiscal and budgetary choices that have been made has led to different outcomes.

ASSESSMENT OF ROAD SURFACE QUALITY AND PLANNING OF MAINTENANCE ACTIVITIES

With the approval of Directive 2008/96/EC a common framework for road infrastructure safety management was created for the first time in the EU. Though it represents a valid step forward in the creation of a harmonised framework for road safety monitoring in the EU, this Directive only applies to the TEN-T corridors and is subject to different interpretations and dissimilar implementation across the EU. In addition to this, the Directive focuses only on procedural aspects of road safety monitoring, and it leaves room for significant variability in the operational activities undertaken by different Member States.

The EU made an attempt to overcome these limits with two research projects. The first one, Pilot4safety, developed a manual, complemented by a collection of best practices that could be a starting point to develop a comprehensive tool that standardises the operational prescriptions to be implemented by road operators and national authorities in order to guarantee a balanced level of road maintenance across Europe. The second one, WhiteRoads, identified the ‘white spots’, that is road sections along the Trans-European Road Network (TEN-T) where no accidents occurred during the study period, despite high traffic flows, and studied them to identify the key features that allowed these sections to achieve such a high level of road safety.

Results from the WhiteRoads project shows that good road design, the presence of adequate maintenance programmes, the installation of reliable and homogenous traffic signage and road markings and appropriate lighting are among the key aspects that determine the success of white spots. The checklist developed within the WhiteRoads project should be considered as a new and complementary tool to the safety audits and inspections laid down in the Road Infrastructure Safety Directive 2008/96/EC on the design, maintenance and management of roads and could also be applied to other relevant road sections not belonging to the TEN-T network.

Several Member States have a well-established procedure for the monitoring of road conditions and the prioritisation of interventions. In many cases however, this does not extend to local or urban roads. Where road maintenance activities are carried out according to the outcomes of the monitoring process, prioritisation rules depend on the way outputs are assessed. For example while some national authorities decide to prioritise roads with the worst absolute indicators (e.g. Poland), others address the roads that are seen to be deteriorating (e.g. UK).

From the case studies, a number of good practices have been identified that could help to improve the cost-effectiveness of maintenance activities on local roads such as: i) the recourse to user-fed information, where electronic or web-based systems are used to allow drivers to report potholes and highway defects directly to road managers or ii) the utilisation of recycled asphalt, a material that has the same level of quality as newly produced asphalt, but costs about 30% less.

SOCIO-ECONOMIC IMPACTS OF ROAD MAINTENANCE

Road maintenance expenditures also yield substantial wider socio-economic impacts. The reduction in journey times associated with timely maintenance is one of the most widely recognised economic benefits of road maintenance. A survey carried out by the Asphalt Industry Association (2010) found that the average cost of poor maintenance per business, at £13,600 per year (€16,300).

There is also evidence of the social cost of road accidents which has been quantified in studies in France, Lithuania and the Netherlands. While the majority of road accidents are down to driver behaviour, some of those accidents could be as a result of drivers behaving in a certain way to account for poor road maintenance.

Studies that have sought to quantify the wider economic impacts of road maintenance activities indicate that the reduction in road maintenance expenditure can have an impact to the wider economy in the range of 100%-250%.

KEY FINDINGS AND RECOMMENDATIONS

When developing road safety policies and interventions, the reliability and quality of data is a key factor. There is scope across Europe for further efforts to link police collision reports to hospital data records to improve data quality and consistency, especially regarding serious injury crashes. Data quality and effective analysis are fundamental to building risk awareness and intervention effectiveness. At the same time as the degree of homogeneity of available data on road maintenance and investment expenditure across the different MS is minimal, it is important to consider additional efforts to improve the standardisation of statistical data collected across the EU.

In light of future parliamentary debates on the actions to be taken by the EU to help preserve the safety and quality of road surfaces and contrast the possible negative impacts generated by cuts in road maintenance activities due to economic downturns, the following actions should be taken into consideration:

- In the ongoing revision of the Road Infrastructure Safety Directive 2008/96/EC of 19th November 2008, it will be important to support the introduction of changes that allow for a more homogenous application across the EU and expand the technical and geographical scope of the application of the Directive.
- Call on the Commission to propose the extension of the experiences of the WhiteRoads project to other categories of roads and use the outcomes of the white spot evaluation to improve safety records on the most dangerous sections.

- Support the dissemination of a checklist similar to those developed in WhiteRoads as a new and complementary tool to the safety audits and inspections laid down in Directive 2008/96/EC and incentivise their application on road sections off the TEN-T network.
- Identify actions and measures that could focus on local and urban roads, which show the highest safety risks and, in some countries, are experiencing the strongest reduction in maintenance activities.
- Help disseminating the good practices that several EU MS have introduced and could help improve the cost-effectiveness of maintenance activities across the EU.

1. INTRODUCTION

1.1. Preface

This study looks at the condition and the quality of road surfaces in the EU and at the trends registered in the budget assigned by EU MS to road maintenance activities in recent years, with the intent to investigate the economic and safety consequences of the lack of regular road maintenance.

The analysis included within this study focuses exclusively on maintenance activities on existing roads and does not include an assessment of investments in new road infrastructure.

The study has been informed by a number of previous studies, desktop analysis and discussions with stakeholders and provides a review of current developments in a subset of Member States based on case studies. Case studies were selected according to a number of criteria: the existence of evidence on recent cuts in the budget allocated to road maintenance activities, the record of poor road safety performance, the presence of good practice in the assessment of the quality of road surface and planning of maintenance activities and the need to ensure a balance between EU15 and EU13 Member States.

1.2. Study Requirements

The objective of this research study is to provide the TRAN Committee with a clear overview of the condition and quality of road surfaces in the EU with specific reference to the economic and safety consequences of the lack of regular road maintenance. In particular the terms of reference for the study required the following activities to be completed:

- Provision of updated key statistical data concerning road safety in the EU-28 - assessed against a list of objectives and targets fixed in the EU road safety plan for 2011-2020. Special attention is given to the extent to which both investment (including construction, renewal and major repair) and good road maintenance programmes can influence safety for the different types of road surfaces and users.
- An overview of the recent trends in road maintenance expenditure in the EU MS and a detailed analysis of available data related to investment and maintenance spending in road infrastructures in a selection of case studies.
- A review of existing procedures and technologies put in place at EU and national level to assess the quality of the road surfaces and to verify the constancy of performance, the programme maintenance interventions and the communication with the road user, including best practices that could help some MS to redress and/or to improve their road infrastructure safety management.
- A balanced assessment of the possible socio-economic impacts of variations in the amount of resources dedicated to road maintenance looking at the possible impacts of road maintenance programmes on the efficiency of the road transport market, safety of transport users, MS economy and labour market as a whole, etc.

Finally, this study provides conclusions on the spectrum of interventions and actions of support that could be taken at the EU level to promote the improvement and the maintenance of a good quality and safe road transport network throughout the EU, even in presence of stringent public budget constraints that limit the scope of spending in this sector.

1.3. Organisation of the research study

The remainder of this research study is structured as follows:

- Chapter 2 provides an overview of the current EU road safety targets, discussing the achievements made in recent years and the challenges yet to be addressed;
- Chapter 3 provides an overview of road maintenance expenditure trends registered in the EU;
- Chapter 4 presents the procedures in use to assess road safety quality in the EU and to plan road maintenance activities over years;
- Chapter 5 outlines the economic and social impact of road maintenance activities; and
- Chapter 6 concludes by outlining key findings and recommendations.

2. ROAD SAFETY IN THE EU 28

This chapter provides the background explaining why, in the context of road safety, road maintenance is an issue of interest for EU transport policy. Firstly, the chapter sets out recent trends in road safety in the EU and compares them with EU policy objectives and targets in this area. The different factors that contribute to the improvement of road safety on EU roads are also discussed in this chapter, along with an assessment of how the quality and condition of road infrastructure affects this.

2.1 Road safety in the EU

2.1.1 Road safety trends

Road safety is monitored at EU level through the collection of statistics regarding road accidents, fatalities and injuries on EU roads. A common data collection methodology has been developed for EU MS and standardized statistics are published in the CARE database - a Community database on road accidents resulting in death or injury. This dataset provides the basis for the assessment presented in this section[2].

Box 1: Road Safety statistics in the EU

The Care Database

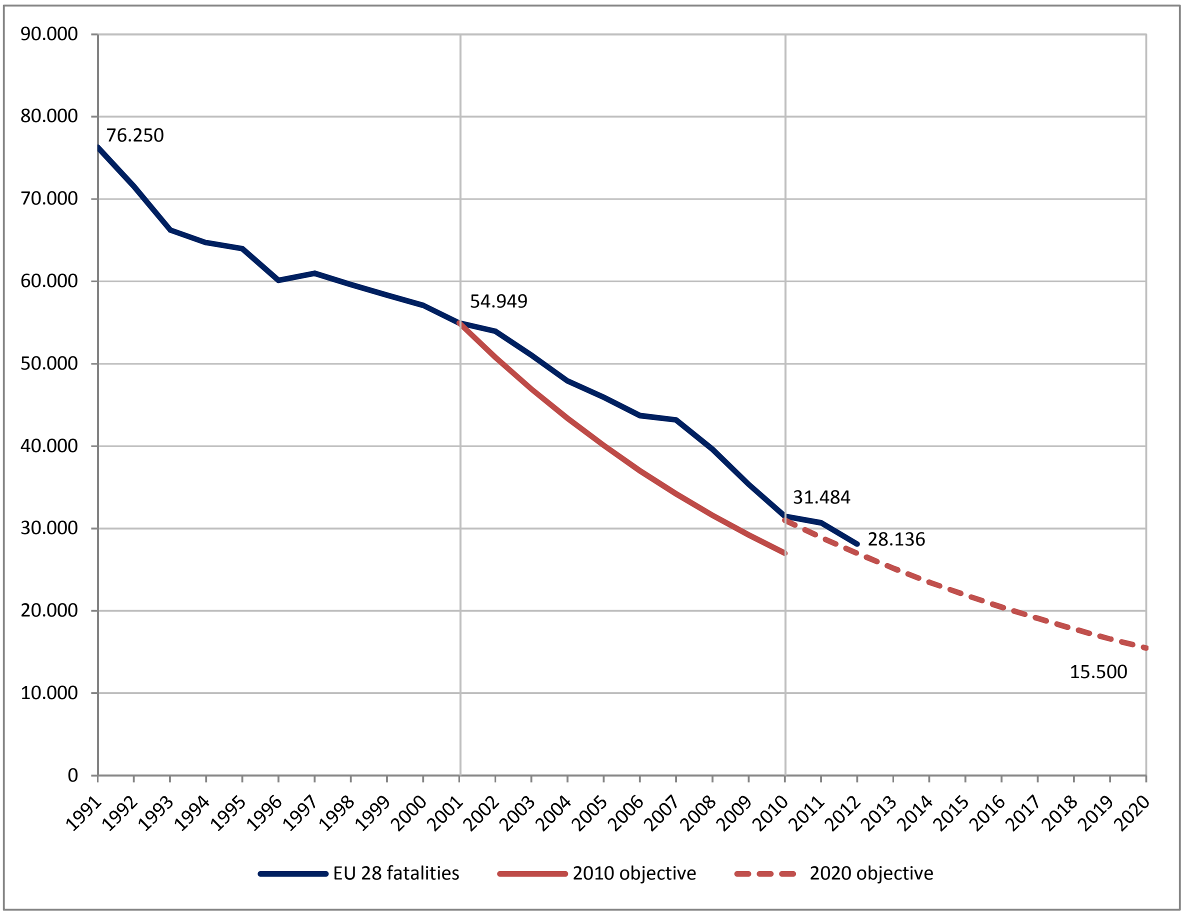
CARE[3] is the European centralised database on road accidents which result in death or injury across the EU, pulling together non-confidential data from all EU Member States. While the yearly production of road safety statistics is the responsibility of each MS (which carry out this task following their own standards and statistical formats), CARE returns a dataset that presents harmonised and comparable data across the EU. This is possible thanks to a framework of transformation rules that ensure the compatibility of data variables and values.

Although significant effort has been made in recent years to improve the quality of the statistical information provided by CARE, there are still a number of issues that hinder the effectiveness of this tool. Firstly, the reliability of data depends primarily on the basic statistics provided by single MSs, whose quality can differ across the EU, as argued by the European Transport Safety Council (2006)[3]. While the accurateness of fatal injuries is quite high across the EU, under-reporting appears to be an issue for injuries and especially for damage-only accidents in a number of MS. Furthermore, although the database provides data differentiated by type of road network and type of road users, it does not provide information on accident causation factors, limiting its role in the shaping of EU road safety policy and measures of intervention.

2 http://ec.europa.eu/transport/road_safety/index_en.htm
3 European Road Safety Council – ETSC (2006), Road accident data in the enlarged European Union, Brussels, Available at: http://www.etsc.eu/documents/Road_accident_data_in_the_Enlarged_European_Union.pdf

Figure 1 below shows the change in the number of road fatalities between 1991 and 2012, together with the targets set for 2010 and 2020 by EU policy in this area[4]. The number of fatalities observed in 2010 was almost 31.000, a level corresponding to 85% of the fatalities reduction target set in 2003 by the EU. Although the EU target has not been achieved, a significant fall has been registered in road fatalities between 2000 and 2010, with a significant step change taking place between 2008 and 2010: over this period road fatalities fell by about 10% per year, against a 4% yearly average registered between 2001 and 2007.

Figure 1: Number of accident fatalities in the EU28, 1991-2012[5]



Source: Steer Davies Gleave elaboration on European Commission data (2013).

Road fatalities in the EU have been decreasing despite a general growth in road passenger transport activity. Between 1995 and 2011, demand (measured in passenger-km) grew by an average of 1.1% per annum in the EU, although growth was higher in the first decade than in following years (the CAGR, or compound annual growth rate, was 1.5% between 1995 and 2005 and 0.6% between 2005 and 2011). This made the goal of reducing total

4 See COM(2003) 311 final “Halving the number of road accident victims in the EU by 2010: A shared responsibility” for the 2010 target and COM(2010) 389 final “Towards a European road safety area: policy orientations on road safety for the years 2011-2020” for the 2020 target.

5 Provisional data for 2013 show a level of fatalities equal to 26,000 (source: European Commission).

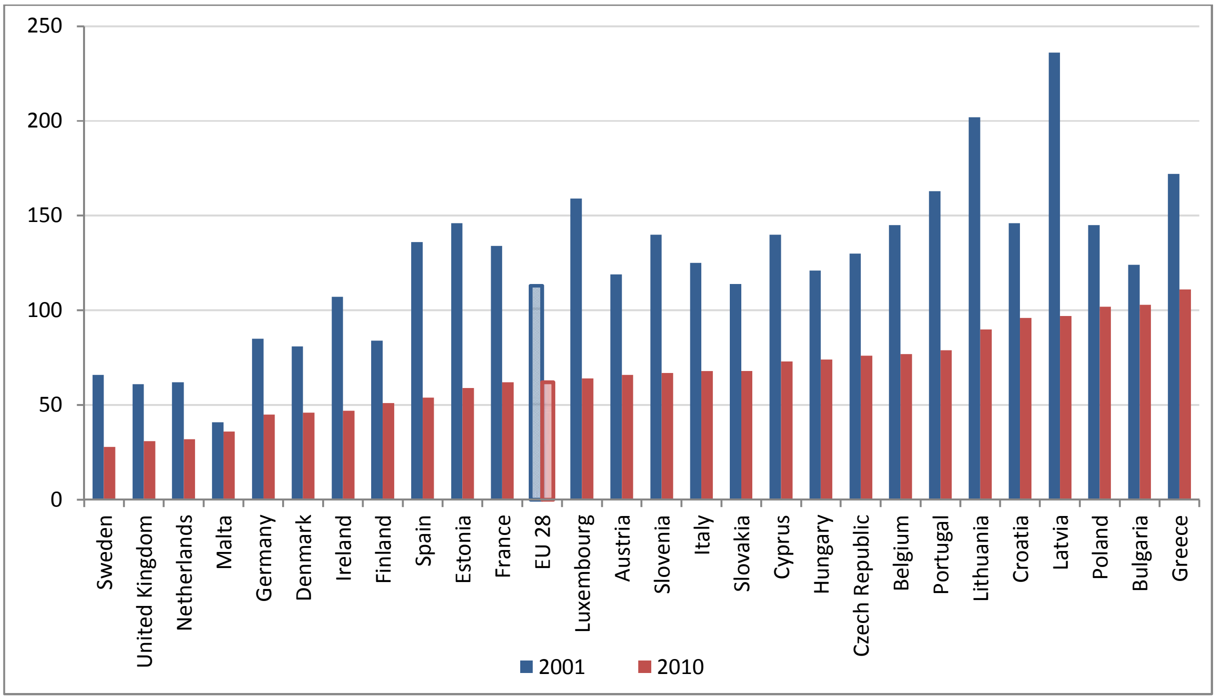
fatalities at the beginning of the 2000s more challenging, and partially explains the lower accident reduction rates experienced in those years.

The general improvement in road safety is also shown by the fall in the risks road users are exposed to:

- Road safety risk, i.e. the risk of being involved an accident causing physical injuries – measured as the number of accidents causing injury as a percentage of million passenger-kilometres - has fallen from 0.32 in 1995 (corresponding to one accident every 3.2 million kilometres) to 0.20 in 2011 (corresponding to one accident every 5.1 million kilometres).
- Road severity risk, i.e. the risk of being involved in an accident causing injuries that results in a fatality – measured as the number of fatalities as a percentage of accidents relating to injury - has also fallen from 4.2% in 1995 to 2.8% in 2011.

The situation varies substantially across the different EU MS, as well as between different types of road users and types of road network. Southern and eastern EU MS tend to have higher than the EU average fatality rates as shown in the figure below. This is a result of both historical/cultural reasons and safety policies adopted in single Member States, as well as the trends registered in car usage in the different countries.

Figure 2: Road fatalities per million inhabitants in EU MS, 2001 and 2010



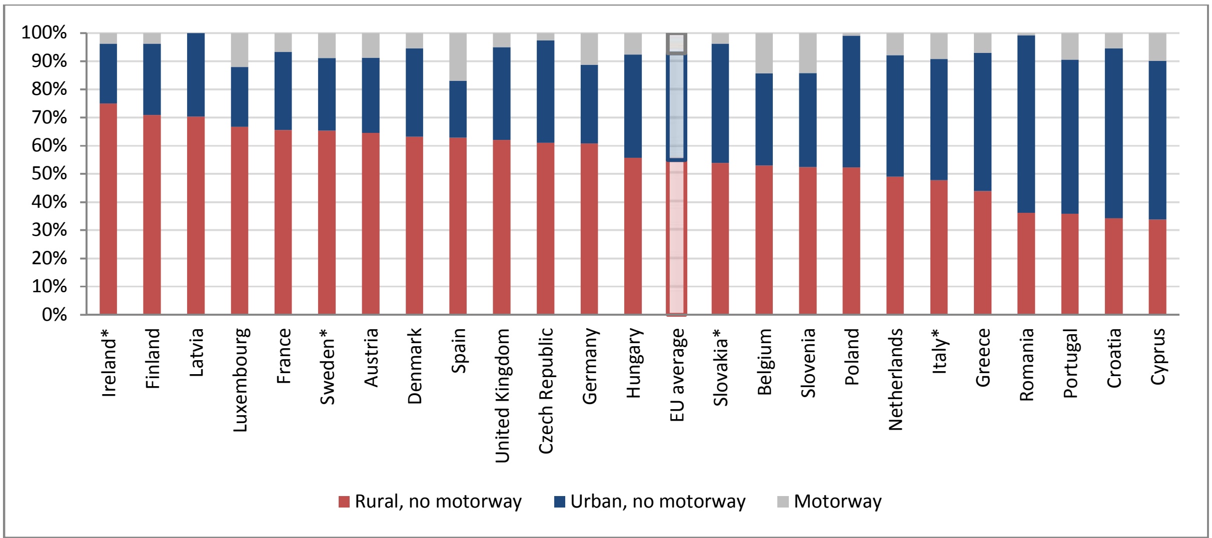
Source: Steer Davies Gleave elaboration on European Commission data (2013).

This variation can be seen in the positive achievements obtained in countries like the UK, the Netherland, Germany, Ireland and Spain which are a consequence of the safety policy and the road network improvements in those MS. The poor performance registered by countries like Poland, Romania, Greece and Bulgaria needs to be balanced against the sharp increase in car usage in these MS: between 2001 and 2010 car ownership increased by 69% in Poland, 37% in Romania, 34% in Greece and Bulgaria, followed by an increase in road traffic of 73% in Poland, 63% in Romania, 58% in Greece and 42% in Bulgaria.

In most countries, fatalities occur predominantly in rural areas, averaging 55% in 2011 and ranging from 75% in Ireland to 34% in Cyprus, while motorways account on average for about 7.5% of accident fatalities in the EU[6].

Between 2000 and 2009, the reduction in the number of fatalities was fairly balanced across the three road types (32% for urban roads, 36% for motorways and 41% for rural roads); however urban and rural roads remain those with the highest share of fatalities. From available statistics it is not possible to identify specific safety and severity risks indexes for the different types of road newtorks across the different EU MS as no EU wide statistics are available on road passenger demand by type of roads. However, as further explained in Box 2, research in this area suggests that accident risks are higher on rural roads than on other types of roads.

Figure 3: Distribution of fatalities by type of road in EU MS, 2011 (2010 when indicated with an asterisk)



Source: Steer Davies Gleave elaboration on European Commission data.

6 This data would ideally need to be assessed against traffic volumes for different types of road which however is only available for the motorway network. As a proxy, accident data by road type could be compared to the road length of the different types of roads in the different EU MS. Unfortunately this data is only available for a subset of countries. The available data does not provide a clear relationship between the share of rural road length and the percentage of road accidents in rural areas. Finland has a large share of rural roads (87%), and a high share of road fatalities in rural areas (71%). Poland has a similar share of rural roads (83%) but a lower share of deaths in rural areas (52%). In the Czech Republic, 61% of road fatalities are recorded in rural roads, but these roads account for only 42% of total road infrastructure.

Box 2: Road Safety risks by type of road network

A research project conducted by the RAC Foundation in 2009 addresses the issue of safety and severity data differentiated by road type with reference to the United Kingdom. The study aims to evaluate the level of danger of the different road types. The UK road infrastructure is divided into motorways, urban “A” roads[7], rural “A” roads, other urban roads, and other rural roads. “A” roads are the principal roads radiating from London. The project found that in terms of the total number of road accidents, motorways have the lowest risk while urban “A” roads the highest. In 2007, relative to motorways, the number of accidents was 2.9 times higher on rural “A” roads, 5.0 times higher on other rural roads, 6.8 times higher on other urban roads, 7.4 times higher on urban “A” roads. With respect to road fatalities, roads classified as “other rural roads” are the most dangerous. Relative to motorways, in 2007 the number of fatal accidents was 2.6 times higher on other urban roads, 3.8 times higher on urban “A” roads, 4.7 times higher on rural “A” roads, 5.8 times higher on other rural roads.

These findings were corroborated by research conducted in 2008 by the OECD[8]. This study brings evidences that rural road crashes are generally more severe than crashes on urban roads, due to a number of factors including higher travelling speed (and thus great levels of energy released on the occurrence of an impact) and relatively poor road geometry in comparison to motorways. Undivided 2-lane rural roads and highways are found to be particularly dangerous. Fatal crash rates per vehicle kilometre can be up to 6 times higher on these road types than on motorways.

Looking at the different types of road users, in 2010, car users accounted for the highest share of fatalities (47.8%), with drivers representing more than two thirds of car fatalities, the remainder being attributed to passengers. Pedestrians accounted for about 20% of road deaths, followed by motorcyclists (14.8%), cyclists (6.7%) and goods vehicle drivers (4.3%). Pedestrians proved to be the most exposed in urban areas where they represent 37% of all fatalities, as well as being those with the highest risk of death when involved in an accident. 2012 data show similar results with car users still accounting for the highest share of fatalities (45%), followed by pedestrian (20.6%) motorcyclists (14.4%), and cyclists (7.5%).

Overall, between 2000 and 2009, the number of fatalities has fallen at a steady rate for cars (-45% over the period), goods vehicle drivers (-40%), cyclists (-33%) and pedestrians (-34%), while the number of fatalities in accidents involving motorcycles has remained constant, suggesting that there is still work to be done in improving safety for this mode.

[7] “A” roads correspond to expressways in the European definition. The difference between motorways and expressways is that motorways have emergency lanes and have higher speed limits.

[8] OECD (2008), Towards Zero – Ambitious Road Safety Target and the Safety System Approach.

2.1.2 EU road safety policy

Road safety is one of the key areas of intervention of the EU common transport policy. Building on the transport strategy set in the 2001 Transport White Paper[9]; in 2003 the 3rd European Road Safety Action Programme (ERSAP)[10] set the challenging goal of halving the number of road fatalities registered in 2001 by 2010.

The figure below illustrates the strategic objectives and areas of intervention included in the 3rd ERSAP.

Figure 4: The 3rd EU Road Safety Action Programme

Many actions were undertaken between 2000 and 2010 to achieve this objective including the introduction of legislative provisions introducing harmonised minimum safety standards for road tunnels (Directive 2004/54/EC), those requiring the use of seatbelts (Directive 2003/20/EC), or the ones introducing harmonised safety management on the TEN-T road network (Directive 2008/96/EC, see box 3).

A number of actions have also been introduced to improve the working conditions of professional drivers: these include Directive 2002/15/EC on the organisation of working time of persons performing mobile road transport activities (Working Time Directive), Directive 2003/59/EC on training of commercial drivers, Regulation EC. 561/2006 to improve the monitoring of driving time regulations using digital tachographs on road vehicles and harmonization of road safety checks (driving times and rest periods Directive)[11].

A comprehensive system of road infrastructure safety management has been introduced by Directive 2008/96/EC of 19 November 2008. Its main objective is to establish procedures to

[9] COM(2001) 370 final, European transport policy for 2010: time to decide, Brussels 12.9.2001. This was then endorsed by the Transport Council on 5 June 2003.

[10] COM (2003) 311 final, Saving 20000 lives on our roads. A shared responsibility, Brussels 2.6.2003

[11] For more detailed information please refer to chapter 2 of the European Parliament study “Social and working conditions of road transport hauliers” published in April 2013, Available online at: http://www.europarl.europa.eu/RegData/etudes/etudes/join/2013/495855/IPOL-TRAN_ET(2013)495855(SUM01)_EN.pdf

ensure that safety is integrated in all phases of the planning, design and operation of road infrastructure. It applies only to the trans-European network but MSs can extend it to other road types and many have done so. The Directive requires the implementation of: road safety impact assessments for infrastructure project at initial planning stage; compulsory road safety audits in all phases of planning, design and early operation of road infrastructure; safety ranking and management of the road network; periodic safety inspections; data management; appointment and training of auditors. A discussion of key features of this Directive and possible areas of improvement is presented later in the study in section 4.2.1.

While the 2010 fatality reduction target was not met, these actions have contributed to a substantial drop in fatalities. As pointed out above, though, the situation is very different across the EU. In a number of cases, thanks to their commitment to enforcement (on such things as driving under the influence, speeding and seat belts) and investments in infrastructure improvements (for example, to transfer high speed traffic from rural roads to trunk routes[12]), some countries performed much better than others. This shows the importance of ensuring that EU policy is appropriately implemented at a national level and is accompanied by a strong commitment and sufficient resources at national level.

At present, the EU ambition of improving safety on EU roads is still quite high and poses considerable challenges for the actions to be taken in the current decade.

In 2010 the Commission published policy orientations on road safety[13] where it reiterated the objective of halving road fatalities and providing a general framework under which concrete action can be taken at European, national, regional or local level. Three main principles guide the policy orientations:

- Striving for the highest road safety standards throughout Europe by encouraging EU citizens to take primary responsibility for their own safety and the safety of others on EU roads, and by focusing on improving the safety of more vulnerable road users;
- Using an integrated approach to road safety – through cooperation with other EU policy areas, such as energy, environment, education, innovation and technology, and justice; and
- Enforcing subsidiarity, proportionality and shared responsibility through the concept of shared responsibility, commitment and concrete actions at all levels from EU countries and their authorities to regional and local bodies.

Bearing in mind the importance of the contribution of national actions to meet this target – and with the intent of granting a more uniform level of road safety within the EU - in its communication the Commission "encourages Member States to contribute, through their national road safety strategy, to the achievement of the common objective, taking into account their specific starting points, needs and circumstances[14].

12 A trunk route is a strategic road which is the recommended route for long-distance and freight traffic.
13 COM(2010) 389 final, Towards a European road safety area: policy orientations on road safety for the years 2011-2020, Brussels.
14 Ibid.

Figure 5: EU policy orientations on road safety 2011-2020

Objective n°1: Improve education and training of road users

Pre-test learning
Driving licence test
Post-licence training

Objective n°2: Increase enforcement of road rules

Cross-border exchange of information in the field of road safety
Enforcement campaigns
Vehicle technology to assist enforcement
National enforcement objectives

Objective n°3: Safer road infrastructure

Objective n° 4: Safer vehicles

Vehicles of today
Vehicles of tomorrow

Objective n° 5: Promote the use of modern technology to increase road safety

Objective n°6: Improve emergency and post-injuries services

Objective n°7: Protect vulnerable road users

Powered-two-wheelers
Pedestrians, cyclists
Elderly people and people with disabilities

Compared to the past, current EU policy has switched its attention to the enforcement of road traffic rules (Objective 2) – a task that is primarily the responsibility of single MS - through the use of modern technologies, the improvement of emergency and post-injury services and the protection of more vulnerable road users.

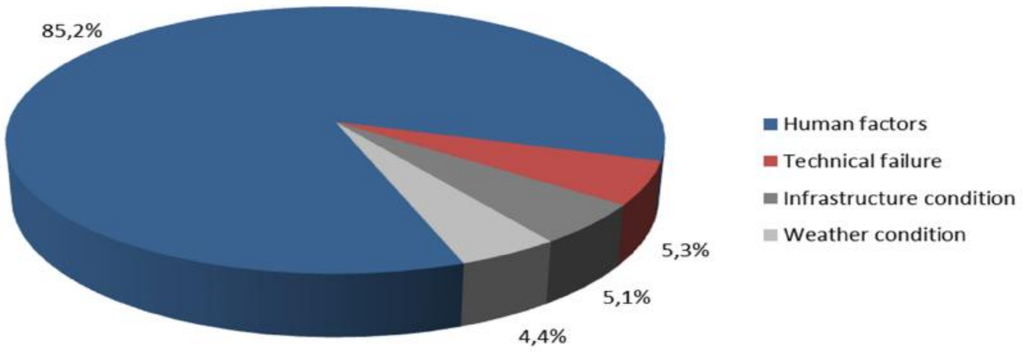
Nonetheless, vehicle and road infrastructure safety (Objectives 3 and 4) are two objectives that continuously appear in EU policy discussions. This can be partly explained by the fact that (i) the development of common standards and procedures in this areas match with the general EU mandate of developing a true internal market for products, works and services and (ii) the quality of the vehicle and road infrastructure still seem to be key elements in the prevention of road accidents, as further discussed in Section 2.2.3. In addition to this EU policy has focused on the use of modern technology both for research purposes and in-vehicle standards (Objective 5), and for emergency and post injuries actions (Objective 6). Finally the Commission, in its communication, underlined the need to prioritize the protection of vulnerable road users (Objective 7).

2.1.3 The causes of road accidents in the EU

Since the adoption of the 3rd ERSAP, the EU has recognized that human error is the most recurring cause of road accidents. This derives from a general consensus that whatever the technical measures in place, the effectiveness of a road safety policy depends ultimately on users' behaviour – such as their willingness to observe driving rules or their ability to drive carefully and have control over their vehicle.

A 2007 study funded by the EU and undertaken by the IRU investigating road accidents causation for trucks confirms this view[15].

Figure 6: Main causes of accidents involving trucks



Source: Steer Davies Gleave elaboration on IRU (2007).

The figure above shows that human factors[16] were responsible for more than 85% of accidents causing injury. The remaining 15% were caused by technical failure (5.3%) poor or inadequate infrastructure (5.1%) and weather conditions (4.4%).

Therefore, vehicle and infrastructure characteristics have a role in ensuring road safety; as drivers can, and inevitably do, sometimes make mistakes, infrastructure and vehicles should be gradually improved to protect users more effectively against their own shortcomings. This can be seen in the fact that vehicles produced today go much further than previously in protecting lives. This is due to standards such as those relating to seatbelts, tyres, lights, mirrors, airbags, to name a few but also to the provision of new technologies that can warn and guide drivers' behaviour.

As for infrastructure, the substantial investments aimed at improving the condition of the road network in some EU countries have helped to improve safety. This is the case in Portugal and Ireland where the EU co-funded improvement of the quality of the road network, which in many cases also diverted traffic from national/regional roads to motorways, has been a major contributing factor in the progress made by these two countries. This is shown in the main transport statistics which show that while road traffic grew by 11.8% and 14.8% in Portugal and Ireland respectively between 2001 and 2010, the number of fatalities by million inhabitants fell by 51.5% and 56.1%. A similar trend can

15 IRU (2007), A scientific study "ETAC" European Truck Accident Causation, Brussels 30.10.2006.

16 For an overview of the different types of Human Functional Failures (HFF) in road accidents refer to the TRACE research project available online at: http://www.trace-project.org/publication/archives/trace-wp5-d5-1.pdf

be seen in Poland where current investments on the road network have been accompanied by an increase in traffic volumes by 69.3% and a decrease in road fatalities rates by 29.7% between 2001 and 2010.

Looking at different types of road users, poorly maintained road infrastructure increases the risk of accidents involving motorcyclists and cyclists but has a smaller impact on car or truck drivers. This point has recently been made by the UK Royal Society for the Prevention of Accidents, which states that motorcyclists are more susceptible to difficulties and hazards created by the design, construction, maintenance and surface condition of roads and stresses the importance of considering the needs and vulnerability of motorclysists and cyclists in planning the design or maintenance of roads[17].

It is difficult to establish a direct link between road quality and the safety of road users, an even more challenging task relates to understanding the extent to which investments in new roads or major repairs, on one side, and maintenance programmes, on the other side, can influence safety for different types of road users.

Box 3: The impact of road condition on road safety

Driver behaviour has been identified as the principal contributor to accidents, but the impact of road condition and maintenance is not negligible. In many circumstances, it is difficult to disentangle causality: there are accidents caused directly by the poor condition of the road, but there are also accidents caused by drivers' behaviour in reaction to the condition or the design of the road. There is, in fact, a correlation between road quality and driver behaviour; in some circumstances even careful drivers make poor choices as a result of the condition of the road or their reading of the road layout.

There are different ways in which the condition of the road surface contributes to, or compromises road safety: (i) localised anomalies, such as ruts, potholes and depressions, whose unpredictability make them dangerous for drivers; (ii) poor wheel-road contact that fails to guarantee a sufficient skid resistance value, due to inadequate road maintenance; (iii) poor geometry and alignment design – i.e. inadequate design of the route of the road; (iv) poor level of service unable to accommodate existing traffic flows; (v) poor signage or markings, e.g. incomplete or missing markings and signs, and poor lighting.

Lack of regular road maintenance can exacerbate some of these factors, especially to ones related to the road surface condition. The purpose of road surface is to keep the vehicle on the correct trajectory and to allow braking in wet and dry conditions.

A study conducted by the National Cooperative Highway Research Program[18] (NCHRP) showed that there is a direct correlation between the number of accidents and the skid resistance value. The study shows that as pavement friction levels decrease, there is a corresponding increase in crash rates. Another study conducted by the Swedish National Road and Transport Research Institute[19] reinforces the theory that accidents increase in slippery conditions.

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[17] http://www.rospa.com/roadsafety/policy/statements/motorcycling.aspx
[18] National Cooperative Highway Research Program (NCHRP) (2009), "Guide for Pavement Friction" USA.
[19] Swedish National Road and Transport Research Institute (2004), "The Influence of Road Surface Condition on Traffic Safety and Ride Comfort", 6th International Conference on Managing Pavements.

The study uses the International Roughness Index (IRI, measure in millimetres/metre) to assess skid resistance. The results show clearly that the accident rate increases as the IRI value rises, whilst accidents increase with increased traffic flow.

Poor road condition caused by insufficient regular (and extraordinary) maintenance was seen as being particularly dangerous when anomalies are localised. There are different types of surface anomalies: (i) ruts - linear depressions created by a permanent deformation of the layers of bitumen caused by the load from a vehicle's wheels; (ii) potholes - depressions brought about by the removal of the superficial layer of tarmac caused by traffic; (iii) depressions - permanent deformations in the road surface due to ground subsidence.

In dry surface conditions these anomalies, if evenly distributed, cause continuous vibrations and bumps which usually increase drivers' attention and, as a result, the risk of accident seems to decrease. If the same anomalies are spread more thinly the risk increases as it is difficult for drivers to assess the pavement's skid resistance and adapt their driving style accordingly. In wet conditions, surfaces anomalies (especially rutting) lead to an increased risk of aquaplaning (a phenomenon whereby the vehicle floats on a layer of water, there is no longer contact between the road and the wheels) and the driver can lose control of the vehicle. The risk of aquaplaning accidents is greatest for large rut depths and during conditions of poor water drainage (small cross fall).

Other aspects strictly related to maintenance are linked to markings, signs and lighting. These aspects contribute to make the road logical and easy to understand. Road markings are a cost effective solution to provide a clear indication of the driving lanes and space, contributing to a predictable driving trajectory. This allows road users to understand the road's layout and act accordingly. A study developed by the EU Road Federation[20] shows that good maintenance of road markings and signs reduces accident risk. Good and continuous street lighting also contributes to improved road safety especially in specific locations such as at intersections, pedestrian crossings, and generally in urban areas.

In summary, there are various qualities of the road's condition which contribute to its safety. A high level of pavement friction, clear signage and road markings are important qualities of a safe road, and it is important that these are maintained throughout the road's lifespan. Anomalies, such as ruts and depressions, reduce road safety as they are a tiring and unpredictable hazard for drivers, and can cause aquaplaning in wet conditions. In addition, roadworks create more hazardous road conditions for both drivers and those who are working on the road.

Appropriate road geometry is an important factor in a safe road. Another important provision is an appropriate level of service for the anticipated traffic flow. However, both of these factors fall under the umbrella of one-off, rather than regular maintenance. A more extensive illustration of the impact of road condition on road safety is reported in Chapter 4.

[20] European Union Road Federation "Marking the way towards a safer future" Brussels 11.12.2013.

We have identified a broad consensus on the approach to be adopted at policy level to improve the safety of new and existing roads, as part of a wider strategy targeted at reducing road deaths and accidents. The latest European Commission as well as the OECD road safety strategy orientations[21], indicate that the approach needs to be founded on the following pillars:

- Presence of accurate and reliable data to be used to assess the results and identify areas of intervention;
- Establishment of a context of shared responsibility, commitment and concrete actions, at the different levels of intervention (e.g. European authorities, Member States, regional and local bodies) and involving the various actors (e.g. road developers, infrastructure managers, civil society, etc.);
- Recourse to an appropriate design for each road type to minimise the probability of accidents occurring and to mitigate injury severity accompanied by the existence of a robust system of road safety audits;
- Use of maintenance and infrastructure safety investment programmes based on procedures for funding allocation and project selection able to prioritise interventions that can tackle safety risks in the most efficient and effective way.

While the first three points listed above have been put on the agenda of road safety policy for some years now, it is only in recent years that the last point is emerging with more urgency. This has become more important as the 2008 economic and financial crisis has put at risk the availability of resources dedicated to road maintenance and investment works in some countries. In its resolution issued on the 27th September 2011 on European road safety 2011-2020, while commenting on a number of aspects of the Commission road safety strategy[22], the European Parliament stressed the importance of a well-preserved road infrastructure to contribute to reducing fatalities and injuries of road users. The resolution calls on the Member States to preserve and develop their road infrastructure through regular maintenance and innovative methods such as intelligent road markings that display safety distances and the direction of travel, and passively safe road infrastructure. It also stresses that regulations for signposting, in particular regarding road works, must be respected as they are crucial for a high level of road safety[23].

The evolution of road expenditure trends before and after the economic and financial crisis is looked at in more detail in the following chapter.

[21] See COM(2010) 389 final, Towards a European road safety area: policy orientations on road safety for the years 2011-2020, Brussels and OECD (2008), Towards Zero – Ambitious Road Safety Target and the Safety System Approach.
[22] COM(2010) 389 final.
[23] See European Parliament resolution of 27 September 2011 on European road safety 2011-2020 (2010/2235(INI)), P7_TA(2011)0408.

KEY FINDINGS

- The analysis of road safety indicators across Member States suggests unambiguously that road safety has improved over the last decade. Between 2000 and 2010 the number of road fatalities fell to 31,500, a level corresponding to 57% of the fatalities registered in 2001, falling short of the target set in the 3rd ERSAP of halving the number of fatalities by 2010. This reduction was achieved despite a general growth of road traffic over the same period. Provisional data for 2013 indicate that road fatalities are still decreasing, as an overall number of 26,000 fatalities has been registered in the EU. 2013 is the second year in a row that saw an impressive decrease in the number of people killed on Europe's roads. Based on preliminary figures, the number of road fatalities has decreased by 8% compared to 2012, following the 9% decrease between 2011 and 2012. For the coming years, the European Commission has renewed its objective of halving fatalities by 2020 through increased focus on the enforcement of road rules.
- The situation varies substantially across the different EU MSs with southern and eastern MSs having higher fatality rates than the EU average. Car users account for the highest share of accident fatalities, followed by pedestrians and motorcyclists. Pedestrians are the most exposed in urban areas.
- When developing road safety policies and interventions, the reliability and quality of data is a key issue. There is scope across Europe for further efforts to link police collision reports to hospital data records to improve data quality and consistency, especially regarding serious injury crashes. Data quality and effective analysis are fundamental to building risk awareness and intervention effectiveness.
- The root causes of road accidents are hard to disentangle. Human factors play a dominant role, but the quality of road infrastructure is also key. To this end, appropriate investment and maintenance activities are necessary to preserve the quality of roads over time.

3. ROAD MAINTENANCE EXPENDITURE IN THE EU

3.1 Introduction

This chapter provides an overview of the recent trends in road maintenance expenditure in the EU and analyses in detail the data available on investment and maintenance spending in road infrastructure. Road maintenance expenditure data is also assessed against overall economic performance of the EU to investigate whether the ongoing economic and financial crisis started in 2008 has had an impact on the amount of resources targeted at the maintenance of road infrastructure in the EU.

3.1.1 Data availability

The collection of homogeneous and accurate information on road maintenance and investment expenditure across the different MS is difficult as the degree of homogeneity of data is minimal, leading to an imperfect dataset. First, the fact that roads are administered differently in different MSs means that the responsibility for keeping the different sections of the road network (e.g. national, regional or local roads) at acceptable standards is assigned to numerous bodies, such as national ministries, regional or local authorities, etc. In many cases, in particularly for administrations in charge of local roads, authorities may not have the resources to accurately record the budget allocated and/or spent, making it difficult to collect relevant and useful information. Secondly, the definition of road maintenance and investment activities is not always clear (see box below) making it problematic to detect exactly what needs to be recorded in each of the two categories, creating discrepancies in the way data is reported across the different MSs.

To date the most accurate international dataset that collects information on road maintenance and investment data is the one produced by the Organisation for Economic Co-operation and Development (OECD) – through the International Transport Forum (ITF). The analysis reported in this chapter is thus primarily based on public information provided in the recently issued ITF publication (2013) on spending trends between 1995 and 2011.

Before discussing this data it is important to explain the assumptions that underpin the ITF database. The first one regards the definitions of maintenance and investment expenditure at the basis of the collected data. The ITF collects road maintenenance and investment expenditure data following the definitions provided by the the United Nations System of National Accounts (see Box 4).

These definitions, however, are not currently implemented uniformely across MSs and the ITF is engaged in discussions with national road authorities, working towards the standardisation of these definitions. This implies that the ITF data used for the analysis of trends in this chapter is not necessarily consistent among Member States. At the same time, there is no harmonised approach across countries on the type of road expenditure data reported, as the data provided by each MS refers to different sections (national, regional, local) of their road network. Finally, data for a number of countries – including some EU

MSs[24] – is missing within the ITF dataset. Despite these limitations it is important to point out that there is consistency in the time series statistics within single countries and a general convergence on the adoption of the same definition for maintenance and investment activities. To overcome some of these limitations, in some cases[25] the data has been supplemented by other evidence on relevant indicators such as asphalt production or maintenance expenditure data provided by stakeholders such as the European Asphalt Pavement Association (EAPA) and the Professional Association of Operators of Toll Road Infrastructures (ASECAP), or added to by relevant national data sources.

Box 4: Definition of investment and maintenance in the road sector

International Transport Forum (ITF) delineation of investment and maintenance expenditure

When considering the delineation of transport infrastructure spending, the distinction between fixed capital formation and intermediate consumption is important. The new purchase, or original production, of a new structure is a clear case of investment, while maintenance expenditure is less clear. Repairs and ordinary maintenance should be noted as intermediate consumption; major reconstructions, renovations or extensions should be recorded as investment. The difference between investment and maintenance is defined as follows by the United Nations System of National Accounts (SNA):

"Ordinary maintenance and repairs are distinguished by two features:

a. They are activities that owners or users of fixed assets are obliged to undertake periodically in order to be able to utilize such assets over their expected service lives. [...] The owner or user cannot afford to neglect maintenance and repairs as the expected service life may be drastically shortened otherwise;

b. Maintenance and repairs do not change the fixed asset or its performance, but simply maintain it in good working order or restore it to its previous condition in the event of a breakdown. Defective parts are replaced by new parts of the same kind without changing the basic nature of the fixed asset" (SNA, para. 6.228).

"On the other hand, major renovations or enlargements to fixed assets are distinguished by the following features:

a. The decision to renovate, reconstruct or enlarge a fixed asset is a deliberate investment decision that may be undertaken at any time and is not dictated by the condition of the asset. Major renovations of equipment, buildings or other structures are frequently undertaken well before the end of their normal service lives;

b. Major renovations or enlargements increase the performance or capacity of existing fixed assets or significantly extend their previously expected service lives. Enlarging or extending an existing building or structure obviously constitutes a major change in this sense, but a complete refitting or restructuring of the interior of a building also qualifies" (SNA, para. 6.229).

[24] See Table 1 on page 37.
[25] See Table 1.

3.1.2 Geographical coverage

The assessment of general maintenance trends has been coupled with an investigation of the trends experienced in MSs where information is available. In many cases we also compare figures between the EU15 and the EU13, as a number of factors characterizing these two groups of MSs, such as the different stages of economic and infrastructure development, and the extent to which they have access to EU Structural and Cohesion funds for transport infrastructure. This can help to explain some of the road expenditure figures recorded.

Due to the limited data available across MSs (more of an issue for maintenance than for general road expenditure) when presenting figures regarding aggregate classifications (i.e. EU28, EU15, and EU13), reference is made to the countries for which data is available. In addition to this, when presenting trends for EU groupings, we include information for all countries that at present belong to that grouping, irrespective of the date they joined the EU. For example, 2006-2011 trends for EU13 road investment expenditure also includes available, pre-accession, data for those countries that entered the EU in 2007 (Bulgaria and Romania) and 2013 (Croatia).

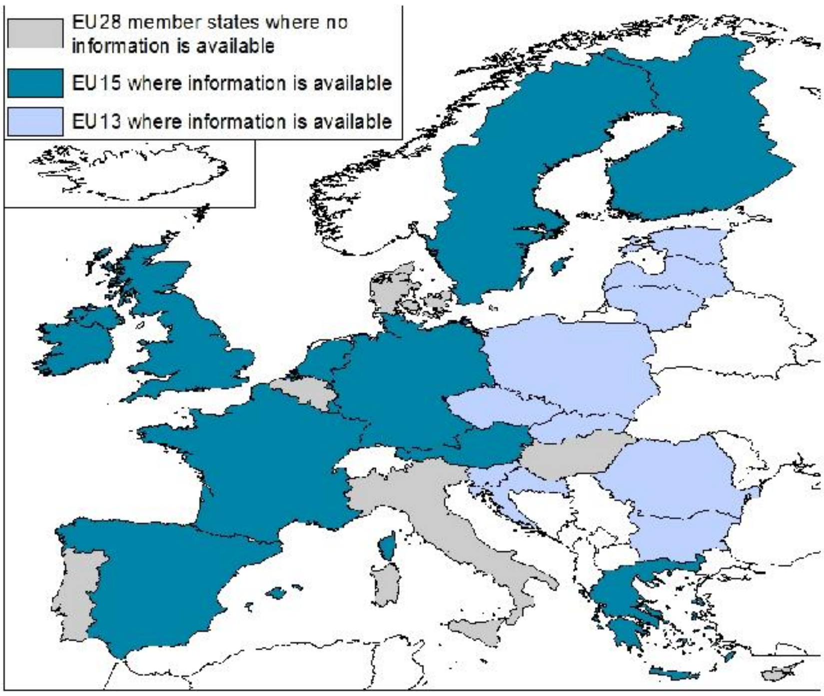
The following table and figures summarise the availability of data collected for each MS. Those Member States coloured in grey in the figures below are those for which data is not available.

Table 1: Road maintenance data availability in EU MS

EU MS	Investment expenditure	Maintenance expenditure	Asphalt production
AT	√	√	√
BE			√
BG	√	√	
HR	√	√	√
CZ	√	√	√
CY			
DK			√
EE	√	√	√
FI	√	√	√
FR	√	√	√
DE	√		√
GR	√		√
HU			√
IE	√	√	√
IT		√	√
LV	√	√	√
LT	√	√	√
LU	√	√	√
MT			

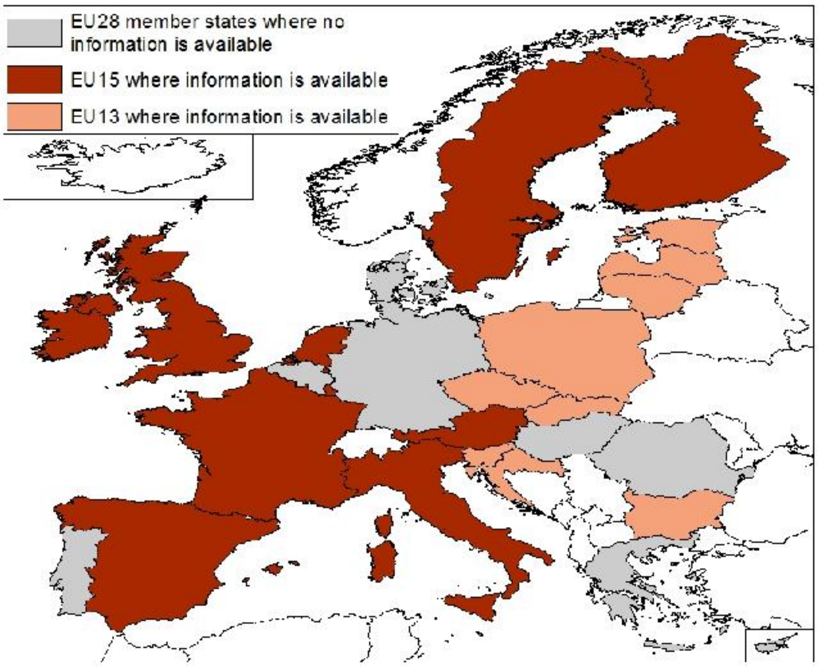
EU MS	Investment expenditure	Maintenance expenditure	Asphalt production
NL	√	√	√
PO	√	√	√
PT			√
RO	√		√
SK	√	√	√
SI	√	√	√
ES	√	√	√
SE	√	√	√
UK	√	√	√

Figure 7: Available data on investment expenditure in the EU



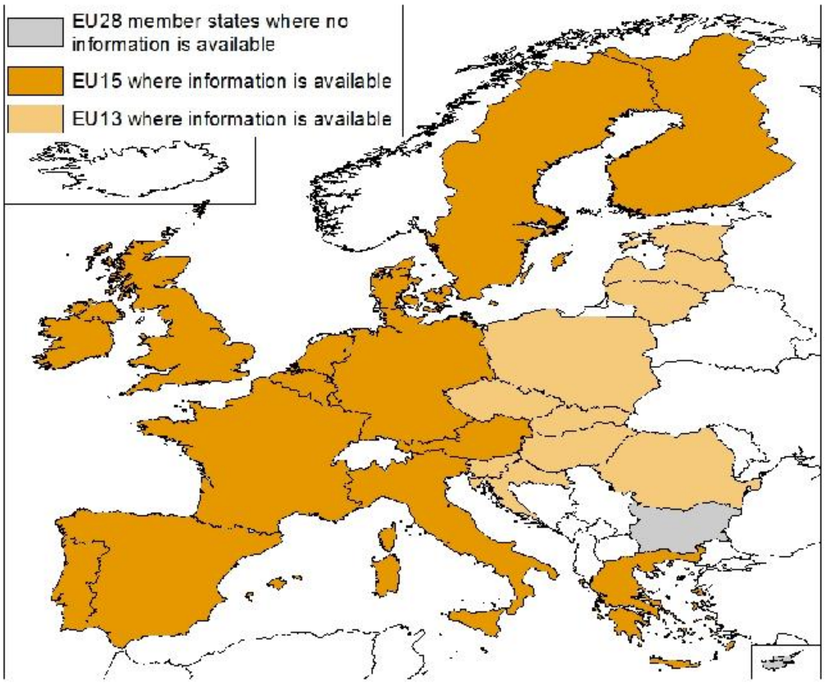
Source: SDG elaboration.

Figure 8: Available data on maintenance expenditure in the EU



Source: SDG elaboration.

Figure 9: Available data on asphalt production in the EU



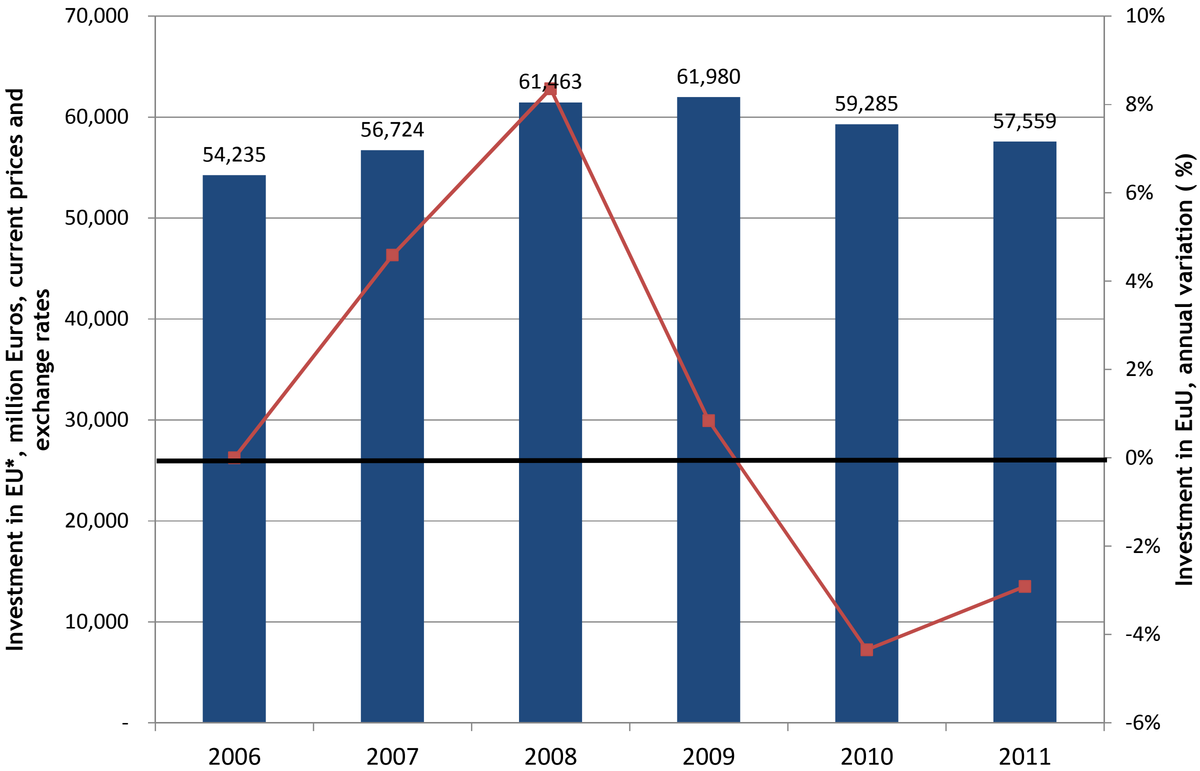
Source: SDG elaboration.

3.2. Road investment and maintenance expenditure trends

3.2.1 Road investment trends in the EU

Total investment levels remained relatively stable in the EU between 2006 and 2011, as shown in the figure below. Road investment was at its highest in 2009, but had fallen by 7.1% by 2011. It is important to note that by presenting aggregate statistics, the information hides where increases in investment expenditure in one country have cancelled out decreases in another country.

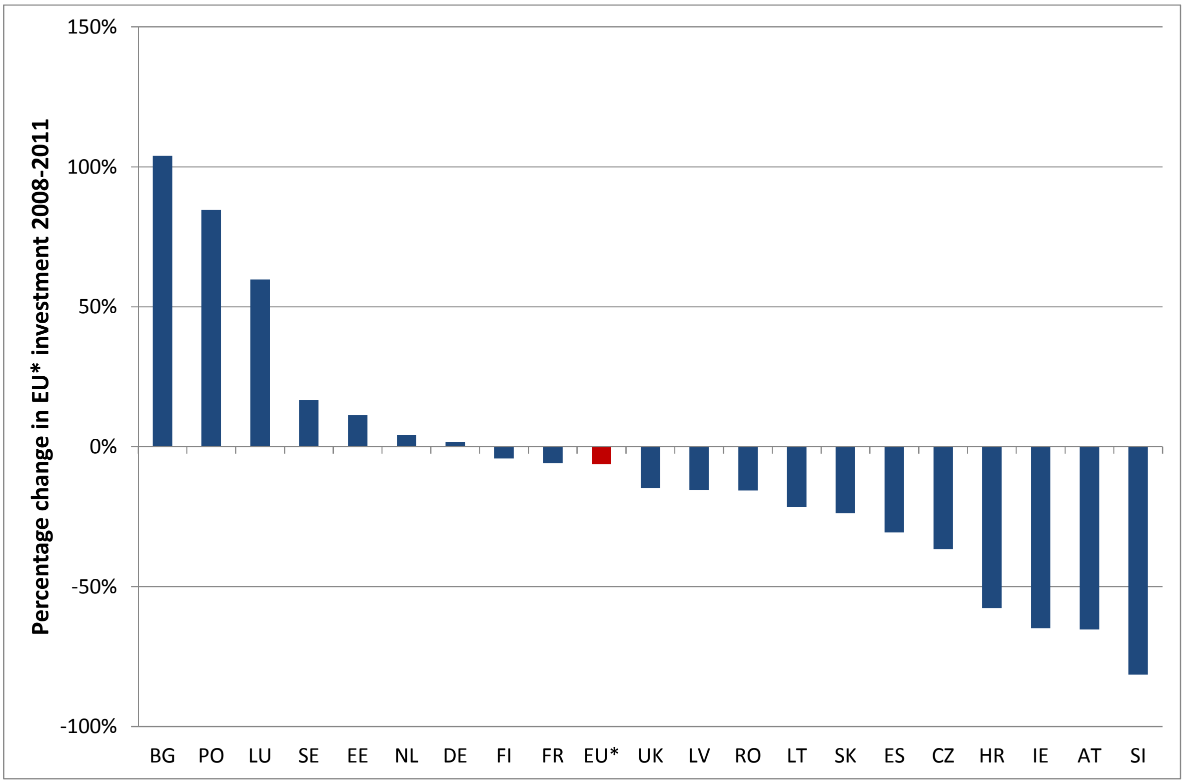
Figure 10: Road investment expenditure in the EU 2006-2011



Source: Steer Davies Gleave elaboration on OECD/ITF (2013).

