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Report on BEXPRAC

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This report is: **FOR DECISION**

1 Executive summary

The national road authorities (NRAs) of 13 European countries launched the BEXPRAC survey (***B**enchmarking of **ex**penditures and **prac**tices of maintenance and operation)* in an effort to benchmark the performance of their maintenance and operation (M&O) policies within the framework of the Conference of European Directors of Roads (CEDR). The benchmark was to be completed by sharing figures and best practices. The timeframe was fixed in such a way that the results and the final reports would be delivered in early 2010 at the latest.

This is the first time a survey like BEXPRAC has ever been undertaken by NRAs at international level; some CEDR member states were highly sceptical about the project and decided not to participate.

The participating NRAs sought to:

- obtain references in order to better justify budget allowances;
- ascertain maintainable levels of service and prioritise rules within a given budget;
- obtain references in order to define performance targets;
- improve performance levels by sharing best practices.

To achieve these goals, the participating countries set up a working group for the BEXPRAC project (WG BEXPRAC). A consultant was hired for two main data collection and analysis modules.

1 **The macroscopic or macro module** with a ***top-down*** approach, which sought to:

- compare the overall costs of operation and maintenance in the participating NRAs;
- explain some of the differences by comparing the distinctive profiles of the networks and the overall levels of service provided.

2 **The microscopic or micro module with a *bottom-up*** approach, which sought to:

- compare actual performance levels on a limited range of small-scale subsets in some of the countries;
- identify the best field practices in road maintenance and operation on the basis of the same observations.

Both modules complemented each other. The macro module provided a comprehensive and structured reference framework; the micro module provided clarification and explanations for differences observed at macro level thanks to a fine-tuned comparison of practices. The results will help each NRA to draw up its own policy and strategy and perhaps facilitate future budget negotiations.

The biggest difficulties encountered were missing or incomplete data in some countries, major differences in the expense allocation rules among the task blocks, and the physical allocation of expenses to a stretch of the road network. Nevertheless, CEDR now has at its disposal a significant international database of road M&O expenses, as well as a set of common definitions for the main task blocks and templates to facilitate any future updates.

Even at this very early stage of international benchmarking, it was possible to draw up a model for the expenses related to the main driving factors; the results of the model range from -30% to +40%. It is worth noting that without a model, the expenses per km of highway vary much more significantly, namely from 1 to 20.

The participating countries listed what they defined as their best practice and, in so doing, provided references and clues to other CEDR members.

WG BEXPRAC made proposals on how best to bring forward the results of the project after its completion. It was felt that it would be of little interest to launch a similar survey in the short term because of the existing major differences in accounting and expense allocation practices in the different European countries. More accurate results could only be obtained after intense international harmonisation efforts.

The mutual understanding and the knowledge of the problems acquired by the WG members, as well as the large amount of data collected, should now be taken forward within the framework of CEDR's SP2 strategic task 3 on asset management entitled 'Long-term investments in road infrastructure'. This would guarantee value for money. Furthermore, the results gained through the asset management programmes, which include the life cycle aspect of different kinds of assets, would help explain some of the M&O expenses more accurately.

Even though task 3 on asset management has been postponed for a while, WG BEXPRAC recommends periodically updating the macro module data collected within the framework of BEXPRAC. This exercise would not be very expensive and would provide valuable information on the evolution of expenses for the maintenance and operation of the networks.

Despite all the difficulties encountered, the BEXPRAC project overcame the widespread scepticism mentioned above and delivered results which met nearly all the objectives set for this project.

Switzerland: Paving on the St Gotthard

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3 Definition of the issue

3.1 General background

Growing pressure to optimise the maintenance and operation of road networks ...

The quest for greater economic performance in the construction, maintenance, and operation of road networks is a high priority in most European countries, particularly as governments are increasingly confronted with growing budget constraints.

For countries with relatively mature networks, the main issues are road maintenance and road operation, due to the fact that:

- these networks are rather old and require much more maintenance;
- growth of traffic and increase of congestion necessitate the constant optimisation of the networks' efficiency;
- social requirements and users' expectations regarding safety and quality of service are constantly rising.

For the political authorities, the NRAs are under increasing pressure to:

- justify the budgets required;
- strike a balance between high levels of service and the budgets available;
- optimise expenditure, while committing to increases in productivity.

... underlines the need for intense benchmarking

Any benchmarking between networks concerns complex topics. In order to be relevant, it has to be conducted thoroughly and to a relatively deep level in order to:

- take into account the distinctive profile of each operated network;
- cover the real-world experience implemented at operational level;
- guarantee the homogeneity and exhaustiveness of scopes for external and internal costs related to maintenance and operation;
- consider that accounting rules and practices can differ significantly from one network to another.

Objectives and the stakes of the project

In 2006, the French Ministry of Finance carried out an in-depth comparison of the state-managed network and the network managed by concession holders, along with a more basic comparison with a few European countries. France wanted to dig deeper into this audit using a common approach towards those countries facing similar situations.

Within the Conference of European Directors of Roads (CEDR), the NRAs of 13 European countries wished to back up their optimisation approaches by benchmarking the performance of their maintenance and operation policies and by sharing best practices. These countries were Austria (AT), Belgium-Flanders (FL), Denmark (DK), England (UK), France (FR), Hungary (HU), Italy (IT), Ireland (IE), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), and Switzerland (CH). The timeframe was fixed in order to produce the results and final reports by early 2010 at the latest.

To optimise road network maintenance and operation, the participating NRAs sought to:

- obtain references in order to better justify budget allowances;
- ascertain maintainable levels of service and prioritise rules within a given budget;
- obtain references in order to define performance targets;
- improve performance levels by sharing best practices, especially regarding:
  - the best split between in-house work and outsourcing;
  - better value for money for outsourced work through appropriate public procurement policies;
  - better value for money for in-house work through modern management and supervision methods.

3.2 Scope and methodology

Scope of the study

In view of the fact that construction expenditure and practices had already been compared in previous benchmark studies, it was decided to focus on maintenance and operation (M&O) of the road networks only.

The following tasks were considered:

- road operation (patrolling, rescue/emergency actions, temporary marking out for road works);
- traffic management and information to road users;
- winter service;
- routine maintenance of roadways and structures (tunnels, bridges, and walls);
- maintenance of equipment (road markings, road signs and traffic lights, road lighting and ITS devices, drainage appliances etc.) and of roadside fittings (service areas, rest areas, shoulders etc.) as well as vegetation maintenance;
- large repairs, preventive or periodic maintenance, and rehabilitation of roadways and structures;
- improvements (regarding safety, environment, and services).

Methodology

This benchmark study included two main modules:

A macroscopic or macro module (***top-down*** approach), which sought to:

- compare the overall costs of operation and maintenance in the participating NRAs for each considered network as a whole, including (depending on data availability) a breakdown of charges per large task blocks (e.g. routine maintenance, routine operation, winter service, traffic management, large repairs, and improvement works);
- explain some of the differences by comparing the distinctive profiles of the networks (by applying the same pertinent segmentation for each network and analysing cost sensitivity to network profiles) and the overall levels of service provided.

A microscopic or micro module (*bottom-up* approach), which sought to:

- compare actual performance levels on a limited range of small-scale subsets in some of the countries;
- identify the best field practices in road maintenance and operation on the basis of the same observations.

For each country this module was based on:

- a special 'roads selection', which means an arbitrary selection of road subsets (either a choice of specific itineraries, or the networks administered by a choice of field units, or a choice of contractor-managed local networks);
- a pertinent segmentation of each country's selection based on network profiles in order to compare comparable entities.