Country-specific data in Figure 11 shows that there is a great deal of variation across EU countries in road investment expenditure registered in the 2008-2011 period. The aggregate EU trend is shown by the red bar, highlighting a 6.4% decrease in road investment over the period. However, some countries departed markedly from this average. Bulgaria and Poland both greatly increased their investment expenditure over these years, whilst Slovenia, Austria and Ireland drastically reduced theirs. Despite the large variations noted in some smaller MSs, road investment expenditure of the largest economies in this sample – Germany, France and the UK – did not vary substantially between 2008 and 2011.

Figure 11: Change in investment in the EU 2008-2011



Source: Steer Davies Gleave elaboration on OECD/ITF (2013).

The large increase recorded in Bulgaria and Poland is mainly attributable to the major road investment programmes co-financed in these countries through EU Cohesion and Structural funds since their accession to the EU. Over the 2007-2013 programming period Poland received 31% of the total EU Cohesion budget allocated to transport, i.e. about €23bn out of a total of €75bn, targeting investment primarily at its road network.

In Romania and Lithuania the impact of EU funding on road maintenance investment has been extensive. While the data above shows a decrease in investment in these countries, the average spending on investment over the 2008-2011 period was very high, with a peak in 2008.

While the sharp decrease in investment witnessed in Ireland and Spain is also attributable to a high baseline in 2008, against which the reduction in the following years appears to be very large, these MSs have experienced a declining trend in investment. Spending on road investment during the 2000-2006 period in these MSs had also been boosted by European funding.

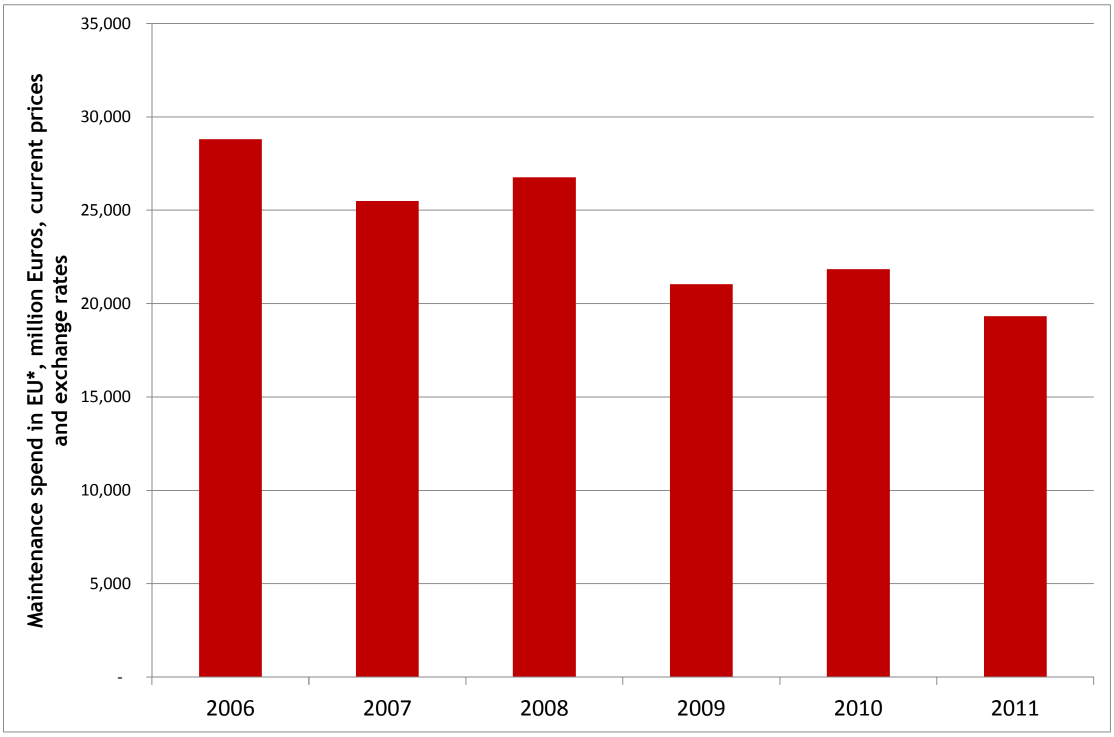
Finally in MSs with mature road networks, such as France, Finland, the Netherlands and Austria, it is not surprising that changes in investment patterns have been either marginal or markedly negative. Once network expansion slows down, the share of expenditure classified as investment is expected to decrease, while the total expenditure on road maintenance may need to increase.

3.2.2 Road maintenance trends in the EU

As shown by Figure 12, OECD data on maintenance expenditure in the EU is less accurate than those for investment activities as figures for some large MS (e.g. Germany, Greece, and Romania) are missing.

From the available statistics, reported in Figure 12, it can be seen that, overall, the downward trend in road maintenance expenditure in the EU in the 2006-2011 period was greater than the one experienced by investment expenditure shown in Figure 10 above. Despite the modest rise recorded in 2008 and 2010, between 2008 and 2011 the reduction in road maintenance expenditure in the EU was close to 30%. From a preliminary assessment it seems that the fall in road maintenance expenditure is not directly linked to the economic cycle, as a decrease was registered prior to the 2008 economic and financial crisis. However, from this aggregate data it appears that the post-2008 economic climate exacerbated maintenance expenditure reductions, as discussed further below.

Figure 12: Road maintenance expenditure in the EU 2006-2011



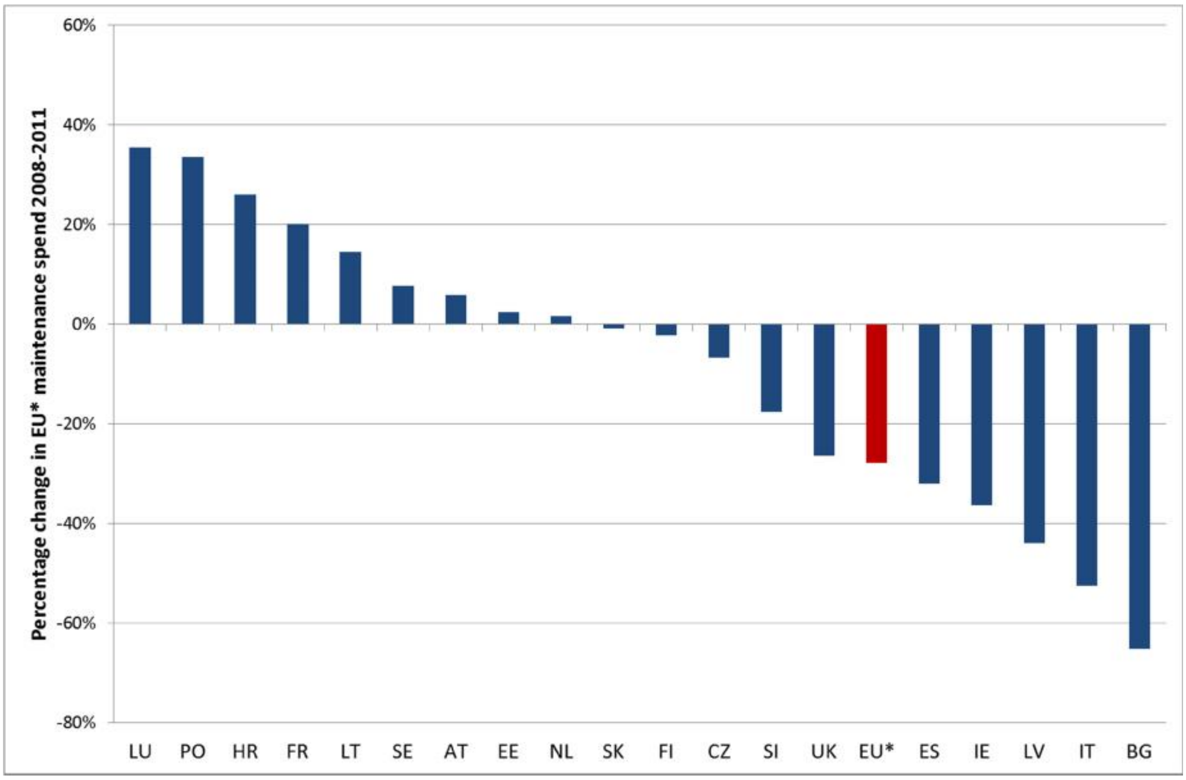
Source: Steer Davies Gleave elaboration on OECD/ITF (2013).

Looking more specifically at national trends, some countries experienced very large reductions in their maintenance budgets as seen in Bulgaria, Italy and the Netherlands. It is of note that Bulgaria's maintenance expenditure fell significantly in the same period that its investment rose. However the large relative change in maintenance spending in Bulgaria hides the fact that maintenance spending is rather small in comparison to investment (four times smaller) every year. At a time of road expansion, it is possible to envisage investment activities replacing maintenance activities. This contrasts with Poland, which has increased both its investment and maintenance expenditure over the 2008-2011 period.

Amongst the EU15 MSs, significant falls in maintenance expenditure can be seen in Italy, Spain and the UK. Information collected in the case studies has shown that in these three MSs road maintenance budgets have been subject to cuts in the last few years, owing to budgetary pressures and the need to reduce government spending overall. A common trait of the cuts across MSs is that they have disproportionately affected local authorites, thus potentially increasing the gap in road quality between local and national roads further.

In contrast, maintenance spending has increased in countries such as France and Sweden between 2008 and 2011. In France, several stimulus plans aimed at countering the economic recession have relied on road maintenance and investment spending as a lever for short-term growth.

Figure 13: Change in maintenance expenditure in a selection of EU[26] MS 2008-2011



Source: OECD/ITF.

3.2.3 Road maintenance expenditure in EU15 and EU13

The EU15 still accounts for the highest proportion of road expenditure in the EU, although the EU13 has seen the most change in investment and maintenance activities. Figures 14 and 15 report data for countries where both investment and maintenance data is available for the 2006-2011 period[27].

26 EU: Austria, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Poland, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.

27 The countries covered are those showing a tick in the first two columns in Table 1.

Figure 14: Maintenance expenditure: EU15 versus EU13, 2006 and 2011

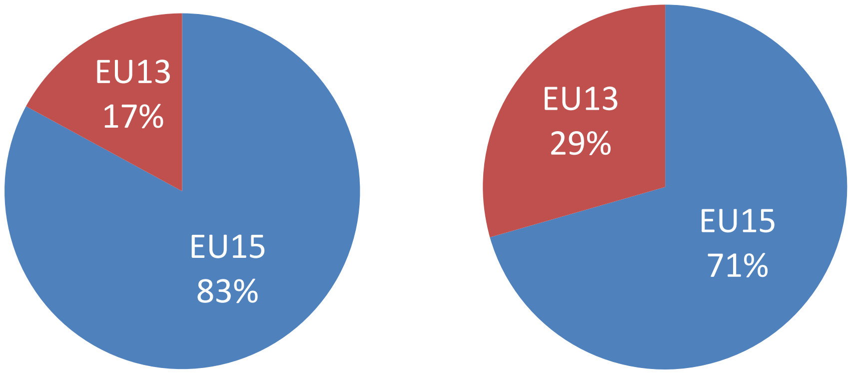
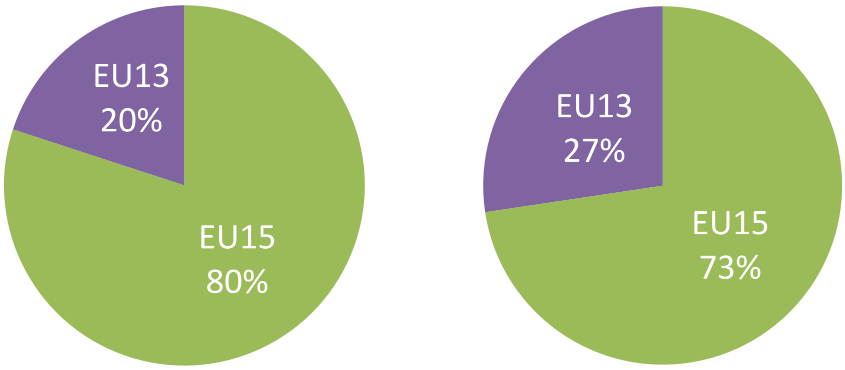


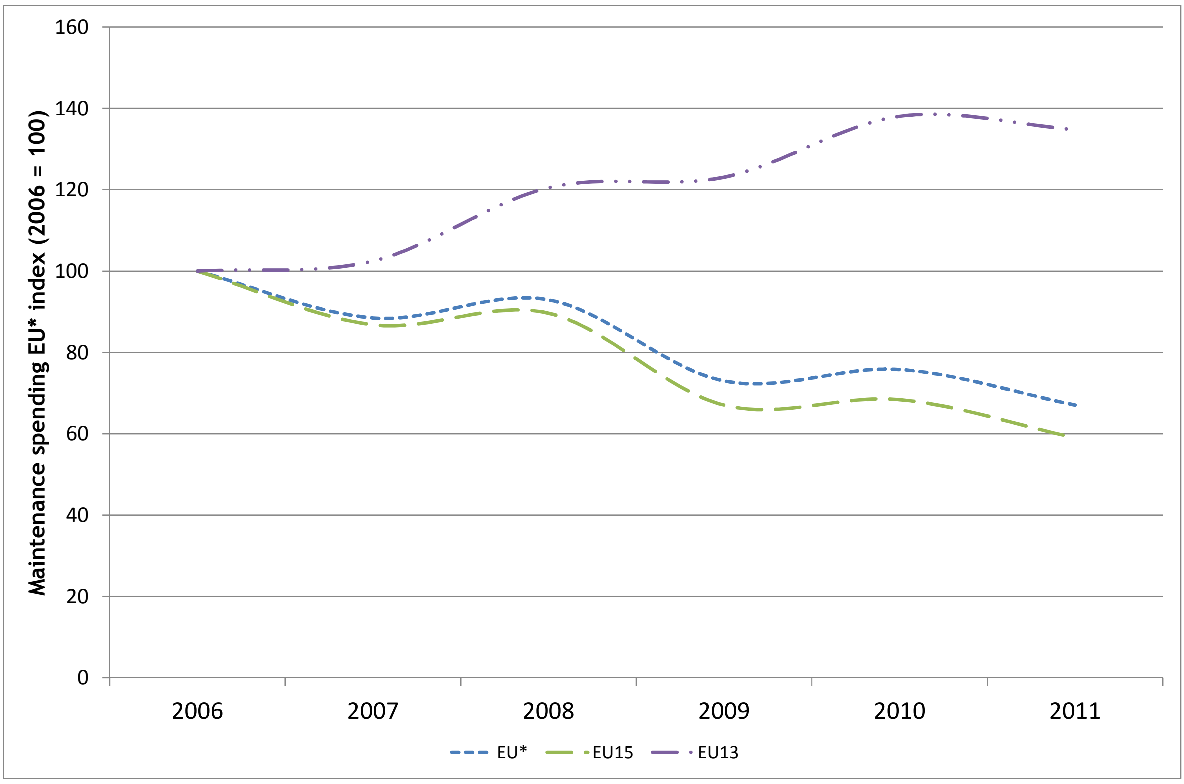
Figure 15: Investment: EU15 versus EU13, 2006 and 2011



In 2006, 17% of total EU road expenditure was spent in the EU13; whilst in 2011, this figure had risen to 29%. When investment and maintenance data are analysed separately, these figures move from 17% to 29% for maintenance and 20% to 27% for investment.

Although most additional expenditure in the road sector in the EU13 was targeted at investments, maintenance expenditure in central and eastern European MSs has been increasing in recent years, thereby becoming a more important component of the EU total. This is clearly shown in Figure 16 illustrating an index of maintenance expenditure (2006=100) for the EU15 and EU13.

Figure 16: Maintenance expenditure trends in the EU 2006-2011



Source: Steer Davies Gleave elaboration on OECD/ITF (2013).

3.3. Road maintenance activities: an assessment through asphalt production data

3.3.1 Road asphalt production as a proxy of road expenditure

In addition to the OECD data set out above we have sourced data on asphalt production from the European Asphalt Pavement Association (EAPA) to examine whether it can serve as a viable proxy for investment and maintenance expenditure in EU28 countries. This data is relevant as the vast majority of all asphalt produced is used for the road sector[28] and more than 90% of the EU's roads are surfaced with asphalt[29].

About 25% of total asphalt production in the world takes place in Europe, and it is mainly destined at the road sectors of the European countries where it is produced: once produced, asphalt can be transported only limited distances from the production site - normally between 30 and 80 km. This is determined by the fact that asphalt must be delivered to the paving site while it is still warm enough to be placed and compacted on the road.

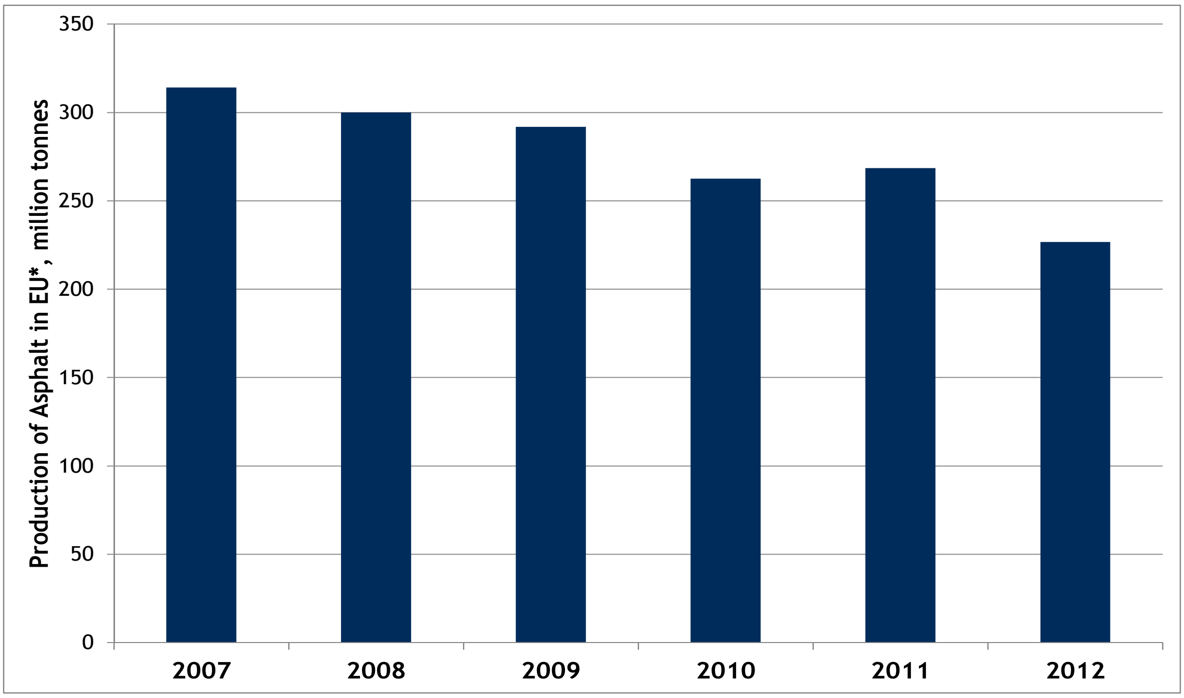
[28] NAPA & EAPA (2011), The Asphalt Paving Industry A Global Perspective, p.5 indicates that 85% of bitumen produced worldwide, a key component of asphalt, is targeted at the road sector.

[29] NAPA & EAPA (2011), The Asphalt Paving Industry A Global Perspective, p.5.

From the above it can be seen that the level of road investment and maintenance works undertaken in a country is highly correlated to the amount of asphalt produced in the same year in its production plants, as the possibility of importing/exporting asphalt is limited. This implies that asphalt production of a single EU MS can be used as a proxy for consumption, and hence for the overall level of road works in each MS. This data however cannot indicate whether this consumption is attributable to investment or maintenance activities on the road network. However, some conclusions can be drawn with appropriate assumptions.

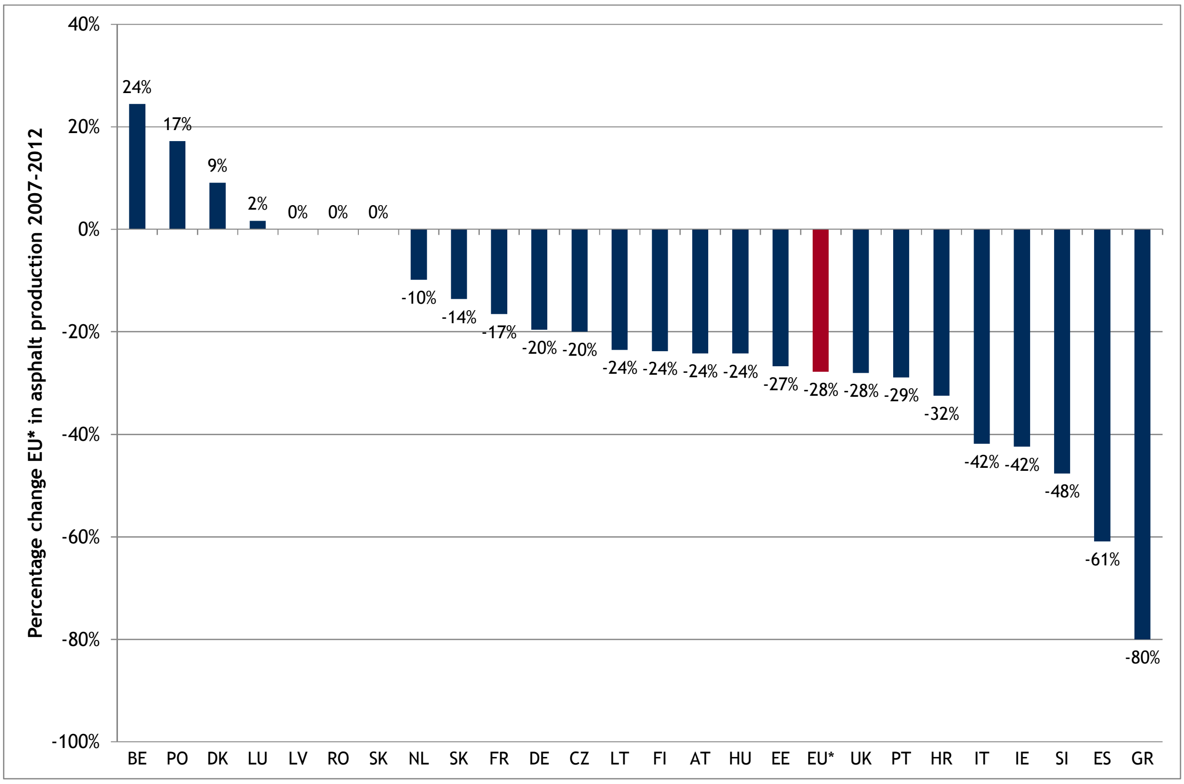
Total asphalt production in EU countries fell almost every year, and by a total of 27.8% over the 2007-2012 period as shown in Figures 17 and 18.

Figure 17: Asphalt production in the EU: 2007-2012



Source: Steer Davies Gleave elaboration on EAPA (2013).

Figure 18: Change in asphalt production in EU MSs: 2007-2012



Source: Steer Davies Gleave elaboration on EAPA (2013).

At a national level, Greece, Spain, Slovenia, Ireland and Italy experienced the greatest falls in asphalt production since 2008: this seem to suggest that investment and maintenance activities have decreased significantly in these MSs. In contrast, Belgium, Poland and Denmark increased production over the same period.

Comparing asphalt production data with the extension of the road network highlights whether variations in asphalt production are driven primarily by changes in the level of investment or are mainly attributable to a variation in the extent of road maintenance activities. The former seems to be the case of Poland, where there has been significant road investment in recent years. The latter is certainly the case in countries such as Spain and Italy, where the size of road network has remained stable since 2007, while the production of asphalt has fallen significantly.

The analysis of asphalt data reveals similar trends to those identified in the analysis of road expenditure. On the one hand, MSs where an increase in asphalt production has been recorded also tend to be the ones where total spending on roads has not decreased (e.g. Poland, Luxembourg). Conversely, the decrease in asphalt production witnessed in MSs such as Spain, Ireland, Italy and the UK is in line with a reduction in road maintenance and particularly in investment in these countries with developed road networks.

Table 2: Asphalt production, investment and maintenance expenditure (2007-12)

	Asphalt production	Investment	Mainteinance expenditure
Belgium	24%		
Poland	17%	85%	34%
Denmark	9%		
Luxembourg	2%	60%	35%
Latvia	0%	-15%	-44%
Romania	0%	-16%	
Sweden	0%	17%	8%
Netherlands	-10%	4%	2%
Slovakia	-14%	-24%	-1%
France	-17%	-6%	20%
Germany	-20%	2%	
Czech Republic	-20%	-37%	-7%
Lithuania	-24%	-21%	15%
Finland	-24%	-4%	-2%
Austria	-24%	-65%	6%
Hungary	-24%		
Estonia	-27%	11%	2%
United Kingdom	-28%	-15%	-26%
Portugal	-29%		
Croatia	-32%	-58%	26%
Italy	-42%		-52%
Ireland	-42%	-65%	-36%
Slovenia	-48%	-82%	-18%
Spain	-61%	-31%	-32%
Greece	-80%	5%	
Bulgaria		104%	-65%
Cyprus			
Malta			

Legend:

- Positive variation (more than 30%)
- Positive variation (less than 30%)
- No variation
- Negative variation (more than 30%)
- Negative variation (less than 30%)
- Unavailable data

Source: SDG elaboration.

Table 2 compares changes in asphalt production (as in Figure 18) with changes in investment and maintenance expenditure (as in Figure 11 and 13) between 2007 and 2012. Countries are sorted with respect to percentage changes in asphalt production (from the largest positive changes to the largest negative changes) and colour coded according to the direction and size of the change – positive variation greater than 30% (dark green), positive variation of less than 30% (light green), no variation (grey), negative variation of less than 30% (orange), and negative variation greater than 30% (red). This has been done to facilitate the comparison with the subsequent lists, which report the corresponding changes in investment and maintenance expenditure.

Only in two MSs, namely Poland and Luxemburg, a strong increase in maintenance and expenditure data is confirmed by an increase in asphalt production, though as already discussed above, in the case of Poland the growth in asphalt production is more likely to be linked to the infrastructure investment boom of recent years rather than to increased maintenance activity. The asphalt production data shows a positive variation also in Belgium and Denmark, suggesting an increase of road works also in these MS, though here expenditure data on investment and maintenance activities are missing and it is not possible to identify the drivers behind this trend.

In the remaining MSs, asphalt production data shows a negative variation over the 2007-2012 period, with the exception of Latvia, Romania and Sweden where no change was recoreded. These figures are not always consistent with the available road maintenance and investment expenditures though.

In four cases – Croatia, France, Lithuania, Austria – the general decrease in asphalt production is accompanied by a negative change in investment and a positive change in maintenance expenditure: here data are congruent and seem to suggest the presence of an increase in mainteanance activities counterbalanced by a decrease of investment works that together led to a overall reduction in asphalt production.

In Sweden, Estonia and The Netherlands, though, a positive change in both maintenance expenditure and investment is accompanied by a zero or negative trend in asphalt production, which does not seem to be intrinsincly consistent.

Data is more congruent for countries reporting negative trends in maintenance expenditure. All MSs reporting a decrease in maintenance expenditure have also experienced a downturn in investment and a decrease in asphalt production. Slovakia, Finland, Czeck Republic and the UK registered a reduction in asphalt production below 30% and reported a decrease both in investment and maintenance activities. Four countries experienced a reduction in asphalt production of over 30% and also reported the largest fall in both investment and maintenance expenditure – Italy, Ireland, Slovenia and Spain.

Overall the analysis of asphalt production data re-states the presence of a significant reduction of maintenance activities in Italy, Ireland, Slovenia and Spain and a likely downward trend also in Slovakia, Finland, Czeck Republic and the UK. The same data also supports an increase in maintenance expenditure in Poland, Luxemburg, Croatia, France, Lithuania and Austria. For all other MSs either asphalt production or road expenditure data are missing, or they show some inconsistencies.

3.4. Economic cycle and road maintenance

3.4.1 Drivers of variation in maintenance in the EU in the 2008-2011 period

This section seeks to identify if there is a relationship between the economic cycle and road maintenance, based on the evidence gathered above in relation to road maintenance and from the evidence collected within the case studies carried out for a selection of countries.

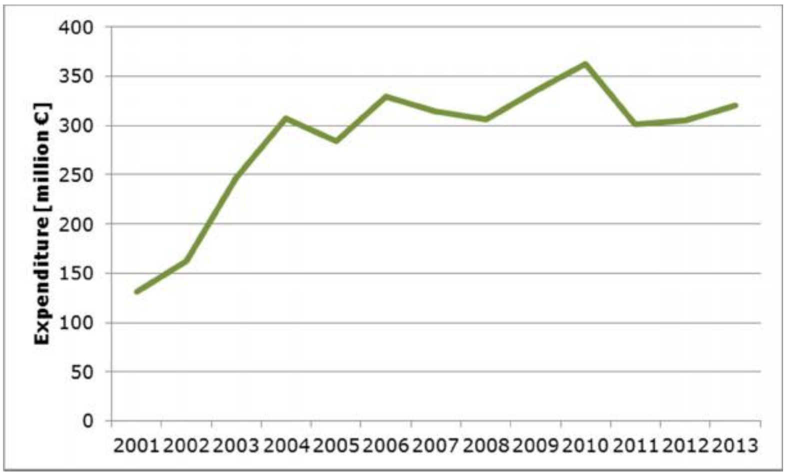
The analysis undertaken in a selection of EU MSs shows that while some MSs experienced a decrease in maintenance activities on some sections of their road network following the 2008 crisis[30], some EU MSs registered an increase in maintenance budget boosted by counter-cycle economic policies. Moreover, as highlighted below, a number of factors influenced the pattern experienced by road maintenance activities including, above all, the type of the organization in charge of road maintenance and the structure of the funding system for the road maintenance budget, which tends to vary not only state by state but also by types of road network within one single country.

Since 2001, the maintenance budget for motorways and expressways in Austria operated by ASFINAG[31] increased gradualy up to 2010, but fell significantly in 2011 and 2012. This was accompanied by a 25% decrease in investment between 2010 and 2011. These patterns are due to the fact that ASFINAG funds its maintenance and invesment operation through the tolls collected from vehicles circulating on its network and by raising the capital it needs for investments on the capital martket. This makes ASFINAG independent of Government budgetary trends, but vulnerable to the variation in traffic flows and the volatility of capital markets. Following the financial and economic crisis, ASFINAG's revenue fell by 9% between 2008 and 2009 because of reduced traffic volumes, which had an impact both on its maintenance and investment decisions. Subsequently revenues rebounded and in 2010 they were back at the pre-recession level of 2008, which can explain the slight recovery in maintenance budget registered in 2013.

30 Which in some cases can be attributable to the economic downturn but in other cases is also due to other concurring factors (e.g. increased focus on investment rather than maintenance activities).

31 http://www.asfinag.at

Figure 19: Trend of maintenance expenditure on Austrian ASFINAG network



Source: ASFINAG (2013).

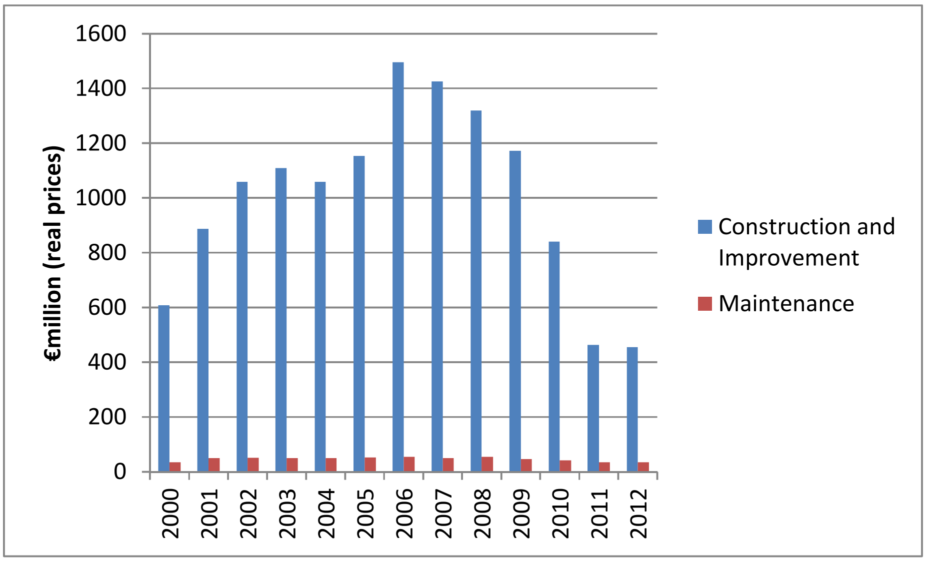
In France the Union des Syndicats de l'Industrie Routière Française (USIRF) reported a significant decrease in the annual road maintenance budget. Since 2008, the overall budget decreased by 25% across all network types (national, county or local) and it is likely that in 2014 this will fall by an additional -5% (-10% on rural roads).

In Germany all federal transport infrastructure investment projects are included in the national infrastructure plan (Bundesverkehrswegeplan) which ensures a coordinated approach to the building of new infrastructure as well as maintenance and upgrading/renewal. Infrastructure capital investments and maintenance activities of the federal roads network are also partly financed by toll income from heavy vehicles, in place since 2005. In contrast to other MSs, expenditure on maintenance of the national road network in Germany increased notably since the start of the financial crisis in 2009. This was mainly due to two economic stimulus packages in these years aimed at mitigating the impacts of the economic downturn in Germany. The first economic stimulus package (2008-2009) provided an additional €2 billion for investments in the federal transport networks (road, rail and waterways). The same amount was spent under the second stimulus package in the period 2010-2011. €910 million of a total of €2 billion under the second stimulus package were spent on the federal roads network, of which €450 million were dedicated to maintenance activities. The Federal Government estimated that it requires annual spending of more than €3 billion in order to maintain the condition of the federal road network at its current level. The reason for this increased spending is mainly as a result of an increase in maintenance costs and increased maintenance needs due to an unexpectedly high increase in heavy traffic on the network.

Over the last fifteen years, Ireland has witnessed the biggest infrastructure expenditure in its history. Figure 20 details the Exchequer's[32] investment in national roads including motorways since 2004.

[32] The United Kingdom Ministry of Economy.

Figure 20: National Road Expenditure in Ireland between 2000 and 2012

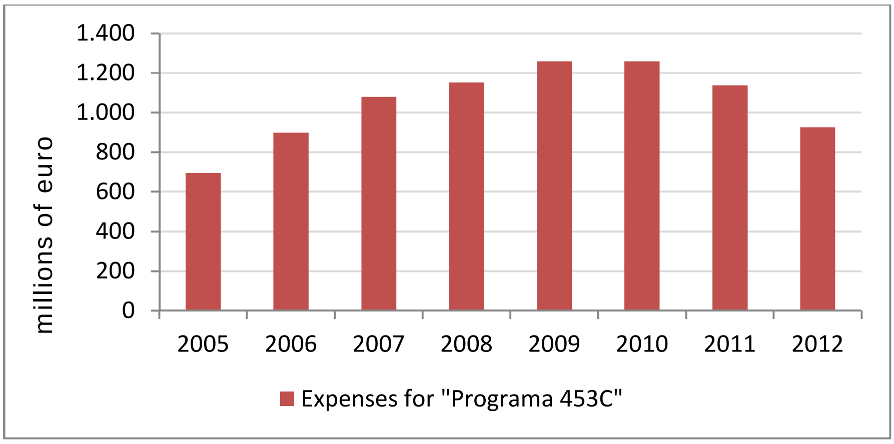


Source: SDG Analysis of NRA Annual Reports.

Maintenance spending on the national road network was only a minor part of overall expeinditure during this period in comparison to the capital expenditure: this derives from the fact that a strong investment programme, supported by EU funds, assisted the extraordinady works such as the replacement of national roads with motorways or the upgrade of existing infrastructure. The economic crisis that hit Ireland in 2008-2009 has led to a steep decline in infrastructure spending. The situation was worsened by two concurring factors: the gradual reduction of EU resources made available to Ireland for the road sector – Ireland had to compete with the 2004 and 2007 accession countries in the 2007-2013 EU budget allocation – and a reform of vehicle taxation and central government funding that reduced the resources available to local authorities.

Another country that received substantial resources for the road sector under the 2000-2006 programming period, Spain, registered a decrease in the road network expenditure both at national and local level. National government allocation for road infrastructure went from €5,989 mil. in 2008 to €76 mil. in 2012. The costs of road maintenance and operational expenditure included in the budget of Programme 453C (Conservación y explotación de carreteras) went from €1,257 mil. in 2009 to €926 mil. in 2012. The rate of decrease is not as rapid as the decrease of general road infrastructure expenditure, but has been constant since 2010. The Budget allocation for 2013 and 2014 is respectively €818 mil. and €820 mil.

Figure 21: Evolution of maintenance and operation expenses in Spain



Source: SDG analysis of programme 453C.

The effect of a falling budget allocation for road network operations is particularly evident when looking at pavement rehabilitation. For instance, the budget for Project Clave 32, dedicated to pavement rehabilitation, went from almost €560 mil. in 2008 to only €37 mil. in 2010. Even more alarming is the fact that in 2011 and 2012 no investments were made in this area. The last tender for Project Clave 32 was launched in 2013 (almost three years after the previous one in 2010) for the amount of only €11 mil.

In Italy, a sharp fall in road maintenance spending started shortly after the 2008 economic crisis. The operator of national roads (except motorways), ANAS, reported a reduction in the expenditure on road maintenance both in routine and structural budgets, respectively of 16% and 43% in the 2008 to 2012 period and registered a total decrease of about €500m. Similarly the budget allocated by local authorities to current and capital expenditure on the roads under their responsibility decreased by 43% and 3% respectively between 2009 and 2011, with northern and central regions being those affected most by the cuts (here the reduction at municipal level reached peaks of 26% and 12% respectively, against an budget increase in some southern municipalities[33]).

In the UK, road maintenance expenditure on the Strategic Road Network, managed by the Highways Agency (HA), has fluctuated considerably, with an average of £850m (€1.02bn) per year in the first half of the previuos decade and of £1bn (€1.2bn) per year in the second half of the decade. However, changes in accounting practices in 2009/10 make it difficult to compare recent figures. Expenditure by local authorities make up between 70% and 80% of all road maintenance spending in England each year. This corresponds to a figure of about £3bn (€3.6bn) in 2011/12 prices. Local authority spending is further split into expenditure on main roads and on minor roads. Trends for both types of road are similar, with a marginal decline over the period 2009-2012.

Planned reductions in both the amount and type funding available for roads will affect road maintenance expenditure in the UK over the next few years. Firstly, funding will have been

[33] The fact that some Italian southern regions increased their budget during the spending review operated by the Italian National Government is explained by the fact that these regions are located in areas that receive resources for transport investments also from the EU structural and cohesion funds, whose operational programmes were not affected by budget cuts.

reduced by 30% between 2011 and 2015 for both the Highways Agency and local governments. Central government expects the Highways Agency and local administrations to be able to make up for this shortfall through efficiency savings, but budgets for road maintenance are likely to be stretched as a result. Secondly, funding for maintenance will not be ring-fenced anymore. Instead, it will be pooled into a single pot of local government funding which is allocated to local authorities, thus with no assurance that it will be spent on road maintenance. Therefore, local budgets will be under pressure from growing spending trends in social care and environmental services. The Local Government Association estimates that a multi-billion pound funding gap will materialise in 2020. Based on these projections, the RAC Foundation has estimated that the proportion of spending on transport and roads by local authorities will decrease from 7% to 4% of the total, at around £2.3bn (€2.8bn) in 2019.

In Lithuania road network management and maintenance is funded by the Road Maintenance and Development Programme (RMPD), which is supported by excise duty on fuel, gas and road taxes. Funds available for road maintenance have fallen following the 2008-2009 economic crisis, with a drop of €24m between 2008 and 2009 alone, and a decrease of 32% since 2008.

Total expenditure on the Polish road network has been rising since accession to the European Union. From 2004 to 2011 actual expenditure on new road infrastructure has risen approximately 500% to a high of over PLN[34] 26bn (€6bn) in 2011. During the period of economic downturn, investment spending in Polish roads has not decreased, mainly due to large amounts EU funding. The budget for routine maintenance has generally increased in the period from 2007 to 2012 with annual expenditure rising from almost PLN 600m (€146m) to a high of almost PLN 1.15bn (€472m) in 2012. Spending on routine maintenance is expected to be in-line with the expansion of the road network.

In Portugal road maintenance expenditure increased significantly between 2000 and 2003, from approximately €113m to €203m, and since then there has been a gradual fall in expenditure. As a result of this trend, in 2013, the amount spent was the same as that spent in 2000. Furthermore, in 2008 there was a significant drop in expenditure on local and regional roads which remains low.

Road infrastructure spending in Romania is highly dependent on central government funding. Although the road maintenance budget increased by 78% between 2004 and 2008, the percentage allocated to this budget actually decreased by 23.7%. No evidence has been found on the impact of the economic crisis on maintenance activities.

3.4.2 Road maintenance expenditure in comparison to economic performance

From the evidence collected it seems that there is no clear correlation between the pattern of road expenditure in the EU MS and the 2008 economic crisis.

[34] PLN: Polish złoty

Table 3: Road maintenance trends in EU MS: 2008-2011

EU MS	Source of evidence	Increase/decrease in maintenance activities
AT	OECD/EAPA	Stable/Increase
BE	EAPA	Possible Increase
BG	OECD	Decrease
HR	OECD/EAPA	Unclear
CZ	OECD/EAPA	Decrease
CY	N/A	N/A
DK	EAPA	Possible increase
EE	OECD/EAPA	Unclear
FI	OECD/EAPA	Decrease
FR	OECD/EAPA	Increase
DE	EAPA	Increase
GR	OECD/EAPA	Decrease
HU	EAPA	Decrease
IE	OECD/EAPA	Decrease
IT	OECD/EAPA	Decrease
LV	OECD/EAPA	Decrease
LT	OECD/EAPA	Decrease
LU	OECD/EAPA	Increase
MT	N/A	N/A
NL	OECD/EAPA	Stable
PL	OECD/EAPA	Increase
PT	EAPA	Decrease
RO	EAPA	Stable
SK	OECD/EAPA	Decrease
SI	OECD/EAPA	Decrease
ES	OECD/EAPA	Decrease
SE	OECD/EAPA	Stable
UK	OECD/EAPA	Decrease

Legend:
Increase/decrease=means that both OECD and EAPA indicators show an increase/decrease of the same type.
Stable=means both OECD and EAPA indicators show stable trends.
Possible increase=refers to an increase in asphalt production in countries where road network size is constant, not confirmed by expenditure data.
Unclear=means that it is not possible to make an assessment.
N/A=not available.

Source: SDG elaboration.

Available expenditure and asphalt production data suggest a significant reduction of maintenance activities in Italy, Ireland, Slovenia and Spain in recent years and a likely downward trend also in Slovakia, Finland, Czeck Republic and the UK. Asphalt production data also suggests a downward trend in Portugal and Hungary. However, at the same time, the information available shows an increase in maintenance expenditure in a number of MSs over the same period: this is the case for Poland, Luxemburg, Croatia, France, Lithuania and Austria. Also Germany seems to have recorded an increase in road maintenance works from the asphalt production dataset.

The case study analysis confirms that the extent to which the crisis has affected the road investment and maintenance activities depends on the structure of the funding mechanism adopted in the different countries and on the political choices made by decision makers. The impact of the crisis has been higher where the funding of road infrastructure is highly dependend on government spending (national or local irrespectively) rather than from other sources of financing (e.g. toll roads). The status of public finance of different MSs and the fiscal and budgetary choices that have been made has then lead to different outcomes. In some cases road investment has been used as a counter-cyclical form of public spending. However at times of budget cuts, putting off investment and repairs in the road sector is a relatively quick way to reduce public spending that has been pursued by a number of EU countries. Thus it is not surprising that the sharpest reduction in spending has been witnessed in MSs that have implemented wide-ranging deficit reduction plans in recent years. This is particurarly the case of Eurozone MSs with higher debt levels – such as Italy, Spain, Portugal and Greece - that had to reduce their public spending in order to be compliant with EU fiscal costraints.

In addition to this, it must be pointed out that maintenance spending is also highly dependent on the size of road infrastructure in previous years. Road construction today will inevitably increase the need for maintenance spending tomorrow. This can be seen as a form of liability which current investment decisions impose on future maintenance budgets. In addition, the more intensive is the pace of road building today, the more likely it is that the need for maintenance appears abruptly and is harder to spread out over time. This might be particularly the case for the TEN-T road networks that are under constructions or have been built in recent years.

A final remark needs to be made on the difficulties that we have encountered in evaluating the relationship between the economic cycle and road maintenance expenditure. The lack of clear definitions and common practices relating to the measurement of road transport infrastructure spending, pointed out at the beginning of the Chapter, hinders accurate measurement of these figures and limits a complete assessment of how this spending relates to economic growth. A similar point was made recently by the ITF[35] that highlights the presence of "significant problems relating to data availability, definitions, coverage, quality and comparability" regarding expenditure in the transport sector and calls for "better and more comparable data [...] to lead to more robust macroeconomic analysis for supporting decision-making".

[35] International Transport Forum, Understanding the Value of Transport Infrastructure, 2013.

KEY FINDINGS

- The degree of homogeneity of available data on road maintenance and investment expenditure across the different MS is minimal, leading to an imperfect dataset: different definitions of maintenance and investment aggregates are in use leading to EU aggregate datasets where the comparability between MSs is limited.
- To assess the evolution of maintenance activities on road works in the EU in recent years the study carried out a comparison between the road expenditure dataset produced by the OECD/ITF, the asphalt production data reported by EAPA and specific country information. The analysis suggests the presence of a significant reduction of maintenance activities in Italy, Ireland, Slovenia and Spain in recent years and a likely downward trend also in Slovakia, Finland, Czeck Republic, the UK, Portugal and Hungary. At the same time, an increase in maintenance expenditure seems to have been recorded in a number of EU MSs over the same period: this is the case for Poland, Luxemburg, Croatia, France, Lithuania, Austria and Germany.
- The extent to which the crisis has affected road investment and maintenance activities depends on the structure of the funding mechanism adopted in the different countries and on the political choices made by decision makers. The impact of the crisis has been higher where the funding of road infrastructure is highly dependend on government spending (national or local irrespectively) rather than from other sources of financing (e.g. toll roads). The status of public finance of different MSs and the fiscal and budgetary choices that have been made has then lead to different outcomes.

4. ASSESSMENT OF ROAD SURFACE QUALITY AND SAFETY PERFORMANCE AND PLANNING OF MAINTENANCE ACTIVITIES IN THE EU

4.1. Introduction

This Chapter discusses the impact of road conditions on road safety and describes the procedures and technologies in place across Europe to assess the quality of the road surfaces and to verify the constancy of performance.

4.2 Impact of road condition on road safety

As discussed in Chapter 2, only a small proportion of accidents seem to be caused by road design and/or poor road maintenance. Instead driver behaviour seems to be the principal contributor to accidents. Nevertheless, in many circumstances, it is difficult to disentangle causality: there are accidents caused directly by the poor condition of the road network, but there are also accidents caused by drivers' behaviour in reaction to the condition or the design of the road. There is, in fact, a correlation between road quality and driver behaviour; in some circumstances even careful drivers make poor choices as a result of the condition of the road or their reading of the road layout.

There are several ways in which road condition contributes to, or compromises road safety. According to existing literature, the key causes are:

- poor wheel-road contact that fails to guarantee sufficient skid resistance, due to inadequate road maintenance;
- localised anomalies, such as ruts, potholes and depressions, whose unpredictability make them dangerous for drivers;
- poor geometry and alignment design – i.e. inadequate design of the road;
- "level of service" / performance too poor to accommodate existing traffic flows;
- poor signage or markings, e.g. incomplete or missing markings and signs, and poor lighting.

As will be discussed in more detail below, a lack of road maintenance or inappropriate design can exacerbate these factors, and thereby increase the number of accidents. Of these factors, only some are attributable to a lack of regular maintenance. For example, geometry and alignment design modifications do not fall within regular maintenance programs.

To assure road safety, road geometry and alignment must be designed to be as homogenous and clear to the driver as possible. The literature refers to this as "design consistency". The appropriate sequence of road features is important as it increases the available time that a driver has to react. For example, road geometry and its alignment affect drivers' speed choices. There is extensive literature on this issue but, as it falls outside the study's scope, it has not been dealt with in detail in this report.

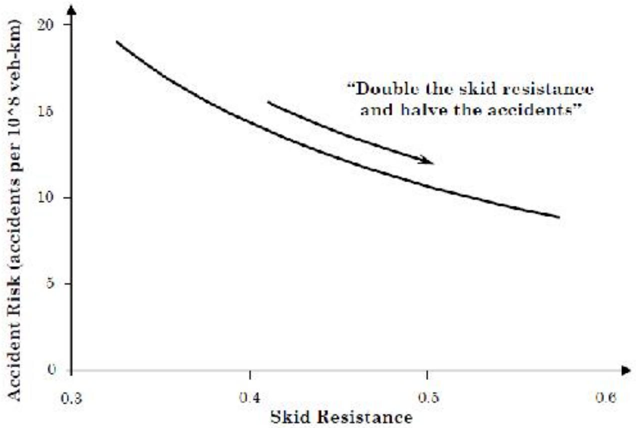
"Level of service" is a qualitative measure of road infrastructure's performance and condition; it is closely linked to traffic flow. A study conducted in Russia showed that accidents increase as a function of increasing traffic flow and, ultimately, with a decreasing level of service. To improve the level of service it is necessary to adapt the geometry of the road (i.e. lane width, number of lanes, etc.) so that it can accommodate the actual traffic flows. However, interventions of this nature are usually categorised as investment and upgrade programmes and therefore fall outside of the scope of this study.

4.2.1 Wheel-road contact

The purpose of road surface is to keep the vehicle on the correct trajectory and to allow braking in wet and dry conditions. A study conducted by the National Cooperative Highway Research Program (NCHRP)[36] showed that there is a direct correlation between the number of accidents and the skid resistance value. The figure below shows that, as pavement friction levels decrease, there is a corresponding increase in crash rates.

One of the main problems is that it is difficult for drivers to assess the pavement's skid resistance and adapt their driving accordingly. Research also shows that when pavement friction falls below a site-specific threshold, the risk of wet weather related crashes increases significantly. However, research conducted on the Italian highway network[37] shows that the number of accidents in fact decreases during adverse weather conditions as drivers react to the weather conditions by driving more carefully.

Figure 22: Relationship between pavement friction and crash risk



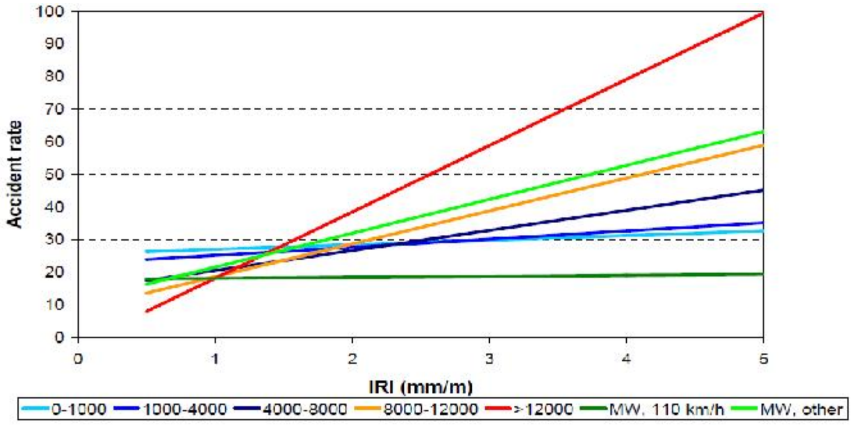
Source: National Cooperative Highway Research Program (2009).

Another study conducted by the Swedish National Road and Transport Research Institute[38] reinforces the theory that accidents increase in slippery conditions. The study uses the

[36] National Cooperative Highway Research Program (NCHRP) (2009), "Guide for Pavement Friction".
[37] C. Rafanelli, T. Montefinale (1993), Incidenti e basi informative Parte 8 – Eventi Meteorologici, 1°Convegno Nazionale CNR-Progetto finalizzato Trasporti.
[38] Swedish National Road and Transport Research Institute (2004), "The Influence of Road Surface Condition on Traffic Safety and Ride Comfort", 6th International Conference on Managing Pavements.

International Roughness Index (IRI, measure in millimetres/metre) to assess skid resistance. The results show clearly that the accident rate increases as the IRI value rises, furthermore accidents increase with increased traffic flow Figure 23).

Figure 23: Correlation between Accident rate and IRI for different traffic flow classes



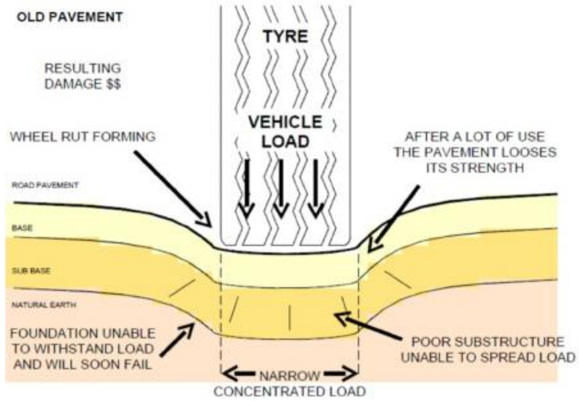
Source: Swedish National Road and Transport Research Institute (2004).

Therefore, a safe road needs to have a good skid resistance value when it is initially built, and this level needs to be maintained throughout its life. The latter is possible only through regular maintenance.

4.2.2 Localised anomalies

Localised anomalies, considered significant for this study, are ruts, potholes and depressions in the surface. Ruts are linear depressions created following a permanent deformation of the layers of bitumen caused by the load from a vehicle's wheels.

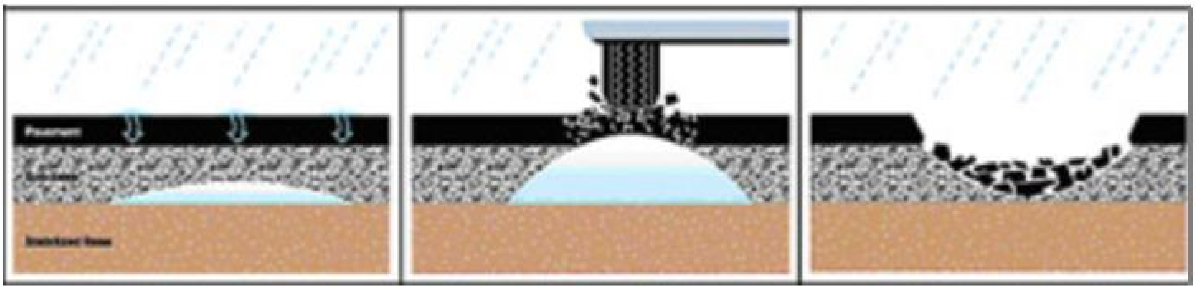
Figure 24: Rutting



Source: http://lgam.wikidot.com/rutting.

Potholes are depressions brought about by the removal of the uppermost layer of tarmac caused by traffic. Pothole depth increases when there is the risk of rainwater entering the gaps in the surface.

Figure 25: Formation of a classic pothole



Source: http://www.halifax.ca/municipalops/potholes/PotholeFAQ.html.

Depressions are permanent deformations in the road surface due to ground subsidence. Their repair falls inside extraordinary maintenance because they relate to road elements below the surface.

These anomalies in the road surface (according to a study conducted by the Swedish National Road and Transport Research Institute[39]) cause, in dry surface conditions, vibrations and bumps which can increase driver fatigue. However, such anomalies usually increase drivers' attention and, as a result, the risk of accident seems to decrease.

In wet conditions, rutting causes an increased risk of aquaplaning which is a phenomenon whereby the vehicle floats on a layer of water as a result of the loss of contact between the road and the wheels, leading to the driver losing control of the vehicle. The risk of aquaplaning caused accidents is greatest where rut depths are larger and where there is poor water drainage (i.e. small cross fall).

An important additional consideration relating to these types of anomalies is that they are dangerous because drivers cannot predict them. They are particularly hazardous when they are spread out along the road rather than when the driver is facing a consistently rough road.

In many cases the repair of ruts, potholes and depressions would require extraordinary maintenance works including a general reconstruction of the road surface to be durature, but often, especially on local or urban roads, for budget and/or operational reasons, repairs are only carried out on the surface providing a temporary solution to the problem without considering the underlying problem.

4.2.3 Poor signage, markings and lighting

Markings, signs and lighting contribute to make the road logical and easy to understand. Road markings are a cost effective solution to provide a clear indication of the driving lanes and space, contributing to a predictable driving trajectory. As a result road users intuitively understand the road's alignment and can adapt their driving behavior accordingly. A study developed by the European Union Road Federation[40] shows that good maintenance of road markings and signs reduces accident risks.