Both modules complemented each other: through a refined comparison of practices, the micro module provided a clarification and explanation of the differences revealed at macro level. The macro module provided a comprehensive and structured reference framework (ground rules and lessons learnt, self-evident facts and proven statements) which could help each NRA to draw up its own strategy or policy and possibly facilitate budget negotiations.

3.3 Governance of the project

In order to ensure sufficient coordination between the NRAs and to guarantee a rigorous validation of the analyses conducted, the project's governance was established as follows:

- a working group (WG) with an appointed chairman and one representative from each participating NRA or similar entity;
- a consultant, who was in charge of the technical secretariat and the required data collection, analyses, and studies and was selected through competitive bidding.

Regarding the micro module, field managers or field supervisors responsible for administering the different subsets within the so-called 'roads selection' (either under in-house management or outsourced) were heavily involved as well.

Roles and responsibilities

WG members steering the project on their respective network, were expected to:

- collect and deliver to the WG chairman and the consultant existing studies and reports that could contribute to the benchmarking study;
- collect and provide the consultant with the expected data in response to the specific requests of the project;
- validate the benchmarking scope for networks for the macro module and the range of tasks;
- decide on the composition of the 'roads selections' and define a proposal for segmentation;
- steer the project on their respective networks;
- identify and activate the selected field managers (cf. micro module);
- facilitate the consultant's access to the different stakeholders in his/her country;
- participate in the validation of both the macro and micro analyses.

Field managers for the micro module were expected to:

- collect and comment on data at field level;
- take part in the validation of analyses;
- identify and document good practices (through interviews and additional information) and explain the service or quality levels and standards applicable on their networks.

The consultant was expected to:

- provide the WG technical secretariat;
- analyse and make the best use of every document provided or referenced by WG members;
- prepare and manage questionnaires and reply to queries as required;
- process data and inputs (from questionnaires, surveys, etc.);
- report on and validate the macro and micro modules;
- draw up the synthesis report.

3.4 Terms of Reference and budget

A first technical meeting held in Paris on 18 March 2008 clarified the aims and the methodology of the study and established the Terms of Reference (ToR) for the project.

These ToR were presented to the CEDR Governing Board at its meeting in Ljubljana on 22 April 2008, with the result that 13 countries decided to:

- join the survey, which would be run technically and financially under CEDR's name;
- mandate CEDR to organise a call for tenders by mid-May 2008 and, where possible, to award the contract to the winning consultant by the end of June for a study duration of 12 to 18 months;
- share the external expenses, which were initially estimated at between €500,000 and €600,000, in the form of individual contributions varying between €20,000 and €70,000 depending on the size of each participating member state's population and GDP.

France: Construction signs

4 BEXPRAC survey

4.1 Development of the study

The survey involved the 13 European countries shown on the map below.

For the selection of the consultant, CEDR organised an international request for proposals and received three valid tenders.

The WG held its kick-off meeting (WG0) on 1 and 2 July 2008. Having evaluated the proposals and heard the candidates, the members of the WG unanimously agreed on the tender submitted by the consortium ECORYS (NL), Egis-BCEOM (F), and COWI (H).

According to the terms of the contract, the official starting date for the survey was 15 September 2008. The survey was expected to last 12 months.
The costs for the consultant (approximately €480,000 including VAT) were paid by CEDR at the beginning of 2009 by means of an ad-hoc fund to which the participating countries and CEDR contributed as follows:

	Contribution in K€	Population in mill.	GDP per capita in US $
Austria	32	8.2	38,400
Switzerland	32	7.6	41,100
Denmark	32	5.5	37,400
Spain	32	40.5	30,100
Flanders (BE)	32	10.4	35,300
France	52	60.9	33,200
Hungary	17	9.9	19,000
Ireland	32	4.1	43,100
Italy	52	58.1	30,400
Netherlands	32	16.6	38,500
Portugal	17	10.7	21,700
Sweden	32	9	36,500
United Kingdom	52	60.9	35,100
CEDR	32		
Total: 14 participants	478		

The WG held the following meetings:

WG 1: 29/30 September 2008: kick-off, inception report

WG 2: 11/12 December 2008: feasibility study macro module

WG 3: 19/20 February 2009: intermediate session on data collections

WG 4: 6/7 April 2009: macro module report

WG 5: 8/9 June 2009: feasibility micro module, analysis of the 2nd draft macro report

WG 6: 28/29 September 2009: micro module and draft synthesis report

WG 7: 9/10 November 2009: approval of the final results from the consultants.

WG 8: 28 January 2010: discussion a first draft of the present final WG report.

4.2 Inception phase

Working language

English was the only working language. Each participating NRA or entity was responsible for the organisation and expense of any necessary translations into their native language and the provision of local interpreters for interviews and other discussions. The one exception to this rule was the reference reports or studies referred to in the reference bibliography.

Using prior studies drafted by CEDR and PIARC

The study had to take into account and use prior studies, notably those managed by CEDR, that could provide available nomenclature of tasks, analysis of existing performance indicators, etc. As for the technical terminology, the WG tried to systematically adopt and use vocabulary recommended by dictionaries and lexicons produced by the World Road Association (PIARC). See at http://termino.piarc.org/search.php

Definition of the scope of maintenance and road operation activities

The maintenance and operation of the road network cover a great variety of tasks and missions; definitions and names differ from one country to another. Appendix 1 shows the nomenclature of maintenance and operation tasks per 'blocks of tasks' which were used for the data collection in order to make the comparisons as consistent as possible

Moreover, the missions assigned to maintenance and operation agencies can vary depending on the countries or networks. For instance, patrolling, rescue/emergency actions, or traffic management can be either the responsibility of the roads department or the police. Nevertheless, it was decided not to collect corresponding data from non-road agencies.

Rules for considering expenses

1 Ensure the exhaustiveness of analysed expenditure items (see appendix 2);

2 Pay particular attention to:

- whether VAT was included or not;
- the accurate distinction between: (a) maintenance and operating expenses (consumption) and (b) investments;
- the asset depreciation and appropriate depreciation periods when applicable (or, alternatively, rental values);
- whether overhead expenses were included or not;
- whether social security contributions paid by the employer on salaries were included or not.

The following terms are used in this report (source: Douglas Harper online etymology dictionary):