[39] Swedish National Road and Transport Research Institute (2004), "The Influence of Road Surface Condition on Traffic Safety and Ride Comfort", 6th International Conference on Managing Pavements.

[40] European Union Road Federation "Marking the way towards a safer future".

Good street lighting also improves road safety especially in specific, potentially dangerous locations such as intersections, pedestrian crossings, urban areas, etc. The aim of road lighting is to provide the required visibility for the driver to read the road and react to oncoming obstacles in a safe manner. On this topic, different studies have shown a direct link between poor lighting and a consequent increase in accident risk.

4.2.4 Road works and accidents: unintended consequences of road maintenance

Road works tend to be unsafe for those working on site (as a result of their proximity of traffic) and to drivers moving through them (resulting from a change in the road layout). A study conducted by the Institute for Road Safety Research in the Netherlands (SWOV)[41] showed that, in the period 2000-2009, 2% of all registered fatal accidents in the Netherlands took place in the proximity of roadworks and roadwork locations seem to display a higher accident rate than at other road locations. The risk is highest in the work zone; roadworks that take longer and cover a longer distance seem to have a lower crash rate. The literature also shows a generally higher crash rate during nighttime.

Guidelines exist for the uniform preparation, indication and marking of roadworks. It is important that these guidelines are followed for large as well as small roadworks. However, an evaluation of roadworks shows that these guidelines are only followed diligently at a few locations.

4.2.5 The impact of road condition on road safety

In summary, there are various aspects of the road's condition which contribute to its safety. A high level of pavement friction, clear signage and road markings are important qualities of a safe road. It is important that these are maintained throughout the road's lifespan. Anomalies, such as ruts and depressions, reduce road safety as they affect driver fatigue, can create a hazard for drivers and can cause aquaplaning in wet conditions. In addition to normal road conditions, roadworks create more hazardous road conditions for both drivers and those who are working on the road and affect the accident rate for a road.

A consistent design of a road's geometry is an important factor in ensuring a safe road. Another important provision is an appropriate level of service for the anticipated traffic flow. However, both of these factors fall under the umbrella of exceptional, rather than regular maintenance, which is the focus of this study. In what follows we illustrate the procedures adopted in EU MS to monitor the performance of their road network and plan for maintenance activities.

[41] Institute For Road Safety Research (2010), "Roadworks and road safety", SWOV fact sheet.

4.3 Road performance monitoring at the EU level

4.3.1 Directive 2008/96/EC

Up to 2008, the EU lacked a harmonised and coordinated framework for procedures relating to road safety audits and impact assessments on the European road network with the exception of tunnels on the trans-European road network whose common safety requirements and procedures were laid down by Directive 2004/54/EC.

However, by then, a number of Member States could already boast a well functioning road infrastructure safety management systems, but there was the need to set up common procedures to ensure a consistent approach to safety across the EU roads.

It was only with the approval of Directive 2008/96/EC of 19 November 2008 that a framework for road infrastructure safety management in the EU was set up, although this was limited to roads on the TEN-T network. The Directive indicates the necessary procedures relating to road safety impact assessments, road safety audits, the management of road network safety and safety inspections by the Member States.

The Directive has three objectives: (i) to ensure that safety is integrated in all phases of planning, design, construction and operation of road infrastructure, (ii) to bring about a common and high level of safety of roads in all EU Member States; and (iii) to use the limited funds for more efficient construction and maintenance of roads.

Five operational provisions are included in the text:

(i) Road impact assessment for infrastructure projects at initial planning stage (impact assessment shall indicate the road safety considerations which contribute to the choice of the proposed solution);

(ii) Road Safety Audits (RSAs) for all infrastructure projects during all the phases (draft design, pre-opening and early operation);

(iii) The identification of “black spots” for road safety, ranking Accident Concentration sections (black spots) to be reviewed every three years ;

(iv) The undertaking of periodic Road Safety Inspections (RSIs) to be carried out by the competent authorities ;

(v) The data management of fatal accidents consisting of compulsory reporting of each fatal accident and of setting up a methodology to calculate the cost of a fatal accident.

The Impact Assessment accompanying the introduction of the Directive estimated that it can help reduce the number of victims on the trans-European road network by more than 600 fatalitites per year and the seriously injuried by about 7,000 per year[42].

[42] Commission of the European Communities (2006), Proposal for a Directive of the EU Parliament and of the Council on road infrastructure safety management, Full impact assessment, Commission staff working document.

Member States were given until 19 December 2010 to bring into force the laws, regulations and administrative provisions necessary to comply with this Directive. On 19 December 2011, the EC published "Guidelines for competent authorities on application of the Directive". MS have been given until March 2012 to fulfil these requirements[43].

Despite the harmonisation efforts, the interpretation of the Directive varies in each Member State and dissimilar approaches to its implementation highlight the limitations of this text.

First, the Directive applies only to the trans-European road network, while the most fatalities due to traffic accidents occur on two-lane rural roads and the majority of accidents occur in urban areas.[44] In order to improve road safety for all users it is crucial to frame a common approach for procedures relating road safety impact assessments, road safety audits, management of road network safety and safety inspections on all roads networks. While proceeding in this direction, attention should also be focused on the procedures to be taken to reduce road safety risks for vulnareble users, such as motorcyclists, cyclists, pedestrians, etc. – an area which is not covered sufficiently by the current Directive. An example is given by the fact that as it focuses exclusively on the methodology and procedures to be followed for safety controls, it does not provide indications on the materials or equipment to be chosen and, as such, does not sufficiently boost the introduction of crash barriers or other tools that could help reduce the accident risks of motorcyclists.

Another limitation is in relation to the legislative instrument chosen. According to the principle of subsidiarity, a Directive is binding upon each MS, in terms of the end that needs to be achieved, although it leaves the means and method to the discretion of the national authorities. As a result, operational approaches related to the goals set by Directive 2008/96/EC are different in each MS. Road Safety Audits (RSA) and Road Safety Inspections (RSI) are conducted differently across the EU, and the experience and the background of road safety inspectors can vary significantly.
Recently, two research projects have tried to address some of the limitations of the Directive and propose actions to improve its effectiveness, i.e.:

- Pilot4Safety;
- WhiteRoads.

In addition to this, the European Commission recently commissioned a study on the effectiveness of the existing EU legislative framework on road infrastructure safety management, which would include also an ex-post evaluation of Directive 2008/96/EC.

4.3.2 The Pilot4Safety Project

The Pitol4Safety project was carried out between June 2010 and May 2012. The main action resulting from this project was the creation of a common "Road safety tools and manual" and experts from across the EU are trained using this tool. A shared and common definition of the different steps composing a RSA was conceived in order to have a: "…systematic and

[43] According to the "30th Annual Report on monitoring the application of EU law" (2012), only Finland has been referred to the Court for the late transposition of Directive 2008/96 on road infrastructure safety management.

[44] « Accident » refers to any kind of road accident; « casualty » refers to accidents leading to serious injuries or death.

independent examination of a road project, designed to highlight potential security issues at the earliest possible stage of planning and construction, to reduce or eliminate these problems and limit the risk for different types of users". Similarly, the RSI is defined in the manual as "a preventive safety management tool implemented by road authorities/operators".

In addition – although the Directive applies only to TEN road network, its contents have been used as a template for the implementation of safety measures on regional roads as some Member States have extended the application of the Directive to other infrastructure.[45] On the basis of the understanding of local stakeholders coming from the six European regions participating in the project[46], in June 2012 a "Safety prevention Manual for secondary roads" was published.

The stakeholders of this project have stated that this manual, and best practices collected through this project, could be a starting point for the European Commission and Parliament to develop a comprehensive tool that standardises the operational procedures to be implemented by road operators and authorities in MSs in order to guarantee a balanced level of road maintenance across Europe.

4.3.3 The WhiteRoads Project

WhiteRoads is a joint project of the European Union Road Federation (ERF) and the Spanish Road Association (AEC), which is taking an innovative approach to road safety at the EU level. Traditionally, improvements in road safety are made in the aftermath of accidents. However, the WhiteRoads project inverts this logic by identifying road sections along the Trans-European Road Network (TEN-T) where no accidents have happened during the study period, despite high traffic flows. The project then highlights the key infrastructure characteristics of these sections of road – called 'white-spots' – from which lessons can be learnt. The project started in 2010 and the final results were officially presented in 2013.

WhiteRoads was developed in different stages. The first of these was to collect and analyse traffic flow and road accident data on TEN-T roads for each MS. After extensive analysis of road accidents in most EU countries, a European White Spot (EUWS) was defined as:

> "A road section of the TEN-T of at least 15 km with no fatal accidents during the last five years considered in the study."

Also important was the identification of EUWS on the TEN-T network in all MSs. A total of 982 EUWS have been identified in the 25 EU Member States for which the analysis of road networks has been completed. The figure below shows, for each country, how many EUWS were identified - France, Spain and Sweden have the greatest number of safe stretches of road. Data for Germany was not available (due to privacy concerns).

[45] It has not been possible to determine which MS have chosen to extend the requirement to other road networks. This is part of the analysis included in the European Commission ex-post evaluation mentioned earlier. A detailed breakdown should be available within that report when it is published.

[46] The consortium of the project is made up of the following organizations:
1. FEHRL (Belgium) for management and training. 2. ASTRAL, Road Management company of Lazio, Italy 3. CDV (Transport Research Centre) - Czech Republic 4. Generalitat de Catalunya, Spain 5. Prefecture of Thessaloniki, Greece 6. Randers Municipality, Denmark.

Figure 26: Number of “White Spots” in each Member State

COUNTRY	NUMBER OF EUWS	COUNTRY	NUMBER OF EUWS
Austria	16	Italy	45
Belgium (Flandes)	8	Latvia	23
Belgium (Walonia)	7	Lithuania	1
Bulgaria	40	Luxembourg	1
Cyprus	3	Poland	9
Czech Republic	22	Portugal	46
Denmark	16	Romania	7
Estonia	11	Slovakia	5
Finland	79	Slovenia	5
France	242	Spain	150
Greece	4	Sweden	106
Hungary	18	The Netherlands	59
Ireland	42	United Kingdom	17

Source: WhiteRoads Project.

After locating EUWS, the project carried out on-site field work to analyse infrastructure characteristics of EUWS located in eight EU MSs (Belgium[47], Estonia, France, Latvia, Lithuania, Poland, Spain and Romania) with differing road conditions. Inspections were carried out between April and October 2012 under relatively good weather conditions. The field work concluded that these white sections of road have a good standard of design, appropriate road equipment, as well as a good level of maintenance - the majority of EUWS have a pavement in normal or good condition. Furthermore, it is important to note that WhiteRoads sections represent stretches of road that have all received adequate funding for maintenance over the past few years.

The final stage of the project was the development of a comparative checklist identifying characteristics common to the white stretches of road. It lists a set of qualities and best practices that should be considered in order to design, build and maintain a safe network. These key processes include the requirement to:

- Check that the road is up to the TEN-T designated standards;
- Check safety levels along the entire route once part of it has been identified as a black spot;
- Ensure that maintenance programmes for the pavement surface exist;
- Provide reliable and homogenous traffic signage;
- Make sure that electronic road signs are functioning correctly;
- Maintain reliable and coherent road markings;
- Ensure maintenance programs for traffic guidance equipment;
- Provide lighting to all road sections.

[47] The main objective of the BE report was "to describe and analyse the geometric characteristics, design, traffic elements for every EUWS identified in BE".

The WhiteRoads checklist should be considered as a new and complementary tool to the safety audits and inspections laid down in the Road Infrastructure Safety Directive 2008/96/EC for the design, maintenance and management of roads. There is scope for the checklist to be applied further; so far the WhiteRoads Project has been developed for the TEN-T network only, but its methodology could be applied to other road networks[48].

4.4 Performance monitoring at the national level

As mentioned above, most EU MSs have long established procedurse for the monitoring of road safety performance on their network. From the case study analysis set out in Annex A it can be seen that several MSs implement uniform techniques to verify performance across a large part of the road network, not limited to the TEN-T ones covered by Directive 2008/96/EC. This section reports the evidence collected on performance monitoring at national level, identifying, where possible, common features and best practice.

To assess a road's condition, authorities in each MS evaluate a number of common parameters, including the following:

- Skid resistance - to provide a good relationship between road and tire;
- Texture (macro and micro) - to evaluate the roughness of the surface;
- Longitudinal and transverse profile - to ensure ride comfort;
- Rutting, cracks and defects;
- Bearing capacity - the ability to sustain a given level of road traffic.

Dedicated monitoring equipment is used to identify and measure these parameters. In most cases this involves a monitoring vehicle, designed to be used in moving traffic, that records the operational parameters listed above in real time. Vehicles typically use a GPS device to record administrative data.
The photo on the left in figure below shows a vehicle used in Germany to measure the longitudinal and transverse profile of the road surface by means of laser technology. The photo on the right shows a measuring wheel used to assess the skid resistance of the road surface. In order to establish a visual record of road surface characteristics, a high resolution camera in combination with special lightning is also used. This camera is fixed at the rear of the vehicle and is visible in the left hand image of figure.

[48] For further details please refer to www.whiteroads.eu.

Figure 27: Vehicles and technology used for recording operational characteristics

Source: Government of Rheinland-Pfalz (2013).

This type of monitoring is usually accompanied by visual inspections. Based on the results of these monitoring exercises, some MSs then prepare a cumulative index which provides the necessary values to assess whether maintenance is necessary and/or when to intervene.

Some MSs also use a Pavement Management System (PMS) that identifies an optimum maintenance strategy taking into consideration budget and other constraints. The following paragraphs will outline in more detail the various monitoring techniques at national level, and the impact on decision-making for road maintenance.

4.4.1 Monitoring techniques

Monitoring of roads in Germany is done regularly. Federal road quality is assessed at intervals of four years, while state and district roads are generally monitored at five year intervals. There is no consistent assessment schedule for urban roads, these are the responsibility of the municipalities. The procedure for road monitoring and assessment (ZEB) was developed jointly by the federal and state governments, and has established organisational and technical structures to carry out the monitoring.

The measured operational characteristics are assigned to the respective road sections and converted into a score ranging from 1.0 (very good) to 5.0 (very bad). These values are then combined into sub-target values to indicate the degree of usability and the degree of deterioration of the road section. These sub-target values are subsequently merged into one total value. The resulting total values for road surface quality are grouped into four categories where:

- Total Value 1.0 to 1.5 = very good
- Total Value 1.5 to 3.5 = acceptable
- Total Value 3.5 to 4.5 = bad
- Total Value 4.5 to 5.0 = very bad

Maintenance funding for national roads is allocated by prioritising expenditure on roads with the worst scores. German municipalities have sought innovative approaches to improve road conditions whilst simultaneously reducing spending on maintenance activities. The municipality of Hamburg, for example, implemented a maintenance process using 100% recycled asphalt. According to most recent observations, the material is of the same quality as newly produced asphalt, but costs about 30% less.

The National Road Authority (NRA) in Ireland has carried out annual surveys of the entire national road network since 2010. The most recent survey of regional roads was carried out in 2011, when over 13,000km were surveyed. This data enables the NRA and Local Authorities to prioritise maintenance for their work programs. Surveys of regional roads were also carried out in 1996 and 2004. Local roads have not been surveyed as it is not considered to be cost effective.

The recorded parameters were reported for every 100 metre sample unit on the entire regional road network. The NRA recently developed an application that allows Local Authorities to upload this data to a central database. The results of the 2011 road scan[49] are presented in Table below which shows the percentage length of regional roads requiring each particular type of intervention. Due to a change in methodology, direct comparisons are not possible.

Table 4: Pavement Condition Survey Results: Road sections requiring intervention, by type of intervention

Year	Road Construction	Surface Restoration	Restoration of Skid resistance	Routine Maintenance
2004	15.1%	23.7%	39.4%	21.8%
2011	23.9%	21.7%	29.6%	24.7%

Source: NRA (2011).

In Poland, road surface quality analysis is carried out using the System for Road Surface Evaluation (SOSN) for asphalt roads, SOSN-B for concrete roads[50]. This is complemented by SOPO, the System for Evaluation of Roadsides, both developed by the General Directorate for National Roads and Motorways. Road surface parameters are grouped into four categories, A, B, C or D as detailed in Table below. The resulting data is published annually. Maintenance is prioritised for sections which have been categorized as Class D and C.

49 NRA 2011 Survey.

50 Asphalt and concrete are two construction materials used to pave road surfaces. The primary difference between the two is that asphalt is made by mixing aggregate with bitumen, a sticky black hydrocarbon which is extracted from natural deposits or crude oil. Concrete is made by mixing an aggregate material with a cement binder and then allowing the mixture to harden.

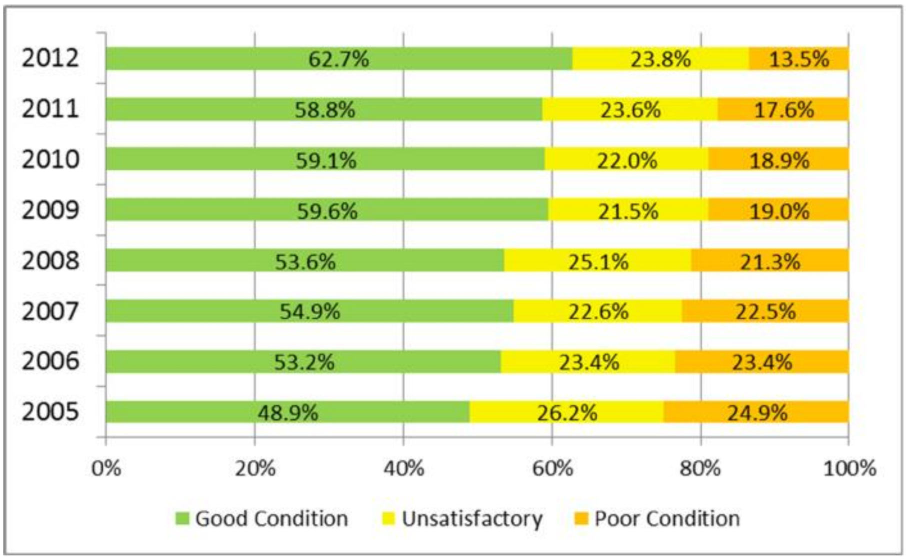
Table 5: SOSN Road surface quality classifications

Class A	Good Condition	New and reconditioned surfaces not in need of maintenance
Class B	Satisfactory Condition	
Class C	Unsatisfactory Condition	Surface with damage, in need of routine maintenance
Class D	Bad Condition	Surfaces with damage in need of immediate repair

Source: GDDKiA.

Figure 24 shows how the condition of road surfaces on the Polish network has improved since 2005. The proportion of roads in good condition has been steadily increasing from under 50% in 2005 to 63% by 2012. During the same period the proportion of roads in poor condition and in need of immediate repair has decreased from 25% in 2005 to a low of 14% in 2012. The percentage of roads in an unsatisfactory condition and in need of routine repair has remained relatively constant throughout the period. During this period it should also be noted that an additional 2,600 km of motorways and trunk roads have been constructed, an increase of 13% over 2005. Poland has also experienced a considerable improvement in road maintenance standards. From 2011, the measurement of the technical conditions of the road is carried out twice a year using radar techniques which allow for further information to be obtained about the road condition. Substantial research efforts have been made to improve materials used in road surfacing, including studies completed on mineral asphalt mixtures for use in reduced temperatures.

Figure 28: Condition of road surface on entire national road network



Source: GDDKiA.

In order to evaluate the condition of roads in Portugal, Estradas de Portugal (EP) developed, between 2003 and 2007, a tool called Sistema de Gestão de Conservação de Pavimentos (SGPav). Through this tool, EP developed what they called a Road Inspections and Interventions Inventory that was completed at the end of 2010. This inventory gave EP a global view of its road network and its condition. To evaluate the condition of the roads, an index that ranges from 0 and 5 is used, where a highest result corresponds to the best quality. The indicator ranges, classes and strategies to take are shown in Table below.

Table 6: Quality index used by EP

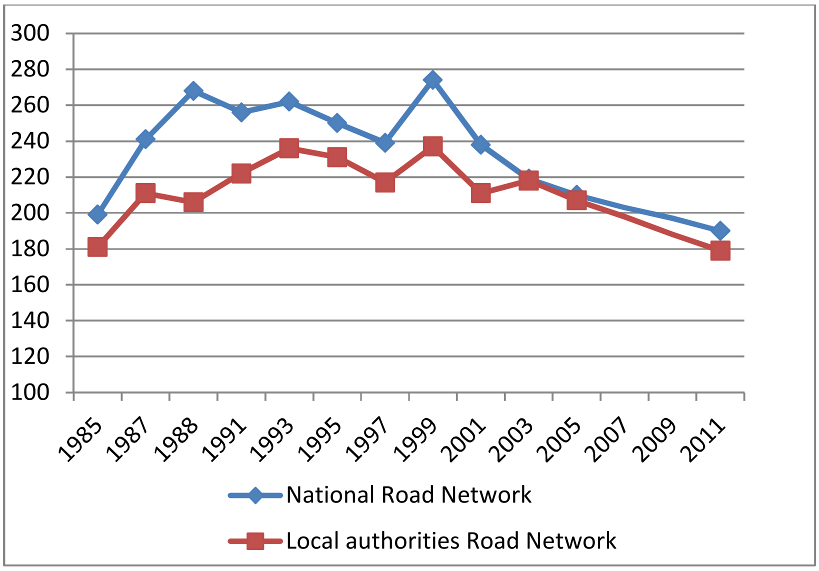
Index	Class	Strategy
Index<2.5	Bad	Need to intervene
1.5≤Index<2.5	Mediocre	Need to give the intervention a higher priority
2.5≤Index<3.5	Reasonable	Stable network, interventions depend on the change in quality
≥3.5	Good	New Network, no need of intervention

For 2011, the average quality level was 2.82 and this level was kept constant, at around 3, between 2007 and 2011. Maintenance activities are scheduled based on the results emerging from the SGPav analysis.

The Department for Transport and the Highways Agency in the United Kingdom have developed a Road Condition Indicator (RCI) to monitor road surface quality. The RCI is based on a set of indicators which are collected annually using road scanning technologies. The parameters recorded are weighted to obtain the RCI for each 10 metre section of road surveyed. The RCI value can fall within a range of 0 to 315. Any value above 100 indicates that road conditions are unsatisfactory, and are likely to require maintenance within the next year.

In Spain, the Spanish Road's Association (Asociación Española de la Carretera), has stated, after extensive monitoring, that the condition of the road surface is poor. As shown in the figure belowError! Reference source not found., the quality of the road surface (national, local and municipal) in Spain improved in the 1980s and then worsened from the beginning of the century to 2011.

Figure 29: Evolution of Road surface quality in Spain 1985-2011



Value	Classification
300-400	Good
200-300	Acceptable
100-200	Deficient
0-100	Very deficient

Source: AEC (2012).

Analysing the data resulting from road surface monitoring the Spanish Road's Association estimated that in order to bring the condition back to acceptable levels, expenditure on maintenance today needs to be twice what it was in 2001.

In France, the assessment of the quality of the national road network is carried out through the use of sophisticated tools which provide information that feed into the calculation of two main indicators that are used to observe the quality of road infrastructure on the national network: IQRN and IQOA. The 2012 figures show that the French road network is still of high quality although there is a downward trend in the scores of the indicators. There has been an 8% fall (compared to 2011) in the amount of roadway in "very good" condition (grade > 17/20) and an 18% increase in the amount of roadway with "average" condition (12> grade> 17). These monitoring tools are very expensives thus are not used by local authorities to monitor local networks.

4.4.2 Performance outputs and road maintenance

The review set out above indicates that national authorities in MSs apply similar performance monitoring techniques. However, the way in which the data compiled is reported and collected varies. Outputs can be categorised under the following three main headings:

- Value-based: road conditions are pulled together to compile a single value for a stretch of road that is compared to others, either in relative or absolute terms;
- Qualitative: a qualitative score is assigned to different sections of roads based on the observed conditions;
- Index-based: road conditions for different stretches of roads are tracked over time and compared to a given year, assessing whether conditions have worsened or improved.

From the analysis undertaken it emerged that different EU MSs use different types of output indicators and, in many cases, use a mixture of them. France uses indicators based on a mix of value-based and index-based outputs; Germany and Portugal use qualitative indicators; Poland a mixture of qualitative and index-based indicators and the UK approach takes into account all the three type of output indicators mentioned above (i.e. value-based, qualitative, index-based)[51].

Consequently, in Member States where road maintenance activities are carried out according to the outcomes of the monitoring process, prioritisation rules depend on the way outputs are assessed. Consequently some national authorities decide to prioritise roads with the worst absolute indicators (e.g. Poland), while others address the roads that are deteriorationg (e.g. UK).

In addition, the approaches to prioritisation of maintenance activities increasingly rely on user-fed information, thanks to the growth of social media across Europe. In the UK, the Highways Agency traditionally relies on the nationally standardised procedures for performance assessment described above. However local authorities have recently been promoting innovative approaches to road maintenance. For instance, some local authorities, including London, have been developing electronic or web-based systems for the public to report potholes and road defects directly to road managers.

The average numbers of reports received from the public by each local authority in England (excluding London) in the financial year 2012/13 is over 12,000. This is up by around 1,000, or nearly 10%, on the year before. The total number of reports from the general public was 1.6 million, compared to 1.5 million in 2011/12. Going forward, other competent authorities across Europe may also start to rely on user-fed information as well as using more thorough technical investigations.

In addition to this, in light of the shaping of a more homogenous framework for road safety monitoring and maintenance programming across the EU – that could accompany a more detailed assessment and potential revision of Directive 2008/96/EC – research that investigated in detail the procedures in place across the different MSs accompained by an exchange and sharing of best practice and experience could certainly be of help. This would allow MSs that do not have well established procedures or suffer maintenance budget cuts to introduce tools able to improve the cost effectiveness of their actions.

[51] See Annex A.

KEY FINDINGS

- Only a small proportion of accidents seem to be caused by road design and/or poor road maintenance. Instead driver behaviour seems to be the principal contributor to accidents. Nevertheless, in many circumstances, it is difficult to disentangle causality. A consistent design of a road's geometry is an important factor in ensuring a safe road; another important provision is an appropriate level of service for the anticipated traffic flow.

- It was only with the approval of Directive 2008/96/EC of 19 November 2008 that a framework for road infrastructure safety management in the EU was set for roads belonging to the TEN-T network. Though it represents a valid step forward in the creation of a harmonised framework for road safety monitoring in the EU, this Directive only applies to the TEN-T corridors and is subject to different interpretations and dissimilar implementation across the EU. In particular, as it focuses only to procedural aspects of road safety monitoring, it leaves room for significant variability in the operational activities undertaken by different EU MSs.

- Two research projects have recently tried to overcome some of the limits of Directive 2008/96/EC. The Pilot4safety project developed a manual, complemented by a collection of best practices, that could be a starting point to develop a comprehensive tool that standardises the operational prescriptions to be implemented by road operators and authorities in EU MS in order to guarantee an even and balanced level of road maintenance across Europe.

- The WhiteRoads project identifies road sections along the Trans-European Road Network (TEN-T) where no accidents have happened during the study period, despite high traffic flows. Road sections of the TEN-T – so called 'white-spots' – have been identified by the study and used to point out the key features that allowed them to achieve such a high level of road safety.

- Good road design, the presence of adeguate maintenance programmes, the installation of reliable and homogenous traffic signage and road markings and adeguate lighting are among the key aspects that determine the success of white spots. The checklist developed within the WhiteRoad project should be considered as a new and complementary tool to the safety audits and inspections laid down in the Road Infrastructure Safety Directive 2008/96/EC on the design, maintenance and management of roads and could also be applied to other relevant road sections not belonging to the TEN-T network.

- Several EU MSs have a well established procedure for the monitoring of road conditions and the prioritasation of interventions. In many cases however, this does not extend to local or urban roads. Where road maintenance activities are carried out according to the outcomes of the monitoring process, prioritisation rules depend on the way outputs are assessed. For example while some national authorities decide to prioritise roads with the worst absolute indicators (e.g. Poland), others address the roads that are seen to be deteriorating (e.g. UK).

- From the case studies, a number of best practices have been identified that could help to improve the cost-effectiveness of maintenance activities on local roads such as: i) the recourse to user-fed information, where electronic or web-based systems are used to allow drivers to report potholes and highway defects directly to road managers or ii) the utilisation of recycled asphalt, a material that has the same level of quality as newly produced asphalt, but costs about 30% less.

5. SOCIO-ECONOMIC IMPACTS OF ROAD MAINTENANCE ACTIVITIES

The importance of dedicating a significant amount of resources to road maintenance has been highlighted throughout this study. A number of stakeholders[52] in different Member States have expressed concerns about the growing maintenance backlog in their countries, resulting in lower road safety standards and losses in efficiency. However, the assessment of the socio-economic impacts of variations in road maintenance resources present some challenges.

This chapter outlines the methods used to assess such impacts and offers an overview of the key technical data requirements. The analysis is presented under three headings:

- Road transport efficiency, particularly in terms of vehicle operating costs;
- Safety and health impacts for road transport users;
- Wider socio-economic impacts, including impacts on economic growth.

This chapter also includes a review of the potential impact of Longer and Heavier Vehicles (LHVs) on long-term road maintenance requirements, and an assessment of whether any additional costs can be, at least in part, covered by additional funding sources.

Due to their limited duration and impact, this chapter does not look at the potential disbenefits due to travel disruptions that could be generated from road closures. It is important to note however that the effect is proportionally more significant on the local road network because maintenance work zones on single carriageway roads cause comparatively more disruption than on multilane highways.

5.1 Road transport efficiency

5.1.1 Vehicle operating costs

The efficiency of the road haulage market depends on a number of factors, ranging from labour costs to road infrastructure quality. The competitiveness of a country's or a region's goods transport sector thus varies considerably across Europe. In addition, private car users face significant private costs from the maintenance and repair of their vehicles, which also vary greatly depending on the characteristics of local roads.

Anecdotal evidence on the direct relationship between road maintenance and vehicle operating costs has been provided by a number of stakeholders participating in this study. For example, the Freight Transport Association in Ireland and the Federation of Motorcyclists in France have complained about the increase in vehicle repairs due to deteriorating road surfaces.

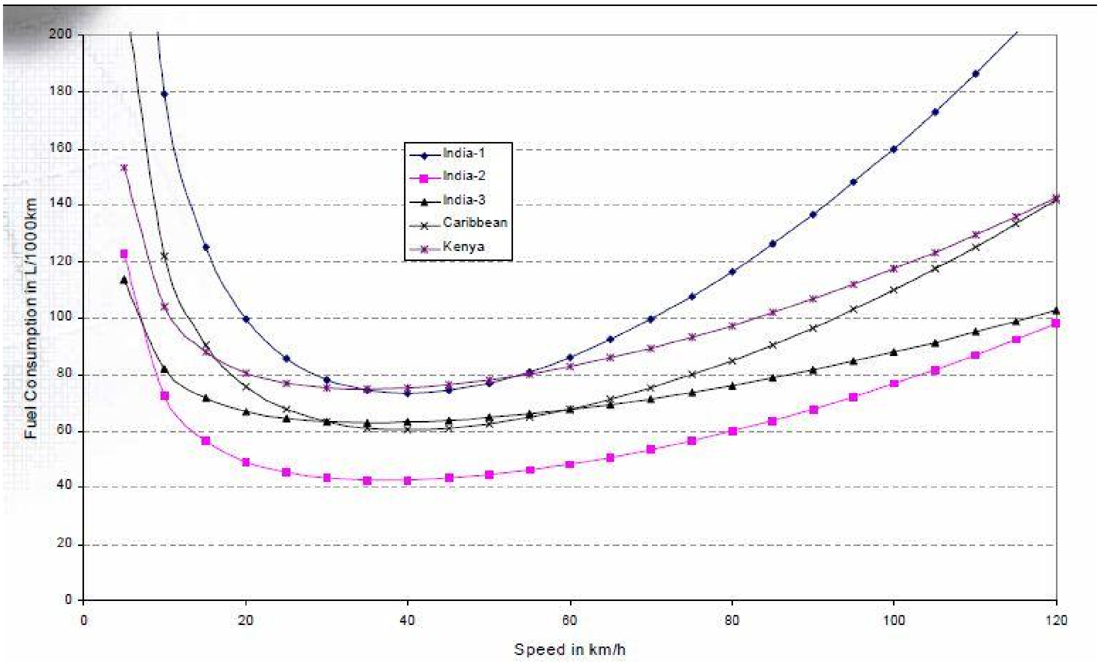
52 The stakeholders that have been consulted fall into the following categories: road users, associations of local authorities, associations of asphalt producers, infrastructural managers.

The World Bank has developed a series of tools to assess the economic benefits of a marginal change in maintenance expenditure through the use of the Highway Development and Management Model, currently in its fourth version (HDM-4). The model is useful to assess the implications of maintenance expenditure in terms of traffic delays and vehicle operating costs. It also offers a good analytical framework within which to analyse the effects of road conditions on vehicle operations. The main elements that contribute to vehicle operational efficiency are:

- Fuel consumption ;
- Tire repairs costs ;
- Costs of other vehicle maintenance, repairs (e.g. shock absorbers) ;
- Depreciation.

In addition, the model can analyse the relationship between road characteristics, vehicle performance and economic or environmental impacts. For example, lower speeds (which can be due to bad road conditions) lead to increased fuel consumption, as shown in the figure 26. As speed is reduced below 40 km/hour, the rate of fuel consumption per km increases substantially, from 80 litres per kilometre to more than 150 litres per kilometre.

Figure 30: Relationship between speed and fuel consumption



Note: India-1, India-2, India-3, Carribbean and Kenya are the labels assigned to different models used by the World Bank to compute Vehicle Operating Costs (VOC).
Source: World Bank, Highway Develompment and Management-4 Road User Effects.

Transport Scotland has recently carried out a comprehensive study on the socio-economic impacts of maintenance spend in Scotland, using HDM-4 as part of the cost-benefit analysis to assess different spending scenarios. For a scenario in which funding is reduced by 40% compared to current levels, the total increase in vehicle operating costs, for local roads and trunk roads, discounted over 20 years, is estimated to be more than £3.5 billion[53]. This figure, albeit large, represents an increase of only about 1% compared with the base case with no reductions in spending.

Results from the analysis carried out in Poland as part of the JASPERS[54] project suggest similar conclusions. By comparing vehicle operating costs at different speeds, it has been estimated that at a speed of 60 km/h the difference in operating costs is PLN 0.017/km (€0.004/km) for cars and PLN 0.1/km (€0.02km) for goods vehicles. Hence vehicle operating costs appear to be in region of 2-3% higher when travelling on roads with deteriorated pavement conditions.

Further evidence emerged from a study carried out by Infraplanas in Lithuania. This study estimated the savings in transport costs for road users (excluding travel time savings) of road rehabilitation. For each Euro invested in road maintenance, they calculated transport cost savings in the region of €0.7 for urban road users and €1.4 for rural road users.

Finally, studies carried out on the Spanish road network since the ‘80s have concluded that poor road surface can increase fuel consumption in light vehicles by 34% (12% for heavy vehicles) compared to a road in good conditions[55]. A poorly maintained road surface can also lead to faster deterioration of tyres, worsening their lifespan by 66% for light vehicles and 10% for heavy vehicles.

It should be noted that lower transport costs, resulting from good maintenance, have a positive effect on the wider economy by reducing the overall cost of production along the supply chain.

5.1.2 Motor insurance claims

The number and value of requests for damages made by road users to local authorities has also proven helpful to shed some light on the extent to which extra costs are borne by road users due to the lack of maintenance. A consultation carried out by Insurance Europe in the context of this study has shown that some insurance schemes have been set up by highway operators in France, Italy, Austria and Poland. The limits for liability are usually around €50m.

In these Member States, claims are made frequently by road users. In Poland, on average motorists make about 2,000 per year for a network of around 17,000km managed by the national authority GDDKiA. In England and Wales, the results from the survey carried out among local authorities indicates that the overall cost of motor insurance claims amounted to just under £32m (€38.5m) in the financial year 2011/12.

53 Transport Scotland, Economic, Environmental and Social Impact of Changes in Maintenance Spend on Roads in Scotland, Summary Report 2012.

54 The Jaspers Blue Book (2008).

55 Protti, J. (2012), Los mensajes sobre la conservación y la realidad de la conservación de nuestros firmes de Carreteras, Revista Asfalto y Pavimentación número 7.

Further evidence emerged in Britain indicating that councils have paid out a total of £2.5m (€3m) in compensation to motorists in the financial year 2012/13 for pothole related damage to cars (an increase of 80% over the previous year).

Table 7: Compensation claims by Local Authorities (LA) in Great Britain

Indicators		England	London	Wales
Number of staff hours spent on claims (on average, per LA)	2012	183	125	99
	2011	172	131	93
Annual amount spent (on average, per LA)	2012	£87k	£53k	£38k
	2011	£105	£68	£55k
Amount paid to road users in claims (total)	2012	£23.8m	£6.3m	£1.8m

Source: ALARM Survey (2012 and 2013).

Other than the direct cost of claims, poor road maintenance also adds an indirect cost in terms of working hours spent by public sector employees to deal with these claims, as detailed in
Table 7. Their time could be better spent on other tasks that could instead lead to an improvement in local road transport efficiency and maintenance.

By observing the trends of these claims over time, it is possible to have an indication of the relative resilience of national and local road networks. As part of this project, we have attempted to collect such information but came across several limitations, including the issues of time lags and the fact that the volume of claims depends on the availability of insurance as well as road quality. By further engaging insurance providers across Europe, new research could provide interesting conclusions in this area.

5.2 Safety and health impacts

The costs of road accidents can be quantified in economic terms, as is done in some MSs. These costs encompass both human costs and material costs such as those in relation to damage of property and settlement costs. In the Netherlands, the Institute for Road Safety Research (SWOV) reports that, in 2011, the costs associated with road accidents amounted to € 12.5 billion, or 2.2% of GDP. By way of an example, the following table, taken from a SWOV document, shows the breakdown of the estimated social costs of road accidents.

Table 8: Costs of road accidents in the Netherlands

Cost category (Euro million)	2003	2006	2011
Medical costs	320	311	352
Property damage	3,546	3,208	3,866
Settlement costs	1,162	1,272	1,293
Production loss	1,466	854	924
Congestion costs	337	241	300
Human costs	5,535	5,031	5,761
Total	12,360	10,920	12,500

Source: SWOV Fact sheet - Road crash costs (2012).

The French Observatory of Road Safety employs a similar methodology to assess the economic costs of accidents and injuries on the country's roads. For instance, the cost of a road fatality was estimated to be around €1.3 million. When injured road users are taken to hospital for 24+ hours, the cost is €143,787 for these sever injuries - €5,752 in case of light injuries. The health costs associated with road accidents are estimated to be €9.5 billion in 2012. Adding the cost of property damages (€12 billion) and insurance leads to a global cost of road accidents equivalent to 1% of French GDP. This figure, which is lower than the Dutch one because different parameters have been considered, has been decreasing steadily since 2007.

The examples quoted above do not attempt to provide a specific figure for each of the different factors causing road accidents. This would be a difficult exercise which would entail the identification of specific classes of accident causalities. Without such specifications, it is not possible to quantify the safety impacts specifically related to road maintenance interventions.

However, insights into the magnitude and scale of these costs are needed in order to outline and evaluate policies appropriately as they provide a useful monetary tool in cost-benefit analyses, and improve the comparability of accident-related costs vis-à-vis other costs. Similarly, the cost of medical conditions arising from increased roughness and bumpiness should be accounted for when evaluating the benefits of maintenance and investment expenditure.

The attempt to identify the impact of road quality on road safety, in economic terms, is provided by Infraplanas in Lithuania. The consultancy estimates that, for each Euro invested in road reconstruction and rehabilitation, cost savings from reduced road accidents would be around 0.3LTD for urban roads and 1.0LTD for rural roads[56]. Further evidence into the social costs of road maintenance will certainly help to highlight the impact of good maintenance in reducing accident risk.

[56] For more information see Annex A Figure 38: Net benefit forecast for 1 LTL invested into road rehabilitation reconstruction and maintenance.

5.3 Wider socio-economic impacts

5.3.1 The analytical framework

Transport can make a substantial contribution to improving the efficiency of the internal market. As such, the quality of road infrastructure facilitates the smooth transportation of goods both nationally and across MSs. Good maintenance plays a crucial role in ensuring that the quality of road surfaces is high.

Assessing the costs and benefits of road maintenance is, once again, not a trivial task. A review of the literature produced in different Member States has highlighted which impacts tend to be considered when assessing the wider benefits of road maintenance spending. In the Transport Scotland study mentioned above[57], the following benefits from road maintenance were deemed to be quantifiable[58]:

- Travel time savings;
- Lower deterioration of road asset values.

In addition, evidence from Scotland – within the UK case studies – and other case studies (e.g. Poland) suggests that maintenance and investment of the road network affects the economic development of more remote regions across Europe.

5.3.2 Travel time savings

The reduction in journey times associated with timely maintenance is one of the most widely recognised economic benefits of road maintenance. When roads are well maintained, the likelihood of road closures due to unforeseen events is reduced. Similarly, routine maintenance can be better planned to avoid peak times, as opposed to reactive maintenance which may not be delayed even when it causes disruptions.

More importantly, the good state of roads is the primary prerequisite for ensuring efficient traffic movements. Journeys for commuter cars, goods transport vehicles and delivery services can be significantly shorter if they take place in roads without potholes, even when weather conditions are adverse. These time savings directly impact the productivity of national and local businesses.

According to a survey by the Manufacturers' Association, the poor maintenance of many local roads in Britain: "…is adversely impacting manufacturing on a number of core business activities. Three-quarters of manufacturers cite it as a barrier to sending and receiving products and raw materials". The Association explains that "more than 60% see it as an impediment to recruiting and sustaining relationships with customers and suppliers. The majority of manufacturers are experiencing significantly increased operating costs and nearly a third a fall in productivity as a result of sub-optimal road quality" (EEF 2012).

57 Transport Scotland, Economic, Environmental and Social Impact of Changes in Maintenance Spend on Roads in Scotland, Summary Report 2012.

58 The study found that the first two sets of benefits could only be quantified for principal roads. In the case of time savings, this is because only higher speeds on good quality roads lead to significant savings. For skidding-related accidents, there was not enough evidence to assess the impact on local roads.

A survey of Small and Medium Enterprises in England and Wales carried out by the Asphalt Industry Association (2010) found that 68% of SMEs consider road maintenance very important for the success of their business, while 44% of businesses thought that local roads were not very well maintained. When asked to point to the main business costs arising from poor maintenance, SMEs indicated the following: negative productivity impacts in terms of time wasted, as well as lost competitiveness from higher vehicle operating costs and fuel consumption. The survey further attempts to quantify the average cost of poor maintenance per business, estimating these to be £13,600 per year (€16,300).

5.3.3 The value of road assets

The OECD has published a series of papers summarising the existing evidence on valuing road assets and planning for road maintenance in order to preserve this value over time, as well as to optimise the level of expenditure against the foreseen costs. Funding for road maintenance is often postponed when pressure is put on budgets because a lack of maintenance does not necessarily lead to immediate failure of the network. However, maintenance deferral can be expensive in the long run. Short-term cost savings from deferring maintenance may be outweighed, even in present value terms, by the consequent need for more expensive treatments in the future.

Deferred maintenance refers to the amount of maintenance and rehabilitation work that should have been completed to retain the road surface in an acceptable condition but had to be deferred due to reduced maintenance funding or policy changes for the preventive maintenance and/or pavement rehabilitation programs.

Pavements that remain untreated can deteriorate at a faster rate. The cost of repairs increases disproportionately as the condition of the pavement decreases over its life. Deferring pavement related preventive maintenance or rehabilitation can lead to a substantial increase in the required repair costs.

Given that, in the long run, deferring maintenance can make future costs greater, the challenge is to provide additional information on the value of roadway facilities and the costs associated with deferred maintenance spending. In particular, it is to quantify the costs of underfunding in order to bring these costs to the attention of decision makers as pointed put by Philippe, Kauppilla, Vassallo and Wlaschin (2013)[59].

Harvey (2012)[60] proposes a way of communicating the cost of maintenance deferral to decision makers through a measure termed the “equivalent interest rate for deferred maintenance” (EIRDM). He sees deferring maintenance as a form of borrowing. Funds are saved in the short-term at the expense of higher outlays in the future. Estimating an EIRDM enables comparisons to be made between cost of borrowing through maintenance deferral and conventional borrowing to fund current expenditures on maintenance.

Evidence emerging from the national case studies shows that research has advanced in several Member States, leading to the estimation of “road maintenance backlogs”. These figures, expressed in terms of millions of Euros, are perhaps indicative of the desire by

[59] Philippe, C., Kauppilla, J., Vassallo, J. and Wlaschin, B., Asset Management for Sustainable Road Funding, Discussion Paper 13, 2013, ITF/OECD.

[60] Harvey, Mark, Optimising Road Maintenance, Discussion Paper 12, 2012, ITF/OECD.

stakeholders to summarise the problem of neglecting road assets in a single figure. Some examples of these estimates include the following:

- In Britain, Bayliss (2012) estimates a funding shortfall of as much as £1 billion (€1.2 billion) a year since 2000. The cost of clearing the backlog maintenance was estimated to cost £9.7 billion (€11.6 billion), and even if local authorities had the required funding and staff, it would take 11 years to eliminate.
- The National Road Authority of Ireland has estimated the replacement cost of the network to be in the around €30 billion. With a 20-30 year life-cycle cost, the network would deteriorate by €1 - €1.5 billion per year with no maintenance budget. With expenditure forecast to be in the realm of €500 million per year, a significant shortfall is likely to arise[61].

5.3.4 Summary of wider socio-economic impacts

The volume of road maintenance expenditures yields substantial wider socio-economic impacts. Some of these, such as the value of travel time savings, can be quantified in accordance with existing analytical frameworks at the national or at the European level. Other impacts, despite being important outcomes of road maintenance, are better described from a qualitative point of view.

Examples of the quantification of wider economic impacts include the aforementioned studies in Scotland and Lithuania: these studies indicate that the reduction in road maintenance expenditure can have an impact to the wider economy in the range of 100%-250%[62].

In Germany, the ADAC (2011) claims that the condition of the German road network is gradually worsening and that a lack of road maintenance can result in total macroeconomic costs equivalent to 4% of German GDP.

Overall, timely and effective maintenance is thus fundamental to ensure that the internal market is working efficiently. It has also been shown that good road maintenance leads to lower transport costs and has positive implications on the safety and health of transport users. The inherent differences in the recording and quantification of those impacts, however, poses severe challenges to any attempts to monetise the impacts of maintenance interventions.

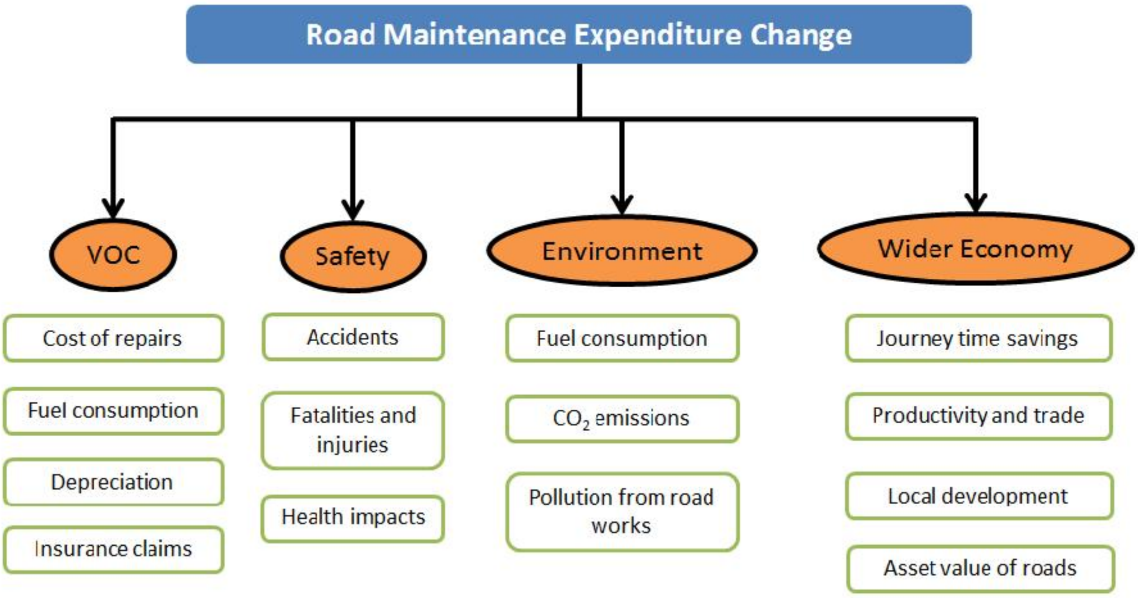
The diagram below summarises the conceptual framework that we recommend for any comprehensive assessment of the socio-economic impacts of a change in road maintenance expenditure, based on our review of the literature mentioned above.

No relevant evidence relating to road maintenance environmental impacts has been identified during the course of this study. A well maintained road surface reduces the deterioration rate of tyres and also fuel consumption but these have to be balanced against the additional environmental negative externalities from the maintenance activity.

[61] See Annex A paragraph 4.5 Socio-economic impacts of road maintenance in Ireland.

[62] Transport Scotland's assessment shows that « for every £1 reduction in road maintenance, there is a cost of £1.50 to the wider economy ». The multiplier effect estimated in Lithuania is even higher: for every 1 LTL spent to rehabilitate roads, the net benefit over 25 years is forecast to be around 2.5 LTL.

Figure 31: Potential impacts of a change in road maintenance expenditure



Note: VOC=vehicle operating costs
Source: Steer Davies Gleave elaboration.

5.4 The potential impact of LHVs

Steer Davies Gleave has recently prepared a study reviewing the available evidence of different impacts related to the increase of height and weight limits for goods vehicles (LHVs, also known as megatrucks). In the study[63], the impact of LHVs on road infrastructure is categorised into three main areas:

- The long-term impacts of heavier weights on road wears and the additional maintenance costs arising from it;
- The impacts on volume and space, both on roads (tunnels, carriageways, level crossings, roundabouts) and at off-site facilities (parking, terminals); and
- The impacts on structures such as bridges, requiring one-off improvements to withstand the additional pressure exerted by LHVs.

With respect to the additional maintenance costs, research by WSP (2010)[64] and the Netherlands Ministry of Transport (2010)[65] has shown that LHVs do not have a significantly more negative impact on the conditions of pavement and road structure than conventional LGVs. This has been confirmed by research carried out in Germany (BASt 2007)[66] that concluded that LHVs do not have a more negative impact on the conditions of pavement and road structure than conventional LGVs. This is partly because the impact is expected to be

[63] European Parliament (2013), A review of megatrucks, available online at: http://www.europarl.europa.eu/RegData/etudes/etudes/join/2013/513971/IPOL-TRAN_ET(2013)513971_EN.pdf
[64] WSP (2010), Longer Semi-Trailer Feasibility Study and Impact Assessment, UK.
[65] Netherland National Ministry of Transport (2010), Experience with LHVs in the Netherlands.
[66] BASt (2007), Auswirkungen von neuen Fahrzeugkonzepten auf die Infrastruktur des Bundesfernstraßennetzes.

smaller due to lower tonnage per axle. At the same time, though, the BASt study pointed out that the introduction of LHVs with a length of up to 25.25m would require substantial investment in infrastructure as the current road infrastructure in Germany is not designed for LHVs.

Vehicle weight is not considered to be a sufficient indicator of strain for road wear. The actual weight-per-axle needs to be taken into account when assessing the impacts of LHVs. Despite their increased weight, LHVs often have a greater number of axles across which weight can be distributed, therefore reducing the axle load. The importance of assessing axle load rather than vehicle load is emphasised both by TML (2008)[67] and VTI (2008)[68], both of which note that weight-per-axle might even be lower for LHVs.

However the potential impact of LHVs remains ambiguous given the limited number of vehicles currently circulating in Europe. Should road deterioration caused by extra-dimensioned vehicles take place, then it will be necessary for road managers to develop accurate systems that relate road usage to damage estimations. A better understanding of such correlation will result in the possibility to apply road user charges that better reflect the damaging potential of those vehicles.

The current regulatory framework for user charges (‘Eurovignette’) was introduced in 2011 by Directive 2011/76/EU. In contrast with the former framework directive which was limited to trans-European roads, the new rules may now be extended to cover all motorways.

Although no reference is made in the Directive to the impact of road wear as one of the criterion to modulate charges, the European Commission has recently conducted an ex-post evaluation[69] of Directive 2011/76/EU which concluded that the Member Staters are not making full use of the opportunity for wider differentiation of toll rates.

Currently, Member States may apply an “external cost charge” on heavy vehicles in order to achieve the key policy goals of reducing the negative external impacts of transport. The level of tolls will be dependent upon the emissions of the vehicle, the distance travelled, as well as the location and time of the road use. In a recent statement[70], Transport Commissioner Kallas suggested that these charges would be subject to multipliers for LHVs under a reformed Eurovignette system.

Besides the difficulties in calculating such “external costs” with respect to LHVs, further problems in the implementation of nation-wide tolling schemes accounting for the external cost charge envisaged by the Eurovignette Directive have recently emerged. In this respect, the European Parliament has invited[71] the European Commission to review Annex I to Directive 96/53/EC and report on its implementation, taking into account, inter alia, impacts

[67] TML (2008), Effects of adapting the rules on weights and dimensions of heavy commercial vehicles as established within Directive 96/53/EC. Final report.

[68] VTI (2008), The effects of long and heavy trucks on the transport system, Sweden.

[69] Commission staff working document: Ex-post evaluation of Directive 1999/62/EC, as amended, on the charging of heavy goods vehicles for the use of certain infrastructures [SWD(2013)1].

[70] Please see “After Eurovignette, EU asks: For whom the road tolls?”, EurActiv.com, 19/09/2013 (http://www.euractiv.com/specialreport-road-transport-dri/eu-asks-road-tolls-news-530550).

[71] See European Parliament Legislative Resolution of 15 April 2014 on the Proposal for a Directive of the European Parliament and of the Council amending Directive 96/53/EC of 25 July 1996 laying down for certain road vehicles circulating within the Community the maximum authorised dimensions in national and international traffic and the maximum authorised weights in international traffic.

on international competition, modal split, costs of infrastructure adaption and the environmental and safety objectives of the European Union as set in the 2011 White Paper on Transport. By 2016, the Commission shall review Annex I to Directive 96/53/EC and submit a report on its implementation to the European Parliament and the Council. On the basis of this report, the Commission, shall, if appropriate, make a legislative proposal duly accompanied by an impact assessment.

KEY FINDINGS

- Some research has been undertaken on the economic impacts of road maintenance showing that good road maintenance can have a positive impact on economic activity.
- There is also evidence of the social cost of road accidents which has been quantified in studies in France, Lithuania and the Netherlands. While the majority of road accidents are down to driver behaviour, some of those accidents could be as a result of drivers behaving in a certain way to account for poor road maintenance.
- The reduction in journey times associated with timely maintenance is one of the most widely recognised economic benefits of road maintenance. A survey carried out by the Asphalt Industry Association (2010) found that the average cost of poor maintenance per business, at £13,600 per year (€16,300).
- Transport Scotland's assessment of wider economic impacts shows that "for every £1 reduction in road maintenance, there is a cost of £1.50 to the wider economy. If figures were available to quantify aspects not currently included in the quantitative analyses, it is expected that these would only enhance the conclusion". The multiplier effect estimated in Lithuania is even higher: for every 1 LTL spent to rehabilitate roads, the net benefit over 25 years is forecast to be around 2.5 LTL.
- There is no evidence that the use of LHVs will materially affect road maintenance as the increased weight of the vehicles is distributed over a larger number of axles. On the contrary, the introduction of LHVs would require substantial investment in infrastructure in MS where the current road infrastructure is not designed for LHVs.

6. CONCLUSIONS

6.1. Lessons learned

As discussed in Chapter 2, between 2000 and 2010 road safety improved significantly across the EU. The number of road fatalities fell to 31,000, a level corresponding to 57% of the fatalities registered in 2001, falling short of the target set in the 3rd European Road Safety Action Programme (ERSAP) of halving the number of road fatalities registered in 2001 by 2010 but still a significant achievement. This reduction was achieved despite a general growth of road traffic over the same period. Provisional data for 2013 indicate that road fatalities are still decreasing, as an overall number of 26,000 fatalities has been registered in the EU. For the coming years, the European Commission renewed its objective of halving road fatalities by 2020 through increased focus on the enforcement of road rules.

The root causes of road accidents are hard to disentangle. Human factors play a dominant role, but the quality of road infrastructure is also a key-factor. As discussed in Chapter 4, there are various aspects of the road's condition which contribute to its safety. A consistent design of a road's geometry is an important factor in ensuring a safe road. Another important provision is an appropriate level of service for the anticipated traffic flow. Both these aspects fall within investment activities rather than maintenance. Nevertheless, also the lack of regular road maintenance can contribute to the worsening of the quality of the road surface. High level of pavement friction, clear signage and road markings are important qualities of a safe road and it is important that they are maintained throughout the road's lifespan. Anomalies, such as ruts and depressions, reduce road safety as they affect driver fatigue, can create a hazard for drivers and can cause aquaplaning in wet conditions.

To date the framework for road maintenance planning and activities to address safety issues is very fragmented. Directive 2008/96/EC – the legislative intervention that disciplines road infrastructure safety management – deals only with the methodological and procedural aspects to be followed for road safety assessment on EU TEN-T roads, without providing prescriptions on the type of materials to be used or equipment to be installed.

A key factor behind the undertaking of regular road maintenance activities is also the commitment and availability of sufficient budget to dedicate to road works. A key question that this study has thus tried to investigate in Chapter 3 is whether there has been any variation in road maintenance expenditure in the EU in recent years that can be attributed to the 2008 economic and financial crisis.

A number of difficulties have been encountered in evaluating the relationship between the economic cycle and road maintenance expenditure. The lack of clear definitions and common practices to measure road transport infrastructure spending hinders accurate measurement of these aggregates and impede a robust assessment of how this spending relates to economic growth. To date the ITF provides the most accurate and updated dataset on transport infrastructure expenditure, which includes the figures on road maintenance and investment that have been used to support our assessment.

However this dataset has some shortcomings and the ITF is working closely with OECD MSs to improve the availability, definitions, coverage, quality and comparability of data. Therefore, to assess the evolution of maintenance activities on road works in the EU we have compared ITF data with the asphalt production data reported by EAPA and specific country information.