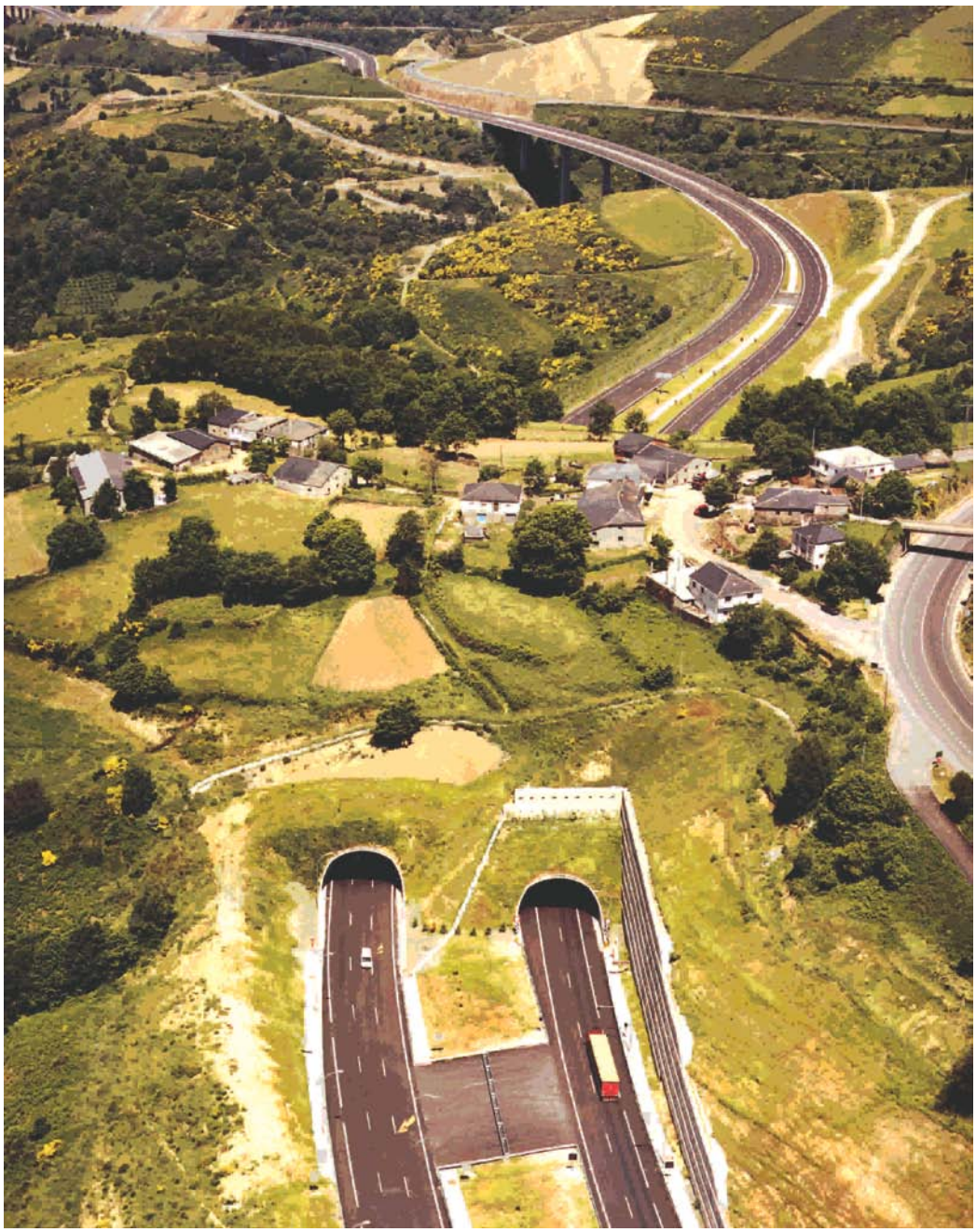
- a **charge** is an entry in an account of something due;
- an **expense** is something spent to attain a goal or accomplish a purpose;
- a **cost** is an amount paid or required in payment for a purchase: a price.

Reference year

Although otherwise specified for some exceptions, all statistics and accounting data to be collected and processed related to the fiscal year 2007 only. 'Only some items, whose costs fluctuated widely, required an average value over the last five years (2003–2007). This value was then calculated and used as the value for 2007.

Consideration of network characteristics

Particular attention was paid to bridges, tunnels, and on/off ramps with the corresponding maintenance costs, because it was clear that the decision to include them or not would have a significant impact on the road length of a network and on the total costs.



Spain: Piedrafita A 6

4.3 Macro study

The macro module concentrated on maintenance and operation expenses for the overall networks in the participating countries.

The final report for this module was delivered by the consultant in November 2009.

The main findings of this phase of the survey are summarised below.

4.3.1 *Main steps*

The main steps involved in this study were:

i) Data collection

- network characteristics (length, cross-sections, bridges, tunnels, ramps, climate zone);
- network condition (pavements and structures);
- network use (traffic, proportion of HGVs, possible indicators of level of service);
- expenses and costs for maintenance and operation (where necessary, converted into €) and their breakdown by task block.

ii) Calculation of normative expenditure ratios, globally and by task block

- per network kilometre
- per 2x2 lane-equivalent kilometre (4Leqkm)—no better weight was found;
- per weighted driven kilometre (WDKm), i.e. 1 truck (over 3.5 metric tons) = 2.5 light vehicles—no better weight was available;
- in addition to these ratios, others could be calculated if relevant

iii) Comparison and discussion of explaining factors for the differences between countries and networks

Brief descriptions of the policies and the organisation of M&O in the participating countries are included as an appendix to the macro study.

4.3.2 *The networks in the survey*

The networks of the following countries or parts thereof were included in the survey: Austria (AT), Belgium-Flanders (FL), Denmark (DK), England (UK), France (FR), Hungary (HU), Ireland (IE), Italy (IT), the Netherlands (NL), Portugal (PT), Spain (ES), Sweden (SE), and Switzerland (CH). These thirteen countries defined all or part of their trunk road networks for this survey.

The consultant collected a significant amount of data on these networks and on the expenses for M&O tasks. After completion of the outsourced contractual work, the WG updated and added some figures for a more in-depth analysis.

These figures are summarised country by country in appendix 3 of the report, which gives:

- the length in km, including the proportion of single, dual (4 lanes), dual+ (5+ lanes), and additional length for ramps;
- the proportion of the length with bridges and tunnels and the proportion of pavements, bridges, and tunnels in need of maintenance;
- the AADT, the share of heavy good vehicles (HGVs) ;
- the number of days per year when the temperature falls below 0° C;
- the user satisfaction index (average when not available);
- the actual Individual Consumption Index (Eurostat 2007)
- the head office expenses (%)
- the breakdown of M&O expenses by task blocks and by purpose (road without structures, bridges, tunnels, environment, and 'others') .

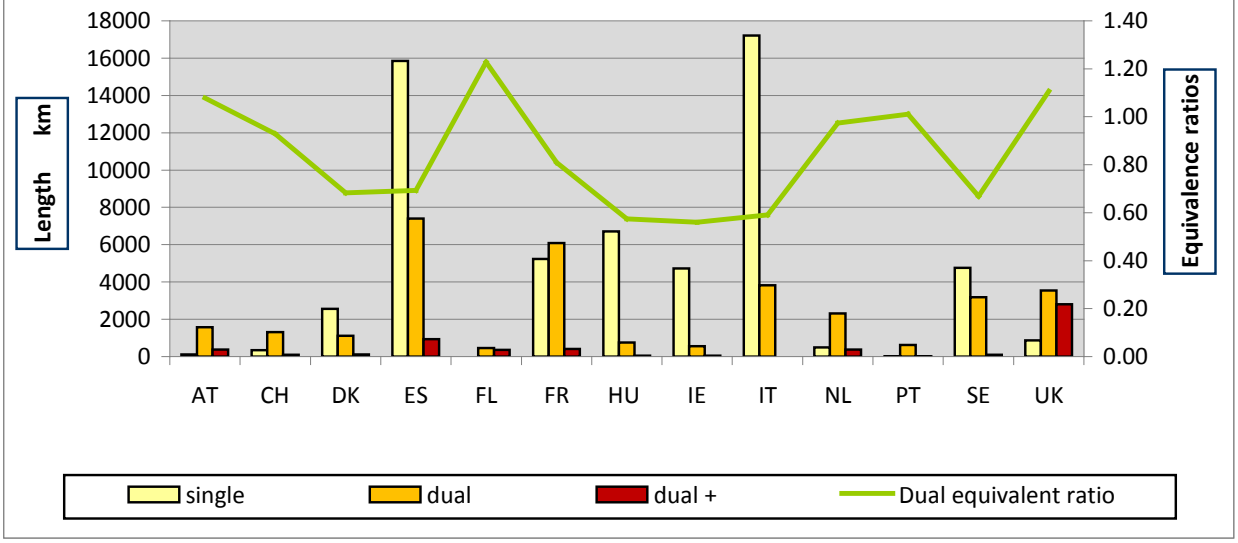
The survey includes nearly 100,000 route km of trunk roads, with an average AADT of over 25,000 vehicles and an average proportion of 13% HGV. Almost half of the survey network is situated in two countries: Spain (ES) and Italy (IT).