In the aftermath of the 2008 economic and financial crisis some EU MSs found it challenging to maintain an adequate level of road maintenance expenditure. The data reviewed in this study points to a significant reduction of maintenance activities in Italy, Ireland, Slovenia and Spain in recent years and a likely downward trend experienced also in Slovakia, Finland, Czech Republic, the UK, Portugal and Hungary. At the same time, an increase in maintenance expenditure was recorded in a number of MSs over the same period: this is the case for Poland, Luxemburg, Croatia, France, Lithuania, Austria and Germany.

As discussed in the case studies reported in Annex A, the different patterns of road maintenance activities registered across the EU since the 2008 economic downturn depend much on the governance of the system. The impact of the crisis has been higher where the funding of road infrastructure is highly dependent on government spending (national or local irrespectively) rather than from other sources of financing (e.g. toll roads). The state of public finances in different MSs and the fiscal and budgetary choices that have been made has then brought different outcomes. In some cases road investment has been used as a counter-cyclical form of public spending. However at times of budget cuts, putting off investment and repairs in the road sector is a relatively quick way to reduce public spending and this has been pursued by a number of EU countries. It is not surprising therefore that the largest fall in spending has been witnessed in MS that have implemented wide-ranging deficit reduction plans in recent years.

In addition to this, it is important to note that maintenance spending is also highly dependent on the size of road infrastructure in previous years. Road construction today will inevitably increase the need for maintenance spending tomorrow. This can be seen as a form of liability which current investment decisions impose on future maintenance budgets. In addition, the more intensive is the pace of road building today, the more likely it is that the need for maintenance appears abruptly and is harder to spread out over time.

Good road maintenance can also have a positive impact on economic activity, as shown in Chapter 5. The reduction in journey times associated with timely maintenance is one of the most widely recognised economic benefits of road maintenance. A survey carried out by the Asphalt Industry Association (2010) found the average cost of poor maintenance per business, at £13,600 per year (€16,300). Studies assessing the wider economic impacts of a lack of regular road maintenance carried out in Scotland and Lithuania show that the reduction in road maintenance expenditure can have an impact on the wider economy in the range of 100%-250%.

There is also evidence of the social cost of road accidents which has been quantified in studies in France, Lithuania and the Netherlands. While the majority of road accidents are down to driver behaviour, some of those accidents could be as a result of drivers behaving in a certain way to account for poor road maintenance. On the other hand, there is no evidence that the use of LHVs will materially affect road maintenance as the increased weight of the vehicles is distributed over a larger number of axles.

6.2. Key findings and recommendations

When developing road safety policies and interventions, the reliability and quality of data is a key factor. There is scope across Europe for further efforts to link police collision reports to hospital data records to improve data quality and consistency, especially regarding serious injury crashes. Data quality and effective analysis are fundamental to building risk awareness and intervention effectiveness.

At the same time as the degree of homogeneity of available data on road maintenance and investment expenditure across the different MSs is minimal, it is important to consider additional efforts to improve the standardisation of statistical data collected across the EU MS. This needs to be done in terms of type of roads covered, length and technical features of roads (e.g. number of carriageways), funding mechanism, definition of maintenance and investment expenditure in use, etc. In doing this it would be useful to further support the actions already taken by the OECD in this area.

Overall there is general international consensus on the approach to be adopted at policy level to improve the safety of new and existing roads, as part of a wider strategy targeted at reducing road deaths and accidents. The approach needs to be founded on the following pillars:

- Ensure the presence of accurate and reliable data to be used to assess the results and identify areas of intervention. In doing this, particular attention should be given to the information available regarding the causes of accidents.
- Establish the concept of shared responsibility, commitment and concrete actions, at the different levels of intervention (e.g. European authorities, Member States, regional and local bodies) and involving the various actors (e.g. road developers, infrastructure managers, civil society, etc.).
- Ensure that there is an appropriate design for each road type to minimise the probability of accidents occurring and to mitigate injury severity accompanied by the existence of a robust system of road safety audits.
- Use maintenance and infrastructure safety investment programmes based on procedures which ensure that funding allocation and project selection can prioritise interventions focused on tackling safety risks in the most efficient and effective manner.

While the first three points listed above have been put on the agenda of road safety policy for some years now, it is only in recent years that the last point is emerging with more urgency. This has become more important as the 2008 economic and financial crisis has put at risk the availability of resources dedicated to road maintenance and investment works in some countries. In its resolution issued on the 27th September 2011 on the European road safety 2011-2020 the European Parliament stressed the importance of a well-preserved road infrastructure to contribute to reducing fatalities and injuries of road users. The resolution calls on the Member States to preserve and develop their road infrastructure through regular maintenance and innovative methods such as intelligent road markings that display safety distances and the direction of travel, and passively safe road infrastructure; it also stresses that norms for signposting, in particular regarding road works, must be respected as they are crucial for a high level of road safety.

In light of future parliamentary debates on the actions to be taken by the EU to help preserve the safety and quality of road surfaces and contrast the possible negative impacts generated by cuts in road maintenance activities due to economic downturns, the following actions should be taken into consideration:

- In the ongoing revision of the Road Infrastructure Safety Directive 2008/96/EC of 19th November 2008, EU policymakers should support the introduction of amendments that allow for a more homogenous application across the EU, reduce the existing variability in the operational activities undertaken by different EU MS, introduce provisions that provide guidance on materials to be used or elements to be installed on the road network to boost its safety performance and expand its scope of application also on road sections outside the TEN-T network that register poor safety scores.
- The European Commission should consider proposing the extension to other categories of roads the experiences of the WhiteRoads project described in previous chapters and use the outcomes of the white spot evaluation to improve safety records on the most dangerous sections.
- The European Commission should support the dissemination of a checklist similar to those developed by the WhiteRoads project as a new and complementary tool to the safety audits and inspections laid down in Directive 2008/96/EC and incentivise their application on road sections not on the TEN-T network.
- EU, national and local policy-makers should identify actions and measures that could focus on local and urban roads, which show the highest safety risks and, in some countries, are experiencing the strongest reduction in maintenance activities. Several EU MSs have a well-established procedure for the monitoring of road conditions and the prioritisation of interventions. In many cases however, this does not extend to local or urban roads. The ongoing mid-term review of the EU road safety policy 2010-2020 could be the right occasion to provide suggestions on how to address this issue.

From the case studies, a number of good practices have been identified that could help to improve the cost-effectiveness of maintenance activities on local roads, including, among others, the recourse to user-fed information, where electronic or web-based systems are used to allow drivers to report potholes and highway defects directly to road managers, and the utilisation of recycled asphalt that has the same level of quality as newly produced asphalt, but can lead to significant cost savings. Table 9 reports a synthesis of the good practices in road maintenance that we have encountered in some of the case studies reported in Annex A, which can be used as reference for other MSs. Table 10 below summarises the main lessons learnt and the recommendations going forward for each of the areas assessed.

Table 9: Road maintenance good practice detected from MS case studies

MS	Organization	Issue addressed	Solution Adopted
AT	ASFINAG	Effective coordination and planning of maintenance work	Set of performance targets for maintenance work limiting the number of construction sites and length of road section: • No more than 3 construction sites on a 100km strip on the high-level road network • No more than 10km for each section of work No more than 5 minutes for delays in travel time due to maintenance activities. See Appendix A, par. 1.4.5 for further details
FR	Public road authorities	Reduction of maintenance costs and optimization of maintenance planning	Devolution and differentiation of maintenance regimes based on different usage patterns of road networks. Introduction of smart road and vehicle technologies. See Appendix A, par. 2.4.3 for further details
FR	USIRF	Facilitation of the maintenance planning process	Creation of a catalogue of global costs of each maintenance procedure and its life cycle cost. See Appendix A, par. 2.4.3 for further details
DE	Municipality of Hamburg	Improving road conditions while at the same time decreasing expenditure on maintenance activities	Implementation of a maintenance process which uses 100% recycled asphalt. See Appendix A, par. 3.4.4 for further details
DE	Municipality of Rednitzhembach	Carrying out of road maintenance without impacting the municipal budget	Implementation of a resurfacing process where only a few centimetres of the road surface are milled off and later applied again. See Appendix A, par. 3.4.4 for further details
IT	ANAS	Planning and carrying out of correct and effective maintenance work	Publication of the document providing extensive information on how to use innovative materials to improve the effectiveness of maintenance activities. See Appendix A, par. 3.4.4 for further details
UK	Department for Transport and Highway Agency	Identification of the most effective ways of maintaining the highway	Development of the Highways Maintenance Efficiency Programme. Issuance of several Toolkits and Best Practice Guidances. Sharing of good practices results to increase overall efficiency. See Appendix A, par. 11.4.4 for further details
UK	Local authorities	Encouragement of road users to report maintenance issues on the network to prioritise planning/execution of maintenance	Development of electronic or web-based systems for the public to report pavement and road defects and alert boroughs and TfL on safety-critical issues. See Appendix A, par. 3.4.4 for further details

Table 10: Lessons learned, recommendations and an assessment of road maintenance expenditure in the EU

Issue	Lessons learned	Recommendations
Data availability	Fatalities and sever injuries: reliability and quality of data is not homogeneous across the EU. Expenditure data: Lack of clear definitions and common practices to measure road transport infrastructure maintenance and investment spending.	Fatalities and sever injuries: Improve the link between police collision reports to hospital data records to improve data quality and consistency, especially for serious injury crashes. Expenditure data: improve the standardisation of statistical data collected across MSs. This needs to be done in terms of type of roads covered, length and technical features of roads, funding mechanism, definition of maintenance and investment expenditure in use, etc. This should be tied with further support for the actions of the OECD in this area.
Extent to which road maintenance contributes to the safety of EU roads	Human factors play a dominant role, but the quality of road infrastructure is also a key factor. This is particularly the case for road infrastructure design. Nevertheless, also the lack of regular road maintenance can contribute to worsening the quality of the road surface. High level of pavement friction, clear signage and road markings are important qualities of a safe road and it is important that they are maintained throughout the road's lifespan. Anomalies, such as ruts and depressions, reduce road safety as they affect driver fatigue, can create a hazard for drivers and can cause aquaplaning in wet conditions.	-Ensure the presence of accurate and reliable data; -Establish the concept of shared responsibility, commitment and concrete actions, at the different levels of intervention and involving the various actors; -Ensure that there is an appropriate design for each road type to minimise the probability of accidents occurring and to mitigate injury severity accompanied by the existence of a robust system of road safety audits; -Use maintenance and infrastructure safety investment programmes based on procedures which ensure that funding allocation and project selection can prioritise interventions focused on tackling safety risks in the most efficient and effective manner.

Issue	Lessons learned	Recommendations
Economic cycle and road maintenance expenditure in EU MS	Following the 2008 crisis some MSs have found it challenging to maintain an adequate level of road maintenance expenditure. Significant reductions have been seen in Italy, Ireland, Slovenia and Spain in recent years and a likely downward trend experienced also in Slovakia, Finland, Czech Republic, UK, Portugal and Hungary. Increases have been recorded in a number of MSs over the same period: Poland, Luxemburg, Croatia, France, Lithuania, Austria and Germany. The different patterns on road maintenance activities registered across the EU since the 2008 economic downturn depends significantly on the governance of the system.	Seek innovative funding techniques to enable a full and correct financing of road maintenance activities including a more detailed consideration of potential user-pays options.
Impacts of variation in road maintenance expenditure	Good road maintenance can also have a positive impact on economic activity. The reduction in journey times associated with timely maintenance is one of the most widely recognised economic benefits of road maintenance, but wider economic impacts in the range of 100%-250% of road maintenance expenditure reduction can be generated by the of lack of regular road maintenance.	Ensure there is a full understanding of how to measure the impact of appropriate road maintenance through the appropriate sharing of best practice in this area and potentially identifying “white spots” for maintenance.
Best practice from EU MS	A number of good practices have been identified that could help to improve the cost-effectiveness of maintenance activities on local roads, as reported in Table 9.	A dissemination of existing good practices implemented in some MSs should be encouraged across the EU to improve the cost-effectiveness of maintenance activities.

Issue	Lessons learned	Recommendations
The role of the EU in addressing road maintenance activities	To date the framework for road maintenance planning and activities to address safety issues is very fragmented in the EU: Directive 2008/96/EC deals only with the methodological and procedural aspects to be followed for road safety assessment on EU TEN-T roads, without providing prescriptions on the type of materials to be used or equipment to be installed.	The revision of the Road Infrastructure Safety Directive 2008/96/EC, allows for a more homogenous application across the EU, reduces the existing variability in the operational activities undertaken by different MSs, introduces provisions that provide guidance on materials to be used or elements to be installed on the road network to boost its safety performance and potentially expands its scope to road sections off the TEN-T network that register poor safety scores. The Commission could extend to other categories of roads the experiences of the WhiteRoads project and support the dissemination of a checklist similar to those developed by the WhiteRoads. Identify actions and measures that could ensure appropriate focus is given to the maintenance of local and urban roads. The ongoing mid-term review of the EU road safety policy 2010-2020 could be the right occasion to provide suggestions on how to address this issue.

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ANNEXES

CONTENTS

LIST OF ABBREVIATIONS

ACA-M	Associação de Cidadãos Auto-Mobilizados (Portuguese Road Users Association)
ADRVEST	Agentia pentru Dezvoltare Regionala (Romanian Regional Development Agency)
AEC	Asociación Española de la Carretera (Spanish National Road Association)
AFITF	Agence de financement des infrastructures de transport de France (French Agency for the Financing of Transport Infrastructure)
AIA	Asphalt Industry Association
AICCOPN	Associação dos Industriais da Construção Civil e Obras Públicas (Portuguese Association of the Public Power and Civil Construction)
AIT	Austrian Institute of Technology
ANAS	Azienda Nazionale Autonoma delle Strade (Italian National Road Agency)
ASEFMA	Asociacion espanola de fabricantes de mezclas asfalticas (Spanish Association of Asphalt Producers)
ASFINAG	Autobahn and high way financing stock corporation (Austria)
BMS	Bridge Management System
BMVIT	Bundesministerium für Verkehr, Innovation und Technologie (Austrian Ministry for Transport, Innovation and Technology)
CAT	Coefficiente di Aderenza Trasversale (Transversal Friction Coefficient)
CdS	Codice della Strada (Italian Road Codee)
CNADNR	Compania Naţională de Autostrăzi şi Drumuri Naţionale din România (Romanian National Company of Motorways and National Roads)
CNIT	Conto Nazionale delle Infrastrutture e dei Trasporti (Italian National Transport Statistics)
CR	Certification of Regularity
DfT	Department for Transport (UK)
DIW	Deutsches Institut für Wirtschaftsforschung (German Institute for Economic Research)

DPIIS	Departamentul pentru Proiecte de Infrastructura (Romanian Department of Infrastructure Projects and Foreign Investment)
DRPCIV	Romanian Driving Licenses and Vehicle Registration Authority
DTTaS	Department of Transport, Tourism And Sport (Ireland)
EAPA	European Asphalt Pavement Association
EP	Estradas de Portugal (Portuguese Road Company)
ERDF	European Regional Development Fund
ETSC	European Transport Safety Council
FEMA	Federation of European Motorcycles Association
FFMC	Fédération Francaise des Motards en Colère (French Association of Angry Motorcyclists)
FGSV	Forschungsgesellschaft fur strassen-und verkehrswesen (German Road and Transportation Research Association)
GDDKiA	Generalna Dyrekcja Dróg Krajowych i Autostrad (General Directorate for Road and Motorways-Poland)
GDP	Gross Domestic Product
GPS	Global Positioning System
HA	Highways Agency (UK)
IDRRIM	Institut des Routes, des Rues et des Infrastructures pour la Mobilité (France Institute for Roads and Transport Infrastructure)
IQOA	Image de la qualite des ouvrages d'art (French Measurement of Quality of Civil Engineering Structures)
IQRN	Image qualité du réseau routier national (French Measurement of Quality of National Roads)
IRI	Ride quality index
LRA	Lithuanian Road Administration Institution
MPD	Mean profile depth
NHT	National Highways & Transport Survey (UK)
NRA	National Roads Authority (UK)
OECD	Organisation for Economic Co-operation and Development

OSEC	Cities and Roads Safety Observatory
PEIT	Plan Estratégico de Infraestructuras y Transporte (Spanish Transport Infrastructure Strategic Plan)
PMS	Pavement Management System
PPP	Public Private Partnership
RCI	Road Condition Indicator
RMPD	Road Maintenance and Development Programme
RSA	Road Safety Authority's
RSP	Road Surface Profiler
SCANNER	Surface Condition Assessment for the National Network of Roads (UK)
SCRIM	Skid Resistance Index Measure
SGPav	Sistema de Gestão de Conservação de Pavimentos (Portuguese System of road surface maintenance)
SHWD	Super Heavy Weight Deflectometer
SITEB	Associazione Italiana Bitume Asfalto Strade (Italian National Association of Asphalt Producers)
SOPO	System for Evaluation of Roadsides
SOSN	System for Road Surface Evaluation for Asphalt Roads
SOSN-B	System for Road Surface Evaluation for concrete Roads
SRN	Strategic road network (UK)
TRACS	Traffic-speed Condition Survey (UK)
UNTRR	Road Transporter's National Union (Romania)
USIRF	Union des Syndicats de l'Industrie Routière Française (Franch Road Transport Union)
ZEB	Road Monitoring and Assessment (Germany)
ŽSI	Winter Severity Index (Poland)

COUNTRY ABBREVIATIONS

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
UK	United Kingdom
HU	Hungary
HR	Croatia
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal

RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia

LIST OF TABLES

LIST OF FIGURES

ANNEX 1: CASE STUDIES

1. CASE STUDY AUSTRIA

1.1 Member State overview

The total road network of Austria is 122,800 km long, of which 1,700 km are motorways. Austria's current level of car ownership is approximately 535 passenger cars per 1000 inhabitants. This figure has steadily increased in the period 2001-2011; the percentage increase over this period was 3.1% (Eurostat).

1.2 Road Safety Statistics

In 2011, Austria registered 523 fatalities on its roads, which represented a 45% decrease from 2001. In terms of fatalities per million inhabitants, Austria's 62 is slightly above the EU27 average of 60. When referring to other indices, Austria remains around the EU27 average level: it noted 69 fatalities per 10 billion passenger kilometres (above the EU average of 61), whilst its figure of 117 fatalities per million passenger cars is marginally less than the EU average of 126. In total there were 35,100 accidents resulting in personal injury on Austrian roads in 2011, which is a 18.4% decrease on the same figure recorded in 2001 (Eurostat and OECD).

1.3 Maintenance budgets analysis

1.3.1 Road infrastructure and maintenance spending for federal roads in Austria

The expenditure for maintenance of the strategic road network, comprising the motorway and the expressway network, is covered by the revenues generated by Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaf (ASFINAG). Its main source of income is tolls collected from vehicles. In addition, ASFINAG raises the capital necessary for its investments on the capital market, while the Austrian Government provides state guarantees for this financing. ASFINAG does not receive any state subsidies.

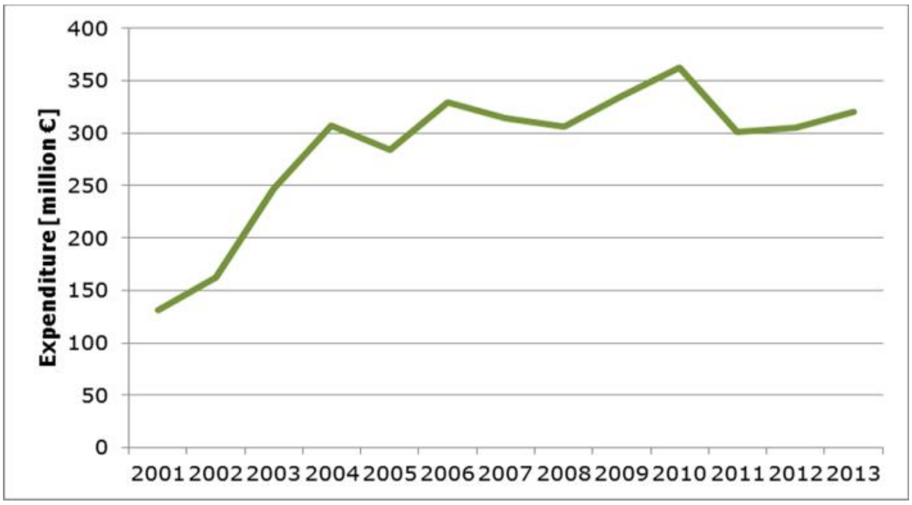
The financing of maintenance activities on the high level road network is not based on the principles of project financing, but on the principles of corporate financing. Therefore, ASFINAG is independent of any other Governmental spending, and due to the economic crisis, there have been no specific changes in its overall strategy for maintenance.

Since 1997, ASFINAG more than quadrupled its investments in the extension, upgrading and maintenance of the strategic network, from €0.29 billion in 1997 to €1.2 billion in 2008.[1] As a result of the financial crisis, ASFINAG's revenue decreased by 9% between 2008 and 2009. Subsequently revenues rebounded and in 2010 were back at the pre-recession level of 2008. As a reaction to the decreased income in 2009 and the weak economic situation of the company in general, ASFINAG diminished its investments by approximately 25% in 2010 and 2011. Infrastructure expenditure between 2011 and 2016 is planned to be around €1 billion for each individual year.

[1] Austrian Ministry of Finance (2011) Infrastrukturbeilage.

Figure 1 below shows the evolution of maintenance spending on the Austrian strategic road network in the period 2001-2013. Since 2001, the maintenance budget has been gradually increasing. While it was particularly high during the years of the financial crisis in 2009 and 2010, maintenance expenditure diminished significantly in 2011 and 2012.

Figure 1: Spent budget for structural road maintenance on the Austrian strategic road network



Source: BMVIT (2013).

The Austrian Ministry of Transport expects and is planning for increased maintenance budgets for the strategic road network in the future. In particular, a large number of bridges are expected to require maintenance in the 2020s. This is mainly due to many bridges, which were built in the 1970s and 1980s, reaching the end of their lifecycle. Figure 2 shows the age distribution of these bridges. A large number of bridges, 23 per cent of the total number, were constructed in the period 1979-1983.

Figure 2: Age distribution of the bridges on the Austrian high-level road

Source: Brandtner (2008).

Due to a lack of consistent budgeting approaches, there is no evidence available for the evolution of money spent for maintenance activities on the road networks under responsibility of the municipalities.

However, the Austrian association for road technology and asphalt, GESTRATA, claims that the maintenance spending on the local road networks is gradually decreasing.

1.4 Road Performance monitoring

1.4.1 Responsibilities

The Austrian high level road network, which includes motorways and expressways, is managed by ASFINAG. ASFINAG is a company operating on a commercial basis, but fully owned by the Austrian Ministry of Transport (BMVIT). ASFINAG is responsible for the planning, construction and maintenance of the Austrian strategic road network.

In contrast, State Roads are managed by the Road Authority of the relevant Federal State, while Local and Urban Roads are within the responsibility of the relevant municipality.

Figure 3: Responsibility over road infrastructure planning and maintenance by road type

Responsibility	Planning and Financing	Operations
High level road network (Motorways and expressways)	ASFINAG	
State Roads (Landesstrassen)	Federal States (Länder)	Road Authorities of the Federal States (Länder)
Local and Urban Roads (Gemeindewege)	Local authorities (municipalities)	

Source: SDG illustration.

1.4.2 Assessment of road surface quality

The Austrian Institute of Technology (AIT) regularly carries out monitoring of road conditions on behalf of ASFINAG and a number of Road Authorities of the Federal States. The AIT currently owns two vehicles, called RoadSTARs, equipped with high-performance sensor, positioning and camera technology enabling it to record key operational characteristics and layout parameters. Measurements of all parameters are taken in a single run without compromising traffic flow at a standard measuring speed of 60 km/h.[2] Figure 4 below shows the two RoadSTAR vehicles run by the AIT on the Austrian road network.

[2] http://www.ait.ac.at/research-services/research-services-mobility/road-surface-and-road-area-measurement-modelling-and-optimisation/road-condition-evaluation/?L=1.

Figure 4: Measurement vehicles RoadSTAR run by the Austrian Institute of Technology

Source: AIT.

The following operational characteristics of the road can be recorded with the RoadSTAR vehicles:

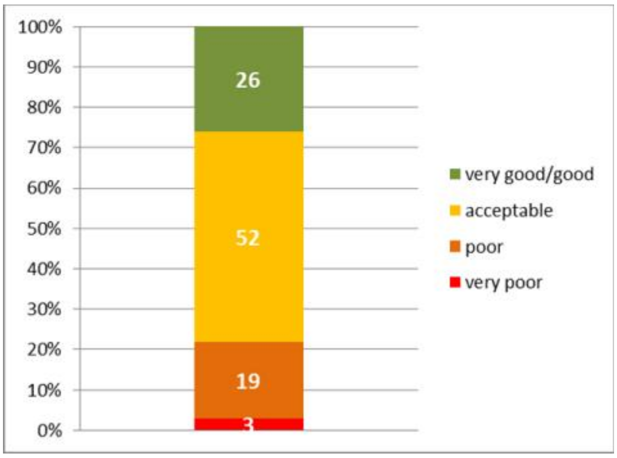
- High-quality, realistic skid resistance measurements in different braking conditions (blocked wheel, ABS, slip ratio of 18%, 25%, 50% and 75%)
- Transverse evenness: rut depth, theoretical water depth in ruts covering a width of 3.30 m and a vehicle width of just 2.50 m
- Longitudinal evenness: true elevation profile and calculation of different indices (IRI, PSD, LWI, wLP, etc.)
- Macrotexture: Mean profile depth (MPD), estimated texture depth
- Surface distress (potholes, fretting, etc.) and cracks from a width of 1 mm based on video footage independent of ambient light / shadow covering a width of 4 m

According to GESTRATA, the condition of the high-level road network in Austria is good compared to its European counterparts. Through continuously increasing expenditure for maintenance in the last decade, the ASFINAG road network has not exhibited any safety relevant defects (e.g. lane grooves, skid resistance). In 2012, ASFINAG was praised by the Austrian Court of Auditors for its maintenance management system.

On the other hand, the State Road network is in a significantly poorer condition. A recent study by the Technical University of Vienna in co-operation with PMS-Consult[3] on the maintenance needs for state roads revealed that current investments in maintenance of state roads are substantially smaller than needed in order to maintain the current condition of this road network. Figure 5 shows the current condition of the Austrian state road network, of which 22% can be classified as in poor or very poor condition.

[3] Litzka, J., Weninger-Vycudil, A. (2011) Baulicher Erhaltungsbedarf fuer die Landesstrassen Oesterreichs. Studie fuer die oesterreichischen landesstrassenverwaltungen.

Figure 5: Distribution of the classification of the condition of the Austrian State Road network in 2010

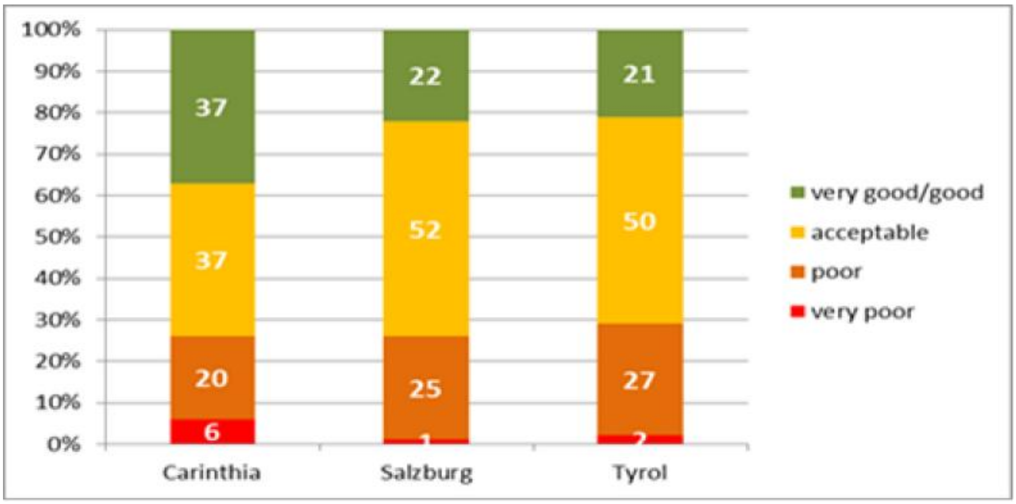


Source: Litzka and Wieniger (2011).

The study further found that the current yearly investments in maintenance of the state road network of approximately €4,800/km need to be increased by 40%, to €6,600/km, to maintain the current condition of the network. To keep the maintenance backlog at less than 20% of the state road network by 2020, maintenance investments would need to be increased by 46%, to a yearly €7,000/km.

However the condition of the state road network depends strongly on the respective federal state. Several federal states, namely Vorarlberg, Tyrol, Upper Austria, Lower Austria and Burgenland, have implemented a pavement management system, following the example of ASFINAG. Figure 6 shows the condition of the state road networks in Carinthia, Salzburg and Tyrol in 2010.

Figure 6: Distribution of the classification of the condition of the State Road network in Carinthia, Salzburg and Tyrol in 2010



Source: Litzka and Weninger-Vycudil (2011).

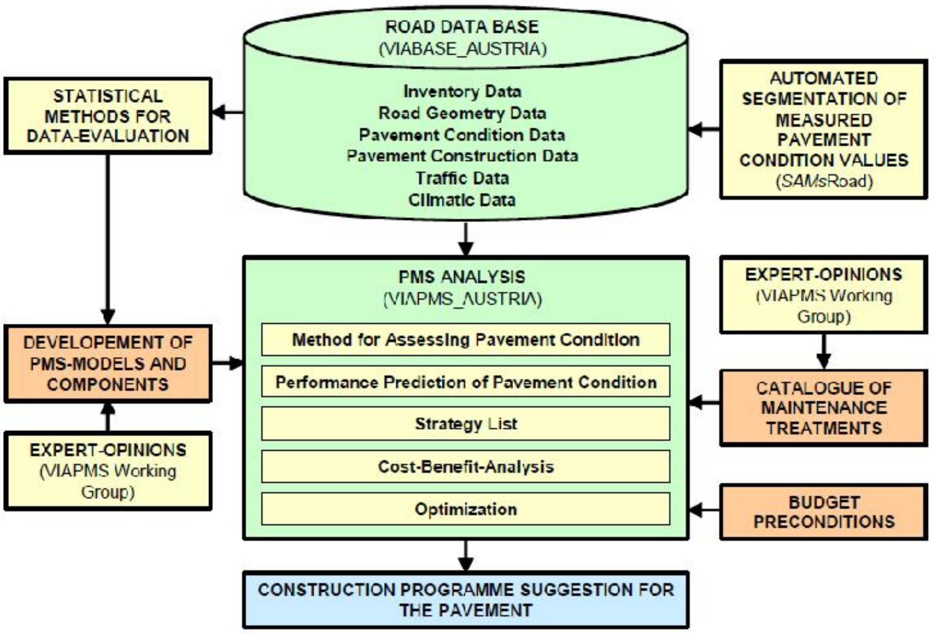
1.4.3 Maintenance intervention

At the end of the 1990s, Austria was one of the first countries in Europe to implement a maintenance management system for the strategic road network under a co-operation between ASFINAG, the Ministries of Transport and Economy, the Federal States and academics.

The maintenance management system includes a regular monitoring of the road surface, as outlined in the above section, and its assessment within a modern pavement management system (PMS). After an implementation phase of about three years, the PMS was put into operation in early 2001.

The Austrian PMS provides a decision-making system with the aim of providing a maintenance activity plan to optimise the overall condition of the road network. The main limiting factor is the generally scarce budget for maintenance activities. For a given set of framework conditions (e.g. budget, road condition), the PMS uses a cost-benefit analysis and heuristic optimisation techniques to identify an optimum maintenance strategy. Figure 7 below shows the different elements of the Austrian PMS and their interactions.

Figure 7: Elements of the Austrian PMS applied to the high-level road network



Source: Weninger-Vycudil et al. (2004).

The method for assessing the pavement condition is the key element for a technical and economic evaluation of different maintenance strategies. In this process, the various measured operational characteristics of the road are standardised to dimensionless indexes, then aggregated into two sub-indexes, a comfort and safety index and a pavement and distress index. Finally these sub-indexes are merged into one overall index.

The overall index can then be used to calculate the benefits of a particular maintenance strategy, but also to define the target function within the optimisation process.

1.4.4 Maintenance intervention on the state road network (The example of Carinthia, Salzburg and Tyrol)

A recent study by the Carinthian audit court[4] compared the maintenance strategies on the state road networks in Carinthia, Salzburg and Tyrol. It found that both road monitoring activities and the road condition assessment process vary strongly among the various states.

In Carinthia, the condition of the state road network has been measured in 2004/05 and again in 2009/10 using visual measurement devices. The focus of these measurements was set on identifying surface defects, lane grooves, and unevenness of the longitudinal profile. However due to the applied visual approach, no skid resistance could be measured.

Based on the results of the visual inspection, the road network was then classified into five categories (very poor to very good). Based on this classification, the federal state of Carinthia then produced a ranking list, which was used to define preferential maintenance activities.

For the first time in 2008, the state of Salzburg commissioned an extensive monitoring of the condition of its state road network. The contracted organisation to carry out these activities was the Austrian Institute of Technology with its RoadSTAR measurement vehicles mentioned above

Based on the data obtained, the state of Salzburg applied a PMS which is consistent with the one used by ASFINAG on the high-level road network. The PMS produced an optimised maintenance strategy for the state road network of Salzburg.

Between 2004 and 2009, the state of Tyrol commissioned the AIT to carry out measurement activities on its state road network using the RoadSTAR vehicles. In addition, the Tyrolean Institute for Material Research and Testing carried out visual measurements of the state road network to validate the results of the AIT. To assess the condition of the road network and to produce an optimised maintenance strategy, the state of Tyrol then applied the same procedure as the state of Salzburg, using a PMS consistent with the one used on the Austrian high-level road network.

As a result of the different approaches, the costs incurred by the different states for the assessment of the road condition and to produce a maintenance strategy varied significantly. While the state of Carinthia spent approximately €5 per km on this process, the costs incurred by the states of Salzburg and Tyrol were substantially higher, with €44 and €41 respectively. The higher costs can be explained mainly by the more sophisticated measurement procedure and the licence fees for the PMS system only applied in Salzburg and Tyrol.

1.4.5 Good practice in maintenance activities

ASFINAG has been praised for their approach towards coordinated maintenance planning. As a general rule, ASFINAG does not allow more than three construction sites on a 100km strip on the high-level road network, with one section of work not exceeding 10km. In

[4] Rechnungshof Kärnten (2013) Bericht des Rechnungshofes, Bauliche Erhaltung von Landesstraßen.

addition, ASFINAG seeks to keep to its performance target of no delays in travel time due to maintenance activities of greater than 5 minutes.[5]

1.5 Socio-economic impacts of road maintenance

As outlined above, ASFINAG does not receive any state subsidies and funds all its investment activities within its commercial revenues. Therefore, ASFINAG's finances do not depend on political decisions regarding the allocation of funds, but do depend on its ability to generate revenue. For example, in the years after the financial crisis, ASFINAG reduced its infrastructure investments due to reduced revenue following a decrease in traffic on the high-level road network.

On the other hand, federal states and municipalities do have substantial budget constraints. States and municipalities in Austria have to allocate a specific share of the total budget to road maintenance, which is often decreasing in times of increased budget needs for budgets for social, health or educational activities.

Furthermore, we could not find any evidence for a socio-economic impact of spending on road maintenance, e.g. an improved road-safety record.

1.6 Summary for Austria

Maintenance expenditure for the Austrian strategic road network has gradually increased over the last 15 years. The maintenance budget is not dependent on political decisions on budget allocation, but depends only on the financial situation of the road operator ASFINAG, which sources its income mainly from tolls.

On its strategic road network, Austria implemented a modern road condition monitoring and assessment system using a pavement management system. Limited funds can therefore be allocated to road maintenance activities to optimise pre-defined objectives, like the overall condition of the road network.

Regarding the rest of the road network, comprising state, local and urban roads, there is no consistent approach to monitoring and assessing the road condition, nor a dedicated allocation of funds to maintenance activities.

We found that a number of federal states implemented a similar maintenance approach on their state road network as ASFINAG does on the high-level road network, including monitoring and assessment processes in combination with a modern pavement management system. Although there is no consistent approach towards monitoring road condition, road condition data surveyed by the federal states suggests that the state road network in Austria is in worse condition than the strategic road network.

[5] Ernst and Young (2012), Effectiveness of national roads maintenance management in Poland.

2. CASE STUDY FRANCE

2.1 Member State Overview

France's total road network is 1,041,800 km long, of which 11,400 km are motorways and 654,200 km are classified as municipal roads. France's current level of car ownership is approximately 500 passenger cars per 1000 inhabitants. This level has slightly decreased in the period 2001-2011; the percentage change over this period was -1.2% (Eurostat).

2.2 Road Safety Statistics

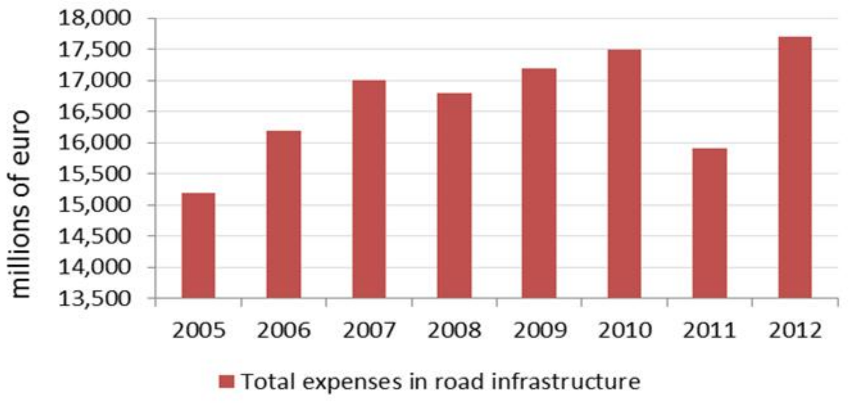
In 2011, France registered 3,963 fatalities on its roads, which represents a 51% decrease from 2001. In terms of fatalities per million inhabitants, France's value of 63 is slightly above the EU27 average of 60. Using other indices France scores more favourably relative to the EU27 average: it registered 44 fatalities per 10 billion passenger kilometres (below the EU average of 61), whilst its figure of 125 fatalities per million passenger cars is marginally less than the EU average of 126. There were 65,000 accidents resulting in personal injury on French roads in 2011, which is a 44% decrease on the same figure recorded in 2001 (Eurostat and OECD).

2.3 Maintenance budgets analysis

2.3.1 Infrastructure spending

The Union des Syndicats de l'Industrie Routière Française (USIRF) told us that they have identified a significant decrease in the annual road maintenance budget. Since 2008, the overall budget fallen by 25% across all network types (National, Departemental or Local) and it is likely that in 2014 this will fall by an additional -5% (-10% on county roads).

Figure 8: Total expenses in road infrastructure



Source: Union Routière Francaise, DGFiP (French Finance Ministry) et SOeS (2013).

The Finance Ministry[6] has identified for 2014 an annual investment budget for the road network of €1,327 mil., €1,353 mil. on maintenance and €213 mil. on regulation, safety and control on the national network. In addition, France has recently created AFITF, an agency in charge of financing land-based infrastructure, but only on the national network. AFITF finances all modes and provided €800 mil. (20% of its total budget) to road projects. Of these, €110 mil. are ring-fenced annually for road maintenance (this value will increase to €160 mil. over the next 8 years).

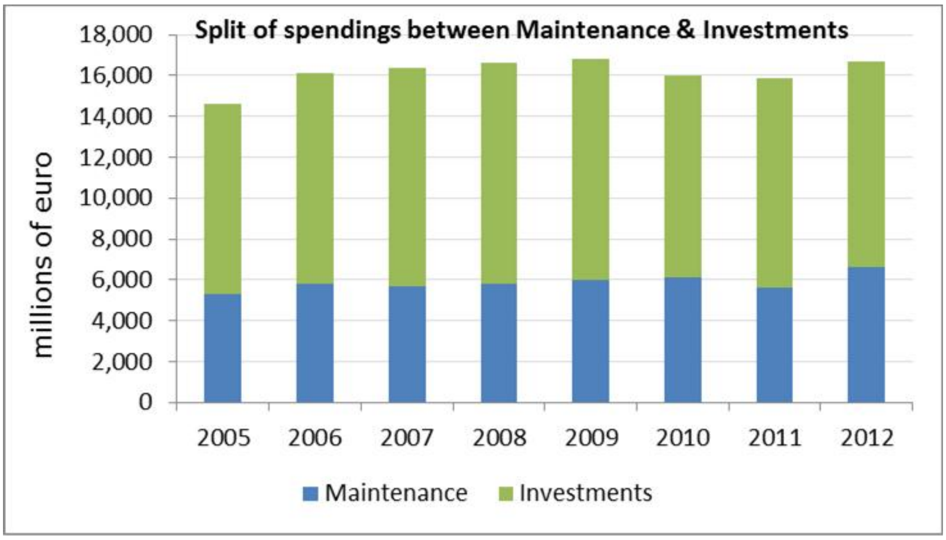
USIRF confirmed to us that road investments and maintenance budgets represent a significant part of the French Counties budgets. Following devolution, each Department received from the central government a grant to raise the quality of the road network, this grant has now been removed. A 2012 report[7] from the French Cour des Comptes states that devolution has led to road related costs being more expensive than when maintenance was treated centrally.

Local authorities have confirmed that the economic crisis has led to an increase in social related expenditure which has meant that the budget dedicated to road maintenance has decreased. In addition, recent changes in legislation mean that more stakeholders need to be involved in the approval process for road works, leading to delays.

2.3.2 Capital investment in roads vs. road maintenance

The figure below sets out the split between road maintenance and investment in France in recent years.

Figure 9: Maintenance vs Investment



Source: Union Routière Francaise, DGFiP (French Finance Ministry) et SOeS (2013).

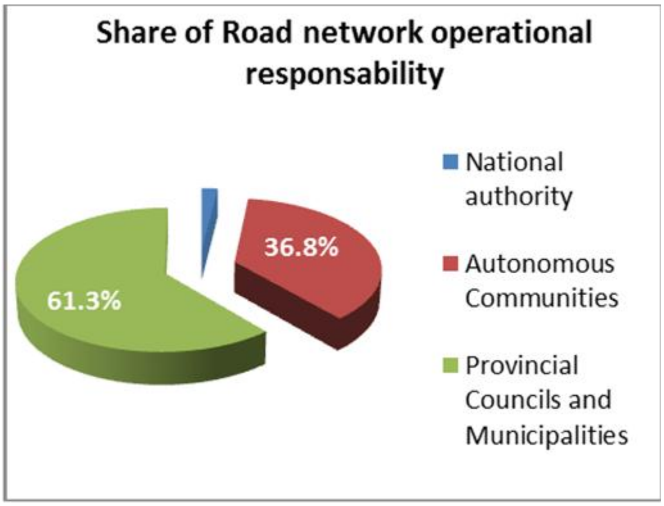
Most French motorways are now operated under concessions and maintenance is mainly paid for through toll revenues. Recently, an agreement was reached between the French government and concessionaires to finance motorway works through an extension of the length of the concession. The state of French motorways is generally considered as being very good and the concessions are set so that it is in the best interest of the operator to maintain the road to a high standard.

6 Data available on French Finance Ministry's website.
7 Source: Report from Cour des Comptes.

2.3.3 National vs. regional vs. urban vs. local roads

The national road network is now 21,000km long, 11,500km of which are motorways and 8,500km of these are operated under a concession with the rest being publically operated. The remaining 9,500 are national roads. Counties are responsible for 378,000km of roads and local authorities manage 655,000km of roads. Each authority allocates different resources to road maintenance and, as a result, there is little, centralised, understanding of the state of local roads.

Figure 10: Road maintenance expenditure – Highways Agency and Local Authorities



Source: French Ministère des Transports (2013).

2.4 Road performance monitoring

2.4.1 Responsibilities for road maintenance

The table below sets out the various responsibilities within the road sector in France following devolution.

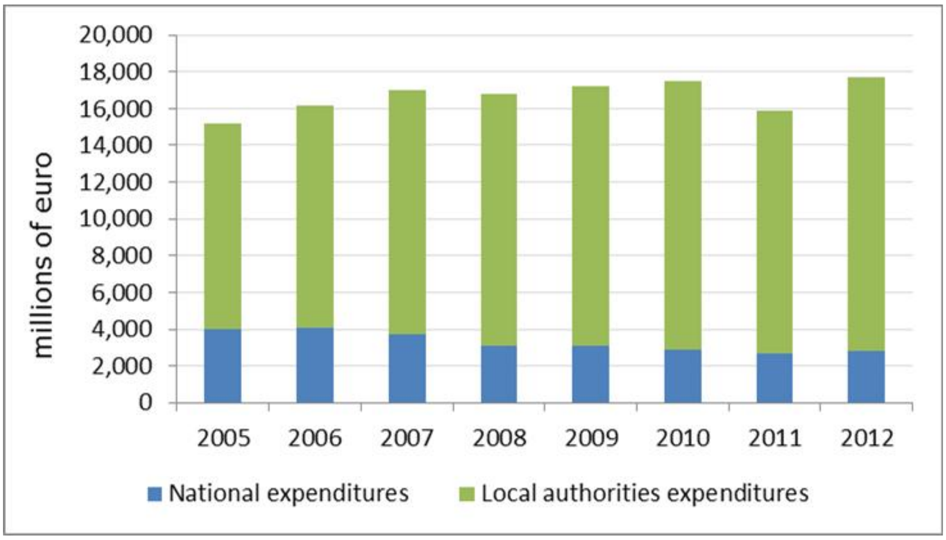
Table 1: Governance of French roads

	Public Authority in charge	Decision Maker	Builders and road manager
Motorway under concession	State	French Ministry of Transport	Concessionaires
State operated motorways and National roads	State	French Ministry of Transport	Inter-Department Road Services
Department roads	Department	Department Public Authority	Engineering services of the Department
City roads	Council	City Council	Engineering services of the City

Devolution has also led to a “brain drain” in the sector with many competencies passing to the private sector and no longer being affordable for local authorities.

The figure below shows the difference between spending from local authorities and those where the source is national funds. As it can be observed, devolution has a very important financial impact for counties and cities.

Figure 11: Split between source spendings



Source: Union Routière Francaise, DGFiP (French Finance Ministry) et SOeS.

2.4.2 Assessment of road surface quality

Assessment of road quality is carried out through the use of sophisticated tools which then provide information that feed into the calculation of two main indicators[8] that are used to observe the quality of road infrastructure on the national network: IQRN and IQOA (described below) which assess the quality of the road on an annual basis. While the IQRD covers the departemental network, it is less effective and more expensive to operate. There are no such indicators in place for local authorities. The 2012 figures show that the French road network is still of high quality although there is a downward trend in the scores of the indicators. There has been an 8% fall (compared to 2011) in the amount of roadway in “very good” condition (grade > 17/20) and an 18%[9] increase in the amount of roadway with “average” condition (12> grade> 17). Only in the bridges and tunnels category has there been an improvement in the scores in 2012.

In order to set up such indicators, road paths need to be regularly probed. Companies such as Technologies Nouvelles in France (similar to others in France and the EU) have developed specific products, such as special trucks equipped with SHWD (Super Heavy Weight Deflectometer) technology, which provide a large quantity of data. Other tools can be used for specific purposes such as Evalis for damage and deformation, Lacroix for deflection or tools measuring the longitudinal evenness or the pavement structure.

8 Report Mobilité 21, Evaluation of National Scheme on Transportation Infrastructure.
9 Report on annual performance regarding program 203 on infrastructure and transportation services.

2.4.3 Scheduling and best practice in maintenance interventions

The general approach to road maintenance in France involves carrying out maintenance in a three-year cycle. Some Counties however are differentiating their maintenance regimes based on the different usage patterns of their respective road networks. This is necessary given the size of the French network and is also being accompanied by a trend towards less detailed but faster and cheaper tools to facilitate monitoring. Some authorities are also considering the introduction of smart road and vehicle technologies to optimise maintenance. Devolution has also meant that maintenance planning has also diversified and studies are underway seeking to reverse this trend and identify appropriate methodologies to ensure appropriate maintenance planning. USIRF is also planning to create a catalogue of global costs of each maintenance procedure and its life cycle cost to facilitate in the maintenance planning process.

The required maintenance expenditure is likely to rise in the future as public authorities cut back on current expenditure at this time. The cost of such a strategy appears to be lower in the long term. This is to be accompanied by modifications to the road path in order to reduce the need for maintenance. USIRF is planning to publish an independent review of existing solutions to help public authorities to make informed decisions on the matter.

Stakeholders such as the FFMC (Fédération Francaise des Motards en Colère), member of FEMA (Federation of European Motorcycles Association), have engaged in discussions with road authorities to highlight their specific needs with respect to maintenance interventions. They expressed concerns both in relation to the way surface quality is assessed (being biased towards cars) and the way interventions are scheduled which they believe do not taking into account specific seasonal effects.

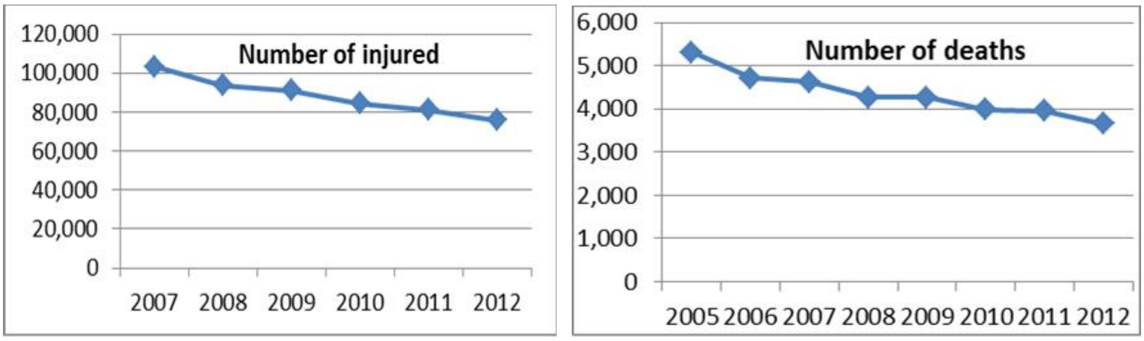
2.5 Socio-economic impacts of road maintenance

The impact of road maintenance on road safety has not been identified in France. However, some weak signals are appearing and the Union des Routes de France should investigate this in more depth in 2014. Indeed an increase in windshield breakages has been identified in recent years. Organisations such as the Union Routière de France is planning to investigate this issue in 2014 to assess the probability of insurance firms increasing their premiums. There has also been a relative increase in the number of deaths on departement roads versus national ones (+14% in 10 years). Even though the cause of most incidents is registered as “human” in most police reports, this imbalance shows that either the infrastructure on national roads is getting better or the departement roads are getting worst. In addition, 66% of deaths on French roads happen on departement roads while only 34% of injuries occur there, illustrating that the accidents are often more severe. This can be explained by the presence of many obstacles at the side of the road or by the specific technical characteristics of the road (signs, poor shaped road shoulders, traffic intersection, double-direction road path, etc.).

We have not been able to identify any studies conducted on the potential link between infrastructure characteristics and road safety and the social security budget. Stakeholders commented that public authorities do not want to commit to minimum levels of asphalt macro-texture as there is a risk a victim of aquaplaning could sue them if those measures were not respected. However, the cost of accidents for the nation has been looked at. One death is estimated to generate a cost of €1,342.072m for society. When someone has to go to the hospital for 24+ hours, the cost is €143,787 and €5,752 in case of light injuries.

Property damage is estimated to €6,778. Those figures do not include property only accidents which generate a global cost of €12,5 bil. annually. In 2012, 76,000 people were injured on French roads and 3,650 died.

Figure 12: Number of injured and death on French roads



Infrastructure is rarely the cause but can be a contributing factor to the accident. For example, inappropriate carriageway separation can lead to dangerous overtaking manoeuvres and ultimately head-on collisions.

Finally a report from the Centre Analyse Stratégique (a public organisation attached to French Prime Minister) on France's attractiveness and competitiveness asserted that the decision of foreign companies to locate on French territories was related to three main advantages. Those are mainly the well skilled manpower, the communication infrastructure (thin and high quality mesh of Internet) and the density and state of transportation infrastructures. If this last point should reduce, IDRRIM is afraid that France's competitiveness would be strongly affected.

2.6 Summary for France

A devolution process has recently occurred in France and this has deeply modified the structure and governance of road maintenance. Counties and cities are now responsible for the vast majority of the French network but even if quality indicators show that they are doing well, it seems the global cost is higher than in the previous situation.

The general quality of roads in France is quite high but some weak signals of potential drops are appearing following a decrease in maintenance budgets.

The infrastructure sector is still adapting to the consequences of devolution and maintenance processes are currently under review in order to provide better value for money at a time where public funding is decreasing. Governance will also evolve and sections of the network will be prioritized to that end.

France has not measured service quality as other Member States have done in the past, but both government and user unions show a high satisfaction with road quality. Transportation infrastructure is key for French competitiveness as many reports have shown.

3. CASE STUDY GERMANY

3.1 Member State Overview

The total road network of Germany is 650,000 km long, of which 13,000 km are motorways. Car ownership in Germany is 525 passenger cars per 1000 inhabitants. This figure has increased steadily in the period 2001-2011; the percentage increase has been 9.8% (Eurostat).

3.2 Road safety statistics

In 2011, 4,009 fatalities were recorded on German roads, which is a 43% decrease from its 2001 level. In comparison with other EU27 countries, Germany performs relatively well when its road safety record is evaluated in proportion to its population. In terms of fatalities per million inhabitants, Germany's 49 is better than the EU27 average of 60. Germany scores 44 fatalities per 10 billion passenger kilometres (better than the EU average of 61), whilst its figure of 94 fatalities per million passenger cars is notably less than the EU average of 126. German roads had 306,300 accidents resulting in personal injury in 2011, which represents a 18.4% decrease on the same figure recorded in 2001 (Eurostat and OECD).

3.3 Maintenance budgets analysis

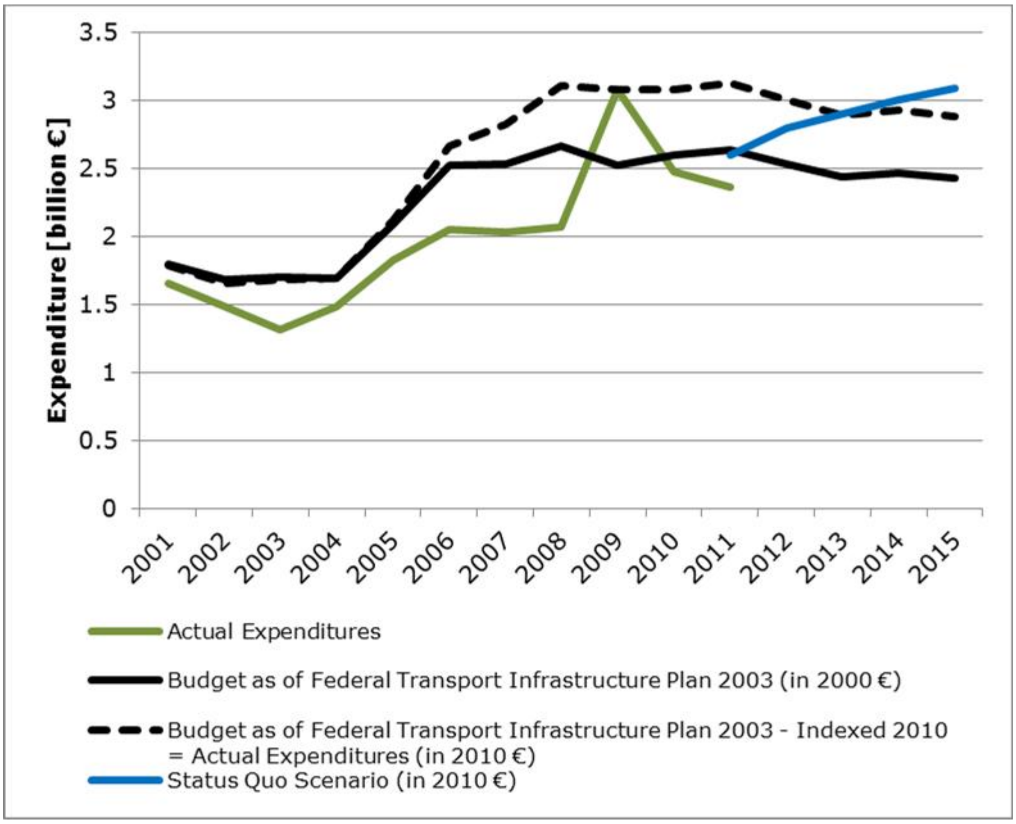
3.3.1 Road infrastructure and maintenance spending for federal roads in Germany

Germany has one of the largest and densest national (federal) road networks in Europe. The federal roads network in Germany represents a considerable economic capital stock with gross fixed assets of around € 196 billion. This is equivalent to approximately one per cent of the gross fixed assets of all economic sectors in Germany.

All federal transport infrastructure investment projects are included in the national infrastructure plan (Bundesverkehrswegeplan) which ensures a coordinated approach towards the realization of new infrastructure as well as maintenance and upgrading/renewal. The national infrastructure plan currently in place covers the period between 2001 and 2015.

The figure below shows the original planned spending for maintenance of the federal road network according to the current national infrastructure plan starting from a 2000 price base (black line) and the planned costs on a 2010 price basis until 2009, and from 2010 indexed to match the trend of the 2000 price basis (black dashed lined). The green line shows the actual expenditure for road maintenance until 2011. It is clear that in all years, apart from 2009, actual spending in maintenance was substantially lower than originally planned.

Figure 13: Road Infrastructure, planned and actual expenditure – National roads and motorways



Source: FGSV (2013).

However, several studies have identified a maintenance backlog from previous years. An analysis carried out by Kunert and Link (2013) reveals an investment shortfall of almost €3 billion for maintenance of the road network in Germany in the period between 2006 and 2011. Around €0.5 billion of this shortfall corresponds to the federal road network, while the remaining €2.5 billion corresponds to the road networks under the responsibility of the federal states, districts and municipalities.

Infrastructure capital investments and maintenance activities of the federal roads network are partly financed by toll income from heavy vehicles, which has been in place since 2005. After accounting for the operating costs of the toll system, all of its income is used for investments in transport infrastructure.