UK: Aerial view of the M6

Although the survey concentrates on the trunk road network, the 13 networks differ considerably from one to another. In Flanders, for instance, the survey network only consists of highways with 4 or more lanes, while in Ireland most of the network consists of 2-lane roads. Because this difference influences expense levels, the networks are also described in terms of dual 4-lane equivalent kilometres (4leqkm). However, subsequent sensitivity analysis revealed that this equivalence factor is not really adequate for explaining the main parts of the M&O expenses.

The figure below shows the main characteristics of the networks included in the survey.

Fig 4.3.2.a Network characteristics

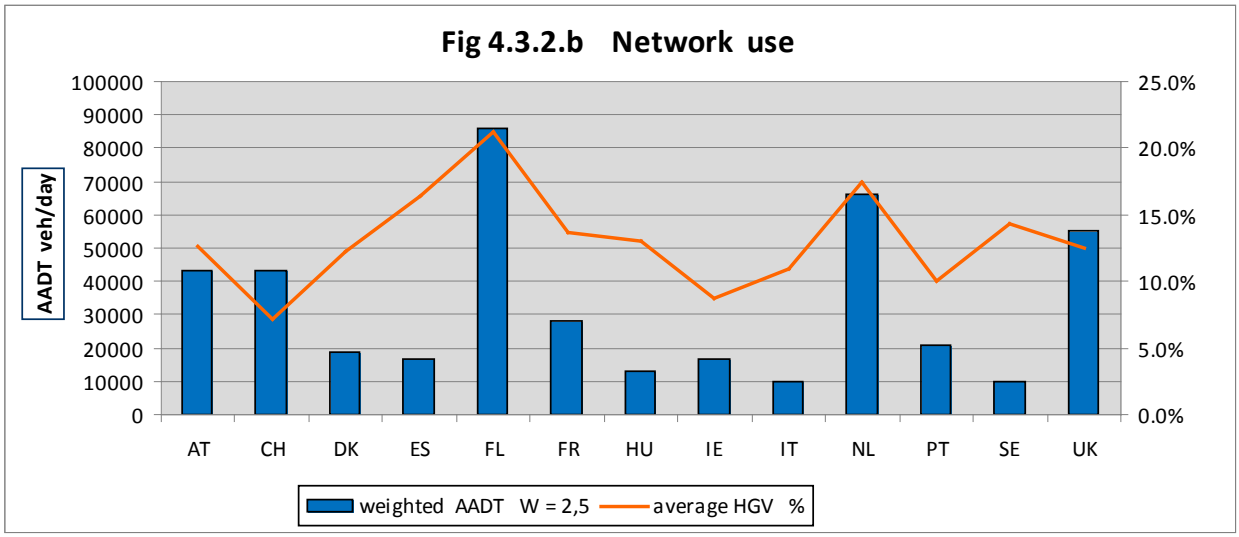


The ratios between the network lengths in terms of route km and dual 4leqkm reflect the differences in network configuration. The ratio is high (above 0.9) for the survey networks of FL, UK, AT, NL, CH, and PT, indicating that these survey networks predominantly contain roads with 4 or more lanes (i.e. 2x2 or wider). The ratio is low (up to 0.6) for HU, IE, and IT, indicating that these survey networks predominantly consist of two lane roads.

LENGTH	AT	CH	DK	ES	FL	FR	HU	IE	IT	NL	PT	SE	UK
NETWORK km	**2,062**	**1,764**	**3,790**	**24,185**	**824**	**11,734**	**7,528**	**5,335**	**21,040**	**3,198**	**654**	**8,046**	**7,235**
Single carriageway 1 to 3 lanes	5.2%	19.8%	67.5%	65.6%	0.0%	44.6%	89.2%	88.5%	81.8%	15.6%	1.3%	59.2%	12.1%
Dual carriageway 4 lanes	76.3%	74.6%	29.4%	30.6%	56.0%	51.9%	10.1%	10.5%	18.2%	72.4%	95.4%	39.6%	49.0%
Dual+ carriageway 5 or + lanes	18.5%	5.6%	3.1%	3.9%	44.0%	3.6%	0.8%	0.9%	0.0%	12.0%	3.3%	1.2%	38.9%
Dual equivalent ratio (4Leq)	**1.08**	**0.93**	**0.68**	**0.69**	**1.23**	**0.81**	**0.57**	**0.56**	**0.59**	**0.97**	**1.01**	**0.67**	**1.11**

Use of the networks

The highest intensities of network use in terms of average AADT are found in FL, NL, UK, AT, and CH (35,000 to 65,000 vehicles per day), while lowest network use intensities are found in IT and SE (below 10,000 vehicles per day), followed by DK, ES, HU, IE, and PT (10,000 to 15,000 vehicles per day); FR (22,000) is close to the average (26,000).



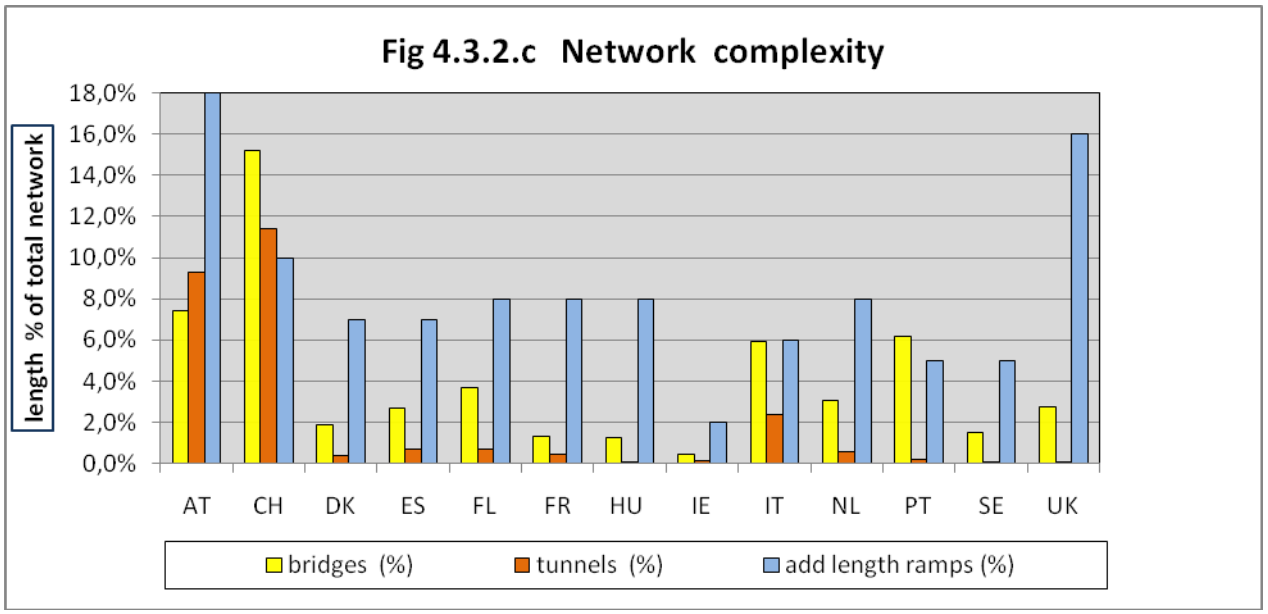
When traffic intensities are expressed in weighted vehicle km (on the standard basis of 1 HGV = 2.5 light vehicles), the difference in the level of use between networks is even clearer: traffic on the survey network in FL, NL, UK, CH, and AT is on average significantly heavier than in the other counties included in this survey.

Interchanges, parallel roads, ramps etc. add another 18% to the network in the case of AT, 16% in UK and 6–10% in most other countries. This has, of course, a direct impact on operating expenses.

Ireland: A1N1, Ballymascanlon

Complexity of the networks

There are significant differences in terms of the complexity of the survey networks. The most obvious difference is in the existence of bridges and tunnels on the network. In the case of AT and CH, bridges and tunnels make up 17% and 27% respectively of the network length, whilst in HU and IE the share is only 1%.



Road network by type of operator

In most countries, the NRAs are responsible for the maintenance and operation of the trunk road networks. In some countries, public or private concessionaires are (also) involved. However, due to limited data availability, expense data from private concessionaires is included in the survey for the AT, PT (only shadow toll), and UK networks only.
In the case of FR, IT, and ES, no data was available from private concessionaires for the BEXPRAC survey. This means that for these countries, the most expensive M&O part of the network (i.e. the toll roads) is not included in the survey.

4.3.3 Global expenses for road maintenance and operations

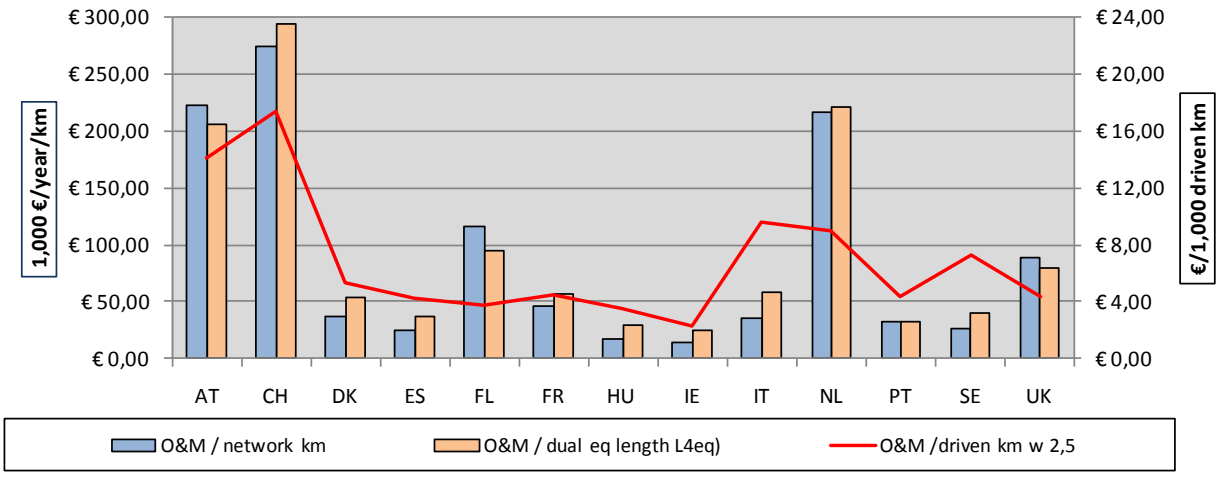
Expense data has been collected and compared for seven maintenance and operations task blocks:

- traffic management (TM)
- routine operations (RO)
- winter service (WS)
- routine maintenance (RM)
- maintenance of signs and markings (MSM)
- maintenance of safety devices (MSD)
- preventive maintenance and rehabilitation (PMR)

Expenses relating to work to improve road networks—such as the improvement of safety, noise barriers, water protection, additional interchanges or service areas etc.—were not included in the comparison. However, the allocation of expenses between rehabilitation and improvements may differ significantly from one country to the other. These differences are one of the main reasons for the wide range of figures for the various countries.

Although an effort was made to collect the expense data in a similar format, there are differences in the way expenses are calculated. The main cost data differences relate to the inclusion of depreciation and financing charges, building charges, environment charges, and organisation overheads. Such differences in the definition of what each country includes in its cost items, should always be kept in mind. Consequently, the following conclusions are tentative and cannot be used to assess efficiency of maintenance and operations.

Fig. 4.3.3: Expense ratios



The expenses per dual 4-lane equivalent km, range from €300,000/year, to less than €30,000/year.
The expenses per weighted driven km, range from €2.30 for 1,000 driven km, to €17.40 for 1,000 driven km.

AT, CH, and NL have the highest expense levels. These three countries are among the countries with a high percentage of complex dual roads in the survey networks and already have extensive preventive maintenance schemes. ES, IE, HU, PT, and SE have the lowest expense levels. With the exception of PT, the networks in these countries are among the networks with a high percentage of 2x1 roads on the network.

The impact of network use on the expenses

It appears that when traffic levels are taken into account, the variation in expense levels between the countries is smaller. This suggests that the level of traffic may be an important factor in explaining differences between countries, perhaps even more than the network length and the cross-section.

Impact of network complexity on total expenses

The complexity of the network, in particular the percentage of tunnels and bridges on the network, is an important factor that explains the differences in expenses.
Even with a relatively low number of bridges and tunnels, a substantial part (between 20% and 40%) of the expenses is devoted to such structures.
The impact of the percentage of bridges and tunnels is best seen from the ratio of expenses per route km of such structures, as compared to expenses per route km of roads without such structures, which is estimated at 10 on average. In other words: it generally costs 10 times more to maintain 1 km of bridge (and even more for 1 km of tunnel) than to maintain 1 km of plain road.

Relation to the quality of the network

The quality of the network describing the need for maintenance was given by each individual country. As there was no common, clearly defined set of rules for describing the condition of the road networks, the comparison given below leaves room for interpretation.

Quality of the network	AT	CH	DK	ES	FL	FR	HU	IE	IT	NL	PT	SE	UK
Pavement in need of maintenance	4.0%	2.0%	60.0%	4.5%	10.0%	15.0%	10.0%	23.0%	33.0%	11.0%		8.0%	1.0%
Bridges in need of maintenance	6.0%	5.0%	2.3%	3.5%	2.0%	8.0%	40.0%	11.0%	9.0%	2.0%		0.0%	3.0%
Tunnels in need of maintenance	9.0%	3.0%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	30.0%	0.0%		15.0%	0.0%
User satisfaction index ERUS 2006	63	79	67	n/a	61	73	n/a	46	53	70	n/a	66	68

n/a = not applicable as these countries did not participate in the ERUS 2006 survey

Road M&O expenses may not only be related to the length, utilisation, and complexity of the network, but may also be the result of the provision of a higher level of service.
Road users may judge the networks differently from the network operator. To assess this, the data from CEDR's European Road User Survey 2006 was used.

It appears that CH scores very well on all aspects in the survey, while IE and IT show low marks on various quality aspects. This hints at a direct relation between input (expenses) and outcome (consumer satisfaction) in these countries.