In contrast to other European countries, expenditure on maintenance of the national road network in Germany increased notably since the start of the financial crisis in 2009. This was mainly due to two economic stimulus packages in these years to mitigate the impacts of the economic downturn in Germany. The first economic stimulus package provided an additional €2 billion for investments in the federal transport networks (road, rail and waterways). The same amount was spent under the second stimulus package in the period 2010-2011. €910 million of a total of €2 billion under the second stimulus package were spent on the federal roads network, of which €450 million were dedicated to maintenance activities.

Since 2005, the national policy for the road network is one of ‘maintenance before extension’, which has led to the increase in road maintenance expenditure.

The Federal Government estimated that it requires annual spending of more than €3 billion in order to maintain the condition of the federal road network at its current level. The reason for this increased spending is mainly as a result of an increase in maintenance costs and increased maintenance needs due to an unexpectedly high increase in heavy traffic on this network. Table 2 sets out the planned governmental spending for the maintenance of the federal road network in the coming years.

Table 2: Planned expenditure for maintenance of the federal roads network (billion €)

2013	2014	2015	2016
2.5	2.6	2.7	2.8

Source: German Bundestag (2013b).

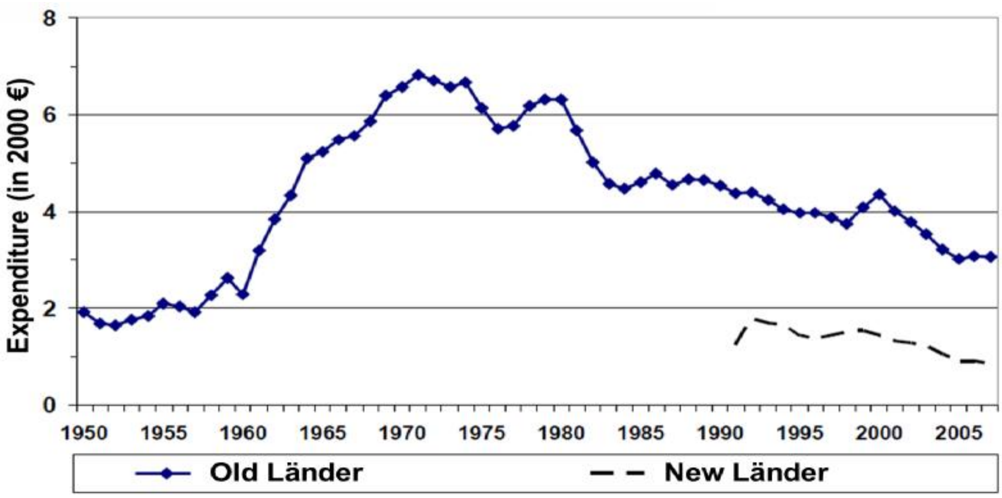
The draft of the new National Infrastructure Plan allocates the highest priority to the maintenance of the existing network. Funds for network extensions and elimination of bottlenecks will therefore only be released after financing of maintenance activities is sufficient.

3.3.2 Road infrastructure and maintenance spending for local roads in Germany

Figure 14 below shows the evolution of investment in road infrastructure by local authorities (municipalities) since the 1950s (adjusted by inflation). Since the early 1980s there has been a continuous decrease in spending in the Old Länder. This is similar to the evolution in the New Länder since the early 1990s. As network length has remained broadly the same, it can be assumed that municipalities have been gradually spending less on the maintenance of their road networks.

In this context, ADAC (2011) reports that a large-scale survey involving local authorities revealed that seven out of ten municipalities have a significant backlog in road investment.

Figure 14: Investments in road infrastructure by municipalities



Source: Difu (2008).

3.4 Road performance monitoring

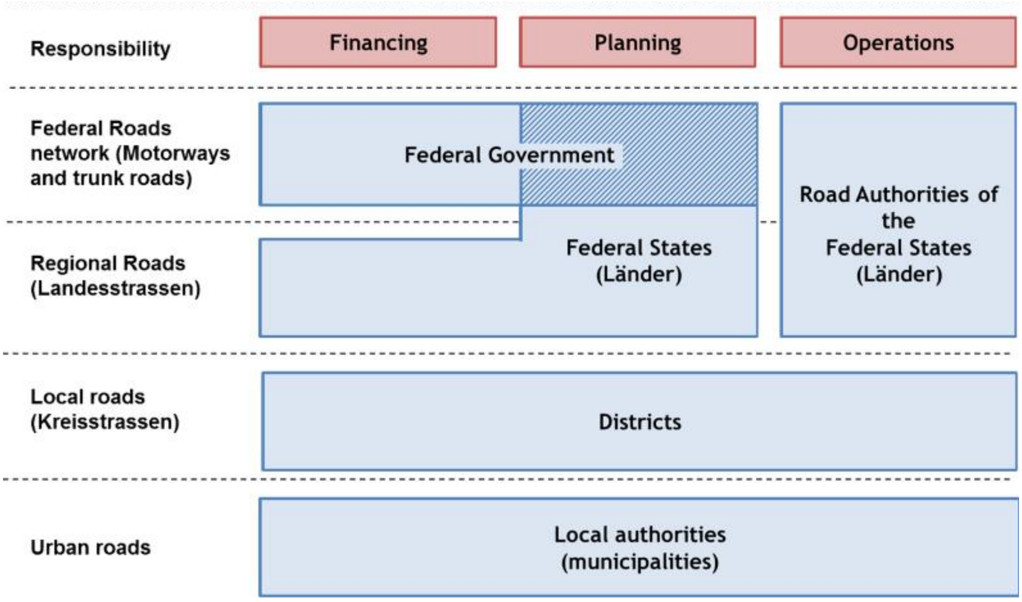
3.4.1 Responsibilities

Responsibility for road maintenance in Germany depends on the road type. Roads in Germany are classified into four categories:

- Federal Roads (Autobahn and Bundesstrassen);
- State Roads (Landesstrassen and Staatsstrassen);
- District Roads (Kreisstrassen); and
- Urban Roads (Kommunalstrassen)

The Federal Government is responsible for financing, planning and operating the Federal Roads Network. However, most tasks are delegated to the Federal States (Länder) who carry out these activities. Districts are responsible for their District Road Networks, and municipalities are responsible for Urban Roads.[10] The following figure gives an overview of the responsibilities over road maintenance by the different road types.

Figure 15: Responsibility over road maintenance by road type



Source: SDG illustration.

3.4.2 Assessment of road surface quality

The condition of roads in Germany is assessed regularly, federal roads in four-year intervals, state and district roads generally in intervals of five years (however this is dependent on the decisions of the respective road authorities). There is no consistent assessment for urban roads, as these are under the responsibility of the municipalities.

Road Monitoring and Assessment (ZEB) is carried out by means of fast driving monitoring systems and comprises four different types of analysis (known as sub-projects). In each of the first three sub-projects, different operational characteristics of the surface are recorded and subsequently analysed and assessed within the fourth sub-project. The monitoring vehicles are designed for use in moving traffic, in addition to the recording activities, administrative data is also recorded (e.g. GPS coordinates) to assign the characteristics to the respective road sections.

The following operational characteristic of the road are recorded:

- Longitudinal and transverse profile (sub-project 1)
- Skid resistance (sub-project 2), and
- Road pavement condition based on cracks and defects etc. (sub-project 3).

Figure 16 below shows, on the left, an example of a vehicle used for measuring the longitudinal and traverse profile of the road surface by means of modern laser technology. On the right, the same figure shows a detailed image of a measuring wheel used for recording the skid resistance of the road surface.

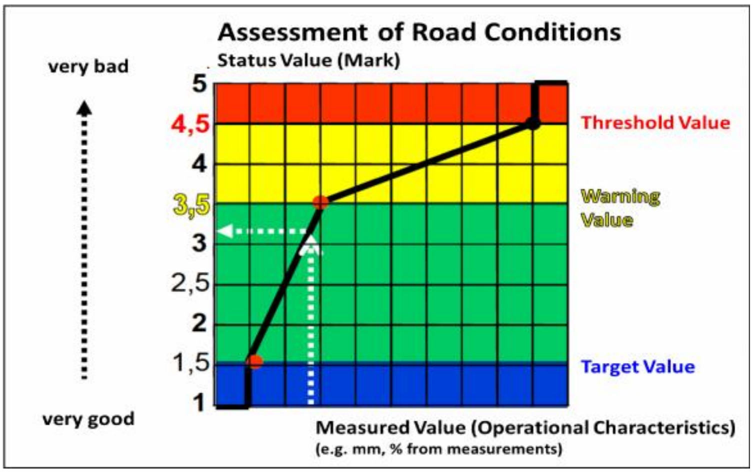
Figure 16: Exemplary images of vehicles and technology used for recording of operational characteristics

Source: Government of Rheinland-Pfalz (2013).

The identified values are then assigned to the respective road sections and converted into dimensionless status values from 1.0 (very good) to 5.0 (very bad). The figure below shows an example of this process.

[10] http://www.forschungsinformationssystem.de/servlet/is/414893/

Figure 17: Presentation of a normalisation function to convert operational characteristics into dimensionless status values



Source: SDG modification of Government of Rheinland-Pfalz (2013).

These values are then combined to sub-target values indicating the degree of usability and the degree of deterioration of the pavement of the road section according to set rules. These sub-target values are subsequently merged into one total value. The resulting total values for road surface quality are grouped into four categories (very good, acceptable, bad, very bad) where:

- Total Value 1 to 1,5 = very good
- Total Value 1,5 to 3,5 = acceptable
- Total Value 3,5 to 4,5 = bad
- Total Value 4,5 to 5 = very bad

The results can be displayed on maps and are used by the road authorities of the federal states as a basis for the planning of their road maintenance activities as well as a basis for their investment and construction planning.

A study by the German Institute for Economic Research (DIW)[11] claims that the degree of maintenance of the road infrastructure has substantially deteriorated over time. The results from the ZEB 2011 show that around 20% of the motorway network and 41% of the remaining federal roads network are already beyond the warning value of 3.5. This means that these sections are in a bad or very bad condition. In addition, 46 per cent of bridges on the motorway network are classified worse than the applicable warning value for bridges of 2.5.

According to the transport investment report issued by the Federal Government (2013), the reasons for this deterioration are: increased prices for road maintenance, an unexpectedly high increase in heavy traffic, as well as an increased number of excessive and special load transports.

The German Institute for Urban Studies (2013) claims that the condition of road bridges in Germany is deteriorating. The main reasons given for this are a substantial increase in heavy traffic, deterioration resulting from the previous application of road salt, acid rain,

[11] Kunert, U. and Link, H. (2013) Verkehrsinfrastruktur: Substanzerhaltung erfordert deutlich höhere Investitionen, in: DIW weekly issue 26/2013.

the construction boom between the 1960s and 1980s, and a lack of maintenance activities particularly of bridges under the responsibility of municipalities. The construction boom between the 1960s and the 1980s implies that many bridges are now reaching a critical age in which they have to be replaced or fully renewed.

To estimate the condition of bridges on the urban road network, the German Institute for Urban Studies carried out an extensive study in which they consulted with more than 500 municipalities. They found that around 50% of bridges under the responsibility of municipalities are in poor condition (classified worse than the warning value of 2.5).

The deterioration of the road network under the responsibility of the municipalities is in many places apparent, but there are no official statistics due to a lack of consistent data collection and documentation.

3.4.3 Maintenance intervention

In 1999, a Pavement management System (PMS) was implemented in Germany. Since then the tool has proved to be successful in monitoring the state of the network, and is now used in nearly all federal states to support the maintenance planning process. The PMS is able to estimate the condition of the road pavement for individual sections of the network based on measured input data and empirically observed long-term road surface condition. The PMS elaborates the data provided by the ZEB, which only provides a snapshot of the current state of the road condition, and provides an estimate of the evolution of the condition of the road network. It also allows for the maintenance programme to be optimised according to the various conditions.

The German PMS has been set up in 8 different modules which can be improved individually without affecting the overall functionality of the PMS. These modules are:

- In the first module, road areas with similar quality are combined into larger, homogeneous sections.
- The second module selects the sections that need to be maintained.
- The third module analyses faults and the causes of faults.
- The fourth module provides a prediction of the changes in road condition.
- The fifth module provides suggestions for structurally feasible maintenance measures.
- The sixth module calculates the effectiveness of these measures and provides a ranking of the various alternatives.
- The seventh module optimises the alternatives given budget restrictions.
- The eighth module provides a suggestion for an optimised maintenance programme.

3.4.4 Good practice in maintenance activities by municipalities

Municipalities have sought innovative approaches to improve the condition of the roads and decrease spending on maintenance activities. The municipality of Hamburg, for example, implemented a maintenance process using 100% recycled asphalt. On selected road sections, each layer of asphalt is milled off separately and subsequently regenerated by adding substances that reactivate the aged bitumen. The regenerated asphalt is then reapplied to the respective road section. According to most recent observations, the material has the same level of quality as newly produced asphalt, but is accompanied by a cost reduction in the order of 30%.

The maintenance approach used in Rednitzhembach, a municipality with a population of 7,000, proved that road maintenance does not need to impact the municipal budget. In 1996, the municipality, which then was one of the most indebted in Germany, stopped filling individual potholes. Instead, 42km of the municipality's road network were progressively resurfaced through a process where only a few centimetres of the road surface are milled off and later applied again. This approach has been effective, contrary to expectations. With this strategy, Rednitzhembach saved a substantial amount of money assisting in the cancellation of its debt.

3.5 Socio-economic impacts of road maintenance

3.5.1 Operating efficiency

The ADAC (2011) claims that the condition of the German road network is gradually worsening. They state that apart from this giving a poor picture, poor infrastructure is also dangerous and brings macroeconomic harm. A lack of road maintenance can result in an increased number of accidents, increased vehicle wear and tear as well as delays due to hampered traffic flow. The ADAC estimated these macroeconomic impacts costs equate to 4% of the German GDP.

The Friedrich Ebert Foundation reports that the condition of the state road network in the German region of Hesse and the amount of spending on maintenance activities has been criticised by industry associations. Due to the poor condition of the road surface, a speed limit was applied to 520km of state road network (out of a total of 7,200km) in 2005. In addition 330 out of 1,950 bridges were closed to heavy vehicles. Due to the poor condition of the road network, truck trips need to be rerouted leading to increased costs for the affected companies.

3.5.2 Impacts on public spending

Socio-economic benefits of investment in road infrastructure can be estimated by means of a cost benefit analysis. This type of analysis has the advantage of also incorporating benefits that do not feed into GDP calculations, e.g. environmental impacts, noise, and other non-monetary costs. Based on the cost-benefit ratios of 1,300 projects listed in the national infrastructure plan, Armbrecht and Hartwig (2005) estimated an annual average net benefit of €173 million over a period of 30 years for each €1 billion of investment in federal road infrastructure.

The ADAC (2013) and the German Institute for Urban Studies (2013) claim that the lack of maintenance spending of municipalities is partly due to the poor financial state of many municipalities. Recent changes in legislation implied that the financial burden on municipalities increased substantially. Only between 2000 and 2010, social spending by municipalities increased by approximately 60%. While up to 2008, municipalities in Germany achieved an overall budget surplus, with €7.7 billion in 2008, this has turned into a substantial deficit of almost €8.9 billion in 2010. However, recent data suggests that in 2011, due to the economic upturn, this budget deficit has been diminished to only €2.9 billion.

In 2007, the Green Party in the German Parliament published a study[12] arguing that there is no empirical evidence for a positive impact on the regional economy and the substantial investments in the extension of the road infrastructure that took place in the New Länder. In response to this study, Pro Mobilität commissioned the Technical University of Berlin and IGES to find further evidence for a link between capital investments in roads and regional economic impacts. Their study[13] found that a positive link between investments in road infrastructure and growth of the local economy can be well described in theory. However, they further concluded that there is no clear evidence on the actual magnitude of this positive impact and the possible spatial distribution of such effects.

3.6 Summary for Germany

Road infrastructure in Germany is generally in a good condition, however, evidence suggests that it has deteriorated in recent years. The reason for this is mainly seen in an increased number of heavy vehicle trips over the period. In addition, the condition of federal roads is notably better than that of state, district or urban roads. Particularly, municipalities suffer from a lack of financial resources and, as a result, this is also the case for urban roads which are operated and maintained under their responsibility.

A Pavement Management System has been put in place to optimise maintenance activities of the national, and state road networks in nearly all federal states. However, there is no consistent approach for the monitoring and assessment of local and urban road networks. However, we found that an increased number of municipalities choose innovative ways to reduce costs and improve the quality of maintenance activities.

Although in recent years, road fatalities have decreased in Germany, there is no clear evidence that this is related to improved road maintenance or a better state of the infrastructure in general. The decrease in fatalities in mainly explained by, as in most other European countries, an increase in vehicle safety and an increased awareness of safety issues.

[12] Bundestagsfraktion Bündnis 90/Die Grünen (2007) Jobmaschine Straßenbau?
[13] Pro Mobilität (2008) Regionale Effekte durch Straßenbau-Investitionen.

4. CASE STUDY IRELAND

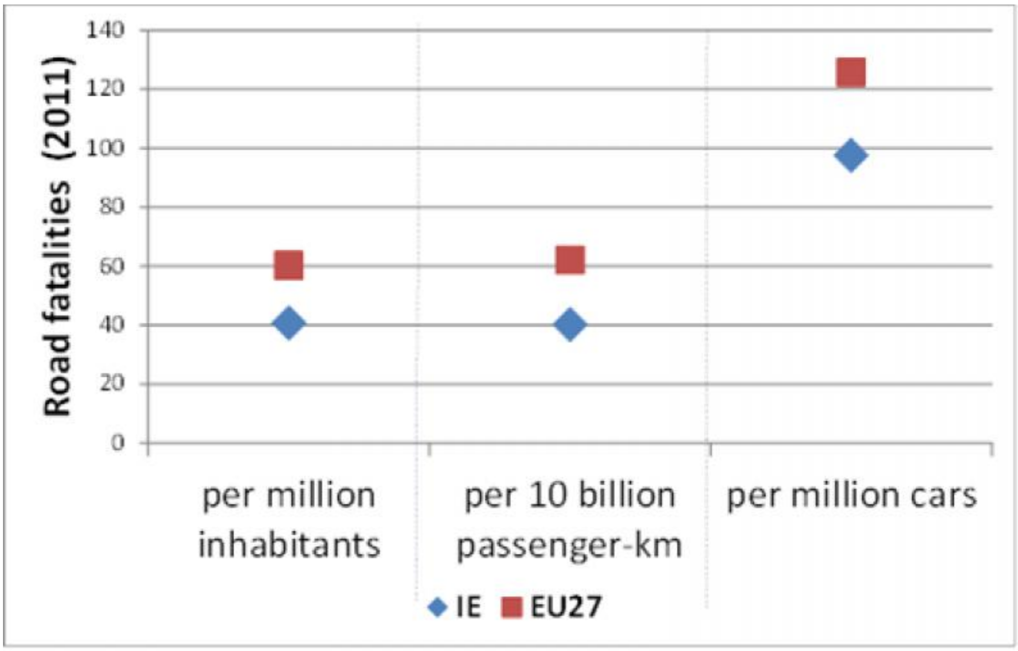
4.1 Member State Overview

Ireland's total road network is 96,000 km long, one of the densest in Europe. The national road network is comprised of 5,515km, consisting of 1,187km of motorway and 4,328km of primary and secondary roads. The national road network carries approximately 45% of all road traffic. Ireland currently has a level of car ownership of 417 passenger cars per 1000 inhabitants, a figure which has increased in the period 2001-2011 – by 16.2% (Eurostat).

4.2 Road safety statistics

In 2011, Ireland recorded 186 fatalities on its roads, which is a 55% decrease from its 2001 level. When Ireland's road safety is judged in proportion to its population, Ireland scores rather better than the EU27 average. In terms of fatalities per million inhabitants, Ireland's 41 is better than the EU27 average of 60. Ireland noted 40 fatalities per 10 billion passenger kilometres (better than the EU average of 61), whilst its figure of 98 fatalities per million passenger cars is notably less than the EU average of 126. Irish roads saw 5,200 accidents resulting in personal injury in 2011, which represents a 24.3% decrease on the same figure recorded in 2001 (Eurostat and OECD).
2013 saw a slight increase in the number of fatalities, 189 in total, leading to concerns regarding the effect of the economic crisis on the enforcement of road safety measures in Ireland.

Figure 18: Road fatalities ratios – IE and EU27 (2011)



Source: Eurostat.

The Road Safety Authority's (RSA) Strategy for 2013 – 2020 sets a target of 25 road collision fatalities per million population or less, equivalent to 124 deaths or less in absolute terms, to close the gap between Ireland and the safest countries. The Strategy has also set an objective of a reduction of 30% in serious injuries to less than 330 by 2020 or 61 per million population. The Strategy's Action Plan centres on four pillars to help achieve these goals which are listed in Table 3 below.

Table 3: Road Safety Authority Strategy 2013-2020

Pillar	
Education	Targeted safety campaigns in schools
	Safety campaigns within wider society
	Training scheme for vocational drivers
Enforcement	Driver testing and licensing
	Road haulage industry
	Testing regimes for motor vehicles
Engineering	Contribute to EU Rules on vehicle standards
	Assist National Roads Authority with road design
Evaluation data and research	Road safety research
	Measuring effectives of road safety initiatives

Source: Road Safety Authority.

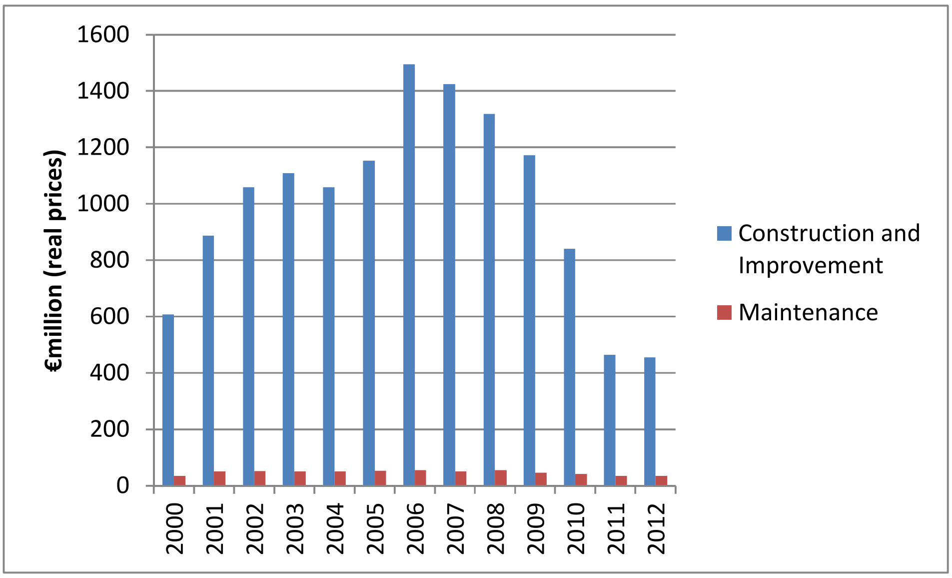
4.3 Maintenance budgets analysis

4.3.1 Road infrastructure and maintenance spending in Ireland

Over the last fifteen years, Ireland has witnessed the biggest infrastructure expenditure in its history. A significant proportion of this investment has been spent on transport infrastructure and specifically on the construction of an inter-urban motorway network radiating from its capital city Dublin, to the cities of Waterford, Cork, Limerick, Galway and to the border with Northern Ireland serving Belfast. The road network has been transformed from having virtually no roads of motorway standard to over 1200km today. Many of the national primary and secondary routes have also seen improvements with many new bypasses built and upgrades undertaken. The Exchequer provided over €13billion of the finance used on the national road network between 2000 and 2010.

Figure 19 below details the Exchequer's investment in national roads including motorways since 2004.

Figure 19: National Road Expenditure 2000 – 2012



Source: SDG Analysis of NRA Annual Reports.

The figure above does not include payments to Public Private Partnership operators which are discussed later. It is evident from the figure that maintenance spending on the national road network was minimal during this period in comparison to the capital expenditure. This demonstrates the extent to which existing national roads were either replaced with motorways or improved with upgrade works. It is also evident from the figure that the economic crisis that has hit Ireland in 2008-2009 has led to a steep decline in infrastructure spending since.

Since September 2009, the National Roads Authority (NRA) has been tasked with the administration of the allocation of Government funding for the majority of road expenditure including regional and local roads. Prior to this, the NRA had responsibility for the national road network only. National roads funding is provided by the Department of Transport, Tourism and Sport (DTTaS) to the NRA, who then uses the Local Authorities as its agents for the undertaking of works on these roads. Regional and local road grants originate in the Local Government Fund. Up to 2008, the Fund was the responsibility of the Department of Environment, Community and Local Government. It was then transferred to the DTTaS who in turn transferred the responsibility to the NRA. Responsibility for the motorway network's maintenance, renewal and operational activities has lied directly with the NRA since 2012.

Until 2011, income from Motor Tax and an Exchequer contribution were the main sources of funding for the Local Government Fund. This Fund enables Local Authorities to carry out their day to day activities as well as financing the expenditure on regional and local roads. The Exchequer contribution was replaced by the income of a newly introduced Household Charge for all residential property owners in 2012. The Comptroller and Auditor General's Annual Report for 2012 stated that the Exchequer Contribution decreased from an average of €500million annually between 2007 and 2009 to €175million in 2011, revealing the extent of the strain on public finances during that period.

Ireland's infrastructure investment received a significant amount of financing from the European Union. Ireland received over €1billion from the following EU funds between 2000 and 2010:

- European Regional Development Fund (ERDF) – Over seventy national road projects received funding from the ERDF due to Ireland's peripheral location within the EU

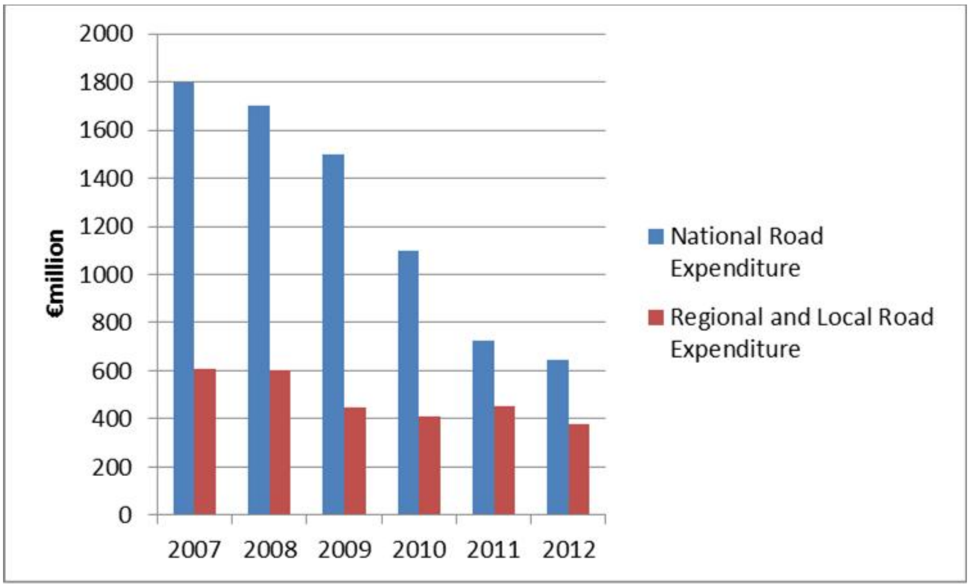
- Cohesion Fund - Ireland qualified for Cohesion funding until the GDP threshold was reached in 2006

- Other Funding:
  - Trans European Transport Network funding
  - INTERREG IIIA supporting cross border cooperation, social cohesion and economic development between the border counties of the Republic of Ireland and Northern Ireland
  - Border, Midlands and Western Regional Operational Programme

Since 2010, ten road infrastructure Public Private Partnership (PPP) schemes have been completed. These were the first road PPPs in Ireland and over €2billion of their financing came from private sources. Under a long term contract, the PPP entity generally constructs, operates and maintains the infrastructure while receiving a combination of direct payments from the NRA and toll revenue. Under these contracts, the NRA can receive a proportion of the toll revenue if usage exceeds a value defined in the contracts. More recently, there has been media attention on the fact that the NRA has had to make extra payments to some PPP entities as road usage has been below expectations[14].

Figure 20 below presents total road expenditure including maintenance between 2007 and 2012. While expenditure on national roads declined by over 64% in this period, spending on regional and local roads decreased less dramatically by approximately 38%.

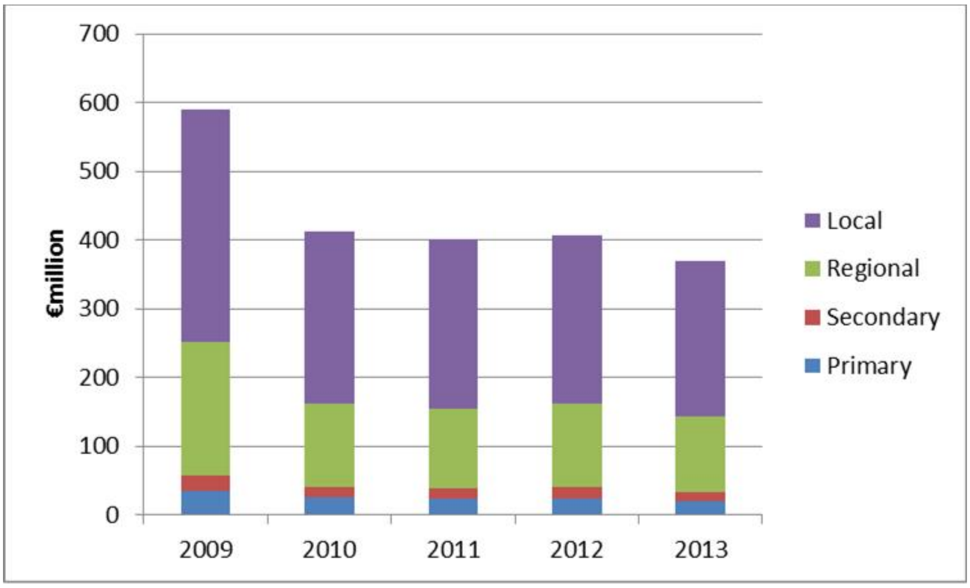
Figure 20: Road Expenditure 2007 – 2012



Source: SDG Analysis of DTTaS Annual Reports.

Local Authority Budgets between 2009 and 2013 provide a breakdown of maintenance and improvement expenditure for the different road types, as demonstrated in Figure 21. Previous reports do not provide a similar breakdown. It is evident that there has been a significant reduction in maintenance expenditure due to both a reduction in the amount of maintenance work undertaken and also likely due to pay cuts and a reduction in staff numbers.

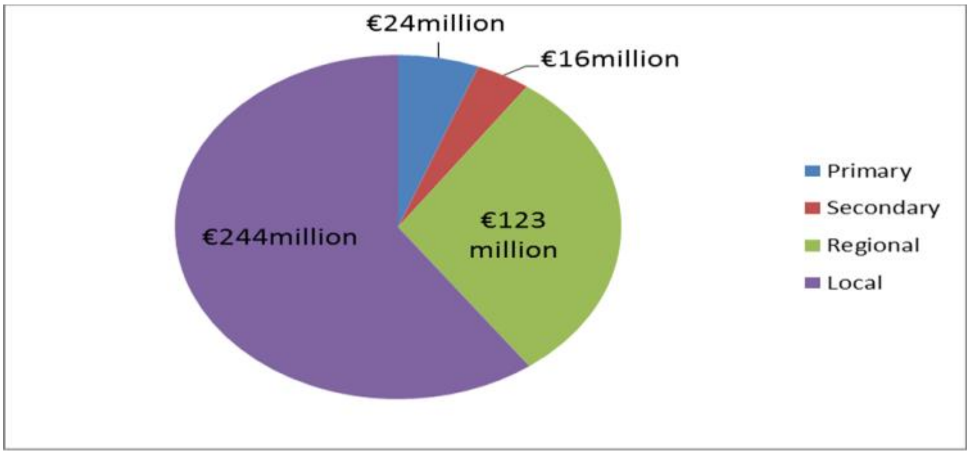
Figure 21: Local Authority Maintenance and Improvement Works 2009 – 2013



Source: SDG Analysis of Annual Local Authority Budgets.

While the total amount of the Local Government Fund has reduced, the proportion of expenditure on each road type has stayed approximately the same, with over 90% spent on regional and local roads. Figure 22 displays this split for the 2013 budget. No breakdown is provided between maintenance and improvement works costs. Pavement strengthening, lining, signing and safety schemes are all considered to be improvement works. A briefing paper for the Oireachtas Committee of Public Accounts provided a 73%/27% split between improvement and maintenance works respectively.[15]

Figure 22: Local Authority Maintenance and Improvement Works Breakdown 2009-2013



Source: SDG Analysis of Annual Local Authority Budgets.

[14] http://www.irishtimes.com/news/politics/underused-toll-roads-could-cost-taxpayer-30m-1.1485661
[15] Oireachtas Committee of Public Accounts (10th of May 2012) – Briefing Paper: National Roads Authority Accounts 2010.

4.3.2 Road maintenance budget outlook

Although the inter-urban motorway network has been completed, the financial crisis in Ireland has put many other road infrastructure projects on hold. Substantial cuts have been made to the public service workforce with the NRA losing over 40% of its staff in recent years. Despite Ireland's recent extremely difficult economic circumstances, the Irish Government has committed to continue to invest in road maintenance and in particular maintaining the national road network which it views as a legacy of the economic boom period.

The Infrastructure and Capital Investment 2012-2016 Capital Spending Programme stated 'amongst the main priorities over the medium term will be ensuring adequate maintenance of the national road network in order to protect the value of previous investments and target the improvement of specific road segments where there is a clear economic justification'.

The road expenditure outlook as agreed in 2011 is detailed in Table 4. The figures do include some close-out payments relating to the completion of the motorway network, most notably in 2012 and 2013. The Government has allocated the majority of funding to road maintenance projects however, with over 85% of funding for regional and local roads to be spent on maintenance and rehabilitation work.

Table 4: Roads Exchequer Investment 2012-2016

€million	2012	2013	2014	2015	2016	Total
National	605	278	288	253	252	1,676
Regional & Local	285	250	240	240	240	1,255
Total	890	528	528	493	492	2,931

Source: Infrastructure and Capital Investment 2012-16: Medium Term Exchequer Framework.

The NRA has estimated the replacement cost of the network to be in the region of €30 billion. With a twenty to thirty year life-cycle cost, the network's maintenance cost averages at €1 - €1.5 billion per year and would deteriorate to the extent of €1 - €1.5 billion per year with no maintenance budget.[16] In light of this, the NRA set out three priorities for road infrastructure investment in 2011:

- Asset Management, Network Rehabilitation and Network Operations
- National Secondary Roads Improvements, Bottleneck Improvement Projects, Safety Projects and Traffic Management Projects
- Major Improvement Projects

[16] Oireachtas Committee of Public Accounts (7th of February 2013) – Statement by Mr. Fred Barry, CEO National Roads Authority.

The NRA reported in mid-2013 that it would not be able to make essential repairs on main roads due to further budget cuts but stated that it saw no safety implications for 2013.[17]

4.4 Road performance monitoring

4.4.1 Responsibilities for road maintenance

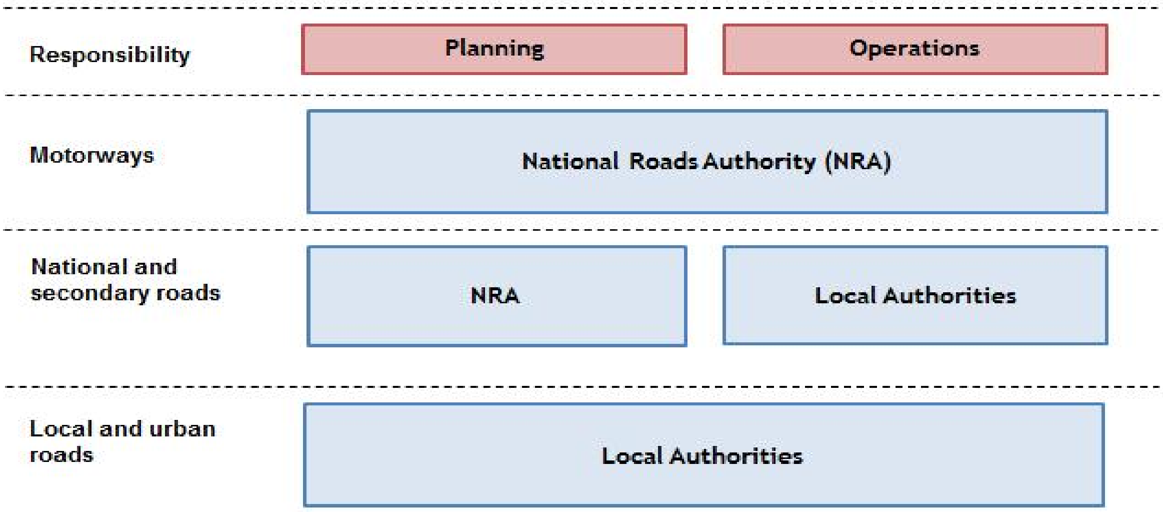
As explained, the National Roads Authority (NRA) under the Roads Act (1993 to 2007) channels expenditure through Local Authorities for all road maintenance except for that on motorways and dual carriageways. The NRA has taken direct responsibility for renewal and operational activities on the motorway/dual carriageway network. While the Local Authorities carry out the maintenance work on the national road network, the NRA has overall responsibility for management of the network including operation, maintenance, renewal and improvement. The national network ranges from primary roads that conform with the latest design standards to coastal national secondary routes which are legacy low-volume routes. Since its establishment in 1993, the NRA has evolved from an entity responsible for the development of a new road network to one of management, maintenance and operation.

Regarding regional and local roads, the NRA carries out certain management and administration obligations along with the allocation of the Local Government Fund. These include:

- Monitoring the progress of the Local Authority Work Programmes and undertaking routine scheme inspections
- Providing technical assistance.

Figure 23 below outlines the responsibilities in respect of each road type.

Figure 23: Responsibility over road maintenance by road type



Source: SDG illustration.

[17] http://www.irishtimes.com/news/politics/oireachtas/nra-unable-to-make-road-surface-repairs-due-to-cuts-1.1466282

Finally, with respect to the new arrangement for the maintenance of motorways, the NRA has divided the motorway network into three regions including PPP sections. The maintenance for each region has been let out on a multi-annual contract.

4.4.2 Assessment of road surface quality

The NRA has carried out annual surveys of the entire national road network, since 2010. Historical data dates back to the 1990s. The most recent survey of regional roads was carried out in 2011, when over 13,000km were surveyed. This data enables the NRA and Local Authorities to prioritise maintenance for their work programmes. Regional road surveys were also carried out in 1996 and 2004. Local roads have not been surveyed as it is not considered to be cost effective. The pavement condition surveys record the following parameters:

- Skid resistance (SCRIM)
- Texture (Macro (MPD) and Micro (SC))
- Ride quality (IRI)
- Rutting (Rut Depth)
- Geometrics
- Visual Condition Rating (Regional survey only)

These parameters were reported for every 100 metre sample unit on the entire regional road network. Two types of vehicles are used; a SCRIM machine and a Road Surface Profiler (RSP). The ride quality index (IRI) decreased from 5.5mm/m to 4.2mm/m between the 2004 and 2011 surveys.

Local Authorities also carry out inspections by driving the routes. The NRA has recently developed an app that allows Local Authorities to upload this data to a central system.
There is no statutory obligation on the NRA or Local Authorities to salt roads in winter. Salting is carried out when the NRA and Local Authorities deem it necessary in order to reduce hazards. The most heavily trafficked roads and the national road network are given priority in these circumstances.

4.4.3 Maintenance intervention

Table 5 shows the parameter matching to intervention type. The results are entered into a mapping programme providing the Local Authorities with the necessary data to prioritise maintenance works.

Table 5: Intervention types

Intervention	Parameters
Road reconstruction	IRI > 8, Left Rut Depth >25mm, Visual Rating of 1 to 4.
Surface restoration	IRI <=8, Left Rut Depth <=25mm, Visual Rating of 5 or 6.
	IRI between 6 and 8, Visual Rating of 7 to 10.
Restoration of skid resistance	IRI <=6, Left Rut Depth <=25mm, Visual Rating of 7 or 8.
	IRI <=6, Left Rut Depth <=25mm, Visual Rating of 9 or 10, MPD <=0.6mm or SC <=0.3.
Routine maintenance	Visual Rating of 9 or 10, SC >=0.3, MPR >0.6mm.

Source: PMS Pavement Management Services Ltd.[18]

The results of the 2004 and 2011 regional road surveys are presented in Table 6. The percentage length of regional road requiring each particular type of intervention is displayed. Due to a change in methodology, direct comparisons cannot be easily made.

Table 6: Pavement Condition Survey Results

Year	Road Construction	Surface Restoration	Restoration of Skid resistance	Routine Maintenance
2004	15.1%	23.7%	39.4%	21.8%
2011	23.9%	21.7%	29.6%	24.7%

Source: PMS Pavement Management Services Ltd.[19]

[18] http://www.engineersireland.ie/EngineersIreland/media/SiteMedia/groups/societies/roads-tranport/Assessing-the-Condition-of-the-Irish-Regional-Road-Network-by-Kieran-Feighan-and-Brian-Mulry-28-11-2012.pdf?ext=.pdf
[19] http://www.engineersireland.ie/EngineersIreland/media/SiteMedia/groups/societies/roads-tranport/Assessing-the-Condition-of-the-Irish-Regional-Road-Network-by-Kieran-Feighan-and-Brian-Mulry-28-11-2012.pdf?ext=.pdf

4.5 Socio-economic impacts of road maintenance

The Road Safety Authority's (RSA) annual report for 2012 mentions the need for money to be diverted to particular elements of road safety requiring attention, specifically roads policing and local road maintenance, despite the current economic climate. No specific indicators are provided. The RSA's strategy for 2013 to 2020 lists a number of actions to be taken in order to maintain the record low levels of road fatalities. This includes a requirement for Local Authorities to publish their prioritised plan on road building construction and maintenance annually.

In response to the "National Budget 2014" announcement, the Freight Transport Association Ireland stated that the continued cuts in road maintenance budgets would lead to 'a progressive deterioration in the condition of the road network, higher maintenance costs for commercial and private road users and will ultimately lead to higher costs to remedy road damage.

The NRA has highlighted that maintenance works are most effective when carried out on a continuous basis. With an annual cost of €1 - €1.5 billion as stated above, the current forecasted expenditure will lead to a shortfall of €500 million - €1 billion in road investment. The budget for capital maintenance has been halved since its peak in the late 2000s and there are concerns that the lack of investment in maintenance could reverse the benefits brought by the expenditure on roads over the last fifteen years.

4.6 Summary for Ireland

Since the establishment of the NRA in 1993, the focus of road infrastructure investment in Ireland has been on the development of the motorway network and on the improvement of the national road network. The network has been transformed with the help of private investment and EU funding. Journey times between Dublin and the other principal cities have been greatly reduced. Road safety has significantly improved, partly due to the improved road infrastructure.

It is only in recent years with harsher than usual winters and severe budget cuts that the importance of road maintenance has been brought to the public's attention. It is clear that over the coming years, the NRA will struggle to maintain the motorway and national road network to their current standards. Local Authorities will also have to carefully manage their maintenance budgets. The availability of greater and improved data should aid the relevant authority in making maintenance investment decisions.

5. CASE STUDY ITALY

5.1 Introduction

The total road network of Italy is 248,700 km long, of which 6,700 km are motorways and 69,000 km of Italy's roads are classed as municipal. Italy's current level of car ownership is approximately 610 passenger cars per 1000 inhabitants, a figure which has increased in the period 2001-2011, a percentage change of 4.6% (Eurostat).

5.2 Road Safety statistics

In 2011, Italy recorded 3,860 fatalities on its roads, which represented a 46% decrease from 2001. In terms of fatalities per million inhabitants, Italy's 64 is slightly worse than the EU27 average of 60. When referring to other indices, Italy remains around the EU27 average with 55 fatalities per 10 billion passenger kilometres (better than the EU average of 61), whilst its figure of 105 fatalities per million passenger cars is notably less than the EU average of 126. Overall there were 205,600 accidents resulting in personal injury on Italian roads in 2011, which was a 21.8% decrease on the same figure recorded in 2001 (Eurostat and OECD).

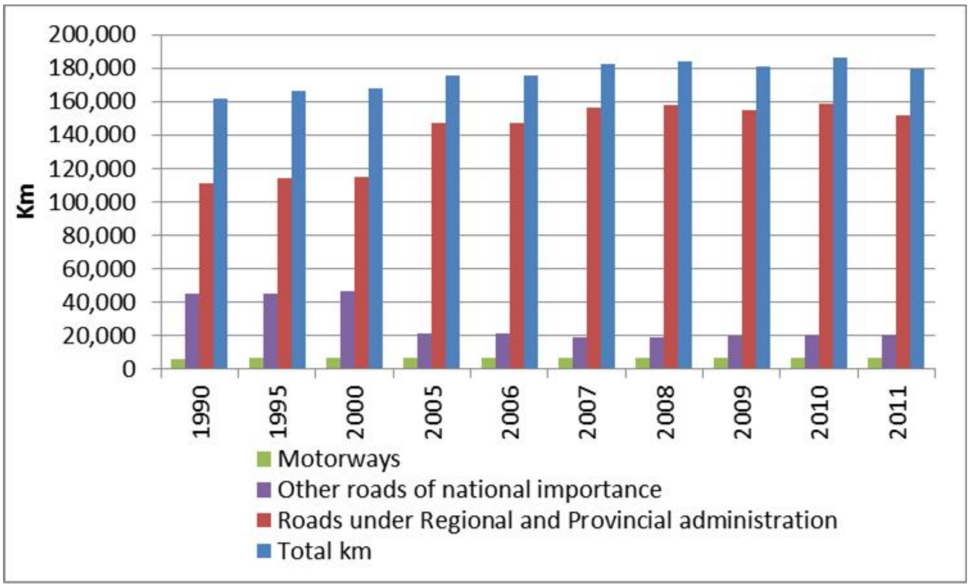
5.3 Maintenance budgets analysis

5.3.1. Road infrastructure and maintenance spending in Italy

Statistics on road spending in Italy are included in the Conto Nazionale delle Infrastrutture e dei Trasporti (CNIT). This document represents the official document prepared by the Ministero delle Infrastrutture e dei Trasporti to present an annual review, based on national statistics and analysis for national infrastructures and transportation. In particular, it evaluates economic expenditure for both public and private sectors regarding road, aviation, rail and other service infrastructure. This document does not however provide detailed information on road maintenance expenditure, but general trends can be observed by looking at the overall spending levels.

Overall, the Italian network length was 179,024 km in 2011: this includes motorways (6,668 km – 4%), national roads plus other roads of national importance (20,773 km – 12%), roads under Regional and Provincial administration (151,583 km – 85%). This figure does not include local roads.

Figure 24: Road network length (2012)



Source: Conto Nazionale dei Trasporti (2012).

Road infrastructure spending in Italy is dependent upon central government funding that is allocated to ANAS, Regional, Provincial and local administrations, depending on their area of administration.

The annual CNIT report publishes total budget allocated for current and capital expenditures by Provinces and Municipalities: this budget has been falling in recent years. Provincial administration spending decreased by 43% in the two-year period 2009-2011. Municipal spending fell by 3%, although this national average hides the variations in different parts of the country: an increase in Southern Italy of 56%, a fall in Northern and Central Italy of 26% and 12% respectively during the same period. Reported CNIT statistics for the three-year period 2009-2011 cannot be compared to previous data as the calculation method changed in 2009.

Table 7: Total budget for current and capital expenditures (Million€) - Provinces

Year	North	Central	South	Italy
2009	1660.2	456.2	930.7	3047.2
2010	1074.3	355.0	422.3	1851.7
2011	1035.3	319.6	387.4	1742.3

Source: Conto Nazionale dei Trasporti (2012).

Table 8: Total budget for current and capital expenditures (Million€) - Municipalities

Year	North	Central	South	Italy
2009	852.4	431.3	399.8	1683.4
2010	674.1	438.5	330.2	1442.8
2011	626.7	377.6	624.1	1628.3

Source: Conto Nazionale dei Trasporti (2012).

The Azienda Nazionale Autonoma delle Strade (ANAS) is the national authority responsible for managing the national road network including safety, movements, improvements and road maintenance over national road network on behalf of the Ministero delle Infrastrutture e dei Trasporti.

Significant information on road maintenance expenditure can be obtained by evaluating ANAS annual financial reports: these documents are the main source of budget amounts used for road maintenance and provide clear information about material spending and the split between routine and structural maintenance budgets.

This data refers to the overall ANAS network which covers both infrastructure managed directly and those where ANAS is delegated to operate maintenance intervention: in general, these reports give an idea for the most important infrastructures on the national network because ANAS management does not cover local roads.

Table 9: Management of national road maintenance in Italy - ANAS

Road authority	ANAS – from 2003 a privately run but publicly owned company.
Category of roads	National roads (strade di interesse nazionale) and motorways, - approx. 1,000 km of motorways are managed directly by ANAS, and approx. 5,800 km are under concession and only monitored by ANAS.
Maintenance management model	Since 2006 there have been extensive corrective measures undertaken, with audit and control being carried out on the basis of an indicator analysis to manage maintenance works.
Entitles responsible for maintenance	A new system of asset performance indicators and operational performance indicators is being created.
Published maintenance standards and control indicators	16 regional offices and 4 motorway divisions.

Reporting	There is a published Charter of Servicing Roads and Motorways (Carta dei Servizi Stradali ed Autostradali) where minimum standards are defined together with the level of service which may be expected by road users. Levels of service in many cases are not very high. However, there is no information in relation to the extent to which these indicators are being complied with.
Quality of maintenance	Comprehensive annual reports.

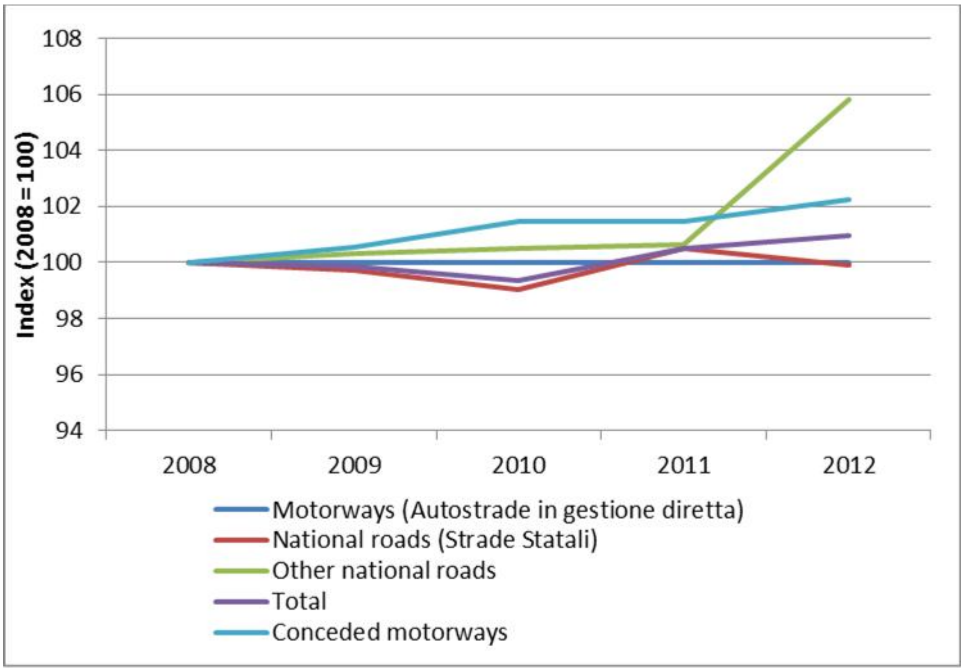
Source: ERNST&YOUNG (2012).

ANAS is a privately run but publicly owned company set up ten years ago which generates its own revenues, as well as receiving public subsidies. Its budget has been fluctuating in recent years and often there are not enough funds available to maintain the road network in an appropriate manner. In order to counter the budget reductions in the road sector, there are plans to introduce tolls on some roads that are not currently within a concession contract.

Justifying maintenance spending is made more difficult by the fact that there is little information available on maintenance as a whole, especially in the area of routine maintenance. The situation should improve following the implementation of a management support tool (SAP).

Some observations can be made by comparing total network length under the ANAS concession to total expenditure by the company. The size of the network managed by ANAS has remained fairly stable in recent years, increasing by only 1% (about 250km) between 2008 and 2012.

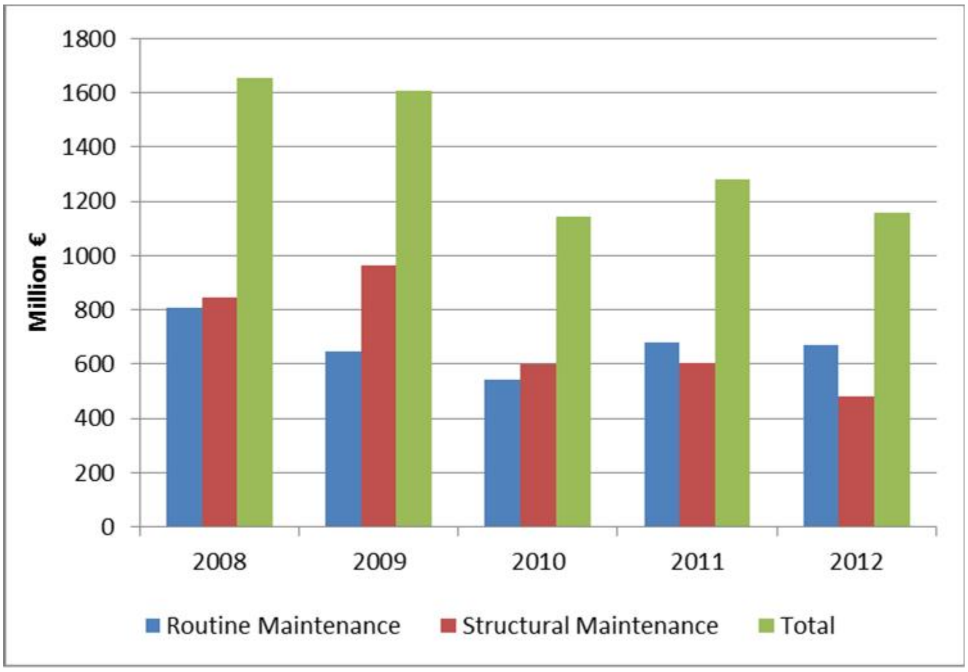
Figure 25: Total km under ANAS concession (Index 100 = 2008)



Source: ANAS Financial Reports.

At the same time, ANAS expenditure on road maintenance has been steadily falling both in routine and structural budgets, dropping respectively by 16% and 43% in the 2008 to 2012 period and registering a total decrease about €500m. This is shown in the figure and table below which also show how ANAS has changed its approach to road maintenance, spending more on localized interventions (minor costs) instead of less structural actions (more expensive) in order to cover a higher number of operations on the network to guarantee a good short-term maintenance level.

Figure 26: ANAS maintenance budget (Million€)



Source: ANAS Financial Reports.

Table 10: ANAS maintenance budgets in Italy (Million€) - Key statistical data

Indicator	2008	2009	2010	2011	2012
Routine Maintenance	806	646	544	678	673
Structural Maintenance	848	964	598	604	483
Total	1,654	1,610	1,142	1,283	1,156

Source: ANAS Financial Reports.

5.4 Road performance monitoring

5.4.1 Responsibilities

The responsibilities in the Italian road network are currently defined in the Decreto Legislativo 285/92 (Codice della strada - CdS, and its update in the Decreto Legge 21 June 2013, n. 69) and splits the overall national network into:

- Motorways;
- Extra-urban roads (which includes national; Regional; Provincial and Local Roads)
- Urban roads;

The responsibility for some of these roads has been devolved to the Regional, Provincial or Municipal authorities. Art. 2, comma 5 of the CdS establishes the public or private entities responsible for road maintenance:

- Motorways: the private concessionaire covers the cost of maintenance through toll revenues;
- National roads: the maintenance is carried out by ANAS;
- Regional roads: Regional administrations are the owners but they entrust the management and the maintenance to ANAS, Provinces or municipalities;
- Provincial roads: The Provinces manage the maintenance;
- Local roads: The Municipalities manage the maintenance.

Figure 27: Responsibilities in planning and maintenance of a road by category

Responsibility	Planning	Operations	
Motorways	Ministero delle Infrastrutture e dei Trasporti and ANAS/private companies	Motorway concessionaire	ANAS (conceded motorways)
National roads	Central authorities and ANAS	ANAS	
Regional, Provincial, Local and urban roads	Local authorities (Regions, Provinces, Municipalities) and ANAS	ANAS or Local authorities (Regions, Provinces, Municipalities)	

Source: SDG elaboration.

5.4.2 Assessment of road surface quality

At the national level, the Ministry of Public Works made it compulsory for road management bodies to draw up “Catasto Stradale”, a geographical information system to track the state of infrastructure. This registry aims to monitor the following:

- Integrated and updated knowledge of assets;
- Real time traffic monitoring;
- Road maintenance optimisation;
- Road safety level
- The database must contain:
- Road geometry and intersections;
- Pavement: parameters, surveys and controls;
- Markings and signs;
- Traffic, accidents and pollution data;
- Maintenance and interventions schedule.

In 2008, ANAS published the document ”Capitolato ANAS – Linee guida di progetto e norme tecniche prestazionali (2008)” setting out the data relating to the road surface quality indicators and best practice to plan and carry out correct maintenance works on a road section. As this is not a law it is not compulsory but it contains useful guidelines for using traditional and innovative materials. Road maintenance interventions must address:

- Roughness (“Aderenza”): the capability to provide a good relationship between road and tyre;
- Macro- texture (“Macro-tessitura”): to evaluate the roughness surface level;
- Surface regularity (“Regolarità”): fundamental to provide safety conditions for users;
- Load (“Portanza”): the capability to sustain a road traffic level.

The main indicators used to measure road quality are set out in the table below. These indicators are derived from a series of assumptions and empirical formulas based on a number of input data[20].

Table 11: Road maintenance indicators – Capitolato ANAS (2008)

Maintenance	Referring to	Indicator	Name
Surface layer maintenance	Roughness	CAT	Coefficiente di Aderenza Trasversale
		BPN	Skid Tester
	Surface texture	HS	Altezza in sabbia
	Surface regularity	IRI	International Roughness Index
Deep layer renewal	Load bearing capacity	FWD	Falling weight deflectometer
		D	Benkelmann beam method

Source: SDG elaboration.

5.4.3 Maintenance intervention

All maintenance interventions are strictly connected to damage type, road quality conditions and traffic load forecasts. ANAS and local administrations plan road maintenance operations based on road service life. Its evolution is related to the indicators identified above which provide the exact infrastructure condition[21].

The Italian law D.Lgs 12/04/06 n. 163, art 93 comma 5 “Codice dei contratti pubblici relativi a lavori, servizi e forniture in attuazione delle direttive 2004/17/CE e 2004/18/CE” states that a maintenance plan must be compiled for all key projects.

The road maintenance schedule (in Italy named Piano di Manutenzione Stradale or PMS) is planned as an equilibrium between budget availability and road condition. However, this must guarantee that the road retains at least the minimal safety level. Two methods can be used to develop a PMS: static and dynamic. The first is the older but most commonly used method based on fixed deadlines for maintenance interventions which are subject to short-term budgetary availability. The second, dynamic method introduces the previously mentioned indicators which return a quantitative measure of the condition of the road over time and let administrations decide what should be classified as a priority intervention and when to undertake the works based on the available budget. Indeed, the dynamic method is based on road service life charts, periodically updated with on-site surveys to evaluate indicators and compare actual to ideal conditions.

The law D.Lgs 12/04/06 n. 163 sets out the requirements for the creation of an appropriate road maintenance plan: any Regional administration may decide to produce its own guidelines and to require that its local authorities apply it. In 2006, the Lombardia Region published the document “Standard prestazionali e criteri di manutenzione delle pavimentazioni stradali” to respond to this requirement. The table below summarizes the list of indicators to be used and the indicators that should be considered per class roads:

Table 12: Road maintenance indicators – Regione Lombardia (2006)

Indicator	Type of intervention	IS	Measure	Unit	Instrument	Referring to
RL	Longitudinal regularity	IRI	High performance	m/km	Profilometer	ASTM E1926, E1170, E1364
		Irregularity depth	Punctual	mm	3 m bar	prEN 13036-7
RT	Transversal regularity	Rutting depth	High performance	mm	Profilometer bar	prEN 13036-8
			Punctual	mm	3 m bar	prEN 13036-8
A	Roughness	CAT	High performance	-	SCRIM or equivalent	prEN 13036-2
		BPN	Punctual	-	British pendulum	prEN 13036-4, CNR

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20 Gestione della Manutenzione Stradale – Indicatori di stato e curve di decadimento delle prestazioni funzionali e strutturali delle sovrastrutture stradali (2000) http://people.unica.it/mauroconi/files/2011/10/coni43full.pdf

21 http://www.stradelandia.it/pubdown/19.pdf

Indicator	Type of intervention	IS	Measure	Unit	Instrument	Referring to
						105/85
M	Macro-texture	ETD	High performance	mm	Texture meter or equivalent	prEN 13036-1
		HS	Punctual	mm	Sand equivalent test	prEN 13036-1
P	Load bearing capacity	Deflection	High performance	mm/100	FWD or equivalent	ASTM D4694, D4695
		Deflection	Punctual	mm/100	Benkelmann beam	CNR 141/92
DS	Surface damages	Administration's own discretion	High performance	Depends on damage type	Video-inspection	
			Punctual	Depends on damage type		

Source: Standard prestazionali e criteri di manutenzione delle pavimentazioni stradali - Regione Lombardia.

Table 13: Indicators per road classification – Regione Lombardia (2006)

Indicator	Type of road						
	R1	R2	P1 Extraurban	P1 Urban	P2 Extraurban	P2 Urban	L+not classified
RL	Yes	Yes	Yes	Yes	Yes	Yes	Suggested
RT	Yes	Yes	Yes	Yes	Yes	Yes	Suggested
A	Yes	Yes	Yes	Yes	Yes	Yes	Yes
M	Yes	Yes	Suggested	Suggested	Suggested	Suggested	Suggested
P	Yes	Yes	Yes	Suggested	Suggested	Suggested	Suggested
DS	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Standard prestazionali e criteri di manutenzione delle pavimentazioni stradali - Regione Lombardia.

In addition, the ANAS Capitolato suggests general best practices for road surface maintenance and renewals, depending on the degree of damage and forecasted traffic for maintenance period. Indication is given for two kind of works: surface maintenance for surface layers and extensive renewals for a road reconstruction. ANAS road maintenance suggestions depend on degree of damage:

- Surface layer maintenance (RS1): small cracks > 45% road section length;
- Surface layer renewal (RS2): scattered cracks > 45% road section length;
- Deep layer renewal (RP1, RP2, RP3): strong and deep damages > 45% road section length.

The document provides extensive information on how to use innovative materials to improve the effectiveness of maintenance activities.

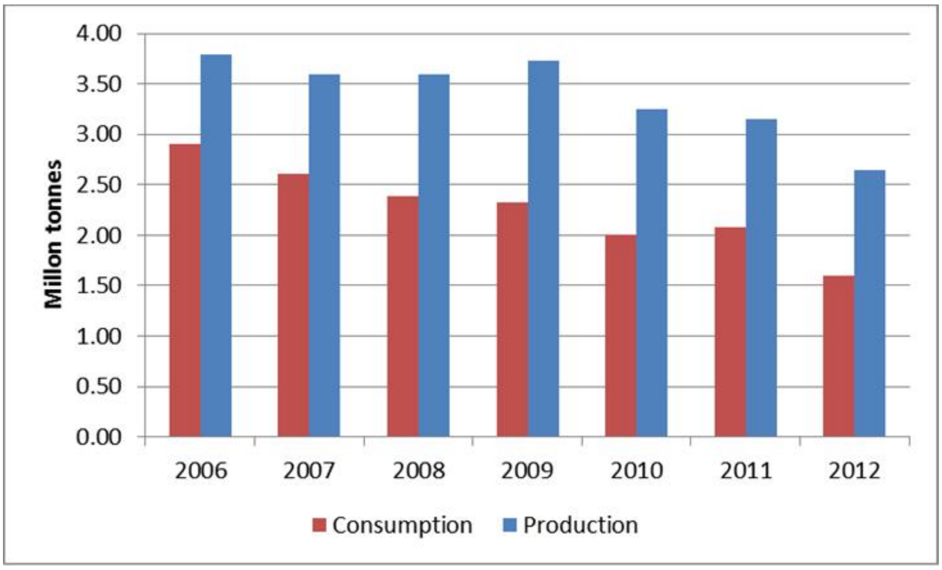
5.5 Socio-economic impacts of road maintenance

Italian legislation delegates road maintenance responsibilities to the owner of the road as mentioned above. These owners are also liable in the event of an accident that is due to the poor quality of the road network and in particular have to pay compensation for accidents caused by unsafe roads even in the presence of warning signs[22].

To detail road maintenance budget spending in Italy, general bitumen consumption could be an indication of its measure. SITEB (Associazione Italiana Bitume Asfalto Strade) is a national association bringing together almost 300 companies and Public Administrations who are currently working for infrastructure planning, construction, control and maintenance. Recent data shows that in the past six years the total amount of bitumen consumed has almost halved (-45%), declining from 2.91 to 1.60 million tonnes. In 2012 consumption recorded another 23% fall compared to 2011, both as a result of the economic downturn and the cost increase of the raw materials which increased from an average unitary price of €275/ton in 2006 to €520/ton in 2012.

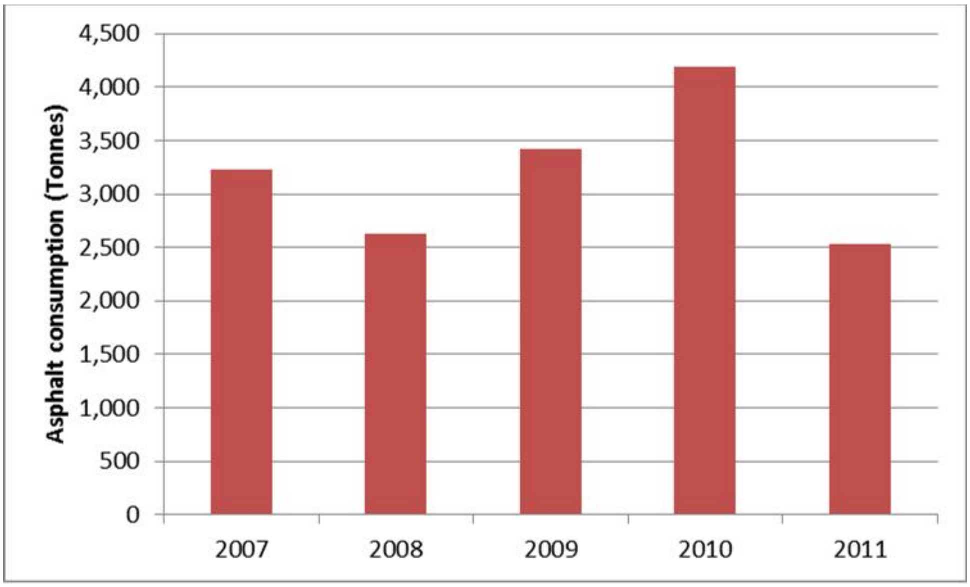
[22] http://www.euroconsumatori.eu/leggi_articoli_regione.php?id=151
http://www.statoquotidiano.it/06/05/2013/la-responsabilita-della-p-a-per-cattiva-manutenzione-pubbliche-strade-xvi/139488/

Figure 28: Comparison between bitumen consumption and production - Million tonnes



ANAS data on hot-mixed asphalt consumption registered a 40% drop between 2010 and 2011 as shown below.

Figure 29: Asphalt consumption – ANAS



Source: ANAS – Bilancio sostenibile (2011).

ANAS regularly publishes a Charter of Servicing Roads and Motorways (Carta dei Servizi Stradali ed Autostradali) where minimum standards are defined together with the level of service which may be expected by road users. In many cases there is no information on whether the targets have been met. Targets range from the minimum number of inspections on the road network (two inspections per year on national roads), to specific infrastructural targets such as improving surface drainage by 10% annually.

5.6 Summary for Italy

The Conto Nazionale delle Infrastrutture e dei Trasporti shows that the total budget for current and capital expenditure is decreasing across the country, over a period of time when the size of the network has remained about the same. The data from ANAS confirm a progressive reduction in global maintenance spending but, at the same time, it is clear where to focus current resources and budget, preferring general routine maintenance instead of specific structural interventions in order guarantee a good short-term maintenance level.

According to SITEB data, national bitumen consumption has dropped significantly in recent years, by about 45% to 2011 and further declining by 23% in 2012. This is as a result of both the economic downturn and an increase in unit costs.

The publication of some key best practice documentation has facilitated the decision making process for maintenance across the country. It is up to each Region to decide how to apply these best practices and implement a maintenance plan, but it is a step in the right direction to improve the efficiency of maintenance spending given current budget cuts.

6. CASE STUDY LITHUANIA

6.1 Member State overview

Lithuania's total road network measures 83,000 km, of which 309 km are classified as motorways. The car ownership rate in Lithuania is approximately 570 passenger cars per 1000 inhabitants, growing by 75% in the period 2001-2011 – a substantial increase in terms of car ownership (Eurostat).

6.2 Road safety statistics

In 2011, 296 road fatalities were recorded in Lithuania, which represents a substantial (57%) decrease from its 2001 level. When road safety is judged in proportion to its population, Lithuania scores below the EU27 average, and in terms of fatalities per million inhabitants, Lithuania's 98 is much higher than the EU27 average of 60. Lithuania noted 97 fatalities per 10 billion passenger kilometres (again worse than the EU27 average of 61), whilst its figure of 174 fatalities per million passenger cars is substantially higher than the EU average of 126. There were 3,300 accidents resulting in personal injury on Lithuanian roads in 2011. This is a notable 45% decrease compared to the same variable recorded in 2001 (Eurostat and OECD).

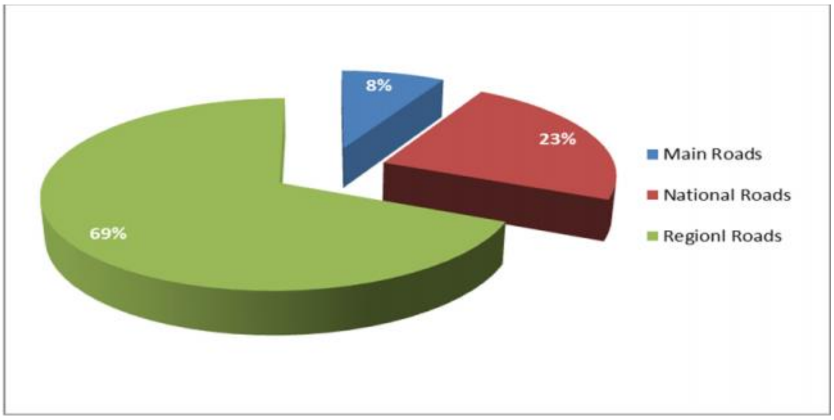
6.3 Analysis of maintenance budgets

6.3.1 Road infrastructure and maintenance spending in Lithuania

Road network management and maintenance is funded by the Road Maintenance and Development Programme (RMPD), which is supported by excise duty on fuel and gas and road taxes.

The State road network is entirely under the responsibility of the Lithuanian Road Administration Institution LRA. It consists of 21,243 km divided into 3 categories: Main Roads (1,746 km), National Roads (4,429 km) and Regional Roads (14,567 km). Pavement type varies mostly between asphalt (64.6%) and gravel (35%), and only a small share is done with concrete (0.3%).

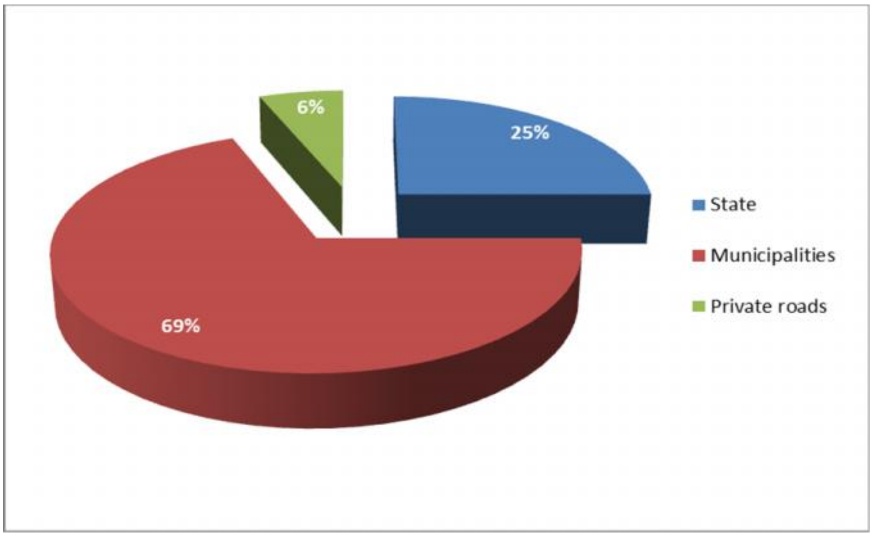
Figure 30: Share of state road network by road type (%)



Source: LRA (2013).

The State road network represents 25% of the total road network in Lithuania. The remaining 75% consists of local roads (69%) and private roads (6%). Responsibility for the local road network management and maintenance lies with local municipalities that receive funds from the Road Maintenance and Development Programme (RMPD), according to the planning done by the Lithuanian Road Administration Institution (LRA).

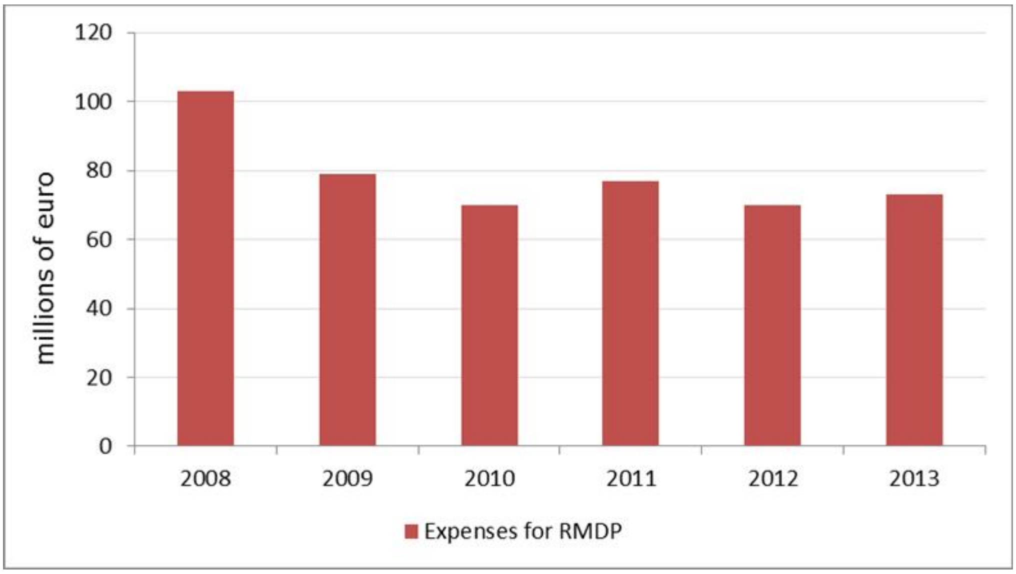
Figure 31: Share of Road network in Lithuania by operational responsibility (%)



Source: LRA (2013).

Allocation of funds for the RMDP is approved by the government annually. As can be seen in Figure 32, funds available for road maintenance have fallen following the 2008-2009 economic crisis, with a drop of €24m between 2008 and 2009 alone, and a decrease of 32% in the last six years. The 2013 road maintenance budget is back at its 2001 level.

Figure 32: Evolution of road maintenance expenses (RMDP) millions of euro



Source: LRA (2013).

Allocation of funds varies significantly according to both road type and the level of maintenance that the LRA is planning to carry out. The maintenance level is in turn decided yearly according to the funds allocated to the RMDP by the State.

Table 14: Funds for 1 km of State road network maintenance in 2013 by maintenance level (Euro)

Road type	Funds for 1 Km	Maintenance level
Main roads	10,710	I
	7,354	II
National roads	3,443	III
Regional roads	1,188	III (asphalt)
	1,742	III (gravel)

Source: LRA (2013).

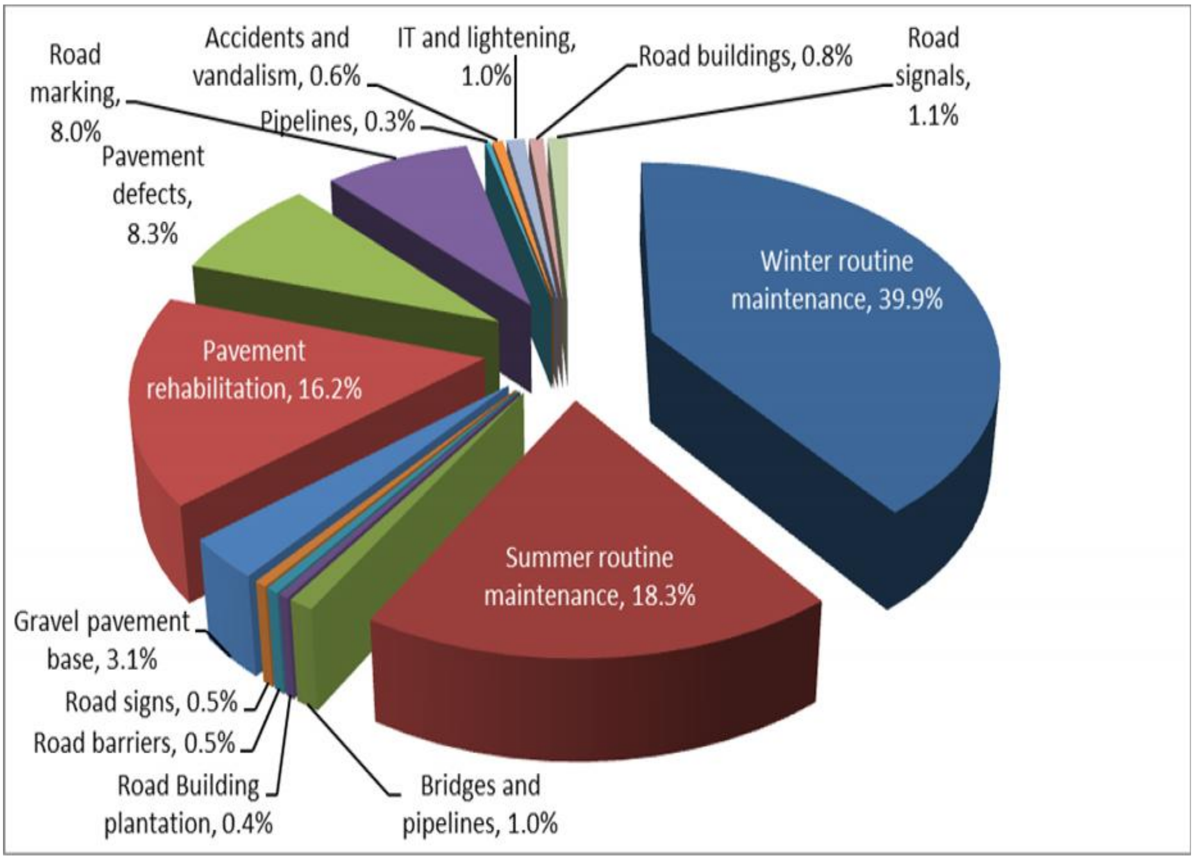
6.3.2 Road maintenance budget outlook

Looking at how the funds of the RMDP are spent, it becomes evident how due to the climatic conditions of Lithuania, priority is given to routine winter maintenance. In 2013, €29.2m was allocated to winter maintenance, almost 40% of the total budget of the RMDP.

This €29.2m was further distributed along the road network according to the result of the Routine Winter Maintenance Funds Indexing Project, which uses the LRA-built Winter Severity Index (ŽSI) to identify priority areas according to weather conditions, such as: precipitation rates; temperature fluctuations; and the duration of the winter season. Overall, a total amount of €56.5m has been allocated for routine road maintenance.

A smaller budget is dedicated to extraordinary maintenance on the road surface. In fact, over the past five years, only in 2011 and 2013 did some sections of the State road network undergo an extraordinary maintenance: 600km in 2011 and 215km in 2013. This means that between 2009 and 2013 only 4% of the State road network underwent systemic and extraordinary rehabilitation, with direct consequences for the overall conditions of the State network system.

Figure 33: Share of road maintenance expenses (RMDP) in 2013 (%)



Source: LRA (2013).

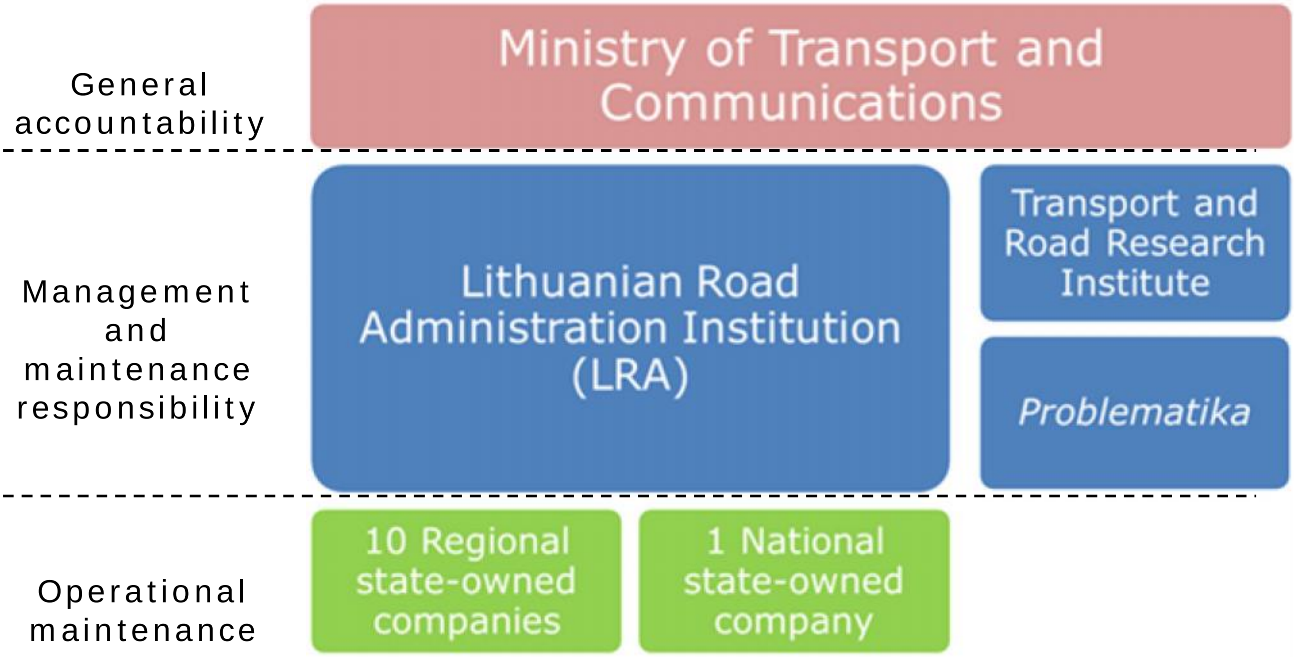
6.4 Road maintenance performance and monitoring system

6.4.1 Responsibilities

In Lithuania, the management and operation of the national road network is under the responsibility of the Ministry of Transport and Communications. Within the Ministry, different tasks are sub-divided between: the Transport and Road Research Institute in charge of research, development and road design; the agency Problematika in charge of road maintenance technical supervision; and the Lithuanian Road Administration Institution (LRA) in charge of the overall management.

Maintenance of the national road system is carried out by ten Regional state-owned enterprises and one motorway state enterprise. Responsibility for the local road network is held by municipalities. All the activities of road management and maintenance are funded through the Road Maintenance and Development programme (RMPD).

Figure 34: Responsibility structure for State road network



Source: SDG illustration.

6.4.2 Assessment of road maintenance quality

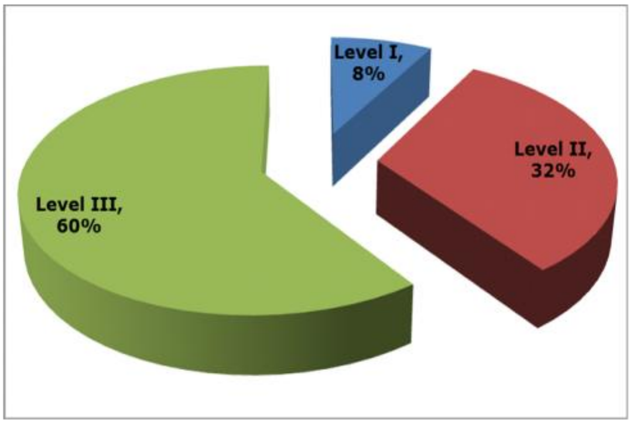
In Lithuania, routine road maintenance and the filling of potholes are carried out by regional and national state-owned companies, while periodic, non-routine interventions for pavement rehabilitation are contracted out by open tenders.

All maintenance operations are carried out according to the Road Maintenance Manual, approved by the Lithuanian Road Administration in 2008. The Road Maintenance Manual is a set of legal documents, which regulate the quality of road maintenance works and their value. It consists of 6 sections and includes: legal standards for road maintenance; economic standards of road maintenance; technology to be used; preparation of the road maintenance program; road technical control; acceptance of works and payment; accounting for road maintenance works; and standards of works, equipment and material use for road works. The manual defines the main performance criteria for maintenance operations, such as time for defect removal, reaction time, road surface condition, interruption time, etc.

Each year the LRA determines the maintenance level for each road according to available funding. Maintenance operations are classified as follow: high (level I), moderate (level II), or low (level III).

- High level of maintenance (level I) has to ensure a high technical and aesthetic road condition and traffic safety 24 h a day and for all seasons of the year.
- Moderate maintenance level (level II) has to ensure a high technical road condition and traffic safety, however, there is less attention to aesthetics and comfort. Maintenance interventions are not guaranteed 24 h a day.
- The low maintenance level (level III) has to ensure only road usability in safe conditions.

Figure 35: State road network maintenance levels in 2013



Road type	Maintenance levels	Funds for 1 Km
Main roads	I	361
	II	1,392
National Roads	II	4,211
	III	719
Regional Roads	I	1,380
	II	1,165
	III	12,022

Source: LRA (2013).

As can be observed in Figure above, in 2013 the maintenance of some 60% of the State road network was carried out only to the extent of ensuring road usability in safety conditions. This share rises to 83% for regional roads. This data is valid for the winter season, whereas during summer all the roads are maintained according level III.

6.4.3 Monitoring system

Lithuania's road maintenance monitoring system is organised according to a three-step format. The first stage consists of internal controls carried out by state-owned companies. The second stage is carried out by LRA inspectors, with continuous examination of the condition of road elements, technology of performed works, compliance of materials and products, and road maintenance conformity to the maintenance levels, as required by the Road Maintenance Manual. The third stage is the special road inspection, carried out twice per year by the LRA road maintenance division.

The LRA also monitors and models the condition of the road network using the data collected from 103 road weather stations, 300 cameras and 800 road maintenance cars. RWIS stations collect information about: traffic; road surface temperature; air temperature and relative humidity; dew point; wind (direction, speed and gusts); precipitation intensity and type; visibility; road construction, and frost depth.

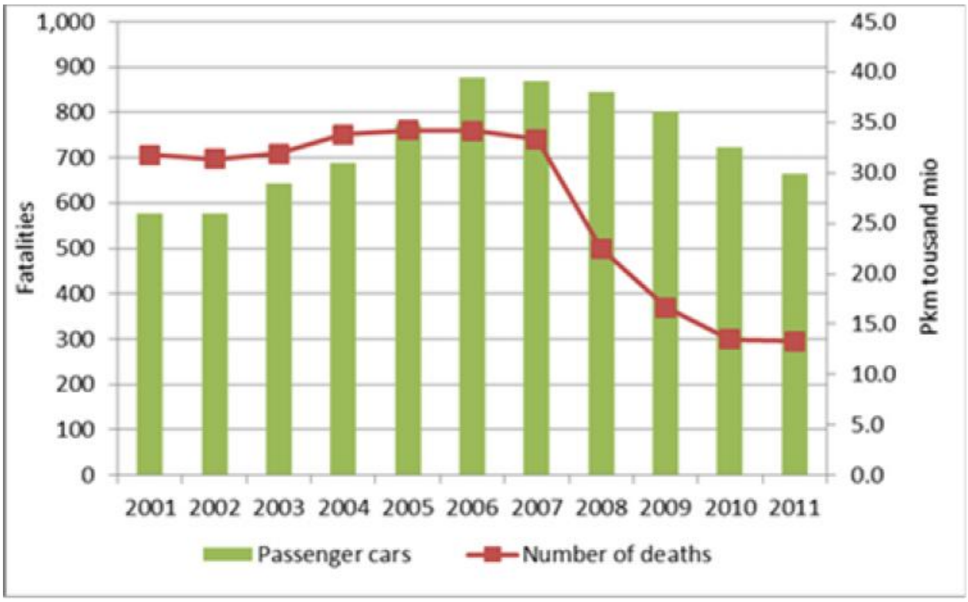
In addition to this, in 2011, a traffic information centre was established within LRA. It collects, organises and provides information about traffic conditions on the state road network and coordinates the road maintenance activities. It gathers information from RWIS stations, the Emergency Response Centre, police, road maintenance companies, and shares the data through a web portal and smartphone application.

6.5 Socio-economic impacts of road maintenance

6.5.1 Road safety

Road safety has improved a lot in Lithuania in the last few years. The number of deaths dropped from a total amount of 706 in 2001 to 301 in 2012. This data is particularly interesting if we take into consideration that over the same period of time car ownership has increased. As can be seen in figure below, this fall in fatalities can be partially attributed to falling traffic. Nevertheless the factor that has had the most effect on this result, according to the European Transport Safety Council (ETSC) is the lowering of the legal blood alcohol limit to 0.4g/l and 0.2 for new and professional drivers along with increased fines for speeding. Between 2001 and 2010 Lithuania achieved a 58% reduction in road deaths (third best reduction in the EU after Latvia and Estonia). For this reason, in 2011 the Minister of Transport received the PIN award from ETSC.

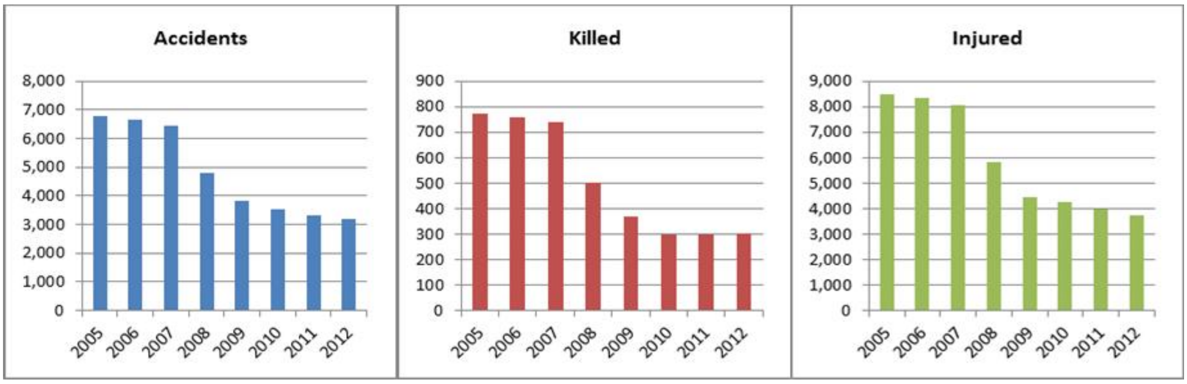
Figure 36: Evolution of total deaths and passenger cars (2001 – 2011)



Source: LRA (2012).

Even though the number of deaths on Lithuanian roads has fallen substantially, mortality remains high, with over 90 deaths per million inhabitants in 2012. In addition to this, as can be observed in Figure 37 the total number of deaths remained stable between 2010 and 2012.

Figure 37: Evolution of total accident deaths and injured (2005 - 2012)



Source: LRA (2012).

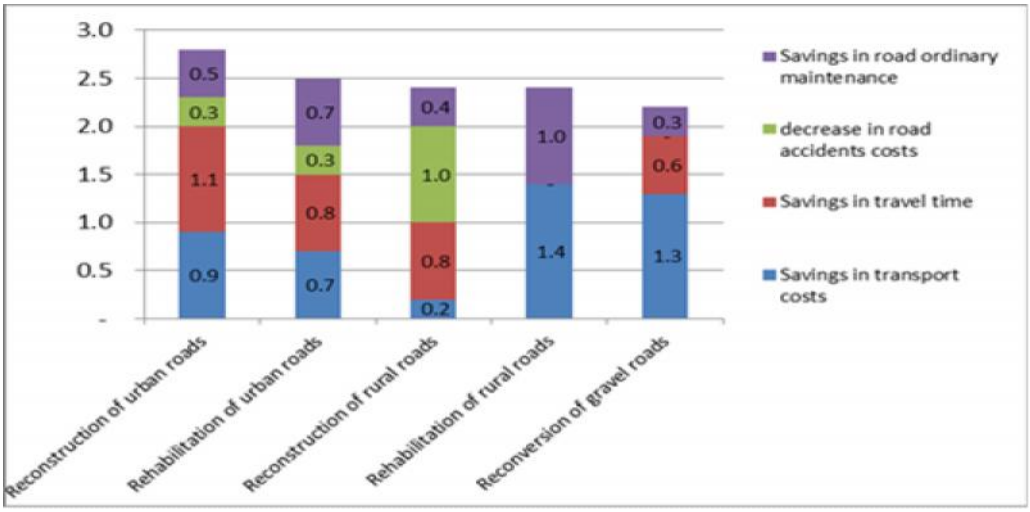
Road safety improvements in Lithuania are sought through the use of a three pillar method based on education, control and engineering solutions. In recent years focus on education and control measures have brought important results, while engineering interventions have been limited to locations with the highest accident rates.

According to a study by Infraplanas based on tens of projects concerning construction, maintenance and renewal of roads in Lithuania, investments in road maintenance and rehabilitation could have positive results on road safety, especially in rural areas.

6.5.2 Economic impacts

According the study mentioned above, investments in road maintenance can also have positive economic impacts in the long term. These findings are based on the analysis of road-related projects implemented or under implementation in Lithuania in the last decade taking into account current economic and transport trends, and the declining tendencies in traffic volume and accidents. Infraplanas estimated that each LTL invested in road rehabilitation, reconstruction and maintenance within the next five years in the long term prospective (25 years, according EC standards) will give an average net value between 2,8 and 2,2 LTL, plus positive environmental externalities.

Figure 38: Net benefit forecast for 1 LTL invested into road rehabilitation reconstruction and maintenance



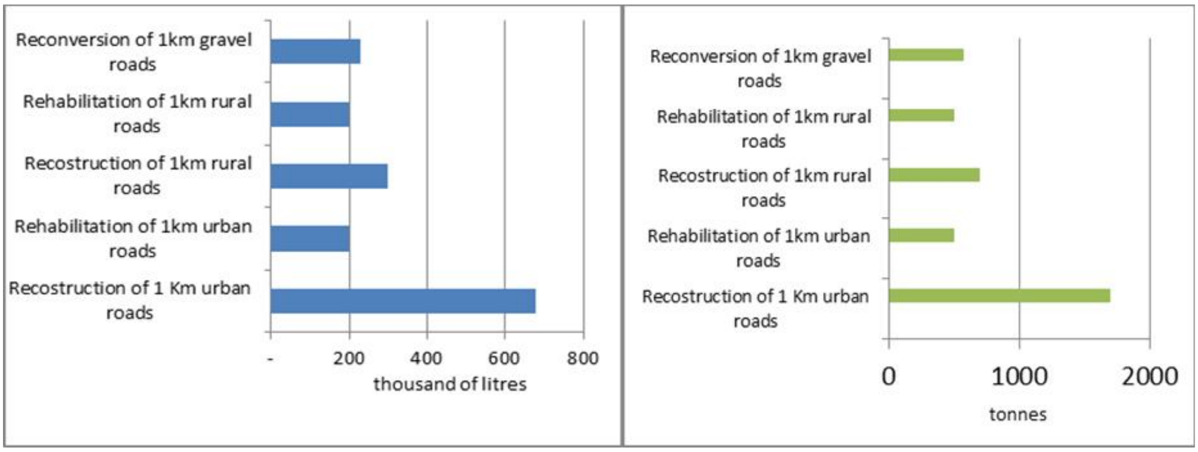
Source: Infraplanas (2013).

The parameters taken into account in these calculations are savings in transportation costs, savings in travel time, decreased road accident costs, and savings in infrastructure ordinary maintenance costs. Looking at the findings summarized in Figure 38 it can be seen how extraordinary maintenance such as road reconstruction and systematic rehabilitation could have positive economic effects in the long term, especially in urban contexts where traffic flows are more consistent.

6.5.3 Environmental and health impacts

According to Infraplanas estimates, road maintenance activities in Lithuania may also have positive impacts on the environment. As can be observed in Figure 39, taking a temporal reference of 25 years, the reconstruction of 1 km of urban roads results in 680 thousands litres of fuel saved and 1700 t of CO_2 emissions avoided (300 thousands litres of fuel saved and 700 t of CO_2 emissions in rural roads). The rehabilitation and strengthening of 1 km of urban roads results in 200 thousands litres of fuel saved and 500 t of CO_2 emissions avoided (200 thousands litres of fuel saved and 500 t of CO_2 avoided in rural roads). The paving of 1 km of gravel roads results in 230 thousands litters of fuel saved and 580 t of CO2 emissions avoided.

Figure 39: Decrease in fuel consumption (thousands of litres) and CO_2 emissions (tonnes) per 1 km of road intervention



Source: Infraplanas (2013).

To pave gravel roads (bearing in mind that 35% of Lithuania state road network is composed of gravel road) can also have positive externality effect on health. Paving 10% of the current Lithuanian gravel state road network per year could avoid the production of 736 tonnes of particles in the next 5 years.

Road transport is also an important source of noise pollution. The level of noise produced by the friction between vehicles and road surface depends on the speed of the vehicles, the characteristics of the surface and its level of deterioration. Irregularities of the pavement, ruts, traverse and longitudinal cracks, also can increase the noise level. Asphalt pavement noise increases about 3 dBA within 6–7 years of usage and in later years of usage it can increase up to 4 dBA. Ordinary and non-ordinary maintenance of the pavement surfaces are fundamental to keep the noise level within the comfort zone for human hearing.

6.6 Summary for Lithuania

In Lithuania, road network management and maintenance is funded by the Road Maintenance and Development Programme (RMPD), which is supported by excise duty on fuel and gas and road taxes. RMPD funds have fallen following the 2008-2009 economic crisis, with a decrease of 32% in the last six years. The 2013 road maintenance budget is back at its 2001 level.

Within the RMPD funds, because the Lithuanian climatic conditions, priority is given to road winter maintenance which absorbs 40% of the expenditure. Little investments are instead dedicated to extraordinary maintenance: between 2009 and 2013 only 4% of the State road network underwent systemic and extraordinary rehabilitation. Ordinary maintenance is to ensure a minimum level (according Lithuanian Road Maintenance Manual), which ensures only road usability in safe conditions along 60% of the road network.

Road safety has improved a lot in the last few years: Between 2001 and 2010 Lithuania achieved a 58% reduction in road deaths. The main reason for this drop is the lowering of the legal blood alcohol limit to 0.4g/l and 0.2 for new and professional drivers along with increased fines for speeding. The number of fatalities stabilized between 2010 and 2013 and national experts stated that investment in road maintenance and rehabilitation could have positive results on road safety, especially in rural areas.

In Lithuania 35% of the national road network consists of gravel roads. To pave gravel roads would have economic and environmental impacts and it would also improve the comfort of drivers and road users.

7. CASE STUDY POLAND

7.1 Member State overview

Poland's total road network extends to 412,000 km, of which 1,000 km are graded as motorways. Municipal roads make up 237,000 km of the total network. Poland's level of car ownership is approximately 470 passenger cars per 1000 inhabitants. This figure has increased markedly in the period 2001-2011; the percentage increase was 71% (Eurostat).

7.2 Road safety statistics

In 2011, Poland recorded 4,189 fatalities on its roads, which rates as a 24% decrease from its 2001 level. In terms of fatalities per million inhabitants, Poland ranks as the worst in the EU27: there are 109 fatalities per million inhabitants (EU27 average = 60). When judged in terms of passenger kilometres and car ownership Poland rates slightly better; Poland noted 105 fatalities per 10 billion passenger kilometres (EU27 average = 61) and 237 fatalities per million passenger cars (EU27 average = 126) which, whilst still worse than the EU average, is better than four of its European neighbours. In 2011, there were 40,000 accidents resulting in personal injury on Polish roads, which represents a 26% decrease on the equivalent figure from 2001 (Eurostat and OECD).

7.3 Maintenance budgets analysis

7.3.1 Road infrastructure and maintenance spending in Poland.

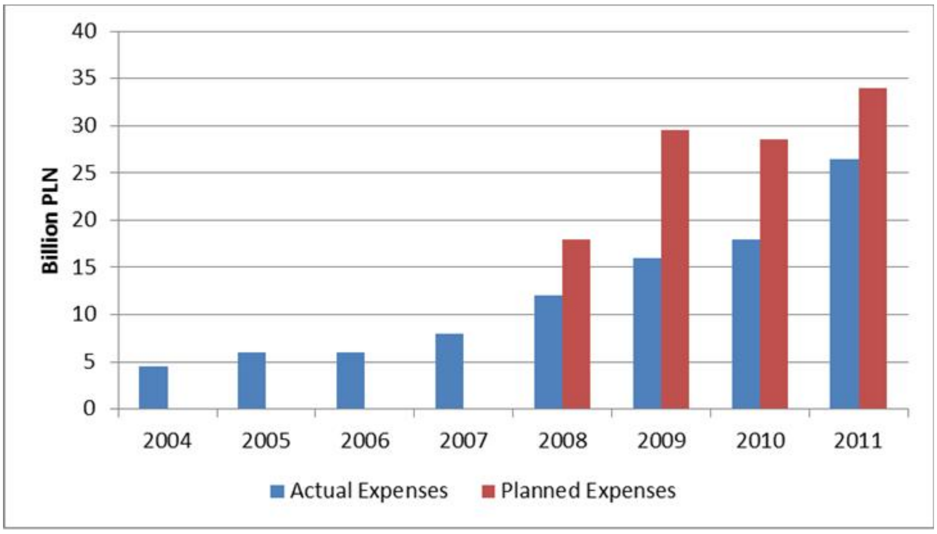
Poland's underdeveloped road network has, in the past, been in part responsible for a poor road safety record and has been a limiting factor in Poland's economic growth. More recently, since joining the EU in May 2004, Poland has seen a step-change in road investment, in part as a result of substantial co-financing from the EU and the World Bank. This support has led to a programme of road infrastructure projects from the building of National highways to overall road improvements through road maintenance and rehabilitation projects, including upgrading many major national roads.

The World bank[23] reported that, in order to develop the road network and capitalise on funding, institutional changes would be necessary. The result was reform within the General Directorate for Road and Motorways (GDDKiA) in 2004 allowing improved working practices between the Ministry of Transport, GDDKiA headquarters and its regional branches. These institutional changes included: appointing a new GDDkiA management in 2008; decentralisation of investment planning, preparation and implementation in regional offices; changing key business processes and procedures within the GDDKiA; and the creation of several units within the GDDKiA including departments for environment, technology and internal audit and control.

[23] World Bank (2009) – Implementation and completion results report on a loan of Euro 100 million to the Republic of Poland for a road maintenance and rehabilitation project.

The restructuring exercise has improved planning and implementation capacity and was accompanied by financial support aimed at clearing the large backlog of road maintenance and to allow for new investments for network expansion. From this point on, Poland has implemented several stages of road and economic development planning, with the next stages due to be completed in 2015.

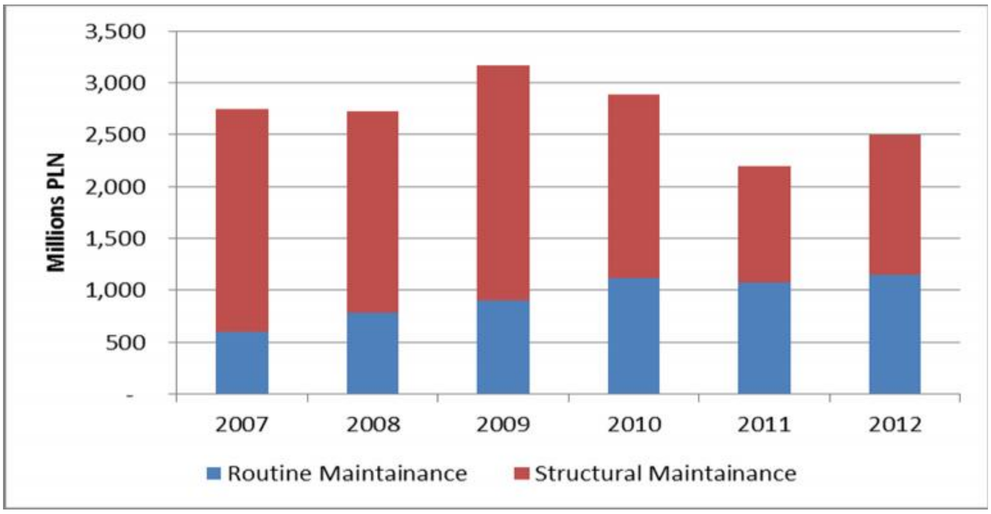
Figure 40: Road Infrastructure, planned and actual expenditure – National roads and motorways



Source: Ernst & Young (2012).

As shown in Figure 40 above, total expenditure on the Polish road network has been rising since its accession to the European Union. From 2004 to 2011, actual expenditure on new road infrastructure has risen approximately 500% to a high of over PLN 26 billion (€6.3billion[24]) in 2011. According to the Financing Programme for National Road Building, the actual expenditure has been lower than planned expenditure for all years. During the period of economic downturn, investment spending into Polish roads has not decreased, mainly due to large amounts EU funding.

Figure 41: Maintenance expenditure (actual) – Routine and structural maintenance



Source: GDDKiA (2014).

[24] (1 EUR = 4.1 PLN) based on exchange rate at 02/08/2012.

Routine maintenance in Poland includes preserving the condition of trunk roads, motorways, bridges and winter maintenance. These activities are focused primarily on the preservation of the current condition of the road for example clearing snow from roads and cleaning of carriageways and hard shoulders. Structural maintenance includes renewals of roads and bridges as well as the upgrading of roads to improved specifications and reinforcement of bridges.

Figure 41 shows the budget for routine maintenance has generally increased in the period from 2007 to 2012 with annual expenditure rising from almost PLN 600 Million (€146 Million) to a high of almost PLN 1.15 Billion (€472 Million) in 2012. Spending on routine maintenance would be expected, in-line with the expansion of the road network.

As a proportion of the total spending, routine maintenance has fluctuated dramatically. This has been due to the large variations in structural maintenance spending which has ranged from 51% to 78% of combined spending and includes the resurfacing of roads that are currently in a poor condition. Between 2010 and 2012 structural maintenance has been supplemented by additional funds to repair road and bridges that were damaged as a result of flooding. Our analysis of winter maintenance (which fluctuates between 8% and 17% of the total budget) has shown a large correlation between the intensity and duration of snowfalls and the amount spent on winter interventions.

From 2010, spending on Polish infrastructure was due to slow down, especially with the end of the Euro 2012 effect which boosted infrastructure spending. Despite this, the 2013 budget has assigned PLN 3 Billion (€730 Million) to the roads infrastructure fund.

7.4 Road performance monitoring

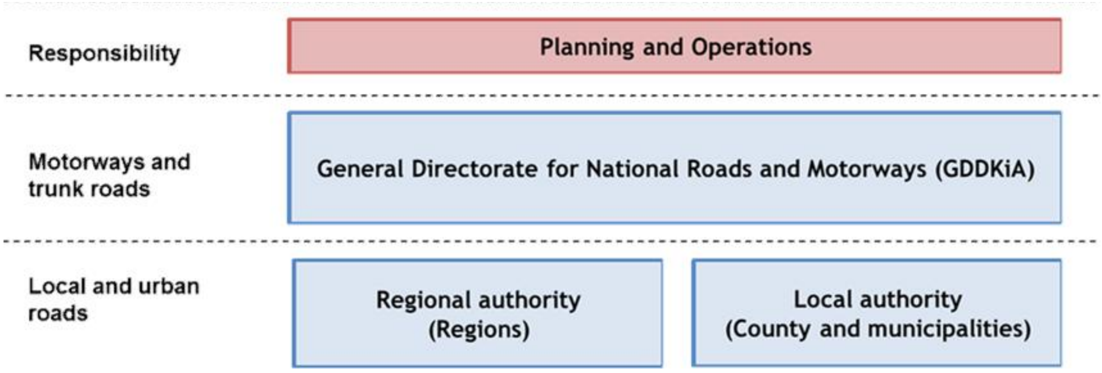
7.4.1 Responsibilities

Roads in Poland are divided into four main types; national roads, expressways and motorways belonging to GDDKiA; regional roads, county roads and roads belonging to cities and towns. In each case, the maintenance and management of these roads as well as responsibility for damage or accidents caused as a result of improper maintenance lies with the manager of each road area.

National roads, expressways and motorways are managed by the directorate for National Roads and Highways, supervised by The Ministry for Transport, Construction and Maritime Economy. The General Directorate for National Roads and Highways (GDDKiA) is broken down into 16 administrative regions each with its own geographical areas of responsibility. Below the regional level there are a further 105 subdivisions spanning 273 road areas.
Regional roads, which are smaller and connect towns, are owned and managed by the relevant regional governments. Each region holds its own budget and implements maintenance works.

County and town roads are smaller in size and capacity than either national or regional roads. These roads are also managed by their corresponding geographical administrative areas.

Figure 42: Responsibility over road maintenance by road type



Source: SDG illustration.

7.4.2 Assessment of road surface quality

Road surface quality analysis is carried out using the System for Road Surface Evaluation (SOSN) for Asphalt Roads, SOSN-B for concrete roads. This is complemented by SOPO , the System for Evaluation of Roadsides[25], both developed by the General Directorate for National Roads and Motorways. The SOSN system is used to gather data on non-urban parts of the national network on the following operating characteristics of the surface:

- cracks and defects,
- longitudinal profile,
- transverse profile,
- road pavement condition,
- skid resistance.

The parameters of road surface conditions are measured both with instrument and visual inspections. The instrument tests focus on longitudinal and cross section profiles, road bearing capacity and skid resistance. Video recording of the surface of the road allows for automatic detection of surface abnormalities such as cracks which are then translated by the equipment to allow for a precise analysis of the condition of the road surface[26].

Resulting road surface parameters from condition assessments are grouped into four categories, A, B, C or D as detailed in the table below. The resulting data is published annually at the end of the first quarter of each year.

Figure 43: SOSN Road surface quality classifications

Class A	Good Condition	New and reconditioned surfaces not in need of maintaiance
Class B	Satisfactory Condition	
Class C	Unsatisfactory Condition	Suraces with damage in need of routine maintaiance
Class D	Bad Condition	Surfaces with damage in need of immediate repair

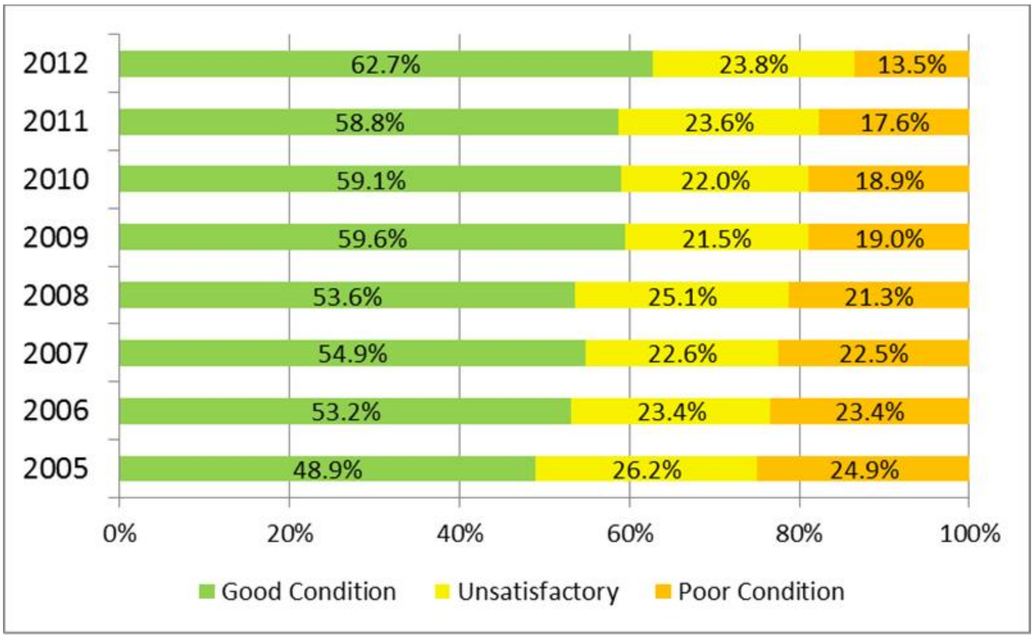
Source: GDDKiA.

[25] GDDKiA – www.GDDKiA.gov.pl

[26] Marcin Staniek (2013), Stereo vision techniques in road pavement evaluation, The XXVIII Baltic Road Conference, Silesian University of Technology, Gliwice, Poland.

These classifications are applied to the entire length of the National Road Network and form the basis of planned maintenance works. Figure 44 shows how the condition of road surfaces on the Polish network has improved since 2005. The proportion of roads in good condition has been steadily increasing from under 50% in 2005 to 63% by 2012. During the same period, the proportion of roads in poor condition and in need of immediate repair has decreased from 25% in 2005 to a low of 14% in 2012. The percentage of roads in an unsatisfactory condition and in need of routine repair has remained relatively constant throughout the period. During this period, it should also be noted that an additional 2600 km of motorways and trunk roads have been constructed, an increase of 13% over 2005.

Figure 44: Condition of road surface on entire national road network



Source: GDDKiA.

7.4.3 Maintenance intervention

There has been a considerable push to improve standards within GDDKiA and on Polish roads in the last decade. The next phase of improvements to monitoring was attained in 2010, with GDDKiA publishing a more complete and in depth analysis of road conditions, taking into consideration drainage and technical condition of road shoulders as factors in increased road surface deterioration.

From 2011 measurement of the technical conditions of the road is carried out twice a year using radar techniques which will allow for further information to be obtained about the road condition[27]- these techniques have been developed by GDDKiA. After the 2004 restructuring, a specialist research and technology department was created. According to the GDDKiA's own publications, substantial research efforts have been made to improve materials used in road surfacing, including studies completed on mineral asphalt mixtures for use in reduced temperatures. This is in addition to several studies into the use of improved radar techniques for measurement purposes.

[27] Ernst and Young 2012, Effectiveness of national roads maintenance management in Poland.

In 2010 an significant change was introduced to the structure of GDDKiA, which included the creation of a Traffic Management Department. This new department acts exclusively in relation to road maintenance. From 2010 the traffic management and maintenance departments were entrusted with the organisational and technical matters of planning and designing and carrying out projects in the field of traffic safety on national roads[6].

7.5 Socio-economic impacts of road maintenance

7.5.1 Road safety

Poland's road safety record is amongst the worst in Europe. In 2012 the average number of deaths on the roads was 93 per million, almost double the EU average of 55[28]. Despite national efforts to improve road safety through the GAMBIT programme, targets of a 50% reduction in fatalities between 2003 and 2013 have not been achieved[29]. Due to the lack of good quality data at levels below the national level for roads, analysis of the causes of the fatalities is difficult to determine as the relationship between road surface quality and crashes is not clear. The World Bank report indicates that general road quality is responsible and some the key risk factors are :

- Unforgiving roadsides
- Lack of sealed shoulders
- Lack of separated carriageways allowing for head on collisions
- Lack of facilities for pedestrians and cyclists
- Speed limits on rural and urban roads different from international best practice.

National records indicate an overall fall in road accidents in the period between 2003-2012 with a reduction from 51,078 accidents in 2003 to 37,046 in 2012, an overall reduction of 37%. This has been reflected in a reduction in road fatalities and injuries against a back drop of increasing vehicle use and, ownership rising to over 24 million vehicles in 2011, an increase of over 55% on 2002 levels.