Looking at the condition of the road pavements, bridges, and tunnels, it should be kept in mind that the categorisation of the condition of the pavement and structures ('good', 'acceptable', and 'in need of maintenance') is not uniform across all countries.

The data received shows that the following countries consider a relatively large proportion of the assets to be in need of maintenance (in 2007):

- pavements (more than 20% of the network): DK, IT, and IE;
- bridges (more than 25% of the number): HU;
- tunnels (more than 25%): IT.

Therefore, in some cases (DK, IT, IE, and HU), relatively low levels of expenses coincide with higher proportions of assets in need of maintenance. The exceptions to this are FR, PT, and SE, which have lower levels of expenses, but not a high proportion of assets in need of maintenance.

4.3.4 Road maintenance and operations expenses by task block

According to the initial ToR, the consultant compared the expenses using the ratios per dual 4Leq km; the table below is extracted from the consultant's macro phase report.

Table 1: Expenses by task blocks per 4leqkm, in €1,000

Task block	AT	CH	DK	ES	FL	FR	HU	IE	IT	NL	PT	SE	UK
Traffic management	4	12	3	-	6	4	5	0	1	36	4	3	1
Routine operation	36	46	5	7	7	*	18	2	21	34	14	3	16
Winter service	17	10	12	3	4	3	11	3	3	7	0	12	3
Routine maintenance of roadways, structures, and roadside fittings	21	30	27	6	35	36	18	8	9	40	11	5	38
Maintenance of road signs and marking	9	3	3	3	19	*	2	5	3	9	3	1	1
Maintenance of restraints and safety equipments	2	11	1	1	3	*	2	1	2	5	1	1	1
Preventive maintenance and rehabilitation	151	207	17	24	38	18	21	6	27	120	7	22	33
Grand Total	**239**	**319**	**67**	**43**	**112**	**61**	**77**	**25**	**67**	**251**	**39**	**48**	**94**

*: included in routine maintenance

The following conclusions are drawn from the expenses for individual task blocks. As definitions may differ from country to country, these conclusions are, in some cases, tentative:

- **Traffic management**: while expenses per 4leqkm are generally at €6,000 per 4leqkm per year, the level is considerably higher in NL. Population density, environmental measures, as well as the extensive use of ITS are probably important drivers that explain these differences.

- **Routine operations**: there is a large variation in expense levels for routine operations. High levels of expenses (€30,000 to €45,000 per 4leqkm) are found in AT, CH, and NL; low levels (less than €5,000 per 4leqkm) in IE, PT, and SE. Possible important expense drivers in this regard are not only traffic levels and network configuration, but also each country's definition of routine operations.

- **Winter maintenance**: The highest levels of expenses for winter maintenance are in AT, CH, DK, HU, and SE (above €10,000 per 4leqkm) and are much lower (€2,000–€3,000) in all other counties. In the case of SE (26%), DK (17%), HU (15%), and IE (12%), the proportion of winter maintenance in total expenses is substantial; in most other countries the percentage is 5% or less. The number of days per year when the temperature falls below 0° C would appear to be an important explanatory factor for this survey.

CLIMATE	AT	CH	DK	ES	FL	FR	HU	IE	IT	NL	PT	SE	UK
Number of days per year below 0 ° C	92	98	79	75	54	32	100	23	4	51	1	151	37
City	Vienna	Bern	Odense	Madrid	Antwerp	Lorient	Budapest	Dublin	Genoa	Rotterdam	Lisbon	Stockholm	Liverpool

Denmark: winter maintenance

- **Routine maintenance:** accounts on average for 25% of total expenses, with a total range of between 10% and 40%. Routine maintenance expense levels are low in absolute figures in ES, IE, IT, PT, and SE, countries that generally have lower traffic levels.

- **Maintenance of signs and markings:** is not a large expense item (less than €5,000 per 4leqkm), with the notable exception of FL and, to a lesser extent, AT and NL.

- **Maintenance of safety devices:** also results in relatively low expenses levels (€5,000 per 4leqkm or less), with the exception of CH, which is probably due to CH's large number of tunnels and tunnel safety devices.

- **Preventive maintenance and rehabilitation:** accounts on average for 40% of total M&O expenses, with a total range of between 19% and 65%. The variation in these expenses accounts to a great extent for the differences in total expenses. These expenses range from €6,000 to €207,000 per 4leqkm.

4.3.5 Road maintenance and operations expenses compared to asset values

The value of the assets has a direct impact on the level of the maintenance expenses. The value of the existing assets was unfortunately not included in the initial data collection. To overcome this missing data, a theoretical value had to be calculated to verifiy the relationship between asset values and the costs of M&O.

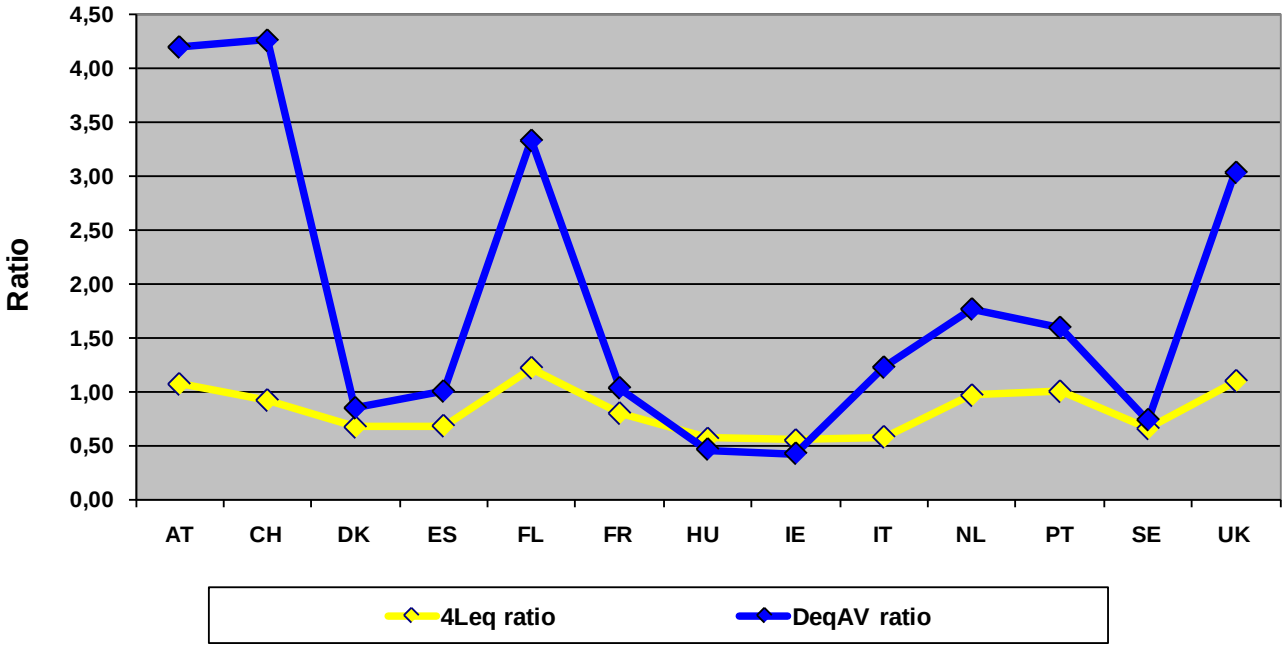
An equivalence factor was introduced, namely the so called 'dual equivalent asset value length' (DeqAV = length of a standard dual 4-lane highway with the same asset value as 1 km of the considered network): This factor was calculated with the following normative values:

- 2 M€/km single carriageway
- 8 M€/km dual carriageway (standard 4 lanes)
- 40 M€/km dual+ (mainly urban)
- +% additional length for ramps
- +50 M€/km bridge
- +150 M€/km tunnel

These values are theoretical and average values. They in no way represent the real value of a single stretch of a specific motorway; they do not include a cost-of-living index, the costs of very expensive land acquisitions, or the complexity of building roads in heavily populated areas.

The results of this theoretical approach are given in the figure below:

Fig. 4.3.5: Comparison 4Leq ratios and DeqAV ratios



The ratios between the network lengths in terms of DeqAV reflect the differences in the network's complexity, basically the share of dual+ sections, as well as bridges and tunnels. The ratio is high, i.e. above 3 times the value of a standard dual carriageway for the networks surveyed in AT, CH, FL, and UK. The ratio is very low for HU and IE at 0.5 and 0.4 respectively, due to the large amount of dual carriageway and low number of structures.

Fig 4.3.5b: Data for the comparison of 4Leq ratios and DeqAV ratios

€ million per network km	AT	CH	DK	ES	FL	FR	HU	IE	IT	NL	PT	SE	UK
Road & equipment (*)	13.6	8.6	4.9	5.3	22.1	6.5	2.9	3.0	3.1	10.9	9.0	4.8	19.7
+ interchanges and ramps	2.5	0.9	0.3	0.4	1.8	0.5	0.2	0.1	0.2	0.9	0.4	0.2	3.2
+ bridges + 50 M€/km	3.7	7.6	0.9	1.3	1.8	0.7	0.6	0.2	3.0	1.5	3.1	0.8	1.4
+ tunnels + 150M€/km	13.9	17.1	0.6	1.1	1.0	0.7	0.0	0.2	3.6	0.9	0.3	0.1	0.1
TOTAL	**33.7**	**34.2**	**6.8**	**8.1**	**26.7**	**8.3**	**3.8**	**3.4**	**9.8**	**14.2**	**12.8**	**5.9**	**24.3**
DeqAV	***4.2***	***4.3***	***0.9***	***1.0***	***3.3***	***1.0***	***0.5***	***0.4***	***1.2***	***1.8***	***1.6***	***0.7***	***3.0***

With the equivalence factor DeqAV, some differences in expenses are easier to explain. The influence of bridges and tunnels is evident, as they make up more than 50% of the values in AT, CH, and IT; the influence of 6-lane roads is exemplified by FL and UK, where they account for more than 80% of the values.

The theoretical figures above describe quite accurately the physical state of the networks. However, as they remain theoretical values, any further analysis, breaking down the costs into task blocks, seemed irrelevant; this is particularly true as the real value and the life span of the various components of the network assets were not available.

4.3.6 Conclusions from the macro module

The following conclusions can be drawn from the macro module of the BEXPRAC survey:

- It was difficult to collect information on road maintenance and operation expenses in a way that allowed for comparisons between countries. Despite the application of strict definitions of expenses and road maintenance and operation tasks, the differences in the data collected prohibit clear conclusions on efficiency levels. Nevertheless, the survey gives some indications of the reasons for differences between the countries participating in the survey.
- Expenses for road maintenance and operation of the trunk road network differ considerably between the 13 countries; the same is true when differences in network configuration are taken into account. As countries with a high level of motorway on the survey network (AT, CH, FL, NL, and UK) show highest expense levels per 4leqkm, maintenance and operation expenses may increase more than proportionally with the road width.
- In some cases (in FL, NL, UK, and, to a lesser extent in AT and CH) high traffic levels may contribute to the level of expenses. In most other countries, the level of expenses shows little or no relation to traffic, indicating that expenses tend to be more related to the availability of the network rather than to traffic.

The difference in overall expenses is particularly due to differences in expenses for *preventive maintenance and rehabilitation* and *routine operations*. Countries with high overall expenses generally show high expense levels for these two task blocks, while countries with low overall expenses show low expense levels for these task blocks.

There are two groups of countries regarding expenses for *routine maintenance*. Relatively low levels of expenses are found in ES, IE, IT, PT, and SE; levels of expenses are higher, but at a similar level, in most other countries.

Expenses for *traffic management*, *winter maintenance*, *maintenance of signs and markings,* and *maintenance of safety devices* are generally low and at comparable levels in the 13 countries. Notable exceptions include higher levels of expenses for traffic management in NL, for winter maintenance in DK and SE, for maintenance of signs and markings in FL, and for maintenance of safety devices in CH.

At the overall level of all task block expenses, the differences can (partly) be attributed to:

- differences in the network configuration;
- the difference in traffic levels on the network (high in AT, CH, FL, NL, and UK; low in most other countries);
- differences in the complexity of the network, reflected by the percentage of structures such as tunnels and bridges on the network (many in AT, CH; few in HU, IE, SE);
- the complexity of the network, reflected by the high number of interchanges in some countries (AT, UK) and the low number of interchanges in others (IE, IT, SE);
- a need for maintenance of aging bridges and tunnels (in NL);
- the service level provided to users, in particular in CH (high level) and IE, PT (low level);
- the difference in the cost of living from country to country, with above-average price levels in AT, CH, and NL and a lower-than-average price level in HU.

4.4 Micro module

The aim of the micro module was:

- to compare actual performance levels on a limited range of small-scale subsets;
- to identify road maintenance and operation best practices on the basis of the same field of observation.

This module gives an insight into the level of expense ratios at the level of single sections of the networks, thereby complementing the insights at the level of the global networks.

It must be underlined that any direct comparison between micro and macro ratios would be hazardous, mainly because:

- the single cases do not represent the entire network (complexity, condition, climate, traffic etc.);
- some kinds of expenses, which are averaged in the macro approach (traffic management centres, resurfacing, marking renewal etc.) may or may not occur for a given section and/or in the year 2007, even taking plural-annual averages for some kinds of expenses;
- the expenses in the micro approach do not include some overheads and are given without VAT.

It is also worth noting that the exchange rate for some currencies since 2007, notably the GBP, may change comparisons between countries.

The main findings of this phase of the survey are summarised below.

4.4.1 Main steps

The main steps involved in this study were:

- to compare task blocks in each of the considered cases;
- to collect data through questionnaires and clarify questions in meetings with the field managers in particular regarding:
  - network characteristics of the subsets under review
  - available elements on the levels of service;
  - available data necessary to compute maintenance and operation charges of the subset
  - complementary information on organisation and practices (performance targets, asset management systems, organisation, out-contracting etc.);
- to calculate ratios and to perform a comparative analysis across the selected subsets and across the different countries;
- to outline good practices in maintenance and operation as highlighted by the countries.

4.4.2 Case selection

The WG chose seven cases for the analysis of the subsets.

The seven cases relate to different types of roads, or cross-sections, ranging from a heavily used urban road (6 lanes or more) to a quiet two-lane rural road.

The study covers 36 road sections, distributed over the seven cases. With the exception of cases 2 and 7 (three sections each), the cases contain four or more road sections, distributed according to the following table.