The proportion of accidents that occur on differing types of roads varies greatly in Poland. The roads with the best safety records for 2012 were motorways (0.7%), express roads (0.4%) and dual carriageways (13.3%) contributing a total of 14.4% of all accidents. The majority of accidents that occurred took place on single carriageway roads, accounting for 82.3% of accidents, 87.8% of road deaths and 82.4% of injuries. Within this period, 49.2% of accidents were between moving vehicles and 27.1% included accidents involving pedestrians. Of all accidents in 2012, only 89 were attributed directly to the poor condition of the road surface by the Police.

7.5.2 Operating efficiency

The Jaspers Blue Book (2008) analyses economic and road data in order to provide indicators of economic effectiveness in relation to Poland's road network. Table 15 shows the relative increases in vehicle operating costs between deteriorated and renovated road surfaces for passenger vehicles and good vehicles without trailers.

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28 World Bank, 2013. Road safety in Poland.

29 World Bank, 2009. Country Report on Poland – Road safety management capacity review.

Table 15: Cost of vehicle use on damaged and repaved roads on level terrain

Speed (km/h)	Passenger Vehicles (PLN/km)		Goods vehicles (PLN/km)	
	Deteriorated pavement	New Pavement	Deteriorated pavement	New Pavement
10	1.231	1.166	3.740	3.559
20	1.197	1.150	3.638	3.488
30	1.170	1.137	3.560	3.434
40	1.150	1.126	3.508	3.298
50	1.136	1.117	3.480	3.379
60	1.128	1.111	3.478	3.378
70	1.124	1.108	3.513	3.402
80	1.126	1.108	3.548	3.427
90	1.131	1.111	3.620	3.478

Source: Jaspers (2008) Blue Book.

The unit cost depends on the annual operating cost, the vehicle type, surface conditions and gradient. Table 15 highlights the relatively low cost differences between newer roads and those in a poorer condition. At a speed of 60Km/h the difference in operating costs is PLN 0.017 /km (€0.004/km) and for goods vehicles PLN 0.1/km (€0.02km). Of greater economic significance is the time spent travelling and the impact of road works in delaying journeys. In 2012 a one hour business trip cost 60.92 PLN (16 EUR) meaning that regular small delays accumulate to significant losses[30].

7.6 Summary for Poland

Since joining the EU Poland has invested considerably in its national road network aided by Structural and Cohesion Funds and loans from the World Bank, including for road maintenance and rehabilitation projects. The focus of this funding has been to facilitate economic development, improve road safety and contribute to creation of the overall European Transport network. Availability of loans and the Euro 2012 football competition both spurred large infrastructure investment projects in Poland, especially road building and improvement projects.

The development of Poland's road network was deemed necessary to overcome bottlenecks in economic and social development as indicated by the strong correlation between regional

30 Ernst and Young 2012, Effectiveness of national roads maintenance management in Poland.

income, unemployment levels and road density[31]. The results of heavy investment in construction and infrastructure so far have contributed to strengthening Poland's economy[32] throughout the economic downturn of 2008-2012 where growth decreased, but economic activity did not stagnate for long. Throughout this period road maintenance budgets and infrastructure spending did not decrease. On the contrary, road investment helped sustain high levels of economic activity.

It is difficult to determine the scale to which improvements to the national road network have impacted on road safety due to there being several key contributory factors. Within the study period, road accidents have decreased as car ownership has increased, indicating an overall improvement. In recent years there has been a large safety campaign aimed at raising awareness of road safety in Poland. Additional measures to curb accidents include a low tolerance policy (for example in relation to alcohol by setting a maximum allowed BAC equal 0.2mg/l) to driving while under the influence of alcohol. Another factor playing an important role in road safety is the affordability of more modern cars with improved safety features. Although cars fitted with airbags will not prevent accidents, other features such as anti-lock braking and the age and general condition of vehicles may play a part in reducing the accident rate.

From recent studies, further recommendations have been made to improve the management and therefore quality of road surfaces in Poland, including: greater use of IT systems to allow for better technical and economic management of road maintenance; guaranteed and steady road maintenance budgets to be set year on year to allow for better planning of routine maintenance works[33] with examples being taken from other European countries such as Germany, and to take into account roads users' needs in maintenance activities including shortening the duration and therefore the impact of road work durations on journey times and economic performance.

[31] World Bank (2009) – Implementation and completion results report on a loan of Euro 100 million to the Republic of Poland for a road maintenance and rehabilitation project.
[32] EC Harris Research, International focus on Poland (2012) Time to invest in Poland – Competition tightening as EU funded infrastructure workload slows.
[33] Ernst and Young 2012, Effectiveness of national roads maintenance management in Poland.

8. CASE STUDY PORTUGAL

8.1 Introduction

Portugal's total road network is 11,000 km long, of which 2,700 km is motorways. Portugal's level of car ownership in 2011 was 447 passenger cars per 1000 inhabitants, an increase of 29% on the 2001 value (Eurostat).

8.2 Road Safety

In 2011, Portugal recorded 891 fatalities on its roads, which stands as a 47% decrease from its 2001 level. When road safety is judged in proportion to its population, Portugal scores consistently worse than the EU27 average. In terms of fatalities per million inhabitants, Portugal's 84 is above the EU27 average of 60. Portugal registered 105 fatalities per 10 billion passenger kilometres (again worse than the EU average of 61), whilst its figure of 189 fatalities per million passenger cars is also higher than the EU average of 126. There were 32,500 accidents resulting in personal injury on Portuguese roads in 2011, which represents a 24% decrease on the same figure recorded in 2001 (Eurostat and OECD).

8.3 Stakeholders and Responsibilities

In Portugal there are several institutions and companies that play a key role in road maintenance and safety, along with others that play a more indirect role. This section sets out the main stakeholders in Portugal and their responsibilities. The list is not exhaustive but gives an overview of the Portuguese institutional framework across the different levels of decision making. Some of the stakeholders approached to assist in the preparation of this case study belong to these organisations.

8.3.1 List of stakeholders and their responsibilities

Secretary of Public works, Transport and Communication at the Ministry of Economy: the central authority which is in charge of transportation policy.

Instituto da Mobilidade e dos Transportes, IMT, I.P[34]: responsible for the regulation and supervision of the road infrastructure sector and for the supervision and regulation of its execution, conservation and management.

Estradas de Portugal, EP[35]: responsible for managing the existing and future National Road Network. It is also responsible for the planning and construction of changes to the network.

[34] IMT - http://www.imtt.pt/sites/IMTT/Portugues/Paginas/IMTHome.aspx
[35] Estradas de Portugal - http://www.estradasdeportugal.pt/index.php

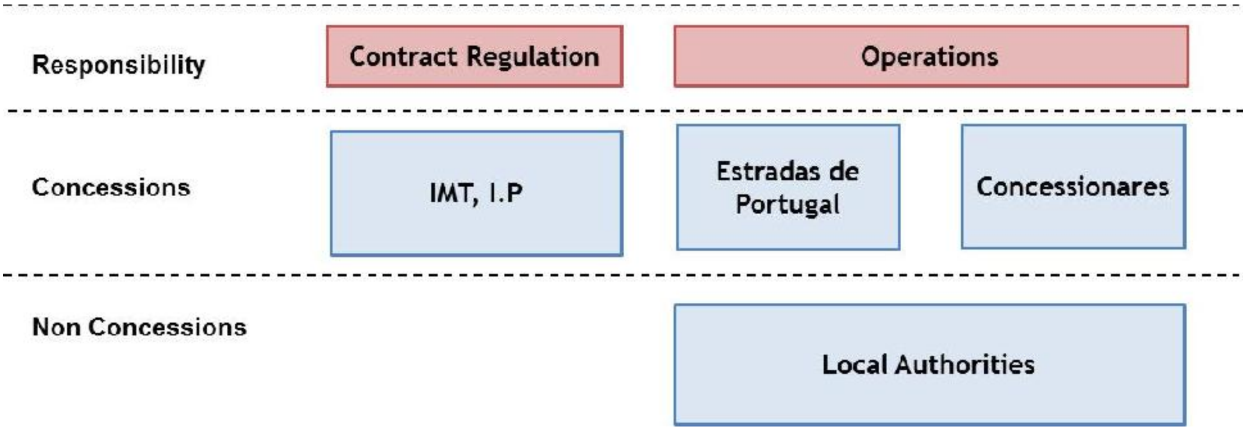
Brisa[36]: a private highways concessionaire in Portugal. Currently Brisa has 6 concessions in Portugal that includes 17 highways and a total of 1352km of motorways that it operates and maintains (approximately 50% of the total highway network).

Local authorities: such as the Municipality of Lisbon which also has road infrastructure responsibilities.

8.3.2 Institutional framework and recent changes

Figure 45 below summarises the general responsible for road regulation and operations.

Figure 45: Regulation and Operation Responsibilities by Stakeholder



Source: SDG Analysis.

In recent years, the organizational structure has gone through a number of changes and the current framework is still quite recent. For example, IMT was restructured and created in 2012, following the merger of several entities. EP was created following the merger of a number of different authorities. The economic crisis has meant that the institutional reorganisation has also been accompanied by substantial budget cuts.

8.3.3 National Road Plans

The National Road Plan was implemented in 1985 and covers all roads excluding local roads belonging to the municipalities.

The National Road Plan 2000 was defined in the Decreto-Lei n.o 222/98 which introduced several significant innovations to enhance the development of the road transport network, the reduction of global road costs and the increase in road safety. In order to accelerate the economic development of some regions, some roads were reclassified to increase their importance. It was also decided to improve the accessibility to some counties in order to correct the asymmetric socio economic developments of the country[37].

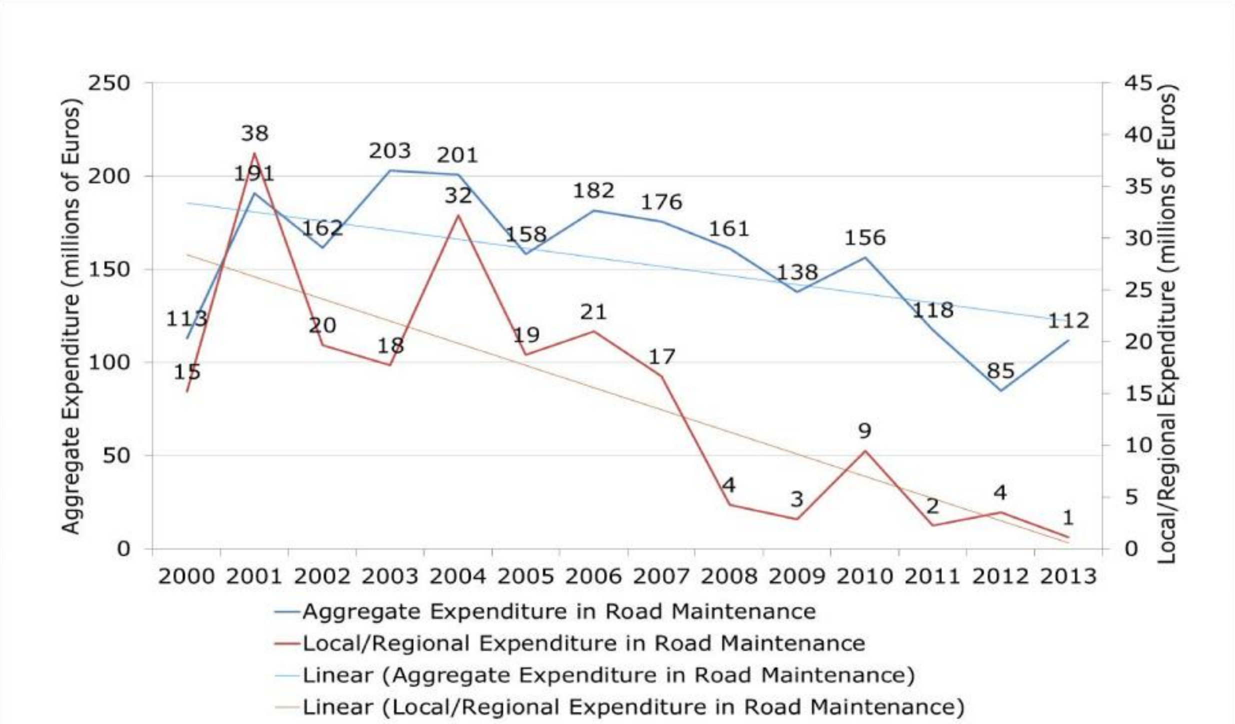
[36] Brisa - http://www.brisa.pt/PresentationLayer/homepageinternacional.aspx?menuid=70
[37] http://www.estradasdeportugal.pt/index.php/pt/areas-de-atuacao/prn/142-legislacao

8.4 Maintenance Budgets

8.4.1 Infrastructure Spending

Aggregate expenditure increased significantly between 2000 and 2003, from approximately €113m to €203m, and since then there has been a gradual fall in expenditure. In 2013, the amount spent was the same as that spent in 2000. Furthermore, in 2008 there was a significant drop in expenditure on local and regional roads which remains low today. Overall, the data shows that, since 2000, there has been an overall downward trend in road expenditure both at the national and at the local level.

Figure 46: EP Expenditure in Road Maintenance



Source: EP.

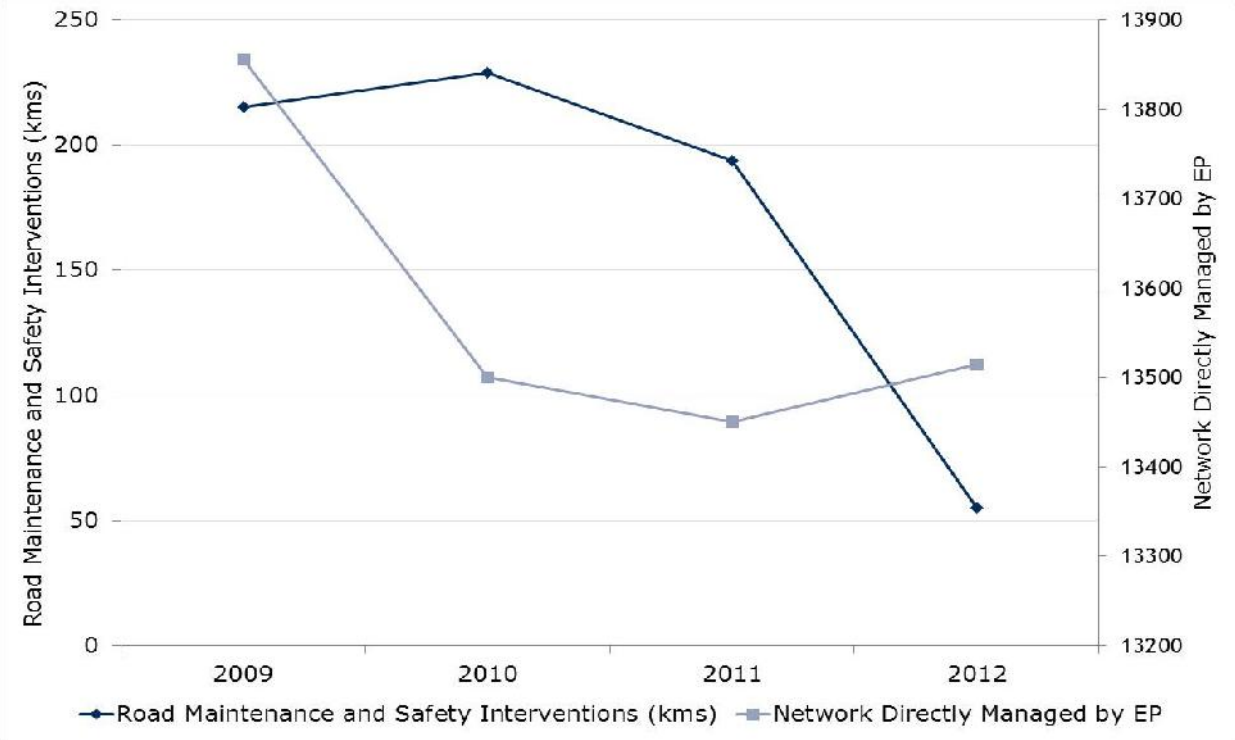
Figure 47 shows the extension of the network directly managed by EP and the network that received maintenance and safety interventions between 2009 and 2012[38].

The network directly managed by EP decreased from 13,855km to 13,450km between 2009 and 2011, and then it increased to 13,515km in 2012. In addition, the amount of network that received maintenance and safety interventions increased slightly between 2009 and 2010, from 215km to 229km. This increase corresponds to a period where the expenditure in road maintenance in aggregate and regional/local levels increased. After 2010, there was a dramatic drop, reaching 55km in 2012.

This means that less than 2% of the network directly managed by EP had any type of road maintenance and safety interventions per year. If we also consider road construction and reconfiguration, this value increases slightly but remains lower than 3%.

[38] EP Annual Reports.

Figure 47: Road Maintenance and Safety Interventions and Network directly Managed by EP (Kms)



Source: EP Annual Reports.

8.4.2 Criteria to allocate the Budget to Road Maintenance

The budgets for road maintenance are defined exclusively through the necessities identified through the Maintenance Management Systems. The allocation will then depend on the prioritization defined in EP's medium term Action Plan and the available budget to execute it[39].The same is true for Brisa O&M, there are no upper or lower limits regarding the allocation of budget to maintenance activities. The allocation of resources is based on a rigorous analysis of the data collected through infrastructure monitoring. Brisa also bases the budget decision on previous experience in maintenance activity[40].

8.4.3 Performance Monitoring

Different techniques and methodologies have been adopted by the different institutions to monitor road quality in order to ensure that road managers can make informed decisions on road maintenance expenditure.

EP's Maintenance Management System is described in a paper published by 3 EP employees[41]. This section is mainly based on information from this paper. EP contracted out the development of a tool called Sistema de Gestão de Conservação de Pavimentos - SGPav (Pavements Conservation Management System). This tool was developed between 2003 and 2007 and since then, EP started to evaluate the quality of the surface at a National Level through Road Inspections and Interventions Inventory updates. The road inventory was finished by the end of 2010, which gave EP a global view of the roads network condition.

39 EP contribution.
40 Brisa O&M contribution.
41 http://www.crp.pt/docs/A45S129-149_Art_T5_7CRP_2013.pdf

In this process, EP used VIZIROAD software to identify and measure the different parameters of road damages using simultaneously a GPS device. Overall, a team of 3 people could inspect, on average, 80km of roads per day.

In 2010, EP started to use a Laser Profilometer that could measure the difference in surface height in order to assess the ideal profile. This enabled EP to calculate international longitudinal indicators such as the International Roughness Index. Through 14 laser sensors, it is possible to obtain a real time image of the transversal profile of the road. It is also possible to measure other parameters like the macro texture of the pavements surface, longitudinal and transversal slopes and radius of curvature. In 2012, a tool to film with high definition images was included, improving the efficiency of operations with two people able to inspect more than 200km per day.

To evaluate the quality of the roads, an index that ranges between 0 and 5 is used, where the higher the value, the better the quality. The indicator's ranges, classes and strategies to adopt are described in following table.

Table 16: Quality Index used by EP

Index	Class	Strategy
Index<2.5	Bad	Necessary to intervene
1.5≤Index<2.5	Mediocre	Necessary to give intervention priorities
2.5≤Index<3.5	Reasonable	Stable network, interventions depend on the quality evolution
≥3.5	Good	New Network, no need of intervention

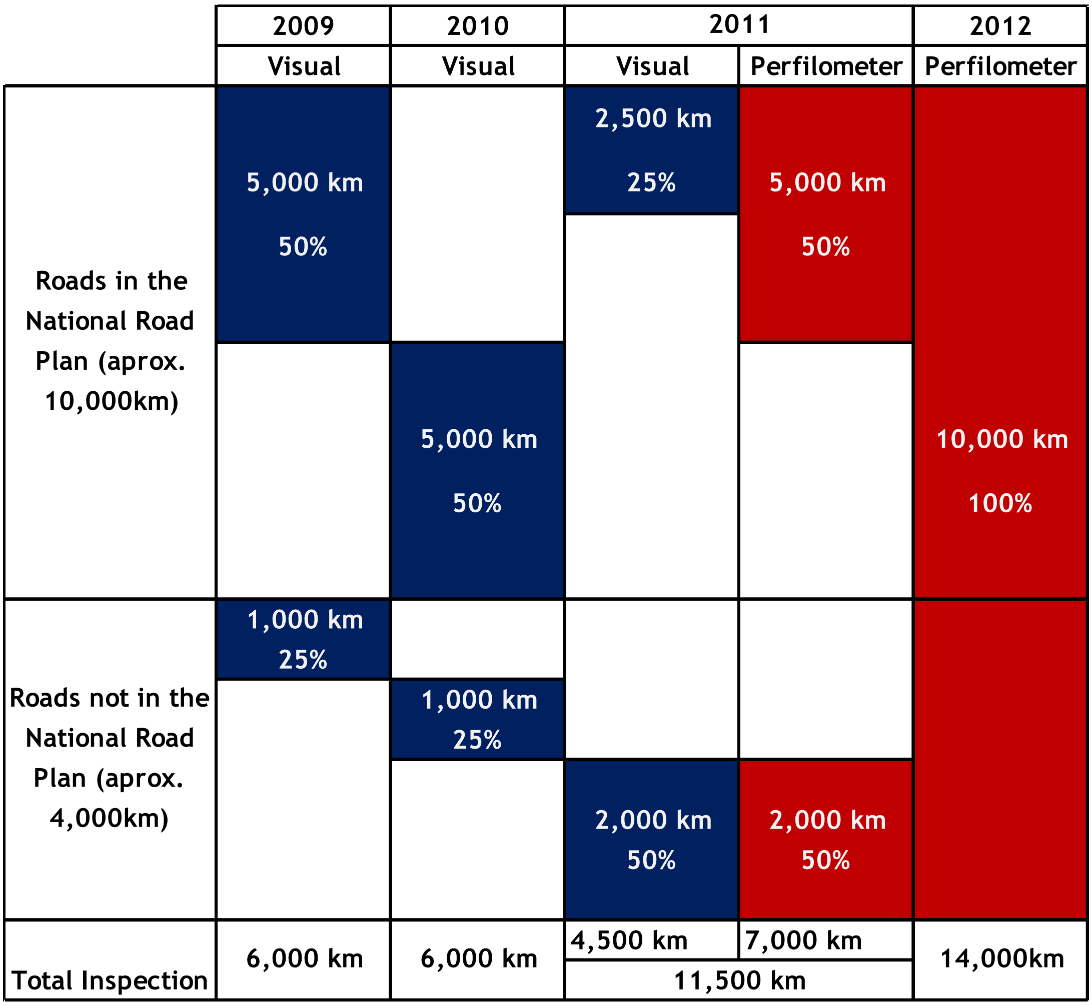
Source: "O Sistema de Gestão de Conservação de Pavimentos da Estradas de Portugal, S.A. - Balanço de uma Implementação Consolidada".

For 2011, the average quality level was 2.82 and this level was kept constant, around 3, between 2007 and 2011. Following the completion of the evaluation, EP adopted a procedure to define the priority interventions, which was based on two criteria:

- the technical urgency and
- the investment adequacy given the traffic in each road.

Each intervention is then ranked using a weight of 65% and 35% for each of these two criteria respectively. Finally, the investment decision will follow this ranking of interventions until the budget limit is reached for each year. This approach makes multiannual planning for the road interventions easier. The figure below sets out the different techniques used for inspecting roads between 2009 and 2012, showing the smooth transition from visual inspections to using the perfilometer.

Figure 48: EP Historic Inspections



Source: "O Sistema de Gestão de Conservação de Pavimentos da Estradas de Portugal, S.A. - Balanço de uma Implementação Consolidada".

In 2011, after the visual inspection of 13,000km of roads, EP concluded that the Portuguese roads had a reasonable level of quality, and for the period 2007-2011, the index of quality was stable.

InIR was a public institute that had the responsibility to supervise the operation and management of the road network in Portugal and it was later merged with IMT. InIR presented at a conference in 2009, information on the indicators of pavement maintenance. The objective was to establish uniform indicators to be applied across all concessions for operation and management. It describes the different methods, the necessary equipment, where the different methods should be applied, the indexes that can be calculated and how often the method should be applied. Some of the methods are described below:

- Longitudinal Irregularity Index (IRI): Assessment of the longitudinal regularity using a profilometer. It will then be possible to calculate the regularity index;
- Transversal Friction Coefficient (CAT): Assessment to evaluate the resistance to skidding of the pavement when it is wet. calculated primarily using the SCRIM (Sidewalk Force Coefficient Routine Investigation Machine) tool;

- Surface Texture Measurement: Assessment used to evaluate the skid resistance and the adherence of the tire and the pavement. Calculated using laser equipment such as MPD (Mean Profile Depth) or SMTD (Sensor Measure Texture Depth);
- Transversal Regularity Measurement (CR): Assessment used to measure the transversal regularity a using metallic ruler with 3000±3mm;
- Freight Capacity Measurement: Used to assess the mechanic resistance of the pavement by using a Falling Weight Deflectometer;

Even though it is not clear if normalized techniques were applied in Portugal before this presentation, it proved that there was awareness of the issue and the intention to use more of these techniques. This work can be seen as a manual of the different techniques and how they can be applied. EP is currently using a profilometer that is able to calculate the International Roughness Index (IRI).

8.5 Socio-economic Impacts of Road Maintenance

8.5.1 Communication with Road Users

EP offers road users road operational information on their website. It also has a call centre and an app with the information regarding road operation as well as access to the video cameras.

Figure 49: App images

Source: Google Play store.

In terms of communication with the users, Brisa has available on its website an app that gives information in real time about traffic and maintenance works. Brisa O&M has a similar way to communicate with the users. Brisa is obliged to inform the users about long term road works through the media, with some time in advance. The highways operated by Brisa also have SOS stations. In terms of local authorities, Lisbon city council provides online information regarding the maintenance works that are being undertaken.

8.5.2 Other relevant studies

The road user association ACA-M has on its website a 2007 study[42] where the different accident factors are analysed. The study explores the accident causes relating to the vehicle, the driver, the road and the environment. In terms of road conditions, the author gives several examples about the sub-optimal design of roads and roadside signs. It also provides examples of the lack of road maintenance. For the case of Lisbon, the author claimed that roads have in general a poor level of maintenance. Two examples are given, where manhole covers were responsible for accidents and damages in car suspensions and where the asphalt was very irregular.

8.5.3 Opinion from other stakeholders

The Associação dos Industriais da Construção Civil e Obras Públicas (AICCOPN, acronym for Association of the public power and civil construction industrials) considers that part of the road network needs maintenance works urgently and they are concerned that the budget cuts suffered recently through the austerity program may compromise the realization of these works[43].

Even though the technology and the inspections to assess road quality aim to give an objective evaluation, there were still different opinions. The Cities and Roads Safety Observatory (OSEC) thinks that it is inappropriate to say visual inspections enable a positive evaluation of the road conditions parameters.[44]

8.6 Summary for Portugal

Budget cuts in Portugal have led to a decrease in road maintenance expenditure in recent years. Data is somewhat contrasting in relation to maintenance expenditure as while OECD data points to a fall in the period 2006-2010, the quality index calculated by EP for 2007-2011 seems to be stable, possibly showing that the full effects of the budget cuts have yet to be felt. There are a number of factors that can explain this, for example, an increase in construction of new roads, more efficient ways to maintain the roads or better decisions in allocation of resources. As mentioned above some stakeholders have questioned the validity of the EP quality evaluation.

Regarding the use of maintenance techniques, EP seems to be applying a consistent program since 2007, by introducing new technologies but also trying to make the results that it extracts comparable. Laser inspections were introduced in 2011 and enable EP to do the inspections more quickly and using less people. The results seem to have a greater level of detail compared to visual inspections.

[42] http://www.aca-m.org/w/images/3/3d/Factores_potenciadores_sinistralidade_rodoviaria.pdf
[43] http://www.aiccopn.pt/news.php?news_id=1591
[44] http://www.tsf.pt/PaginaInicial/Portugal/Interior.aspx?content_id=1875574&page=-1

Regarding the communication with the users, it seems that EP, highway concessionaires and local authorities communicate with the road users mainly through the internet or an app. In several cases, real time information is provided. This can lead to improved traffic management in the presence of road works for maintenance.

With respect to economic impacts, even though there is a limited amount of information specifically about Portugal, the study available on the ACA-M website explores the different accident causes, including the driver, the vehicle, the road and the environment. The objective of the study is to distinguish the causes and highlight several examples of bad practices for each of the car accidents causes. The author highlights two specific situations related to road maintenance in Lisbon, where manhole covers have a negative impact on the suspension of the car and where the asphalt is in bad condition. The study finds that different factors, including low expenditure in road maintenance, can cause accidents or have a negative impact on the vehicles.

9. CASE STUDY ROMANIA

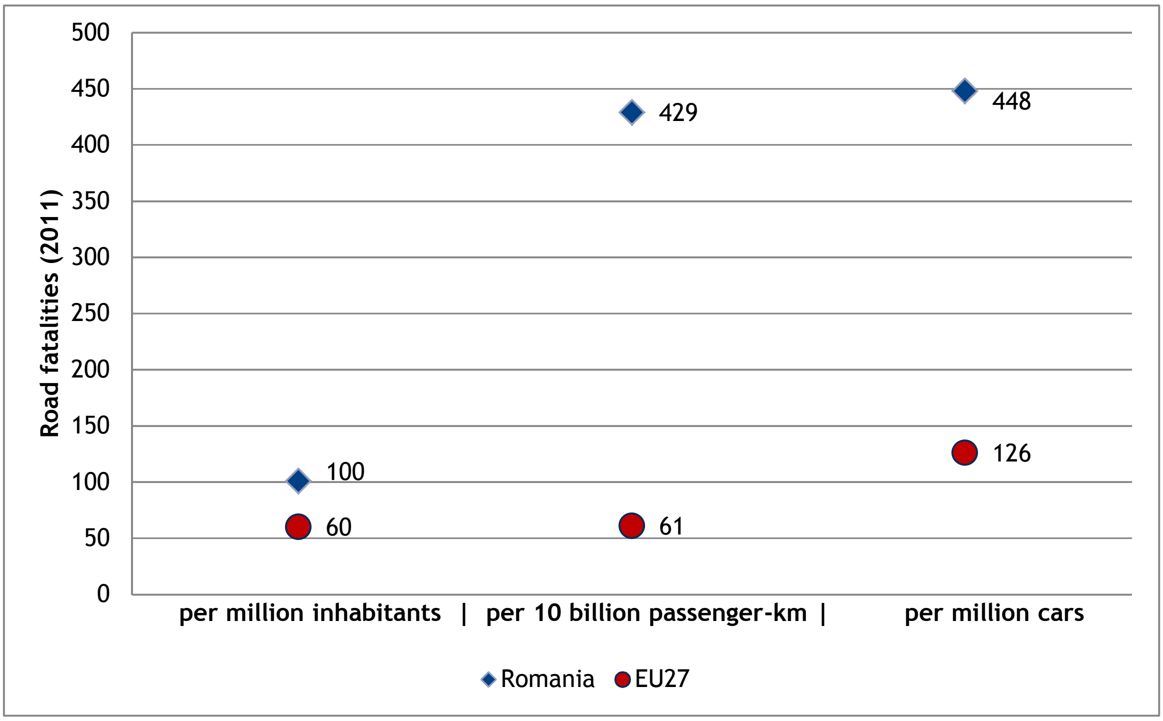
9.1 Member State overview

Romania's total road network is 195,589 km long, with 84,185 km public roads, of which 550 km are motorways. Modernized roads account for 27,665 km of the total network. Car ownership in Romania is 225 passenger cars per 1000 inhabitants, this figure grew by 46% in the period 2002-2013 (DRPCIV – The Driving Licenses and Vehicle Registration Authority).

9.2 Road safety statistics

In 2011, Romania recorded 2,018 fatalities on its roads, which represented a 34% decrease from its 2008 level, of which 55% were on national roads. Romania's roads had 9,290 accidents resulting in personal injury in 2011, which is a 12.7% decrease on the same figure recorded in 2008, this was an increase of 38.88% from the figure recorded in 2003 (CNADNR - The National Company of Motorways and National Roads of Romania).
When Romania's road safety record is analysed in relation to its population, it can be seen that it has one of the least safe road networks in Europe. In terms of fatalities per million inhabitants, Romania's 100.9 is one of the highest in Europe (EU27 average = 60). In 2010, Romania recorded 429 fatalities per 10 billion passenger kilometres, which is much higher than the EU average of 61. Romania's 448 fatalities per million passenger cars is also one of the highest in Europe – the EU average is 126. Figure 50 below summarises these results.

Figure 50: Road fatalities ratios – Romania and EU27 (2011)



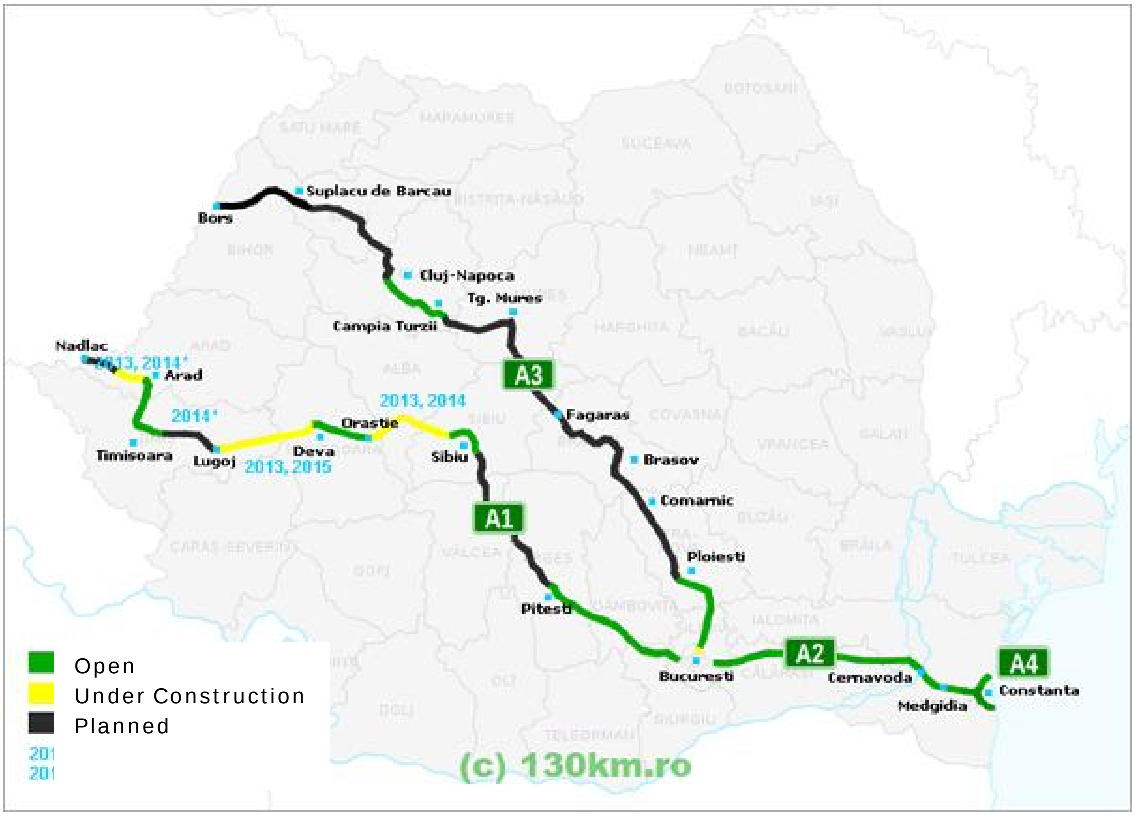
Source: CNADNR.

More than 95% of national roads are single carriageway roads, therefore driving involves a lot of potentially dangerous overtaking. This increases the risk of accidents and makes driving more aggressive.

The two main objectives of the Ministry of Transport are to rapidly increase the length of the motorways and to introduce more dual carriageway roads in order to increase safety and reduce traffic congestion.

Romania currently has approximately 550 km of highway with another 84 km to be open to traffic in late 2013/early 2014. With increased focus on building new motorways there is a risk of a decrease in the maintenance budget, in proportion to the country's needs.

Figure 51: Romania's motorway network



Source: 130km.ro website.

Other Ministry of Transport actions for increasing road safety include:

- Improving driver training;
- Improving the legal framework and increasing efficiency in enforcement (less than 50% of fines are paid).

The CNADNR has also started testing new safety strategies. One safety project on DN1, between Saftica and Balotesti, managed to reduce the accident rate by over 65% through:

- Separating carriageways;
- Remodelling intersection and altering the radius of curves;
- Adding pedestrian refuge points at crossings.

9.3 Maintenance budgets analysis

9.3.1 Road infrastructure and maintenance spending in Romania

Road infrastructure spending in Romania is highly dependent on central government funding. There is a road tax for the National Roads network but there are no tolled roads. CNADNR, an Executive Agency of the Department of Infrastructure Projects and Foreign Investment (DPIIS), is responsible for operating, maintaining and improving the National Road Network in Romania. The National Road Network comprises 19.3% of the total public road network in Romania, but it serves 75% of all road traffic. The development and maintenance of other roads is the responsibility of local authorities.
Although the road maintenance budget increased by 78% between 2004 and 2008, the percentage allocated to this budget from the GDP actually decreased by 23.7%

Figure 52: Total Spending on Roads, 2004-2008 (% of GDP)

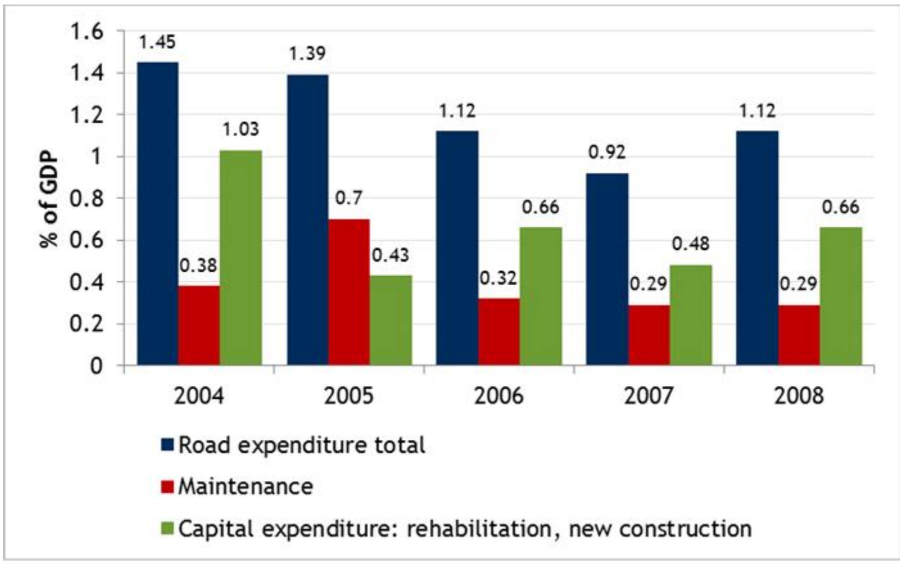
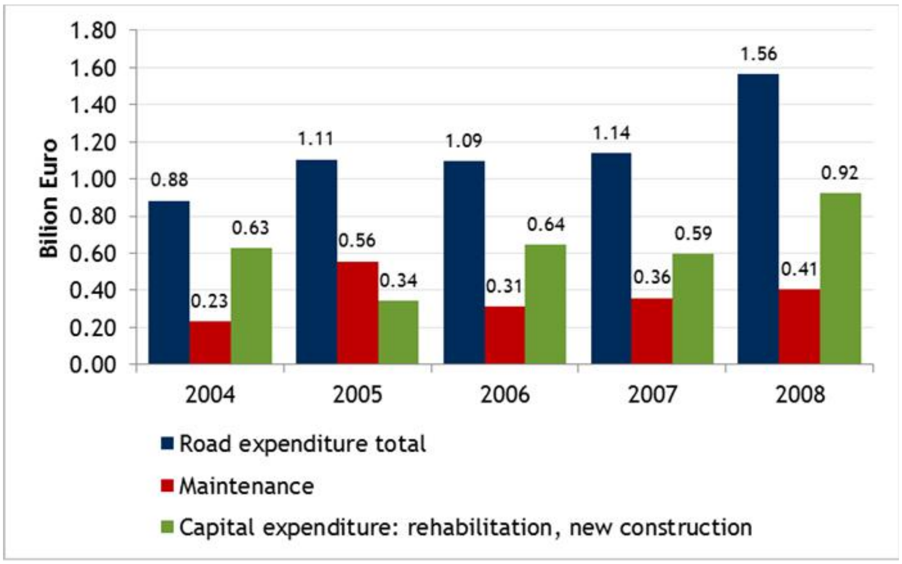


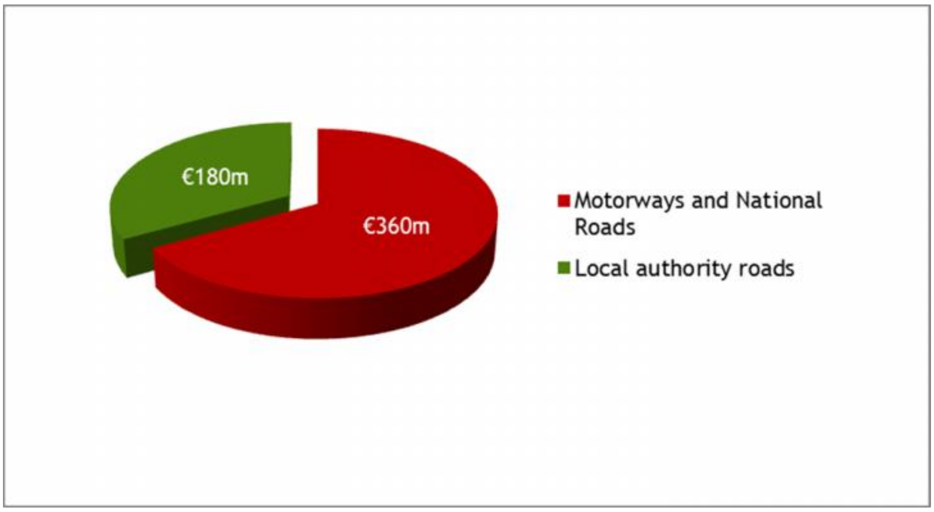
Figure 53: Total Spending on Roads, 2004-2008 (Billion Euro)



Sources: World Bank estimates; CNADNR; Ziarul Financiar.

The national roads and motorways maintenance budget for the period 2008-2013 was 9.26bn RON (€ 2.15bn), which is equivalent to around €360 mil. per annum (CNADNR). There are 41 counties in Romania, each has an average annual budget for road maintenance of about €4.5m amounting to a total of RON775m (€180m)[45] per annum. Expenditure by local authorities covers between 30% and 40% of total road maintenance spending in Romania each year. Local authority spending is further split into expenditure on principal roads and on minor roads.

Figure 54: Share of road maintenance expenditure by road type



Sources: CNADNR; Local Councils.

9.3.2 Road investment finance

Until 1992, all road maintenance in Romania was paid for on the basis of the time taken and material consumed.

In 1995, with the strong support of the central economic agencies, the government created a Road Fund, initially fed by supplementary taxes on petrol, diesel fuel, and vehicle registration, complemented later by annual fees on vehicle capacity. In 1997 this fund collected US$250m (€227m)[46], financing over 90% of road expenditures, which freed budgetary resources for other purposes. Road finance is now based on user-related taxes that aim to recover the cost of road use from vehicle owners and operators according to the costs they impose on the road network.

Long-term relationships have been established with the international financial institutions, which have secured finance for road rehabilitation. This type of financial support has grown considerably in recent years, supporting the Romanian government's efforts to provide operational and maintenance expenditure on the national road network in conjunction with tax revenues.

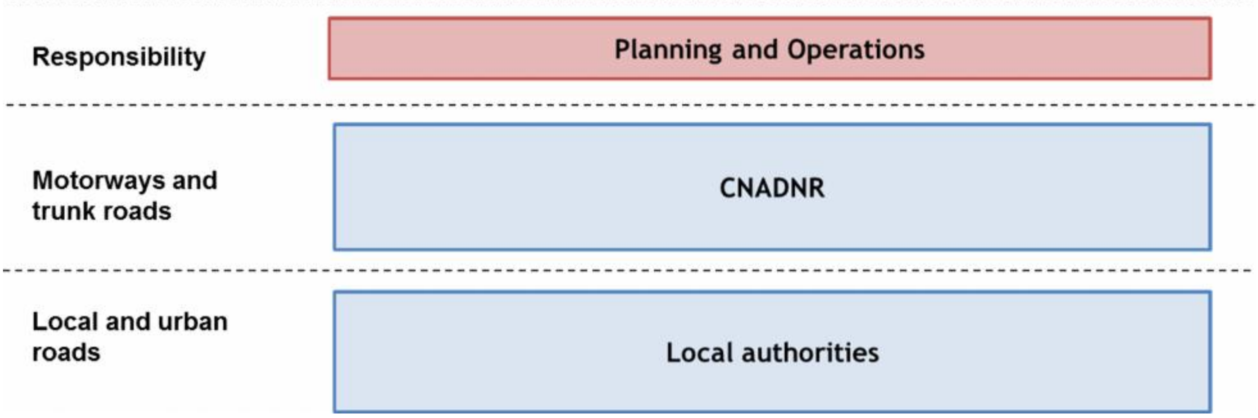
[45] Based on the January 2012 exchange rate : EUR/RON = 4.31
[46] Based on the first exchange rate from 1999 : EUR/USD = 1.1

9.4 Road performance monitoring

9.4.1 Responsibilities

The national roads and motorways are monitored and maintained by CNADNR while local roads are managed and maintained by Local Authorities.

Figure 55: Responsibility over road maintenance by road type



Source: SDG illustration.

9.4.2 Assessment of road surface quality

The assessment of road surface quality is done by the authority that is responsible for that road. By using an optimised road management system (PMS) and a bridge management system (BMS), CNADNR is looking to make road and bridge maintenance more efficient by considering the managing costs and the impact that the quality of the road network has on the costs of the road users.

This system uses different strategies to establish either a single road section's maintenance and rehabilitation policy or the policy for the entire road network. It also allows the optimum usage of resources, time saving and helping the manager to make the best decisions regarding the type of works that are needed along with their prioritisation.

9.4.3 Maintenance intervention

As a result of adverse weather conditions, winter road snow clearing is a large part of the operating expenditure for road managers. During the 2012-2013 winter, the National Road Network snow clearing and other winter specific activities cost on was RON 209m (€47.5m), equivalent to 14% of the yearly maintenance budget (CNADNR). The need to clear snow from roads is dictated by the adverse impacts on surface resilience of high, prolonged snow depths.

9.5 Socio-economic impacts of road maintenance

A series of interviews carried out with road freight associations in Romania revealed that potential customers were concerned with, among others, the poor quality of the domestic road network limiting the domestic market.

By way of example, it can take up to 16 hours for a truck leaving Timisoara to reach Bucharest, 580km away, due to bad quality of roads which increase delays en-route; delays are also often registered en-route from Constanta due to congestion in the Port of Constanta and bad quality infrastructure.

The main challenge facing freight companies is the poor quality of the roads for both international and local traffic. These have a significant impact especially on the margins for agro-food products with short shelf life (ADRVEST). According to the Road Transporter's National Union (UNTRR) the cost of traffic congestion is over €200m per year and is reflected in the product's shelf price that Romanian consumers have to pay for.

The state of county roads has a deep impact at a lower geographical economic level. The trade potential of local businesses is restricted to a limited area and investors are discouraged from investing in more remote locations due to poor road infrastructure.

9.6 Summary for Romania

Romania's road infrastructure is among the least developed in Europe in terms of coverage, and scores poorly in both connectivity with other EU member states and safety.

However 85% of the goods and passenger transports take place by road. Therefore the national logistics sector is penalised by the poor quality of roads and transport costs are pushed up.

Other negative social impacts of poorly maintained roads include a very high number of fatalities and the persistent economic isolation of remote communities. As motorway expansion continues, there is a risk that the maintenance budget would suffer a decrease.

10. CASE STUDY SPAIN

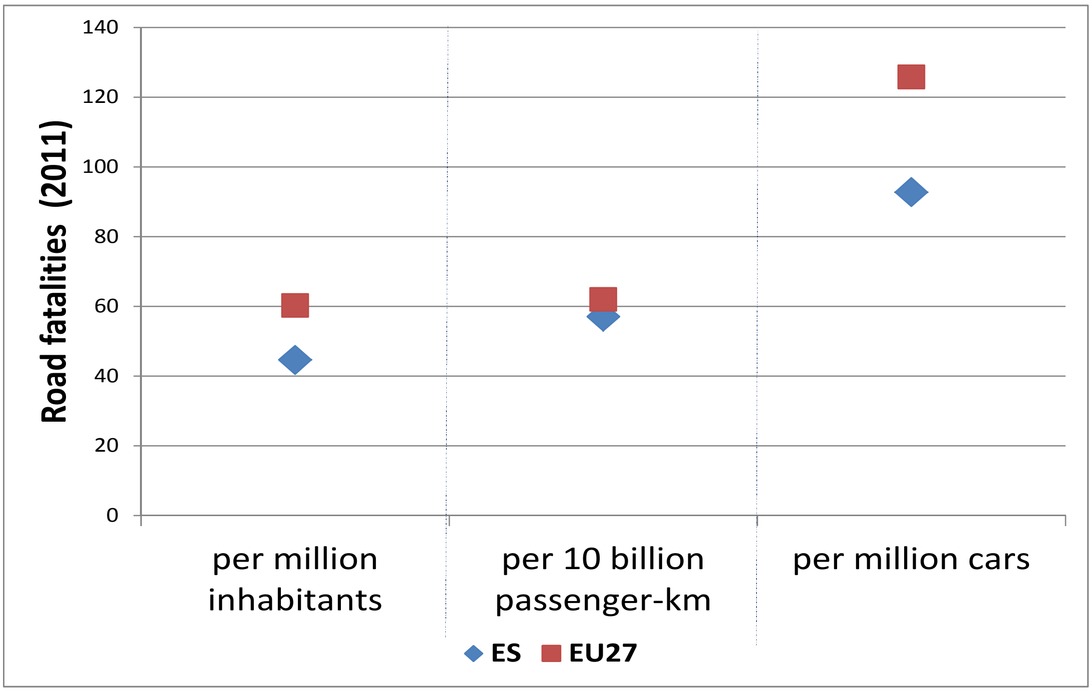
10.1 Member State overview

Spain's total road network is 150,000 km long, of which 15,000 km are motorways. Car ownership in Spain is 482 passenger cars per 1000 inhabitants. This measure has seen a small increase in the period 2001-2011; car ownership has increased by 8.8% in the same period (Eurostat).

10.2 Road safety statistics

In 2011, Spain recorded 2,060 fatalities on its roads, which is a significant (63%) decrease from its 2001 level, indeed this is a greater percentage reduction in fatalities than most other EU nations (only Latvia's fatalities fell by a greater proportion over this period). When Spain's road safety is evaluated in proportion to its population it also scores reasonably well. In terms of fatalities per million inhabitants, Spain's 45 is lower than the EU27 average of 60. Spain recorded 60 fatalities per 10 billion passenger kilometres, which is close to the EU average of 61, whilst its figure of 93 fatalities per million passenger cars is markedly less than the EU average of 126. Spain's roads saw 83,000 accidents resulting in personal injury in 2011, which is a 17.3% decrease on the same figure recorded in 2001 (Eurostat and OECD).

Figure 56: Road fatalities ratios – ES and EU27 (2011)



Source: Eurostat.

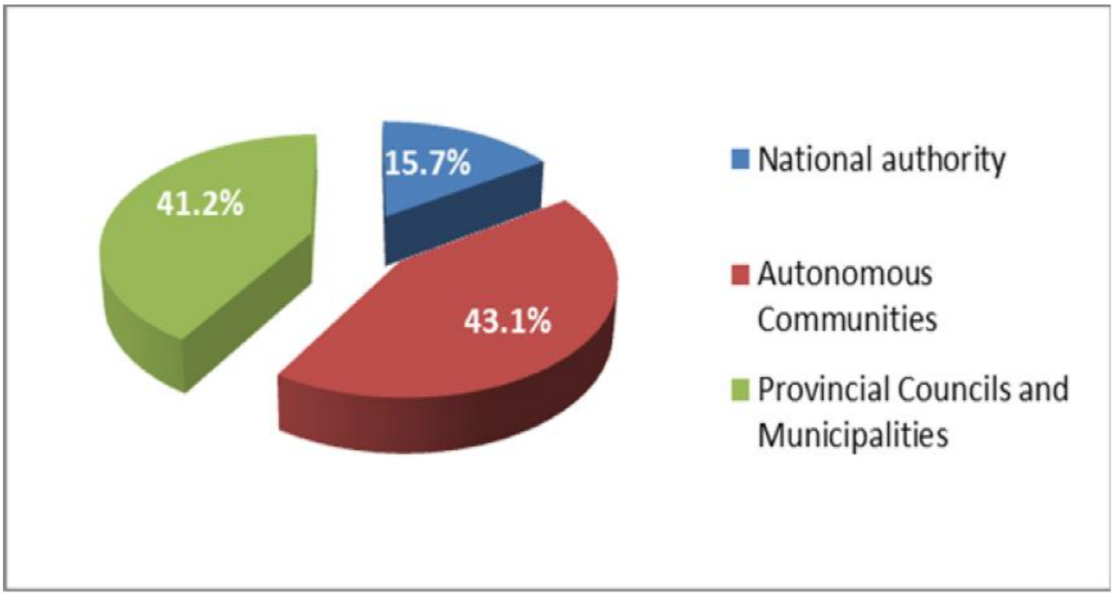
10.3 Maintenance budgets analysis

10.3.1 Road infrastructure and maintenance spending in Spain

Road network management and operation in Spain is under the responsibility of the General Direction for Roads (Dirección General de Carreteras), a section of the General Secretary for Infrastructure (Secreteria General de Infrastrcuturas), that reports to the Secretary of State for Infrastructure, Transport and Housing (Secretaria de Estado de infraestructura, transporte y vivienda). The whole structure is included in the Ministry of Development (Ministerio de Fomento). Management and maintenance are respectively the responsibility of the General Branch for operations and network management (Subdirección General de Explotación y Gestión de la Red) and the Branch for maintenance (Subdirección de Conservación).

The national authority is responsible for the operation of only 15.7% of the total road network in Spain. The rest of the network is operated by: Autonomous Communities (Comunidades Autónomas) 43,1%, and the Provincial Councils and Municipalities (Diputaciones y cabildos) 41.2%.

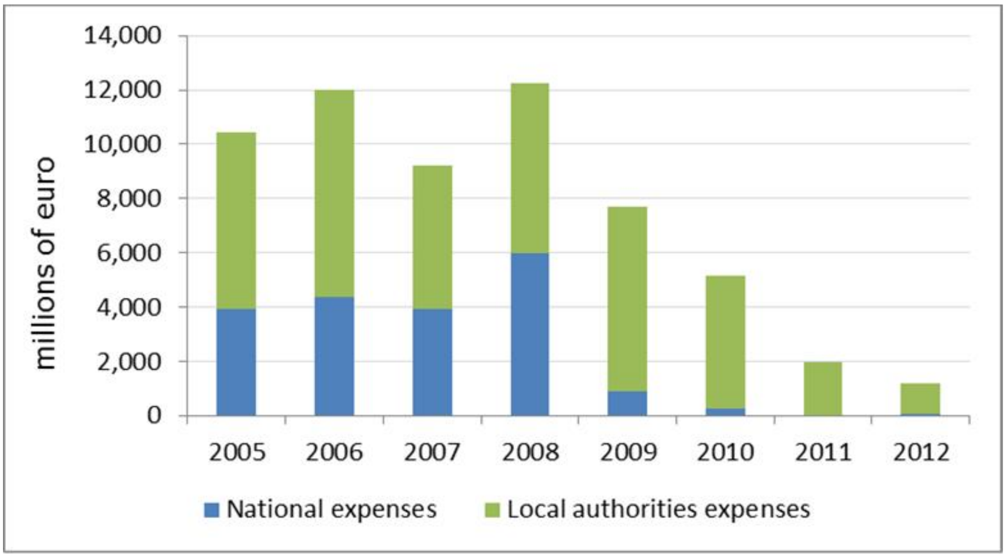
Figure 57: Share of Road network operational responsibility



Source: DGT (2012).

Road infrastructure spending in Spain is highly dependent on government funding. Expenditure is divided between the National Government and Local Authorities. As can be seen in the figure, the decrease in budget allocation for road network operations has been particularly significant at the national level in the past few years. National government allocation for road infrastructure went from €5,989 mil. in 2008 to €76 mil. in 2012. The share of expenditure by local authorities has thus increased, however severe cuts have also been made to local budgets. This reduction partly reflects a return to “long-term” spending patterns after a construction boom in the past decade.

Figure 58: Total expenditure in road infrastructure in Spain



Source: Ministerio de Fomento (2012).

The figure above refers to the expenditure for 98% of the national road network in Spain. The remaining 2% is covered by concession agreements and funds for maintenance activities on these roads come from different sources, including concession toll revenues.

Management and maintenance of the tolled highways is the responsibility of the concessionaires, and regulated by individual concession contracts. Revenues for maintenance are linked to toll payments, and hence these have been more resilient than public maintenance spending despite the reduction in traffic volumes.

Both management and maintenance of local roads are under the responsibility of municipalities. Local budgets have also been reduced in recent years, as detailed below.

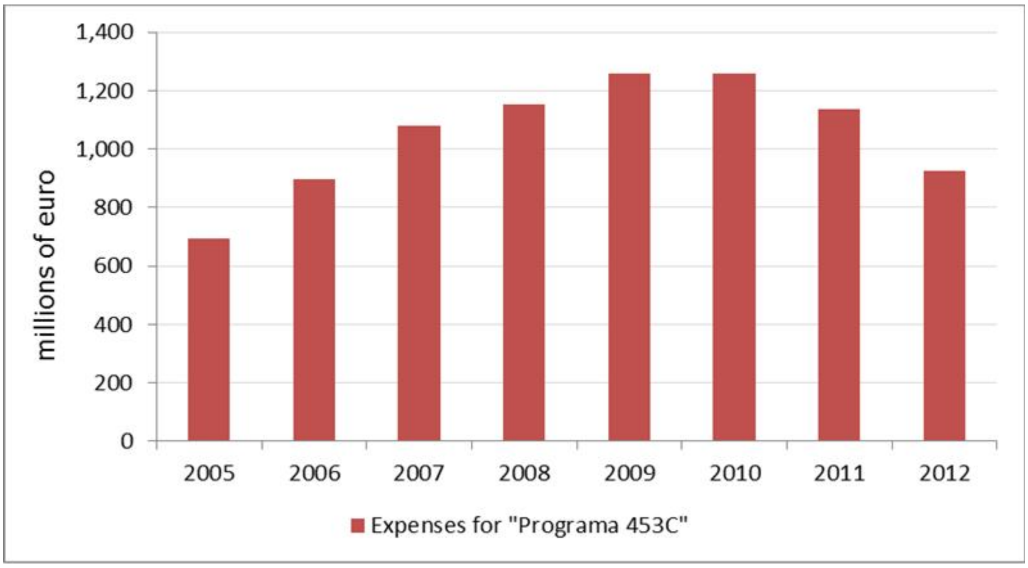
10.3.2 Road maintenance budget outlook

The Road infrastructure spending review started in 2010 has affected the different segments of maintenance budget.

As is set out in Figure below, road maintenance and operational expenditure has decreased in recent years. These costs, included in the budget of the programme 453C (Conservación y explotación de carreteras) went from €1,257 mil. in 2009 to €926 mil. in 2012. The rate of decrease is not as rapid as the decrease of general expenses in road infrastructure, but has been constant since 2010. The Budget allocation for 2013 and 2014, in fact, is respectively €818 mil. and €820 mil.

It should be noted that Programa 453C also includes activities that are not directly related with maintenance interventions including contracts for the ordinary management of the road network. These contracts include actions like cleaning, winter safety operations, replacement of vertical signals etc.

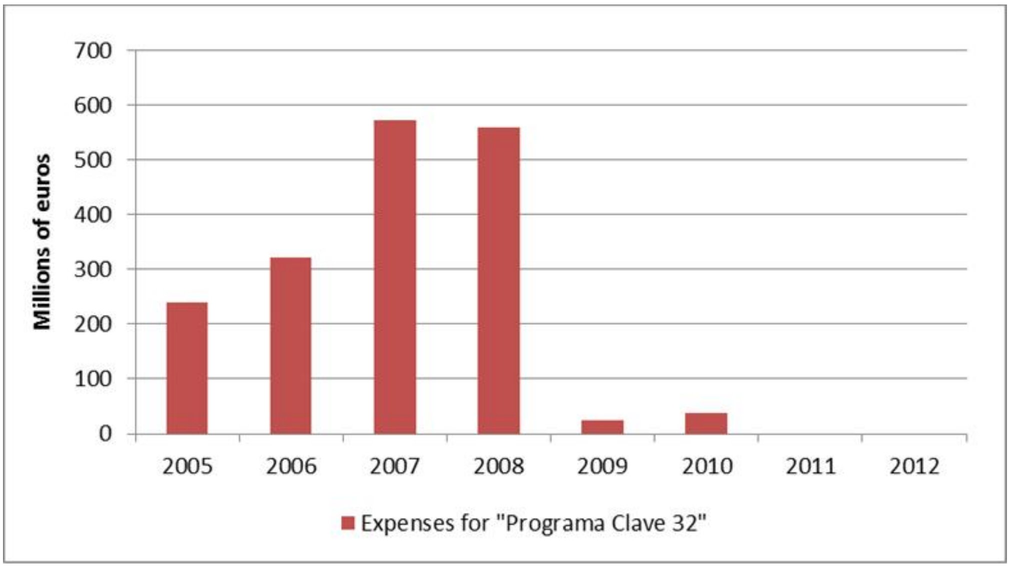
Figure 59: Evolution of Maintenance and operation expenses (Programa 453C)



Source: Val Melús (2010), Ministerio de Fomento (2012).

The effect of a falling budget allocation for road network operations is particularly evident when looking at pavement rehabilitation. For instance, the budget for Project clave 32, dedicated to pavement rehabilitation, went from almost €560 mil. in 2008 to only €37 mil. in 2010. Even more alarming is the fact that in 2011 and 2012 no investments were made in this area. The last tender for Project clave 32 was launched in 2013 (more than 900 days after the previous one in 2010) for the amount of only €11 mil.

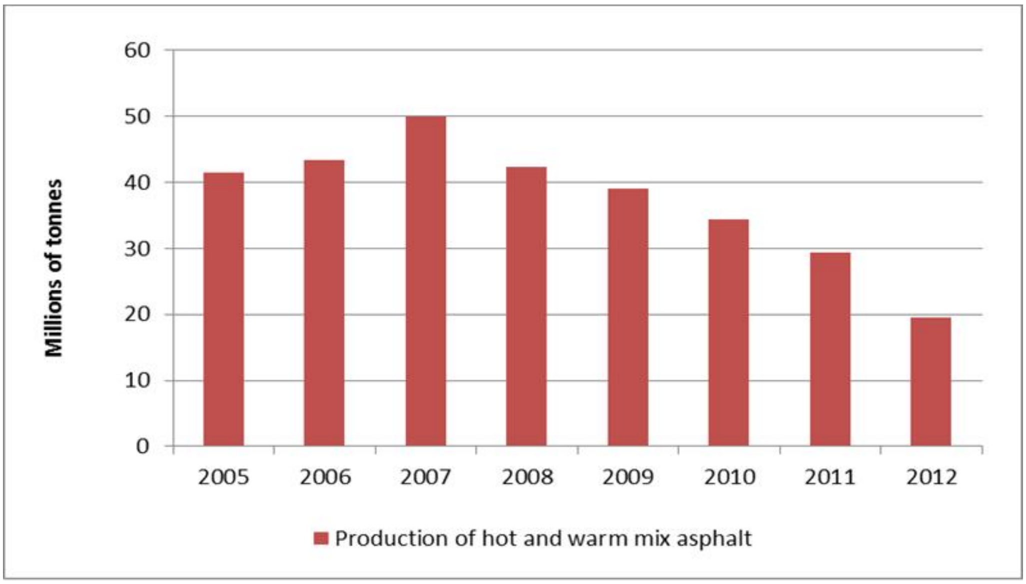
Figure 60: Evolution of pavement rehabilitation costs (Proyecto clave 32)



Source: Val Melús (2010), SEPG (2012, 2013).

The data above refers to the 165,000 km of National Roads. In addition to these, in Spain there are almost 500,000 km of local roads under the responsibility of the Municipal authorities: 128,180 km of urban roads and 361,517 km of extra-urban roads. There is no clear information regarding the exact investment by single municipalities in order to maintain this network, although the figures on asphalt production give an indication of the trends.

Figure 61: Evolution of total production of hot mix asphalt (million tonnes)



Source: EAPA (2012).

This data should be read bearing in mind that:

- In Spain road transportation is, by far, the main mode transportation: 89.5% of passenger journeys and 83.9% of goods transport occur on roads.
- The Spanish Highway network has grown by 249% in the past 20 years, from 4,496 Km in 1993 to 11,676 in 2013.

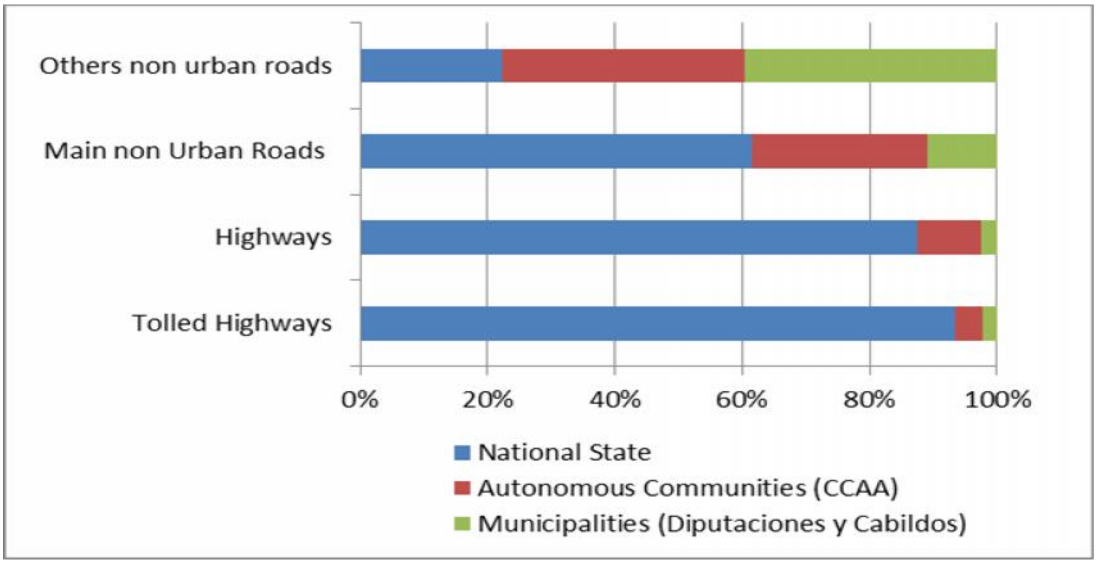
These two factors could mean that in the near future, in order to maintain the Spanish road network, the Government would be required to invest even more than in the first half of the decade 2000.

10.4 Road performance monitoring

10.4.1 Responsibilities for road maintenance

As set out above, the National Government is responsible for the overall state of the entire national Road network, but, as can be seen in Figure 62, the operational management and maintenance is shared with local authorities. Only tolled highways remain almost entirely under the direct responsibility of central government, but in this case the management and maintenance activities are carried out by the concessionaires. The 500,000 km of the local road network is instead entirely the responsibility of Municipalities.

Figure 62: Share of management and maintenance responsibilities on different types of roads of the National Road Network

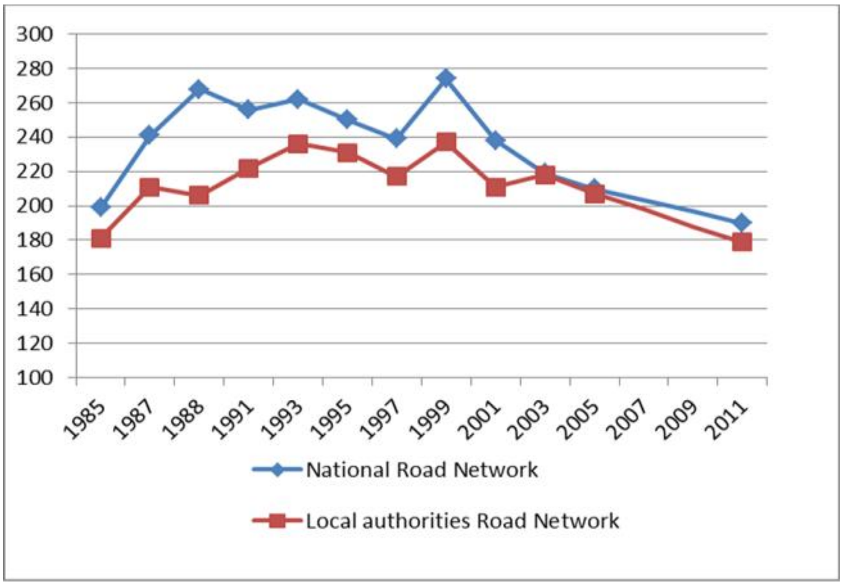


Source: Val Melús (2010).

10.4.2 Assessment of road surface quality

Road surface quality in Spain, according to the national stakeholders gathered under the umbrella of the Spanish Road's Association (Asociación Española de la Carretera), is poor. As can be observed in Figure 63 below, the quality of the road surface (national, local and municipal) in Spain improved in the 1980s and then worsened from the beginning of this century. This fall brought the condition of road surface to the low level registered in 2011.

Figure 63: Evolution of Road surface quality in Spain 1985-2011

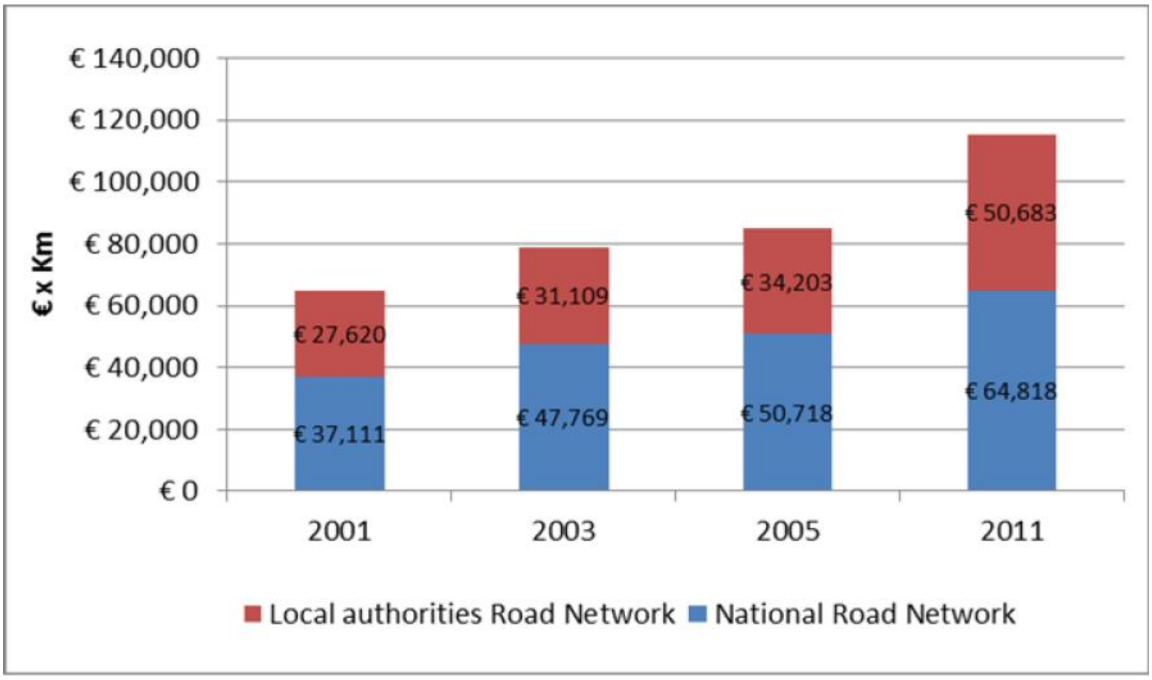


Value	Classification
300-400	Good
200-300	Acceptable
100-200	Deficient
0-100	Very deficient

Source: AEC (2012).

Reduced maintenance expenditure has thus already had some effects on road surface conditions. As a consequence, the Euros per Kilometres needed today in order to re-establish the conditions of safety and comfort for the users has almost doubled from 2001, according to AEC estimates.

Figure 64: Evolution of Investments need in order to maintain Spanish Road Network, €/Km 2001-2011



Source: AEC (2012).

Other aspects that are monitored by AEC because they are seen as being important measures for the level of safety of Spanish roads are: road signs, containment systems, balancing state, illumination. Excluding the balancing state, all the others have been found to be in a poor condition on National and Local roads.

10.4.3 Maintenance intervention

Road maintenance involves a complex system of activities and interventions. In order to be effective, long-term planning and coordination are essential. In Spain, according to a study prepared by ASEFMA and the Universidad Politécnica de Madrid (Val Melús 2010), planning of road maintenance is insufficient at a national level, variable and incoherent in the autonomous communities, and almost completely non-existent within local administrations.

Road maintenance strategies can be categorised into areas of intervention: prevention and conservation. A prevention strategy consists of simple and constant interventions (each 3-6 years), for example superficial renovation of the road surface (3-5 cm), combined with permanent and real-time sealing of cracks. A conservation strategy, on the other hand, consists of more costly interventions, such as: regrowth, milling and replacement of the pavement each 12-16 years, combined with the repair of localized, significant damage. National and local authorities in Spain, albeit without any clear strategic plan, tend to implement strategies that are of a conservative rather than preventive nature. In recent years, the lack of long-term planning has frequently resulted in poor quality road surfaces and consequently increased costs for users in terms of vehicle’s maintenance, as well as low levels of safety and comfort.

A first attempt to plan road maintenance operations is Spain was made in 1984, with the Road’s General Plan (Plan General de Carreteras) 1984-1991 (subsequently extended until 1994). In this plan, almost half of the budget (€4,808 mil.) was dedicated to the construction of new highways, while 8,8% (€420 mil.) was allocated specifically to road pavement maintenance (50% of the total budget for road maintenance). The Plan General de Carreteras then allocated 6,321 €/Km for surface maintenance which became 5,126 €/Km because of increased expenditures on highways.

In the following plan, the Infrastructure Directive Plan (Plan Director de Infrastructure) for 1993-2007, road maintenance gained additional focus, as one of the eight priorities of the plan. The total budget allocation for road maintenance was €681m per year, while 10,284 €/Km was dedicated to surface maintenance (assuming 50% of the total road maintenance budget assigned to this sector) – almost the double amount of that allocated in the Plan General de Carreteras 1984-1991. Nevertheless, political alternation had a negative influence on road maintenance investments. In fact, after the political election of 1996 and the relative change in the government team, the Plan Director de Infrastructure remained only on paper. Between 1996 and 2000 the new government decided to focus its efforts on the telecommunications sector, reserving few investment opportunities to the Road infrastructure.

The successive plan was completed in 2004: The Strategic Plan for Infrastructures and Transportation (Plan Estratégico de Infraestructuras y Transporte – PEIT) 2005-2020. The PIET, even though it mainly conforms to a conservative strategy, sets an important goal for 2012: to link the annual investment for road maintenance to the National Road Network asset value (estimated to €170,875 mil.) planning to spend 2% of the National Road Network asset value in road maintenance per annum. The PIET forecast a level of expenditure on road surfacing of 19,520 €/Km. It should be noted, however, as shown previously in Figure 58, that although the budget allocation for road maintenance grew between 2005 and 2009, it never reached 1% of the National Road Network asset value. Moreover, road maintenance expenditure started decreasing from 2010, and is expected to be €820 mil. for 2014.

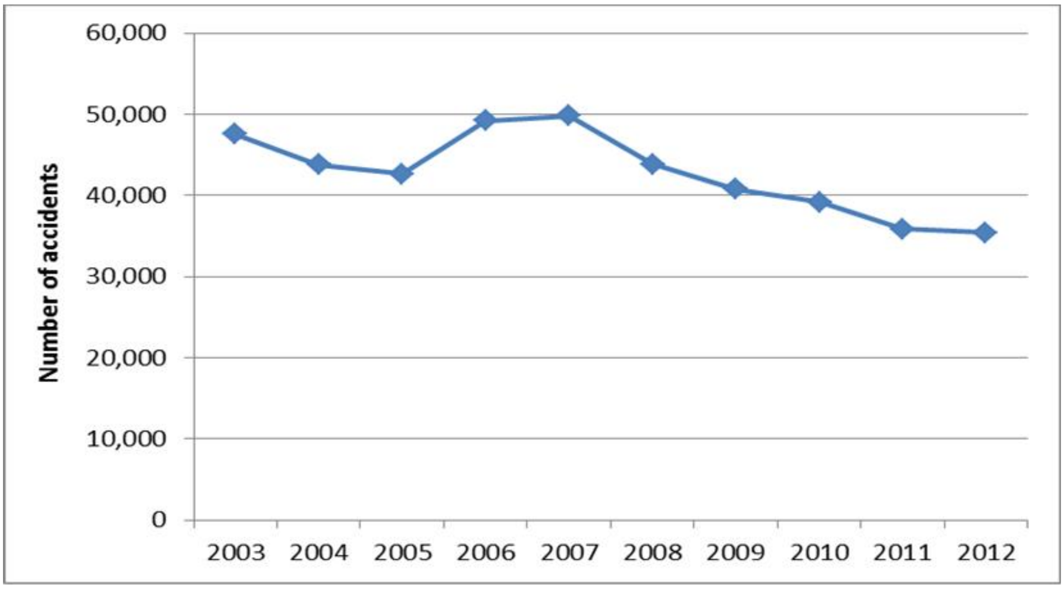
These budgetary fluctuation, according to ASEFMA, have led to both a reduction in the condition of the road surface and a reduction in innovation on the part of national companies operating in the sector.

10.5 Socio-economic impacts of road maintenance

As has been stated in previous studies, the most influential factor behind road safety is driver behaviour. Excessive speed, alcohol, distraction, and lack of respect for the highway code are the main causes of accidents. Nevertheless, in some cases the conditions of the road infrastructure is also a significant factor. The two infrastructure parameters that have a direct impact of safety are: i.) the friction coefficient of the pavement, and ii.) the regularity of the surface. An irregular road surface caused by a lack of road maintenance can increase the risk for accidents mostly when it occurs in spot locations.

As can be observed in Figure 65, the number of accidents causing fatalities on Spanish non-urban roads between 2003 and 2012 has been decreasing by an average of 3% per annum. This fall in accidents may be due to an improvement in the quality of roads, but is also due to the fall in traffic on Spanish roads after 2007.

Figure 65: Evolution of number of accident with deaths on Spanish extra-urban roads 2003 – 2012



Source: AEC (2012).

Road surfacing may also have direct and indirect economic impacts on transportation costs. According to a study prepared by the Institute of Transportation and Communication Studies (Instituto de Estudios de Transportes y Comunicaciones) on the Spanish road network, a moderately deficient road surface can accelerate the fuel consumption of light vehicles by 34% (12% for heavy vehicles), further causing an increase in their CO2 emissions. According to the same research, a poorly preserved road surface can also increase the maintenance costs of vehicles by 185% for light vehicles and by 129% for heavy vehicles. Finally, a poorly maintained road surface can lead to a reduction in the total life of tyres of about 66% for light vehicles and 10% for heavy vehicles.

10.6 Summary for Spain

In Spain, road maintenance and operational expenditure decreased significantly in the last years with an acceleration after the 2008 economic crisis. The spending review has been particularly notable in pavement rehabilitation as the budget allocated went from almost €560 mil. in 2008 to only €37 mil. in 2010. An example of the impact of such a policy is the fact that between the summer of 2010 and the spring of 2013 no investments were made in this area.

In addition to this, planning and implementation of road maintenance interventions have been fluctuant and often fragmented. Thus national companies operating in the sector have received few stimulus to invest in innovation and development of new techniques.

Road surface quality in Spain is poor and it is decreasing from the beginning of the century. According to the stakeholders gathered under the umbrella of the Spanish Road’s Association, the quality of the road surface in 2011 is the same registered in 1985 and the needed investments grew: the Euros per Kilometres needed today in order to re-establish the conditions of safety and comfort for the users of Spanish road network has almost doubled from 2001.

11. CASE STUDY GREAT BRITAIN

11.1 Member State overview

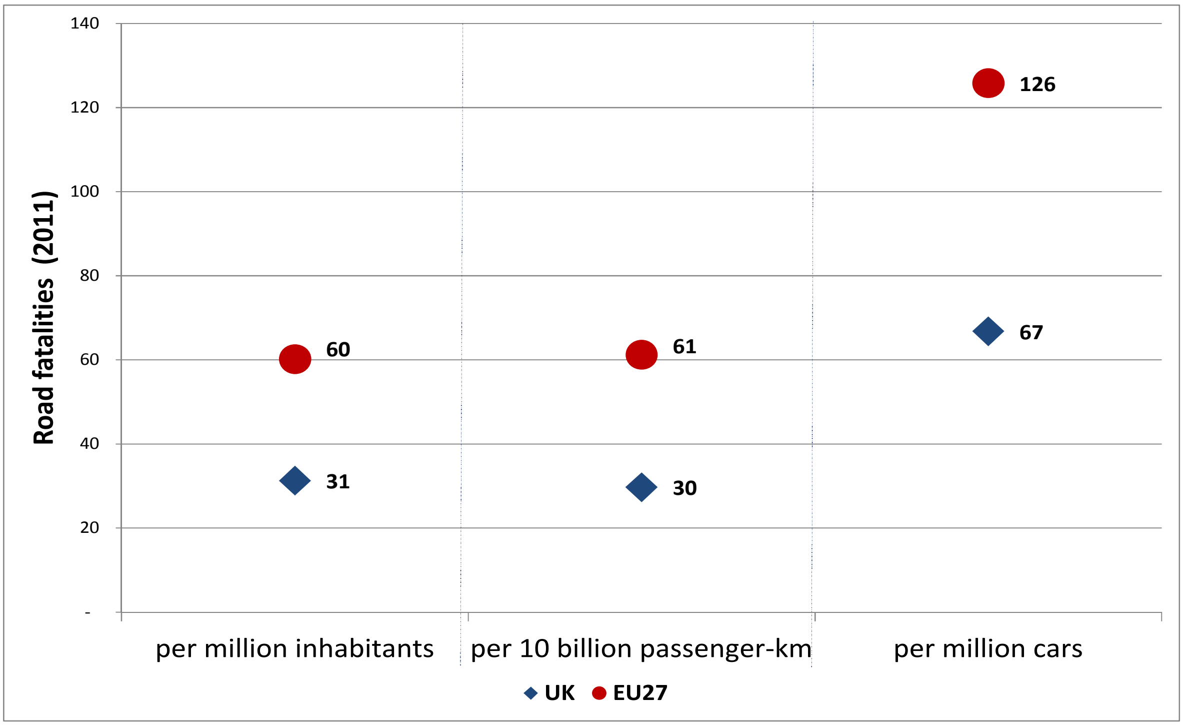
The UK's total road network is 416,000 km long, of which 3,700 km are motorways. Municipal roads account for 344,000 km of the total network. Car ownership in the UK is currently at 466 passenger cars per 1000 inhabitants, this figure grew by 7.0% in the period 2001-2011 (Eurostat).

11.2 Road safety statistics

In 2011, the UK recorded 1,960 fatalities on its roads, which represented a 46% decrease from its 2001 level. The UK's roads had 157,100 accidents resulting in personal injury in 2011, which is a 34% decrease on the same figure recorded in 2001 (Eurostat and OECD).

When the UK's road safety record is analysed in relation to its population it can be seen that it has one of the safest road networks in Europe. In terms of fatalities per million inhabitants, the UK's 31 is the lowest in Europe (EU27 average = 60). The UK recorded 30 fatalities per 10 billion passenger kilometres, which is much lower than the EU average of 61, and only bettered by Sweden. The UK's score of 67 fatalities per million passenger cars is also the lowest in Europe – the EU average is 126. Figure 66 below summarises these results.

Figure 66: Road fatalities ratios – UK and EU27 (2011)



Source: Eurostat.

The long-term objective is to further lower fatalities by around 37% on 2010 levels by 2020. To this end, the UK Government’s Strategic Framework for Road Safety (2011) proposed a vision which strengthens Britain’s safety record based on two main pillars:

- devolving power to local governments by decentralising funding and increasing local flexibility in setting targets and enforcement; and
- developing skills and attitudes throughout a driver’s life by promoting more targeted and effective education.

The remainder of this case study focuses on Great Britain, and on England and Wales in particular, given the institutional framework and data availability.

11.3 Maintenance budgets analysis

11.3.1 Road infrastructure and maintenance spending in Great Britain

Road infrastructure spending in GB is highly dependent on central government funding. A very small proportion of roads are tolled. The Highways Agency (HA), an Executive Agency of the Department for Transport (DfT), is responsible for operating, maintaining and improving the strategic road network (SRN) in England on behalf of the Secretary of State for Transport.

The SRN comprises 2% of the total road network in England, but it serves one third of all road traffic. The development and maintenance of other roads is the responsibility of local authorities (LAs), which receive grant funding from central government as part of “single pot funding” as explained below.

Annual spending on major road projects in England fell from a high of £2bn (€2.42bn)[47] in the early 1990s to a low of £400m (€484m) in the early 2000s. Overall, the total length of trunk roads in England is comparably lower than other Member States, and network densities are among the highest in Europe. No considerable road expansion has taken place over the past 10 years.

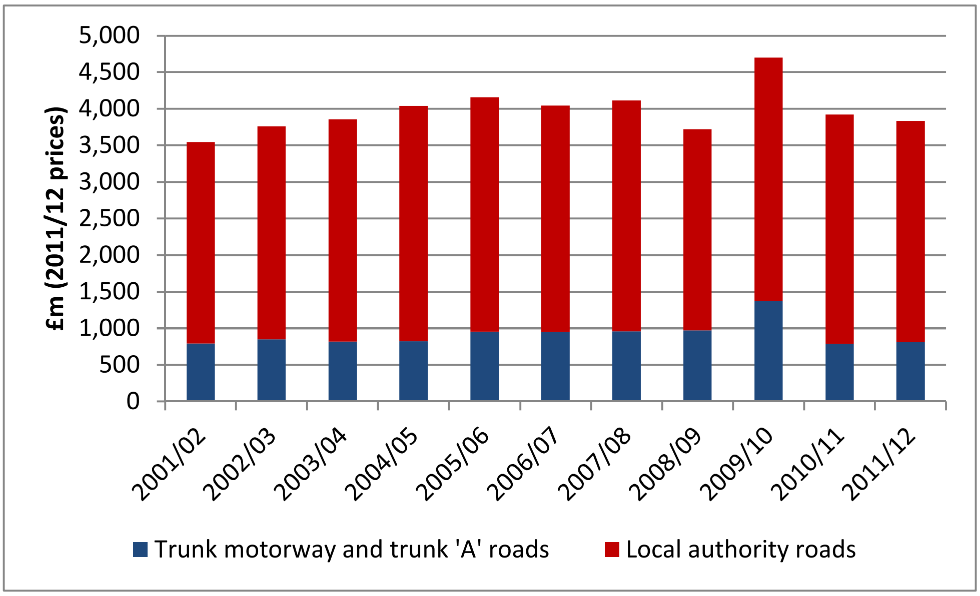
Road maintenance expenditure on the SRN has fluctuated considerably, with an average of £850m (€1.02bn) per year in the first half of the 2000s and of £1bn (€1.2bn) per year in the second half of the decade. However, changes in accounting practices in 2009/10 make it difficult to compare recent figures.

Expenditure by local authorities make up between 70% and 80% of all road maintenance spending in England each year. This corresponds to a figure of about £3bn (€3.6bn) in 2011/12 prices. Local authority spending is further split into expenditure on principal roads and on minor roads. Trends for both types of road are similar, with a marginal decline over the period 2009-2012.

In 2011/12, 7.6% of the principal road network underwent maintenance. Since 2006/07, on average, 6.7% of the principal road network was maintained each year, primarily through resurfacing. Only 4.1% of minor roads received treatment in 2011/12, with an average over the same period of 3.8%.

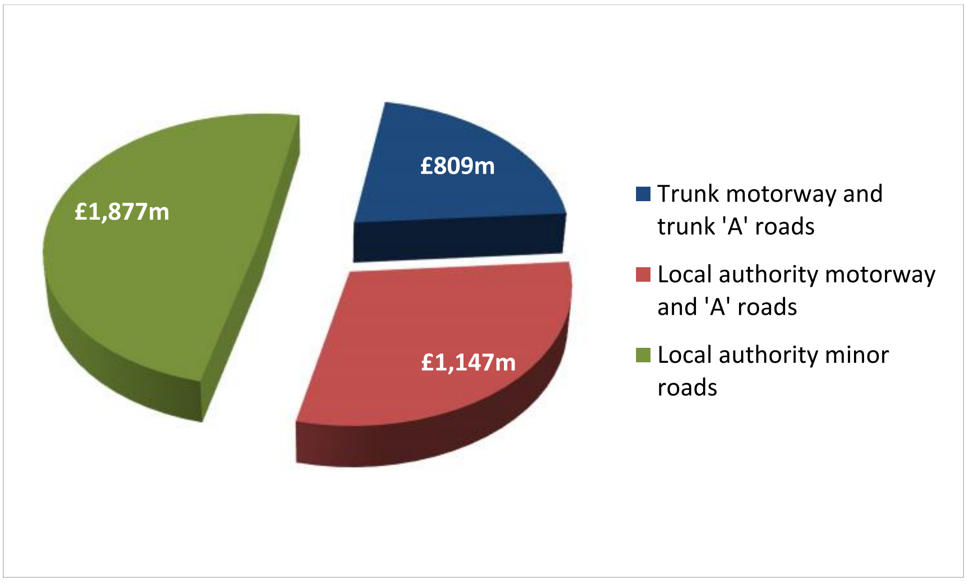
[47] Based on the January 2012 exchange rate : GBP/EUR = 1.20

Figure 67: Road maintenance expenditure – Highways Agency and Local Authorities



Source: DfT (2013).

Figure 68: Share of road maintenance expenditure by road type



Source: DfT (2013).

11.3.2 Road maintenance budget outlook

The Government's Comprehensive Spending Review 2010/11 introduced substantial reductions to the Highways Agency's budget over the next few years. Expenditures will fall by around 30% to £663m (€800m) between 2010/11 and 2014/2015. According to the DfT's SRN Performance Specification 2013-2015, efficiency savings by the HA of up to 20% should partially offset the planned reduction in expenditure.

On the other hand, the share of funding received by local government is set to decline, with a reduction of 28% in real terms between 2010/11 and 2014/15. However this is based on financial projections made at the time of the Comprehensive Spending Review. A key policy change introduced alongside the reduction in funding is the following: the projected maintenance budget is to be "pooled" in a wider single pot of local government funding which is allocated to local authorities, thus with no assurance that it will be spent on road maintenance.

Given the projected decrease in total local government funding to 2019/20, the Local Government Association has assessed funding prospects for LAs and concluded that a multi-billion pound funding gap will materialise in 2019/20. Budgets will be under pressure from growing spending trends in social care and environmental services. Based on these projections, the RAC Foundation has estimated that the proportion of spending on transport and roads by local authorities will decrease from 7% to 4% of the total, at around £2.3bn (€2.8bn) in 2019/2020.

The DfT recognises the key challenges that local authorities are facing in maintaining the road network, given the series of extreme weather events in recent years and growing energy prices, which constitute a high share of maintenance costs. Some efficiency gains are envisaged as the 153 bodies currently managing local roads could adopt a more coordinated approach to procurement and construction (Action for Roads, 2013). From 2014/15, funding certainty will be enhanced as 5-year budgets will be introduced, as opposed to 2-year budgets currently.

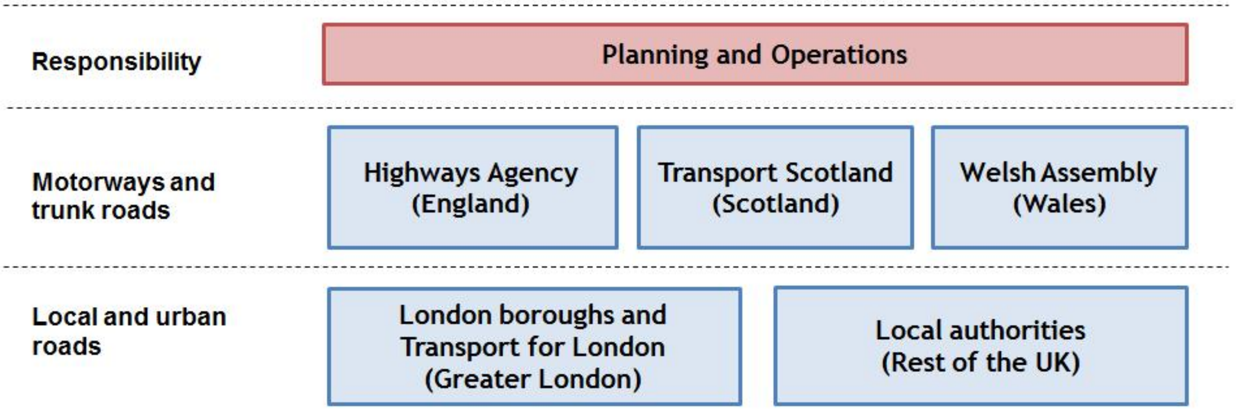
However the ALARM Survey 2012-2013 reported that 94% of English authorities foresee having to make cuts to their highway maintenance service, and over 90% of authorities in London and Wales foresee staff reductions and reduced service delivery.

11.4 Road performance monitoring

11.4.1 Responsibilities for road maintenance

As explained, different bodies are responsible for road maintenance in GB. The Highways Agency (HA) is charged with the planning and operation of the strategic road network. It publishes an annual report setting out spending plans and road quality. Between 1998 and 2009, the responsibility for maintenance was devolved further to local authorities through the "detrunking programme". As such, local authorities have been increasingly tasked with the maintenance of the remaining parts of the network. Scotland and Wales also have devolved oversight powers over their respective infrastructure.

Figure 69: Responsibility over road maintenance by road type



Source: SDG illustration.

The HA negotiates and earmarks funding for road maintenance two years in advance, based on a review of road pavement conditions monitored through performance indicators. Structural maintenance works are tendered out, usually on the basis of Performance Based Contracts, to private contractors. These contracts define the principles and the objectives of the work to be carried out, and payment is conditional upon satisfying them. More than 90% of the HA's expenditure is spent through contracts with the supply chain.

In 2011, the first of the new "asset support contracts" was awarded in the South West. More of these contracts will be used to drive service providers to deliver an agreed level of service on the network, while providing best value. A percentage 'year on year' reduction in cost is mandated within the contract. 'Continual improvement and innovations' clauses also encourage the service provider to seek efficiencies and reduce costs over the duration of the contract.

11.4.2 Assessment of road surface quality

The Department for Transport and the Highways Agency have developed a Road Condition Indicator (RCI) to monitor road surface quality. The indicator is based on a set of indicators which are collected annually using road scanning technologies. In particular, the equipment that carries out the assessment on local roads is called SCANNER (Surface Condition Assessment for the National Network of Roads) the equipment used for trunk roads is known as TRACS (Traffic-speed Condition Survey).

The parameters recorded by SCANNER and TRACS are the following:

- Rut depth
- Evenness of the road (longitudinal profile)
- Texture of the road surface
- Cracking of the road surface

These parameters are weighted to obtain the RCI for each section of road (10 metres) analysed. The RCI can vary between 0 and 315. Any values above 100 indicate that road conditions are below the required levels and are likely to require maintenance within the next year.

The overall index of road conditions for England is the Highway Condition Index (HCI) which is derived by grouping together all the RCIs. It is indexed to 2006/07 at 100. If the index goes up, it means there has been an increase, on average, of the condition of the road network across the country.

11.4.3 Maintenance intervention

Maintenance intervention in England is scheduled based on the findings of the monitoring activities. This approach ensures that sections with the worst scores are prioritised given limited funding. This also allows for the appropriate planning of expenditure as the monitoring provides a clear indication of the roads in need of maintenance in the near future.

The latest statistical bulletin (2009/2010) stated that only 6% of the classified road network was in poor condition. This is consistent with the figures showing the percentage of the network which received maintenance in the following years, which is around 6-7% of the total. The percentage of national trunk roads requiring further investigation (i.e. reputed to be in poor conditions) was only about 3-4% for motorways and A roads (DfT 2013).

The survey of local authorities (ALARM 2012) carried out by the asphalt industry suggests that 19% of English roads (excluding London), and 27% of London roads were considered to be in poor condition according to local road managers. This appears to show a trend of declining quality, which contrasts with the trend of improving quality at the national level. The historical trends analysed by Bayliss (2012) indicate that the reduction in local road maintenance spending in 2010 was significant (-9.5% year on year).

Table 17: Average length of time (years) before roads are resurfaced

Type of road	England	London	Wales	Urban	Rural
Principal roads	31	21	48	24	20
Non principal roads	59	28	97	34	31
All roads classes	58	32	72	40	45

Source: ALARM Survey (2013).

While routine maintenance follows the practices described above, reactive maintenance is highly dependent on contingent events. With the severe weather events experienced across Britain in recent years, including severe flooding and below average winter temperatures, local authorities have requested further support from central government. By way of an example, the average cost of flood damage in 2012 was almost £4m (€4.8m) per local authority but only £300m (€360) was provided by central government between 2011 and 2012 to cope with the additional cost resulting from this damage.

Table 18: Road maintenance statistics – by GB Local Authority in 2012

Indicator (per authority)	England	London	Wales
Average annual budget shortfall	£6.2m	£6.2m	£6.2m
Percentage of budget used on reactive maintenance	25%	33%	30%
Average number of potholes filled last year	16,041	3,102	7,082
Average cost of flood damage in 2012	£3.9m	£0.7m	£2.1m

Source: ALARM Survey (2013).

Table 18 offers further insights on road conditions at the local level, extracted from the ALARM Survey. It shows that the average annual budget shortfall is around £6m (€7.2m) per local authority. This is consistent with calculations made by Bayliss (2012) which estimate a funding shortfall of as much as £1 billion (€1.2 billion) a year since 2000. The cost of clearing the backlog maintenance was estimated to cost £9.7 billion (€11.6 billion), and even if local authorities had the required funding and staff, it would take 11 years to eliminate.

11.4.4 Innovative practices

The DfT and the HA have been working together with councils and suppliers to develop the Highways Maintenance Efficiency Programme. The programme is a collaborative effort to identify the most effective ways of maintaining the highway and sharing the results. Participating authorities share information on increasing efficiencies – ranging from advice on how best to fill potholes to standard-form contracts that can help them to cut their procurement costs. Several Toolkits and Best Practice Guidance have been issued.

Local authorities are further developing electronic or web-based systems for the public to report potholes and highway faults. The average numbers of these reports received from the public by each local authority in England (excluding London) over 2012/13 is over 12,000. This is up by around 1,000, or nearly 10%, on the year before - although there were fewer instances reported in London and Wales than the previous year. The total of reports from the general public projected across England and Wales was 1.6 million, compared to 1.5 million in 2011/12 (ALARM Survey).

In London, the executive transport agency TfL also encourages road users to report maintenance issues on the network. The electronic tool “Report IT” offers the opportunity for crowd-sourcing techniques, allowing members of the public to report pavement and road defects and alert boroughs and TfL of safety-critical issues. The public’s reports are used to prioritise planning and execution of maintenance.

11.5 Socio-economic impacts of road maintenance

Stakeholders in Britain place great importance on the quality of the road network in relation to its impacts on economic growth and trade, road safety and its wider budgetary implications.

11.5.1 Wider economic impacts

According to a survey by the Manufacturers' Association, the state of British roads, from the high levels of congestion on key arteries to the poor maintenance of many local roads, "is adversely impacting manufacturing on a number of core business activities. Three-quarters of manufacturers cite it as a barrier to sending and receiving products and raw materials". The Association explains that "more than 60% see it as an impediment to recruiting and sustaining relationships with customers and suppliers. The majority of manufacturers are experiencing significantly increased operating costs and nearly a third a loss of productivity as a result of sub-optimal road quality" (EEF 2012).

Quoting a study by Parkman and others (2013), the RAC Foundation has highlighted the overall disbenefit to society of reducing road maintenance expenditure on the Scottish road network. The quantitative analyses show "that for every £1 reduction in road maintenance, there is a cost of £1.50 to the wider economy. If figures were available to quantify aspects not currently included in the quantitative analyses, it is expected that these would only enhance the conclusion". Among the impacts of poor maintenance on the economy, the authors list the following:

- negative impacts of any increase in road closures due to unforeseen events;
- costs of delaying major repair work on significant structures leading to closures;
- weight restrictions or more extensive maintenance work;
- wider economic disbenefits such as reduced tourism or local economic activity.

A survey of Small and Medium Enterprises in England and Wales carried out by the Asphalt Industry Association (2010) found that 68% of SMEs consider road maintenance very important for the success of their business, while 44% of businesses thought that local roads were not very well maintained. When asked to point to the main business costs arising from poor maintenance, SMEs indicated the following: negative productivity impacts in terms of time wasted, as well as lost competitiveness from higher vehicle operating costs and fuel consumption. The survey further attempts to estimate the average cost of poor maintenance per business, resulting in £13,600 per year (€16,300).

The general public expresses similar concerns to those of businesses. In 2012, the National Highways & Transport Survey (NHT Survey) found that "61% of residents in England were dissatisfied with the condition of local roads. Only 27% were satisfied with the condition of this asset, giving a net satisfaction rating of minus 34%, much worse than for the years that preceded the recent hard winters" (NHT Survey, 2012). In the 2013 RAC Report on Motoring, respondents were asked about the "issues that most concern motorists". Condition/maintenance of UK roads was equal second in importance, after the cost of fuel for running a car (RAC 2013).

11.5.2 Insurance costs

One of the areas receiving increasing scrutiny by motorists associations and local councils is that of motor insurance claims that drivers in the GB make to local authorities, either directly or through their insurers, with respect to damage incurred due to poor road conditions. The trend in the number and severity of claims can become, in the near future, a valid indicator of – at least perceived – road quality. The main figures for recent years are captured by the ALARM survey and summarised in Table 19 below.

The average amount paid per claim ranged from £370 in Wales to £893 in London. The year on year variation changed dramatically depending on the geographical area. Also, larger claims tend to take longer to resolve. However the results from the survey indicate that the overall cost of motor insurance claims amounted to just under £32m (€38.5m) in the financial year 2011/12.

Table 19: Compensation claims by Local Authorities in Great Britain

Indicators		England	London	Wales
Number of staff hours spent on claims (on average, per LA)	2012	183	125	99
	2011	172	131	93
Annual amount spent (on average, per LA)	2012	£87k	£53k	£38k
	2011	£105	£68	£55k
Amount paid to road users in claims (total)	2012	£23.8m	£6.3m	£1.8m

Source: ALARM Survey (2012 and 2013).

Further evidence emerged from a request made under the Freedom of Information Act by the breakdown expert firm Britannia Rescue. From their survey of local authorities, it appears that councils have paid a total of £2.5m (€3m) in compensation to motorists in the financial year 2012/13 for pothole damage to cars only. They estimate that around 200,000 potholes are present on British roads, following the combination of a harsh winter and a dry summer that has particularly harmed road surfaces. As a result, claims have increased by almost 80% in one year. Their calculations show that the amount paid out in compensations could have been used to repair one quarter of potholes.

11.6 Summary for Great Britain

In Great Britain, the Highways Agency and local councils are responsible for the national and local sections of the road network respectively. Maintenance budgets have remained fairly stable in recent years, based on the 2-year budget allocation made by central government. The proportion of roads classified as needing repair is low and road safety statistics show continuous improvement over the past decade.

However, stakeholders do not appear to be satisfied with road conditions in Britain. Parallel surveys conducted among local authorities, SMEs and the general public indicate that better road maintenance is considered to be a priority to improve safety and business productivity, as well as to reduce the cost of vehicle repairs. Against this background, local authorities begin to face a substantial funding gap which is projected to widen over the next few years. This raises some concerns about their ability to keep the road network in good conditions.

At the same time, the study of road maintenance in Britain presents a number of good practices. Budget cuts are accompanied by greater budget certainty which will see a change to 5-year allocations to road maintenance budgets. Advanced systems are used to screen road surface quality regularly and prioritise interventions. In addition, local authorities are establishing reporting systems which favour the crowdsourcing of information about roads in need of repair. Finally, various stakeholders are engaged in collecting and reporting data on road maintenance, facilitating the exchange of information and putting pressure on central and local government.

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ANNEX 2

1. IMPACT OF ROAD CONDITION ON ROAD SAFETY

As discussed in Chapter 2, only a small proportion of accidents seem to be caused by road design and/or poor road maintenance. Instead driver behaviour seems to be the principal contributor to accidents. Nevertheless, in many circumstances, it is difficult to disentangle causality: there are accidents caused directly by the poor condition of the road network, but there are also accidents caused by drivers' behaviour in reaction to the condition or the design of the road. There is, in fact, a correlation between road quality and driver behaviour; in some circumstances even careful drivers make poor choices as a result of the condition of the road or their reading of the road layout.

There are several ways in which road condition contributes to, or compromises road safety. According to existing literature, the key causes are:

- poor wheel-road contact that fails to guarantee sufficient skid resistance, due to inadequate road maintenance;
- localised anomalies, such as ruts, potholes and depressions, whose unpredictability make them dangerous for drivers;
- poor geometry and alignment design – i.e. inadequate design of the road;
- "level of service" / performance too poor to accommodate existing traffic flows;
- poor signage or markings, e.g. incomplete or missing markings and signs, and poor lighting.

As will be discussed in more detail below, a lack of road maintenance or inappropriate design can exacerbate these factors, and thereby increase the number of accidents. Of these factors, only some are attributable to a lack of regular maintenance. For example, geometry and alignment design modifications do not fall within regular maintenance programs.

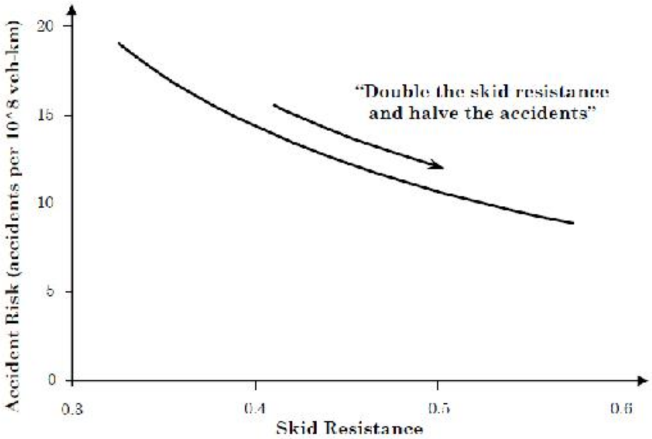
To assure road safety, road geometry and alignment must be designed to be as homogenous and clear to the driver as possible. The literature refers to this as "design consistency". The appropriate sequence of road features is important as it increases the available time that a driver has to react. For example, road geometry and its alignment affect drivers' speed choices. There is extensive literature on this issue but, as it falls outside the study's scope, it has not been dealt with in detail in this report.
"Level of service" is a qualitative measure of road infrastructure's performance and condition; it is closely linked to traffic flow. A study conducted in Russia showed that accidents increase as a function of increasing traffic flow and, ultimately, with a decreasing level of service. To improve the level of service it is necessary to adapt the geometry of the road (i.e. lane width, number of lanes, etc..) so that it can accommodate the actual traffic flows. However, interventions of this nature are usually categorised as investment and upgrade programmes and therefore fall outside of the scope of this study.

1.1 Wheel-road contact

The purpose of road surface is to keep the vehicle on the correct trajectory and to allow braking in wet and dry conditions. A study conducted by the National Cooperative Highway Research Program (NCHRP)[48] showed that there is a direct correlation between the number of accidents and the skid resistance value. Figure below shows that, as pavement friction levels decrease, there is a corresponding increase in crash rates.

One of the main problems is that it is difficult for drivers to assess the pavement's skid resistance and adapt their driving accordingly. Research also shows that when pavement friction falls below a site-specific threshold, the risk of wet weather related crashes increases significantly. However, research conducted on the Italian highway network[49] shows that the number of accidents in fact decreases during adverse weather conditions as drivers react to the weather conditions by driving more carefully.

Figure 70: Relationship between pavement friction and crash risk



Source: National Cooperative Highway Research Program (2009).

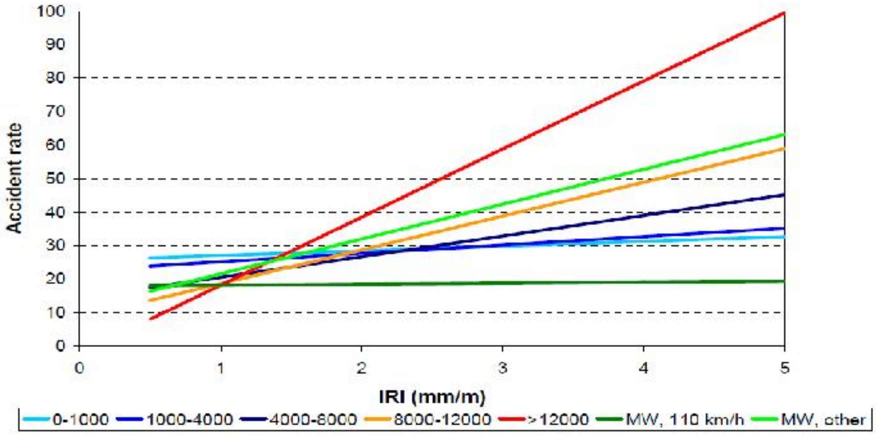
Another study conducted by the Swedish National Road and Transport Research Institute[50] reinforces the theory that accidents increase in slippery conditions. The study uses the International Roughness Index (IRI, measure in millimetres/metre) to assess skid resistance. The results show clearly that the accident rate increases as the IRI value rises, furthermore accidents increase with increased traffic flow Figure 71).

[48] National Cooperative Highway Research Program (NCHRP) (2009), "Guide for Pavement Friction".

[49] C. Rafanelli, T. Montefinale (1993), Incidenti e basi informative Parte 8 – Eventi Meteorologici, 1°Convegno Nazionale CNR-Progetto finalizzato Trasporti.

[50] Swedish National Road and Transport Research Institute (2004) , "The Influence of Road Surface Condition on Traffic Safety and Ride Comfort", 6th International Conference on Managing Pavements.

Figure 71: Correlation between Accident rate and IRI for different traffic flow classes



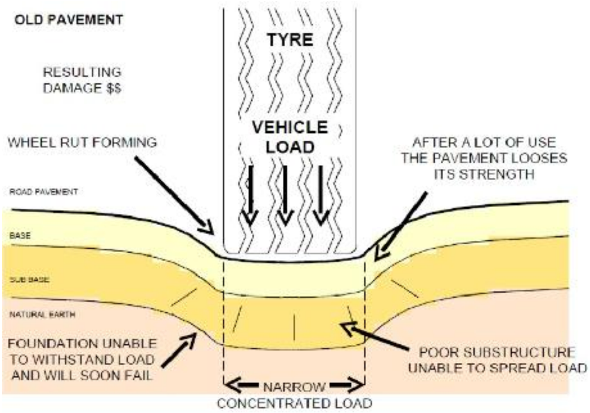
Source: Swedish National Road and Transport Research Institute (2004).

Therefore, a safe road needs to have a good skid resistance value when it is initially built, and this level needs to be maintained throughout its life. The latter is possible only through regular maintenance.

1.2 Localised anomalies

Localised anomalies of relevance for this study are ruts, potholes and depressions in the surface. Ruts are linear depressions created following a permanent deformation of the layers of bitumen caused by the load from a vehicle's wheels.

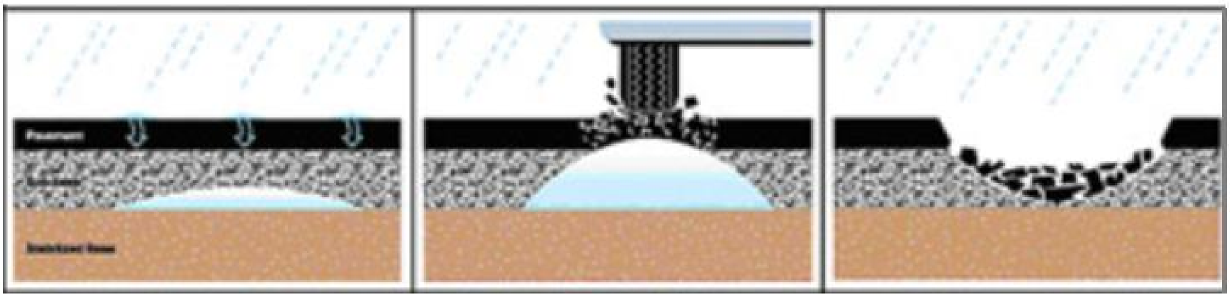
Figure 72: Rutting



Source: http://lgam.wikidot.com/rutting.

Potholes are depressions brought about by the removal of the uppermost layer of tarmac caused by traffic. Pothole depth increases when there is the risk of rainwater entering the gaps in the surface.

Figure 73: Formation of a classic pothole



Source: http://www.halifax.ca/municipalops/potholes/PotholeFAQ.html

Depressions are permanent deformations in the road surface due to ground subsidence. Their repair falls inside extraordinary maintenance because they relate to road elements below the surface.

These anomalies in the road surface (according to a study conducted by the Swedish National Road and Transport Research Institute[51]) cause, in dry surface conditions, vibrations and bumps which can increase driver fatigue. However, such anomalies usually increase drivers' attention and, as a result, the risk of accident seems to decrease.

In wet conditions, rutting causes an increased risk of aquaplaning which is a phenomenon whereby the vehicle floats on a layer of water as a result of the loss of contact between the road and the wheels, leading to the driver losing control of the vehicle. The risk of aquaplaning caused accidents is greatest where rut depths are larger and where there is poor water drainage (i.e. small cross fall).
An important additional consideration relating to these types of anomalies is that they are dangerous because drivers cannot predict them. They are particularly hazardous when they are spread out along the road rather than when the driver is facing a consistently rough road.

1.2.1 Poor signage, markings and lighting

Markings, signs and lighting contribute to make the road logical and easy to understand. Road markings are a cost effective solution to provide a clear indication of the driving lanes and space, contributing to a predictable driving trajectory. As a result road users intuitively understand the road's alignment and can adapt their driving behavior accordingly. A study developed by the European Union Road Federation[52] shows that good maintenance of markings and signs reduces accident risks.

Good street lighting also improves road safety especially in a specific, potentially dangerous locations such as intersections, pedestrian crossings, urban areas, etc. The aim of road lighting is to provide the required visibility for the driver to read the road and react to oncoming obstacles in a safe manner. On this topic, different studies have shown a direct link between poor lighting and a consequent increase in accident risk.

[51] Swedish National Road and Transport Research Institute (2004) , "The Influence of Road Surface Condition on Traffic Safety and Ride Comfort", 6th International Conference on Managing Pavements.
[52] European Union Road Federation "Marking the way towards a safer future".

1.2.2 Road works and accidents: unintended consequences of road maintenance

Road works tend to be unsafe for those working on site (as a result of their proximity of traffic) and to drivers moving through them (resulting from a change in the road layout). A study conducted by the Institute for Road Safety Research in the Netherlands (SWOV)[53] showed that, in the period 2000-2009, 2% of all registered fatal accidents in the Netherlands took place in the proximity of roadworks and roadwork locations seem to display a higher accident rate than at other road locations. The risk is highest in the work zone; roadworks that take longer and cover a longer distance seem to have a lower crash rate. The literature also shows a generally higher crash rate during nighttime.

Guidelines exist for the uniform preparation, indication and marking of roadworks. It is important that these guidelines are followed for large as well as small roadworks. However, an evaluation of roadworks shows that these guidelines are only followed diligently at a few locations.

1.2.3 Main conclusions on the impact of road condition on road safety

In summary, there are various aspects of the road's condition which contribute to its safety. A high level of pavement friction, clear signage and road markings are important qualities of a safe road. It is important that these are maintained throughout the road's lifespan. Anomalies, such as ruts and depressions, reduce road safety - as they affect driver fatigue - and can create a hazard for drivers and can cause aquaplaning in wet conditions. In addition to normal road conditions, roadworks create more hazardous road conditions for both drivers and those who are working on the road and affect the accident rate for a road.

A consistent design of a road's geometry is an important factor in ensuring a safe road. Another important provision is an appropriate level of service for the anticipated traffic flow. However, both of these factors fall under the umbrella of exceptional, rather than regular maintenance.

[53] Institute For Road Safety Research (2010), "Roadworks and road safety", SWOV fact sheet.

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