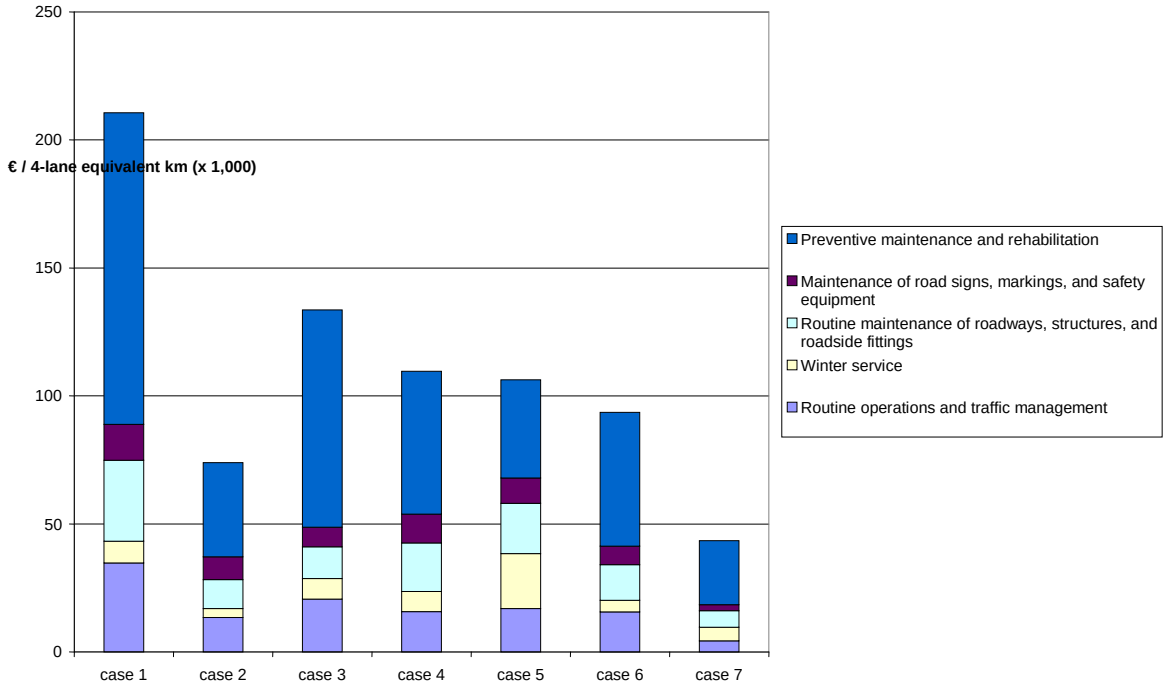
Case	Site	Cross-section	ADT	Type of maint.	AT	CH	DK	ES	FL	FR	HU	IE	IT	NL	PT	SE	UK	No. cases
1	Urban	6 lanes	> 60,000	All	✓	✓		✓	✓	✓	✓			✓			✓	**8**
2	Rural	4 lanes	> 30,000	Night					✓							✓	✓	**3**
3	Rural	4 lanes	> 30,000	Day	✓	✓			✓		✓						✓	**5**
4	Rural	4 lanes	< 30,000	All				✓ ✓					✓	✓		✓	✓	**6**
5	Mount.	4 lanes	All	All	✓			✓		✓			✓					**4**
6	Rural	2 lanes	> 7,000	All				✓			✓		✓	✓		✓	✓	**7**
7	Rural	2 lanes	< 7,000	All				✓		✓	✓					✓		**3**
					3	**2**	**-**	**6**	**3**	**3**	**4**	**-**	**3**	**3**	**-**	**4**	**5**	**36**

Spain: the outskirts of Madrid

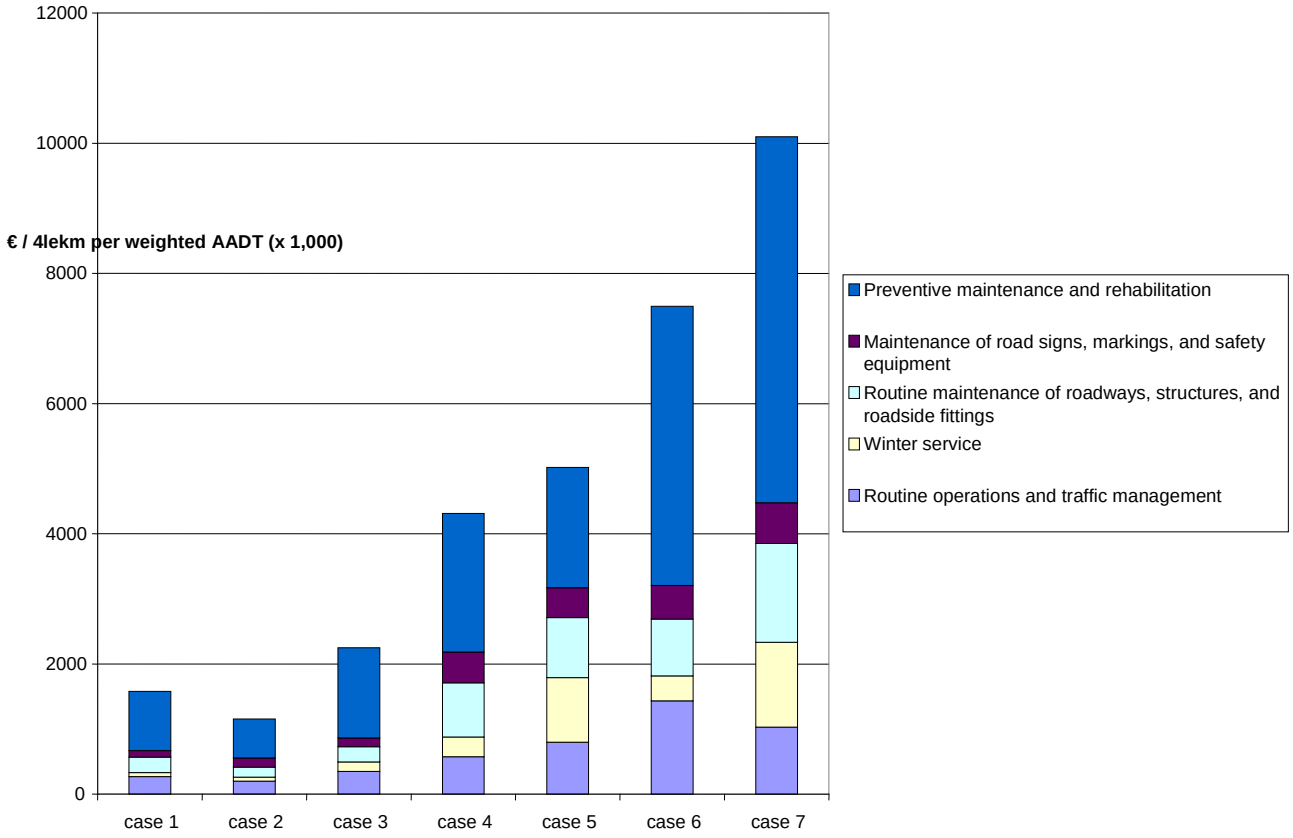
4.4.3 Main conclusions on typical road sections

The ratios calculated for the different cases are summarised in the figures below

Average expenses per 4-lane equivalent km in selected cases (in € thousand)



Average expenses per 4leqkm corrected by weighted traffic intensity in selected cases (in euro and 1,000 weighted vehicles)



The following conclusions can be drawn from the micro module:

- Expenses for a busy urban road with 6 lanes (or more) are substantially higher per kilometre than those for a 2-lane or 4-lane road, even if the difference in the number of lanes is taken into account. Expenses for a quiet 2-lane road, again corrected for the number of lanes, are lower per kilometre. This indicates that the expenses increase more than proportionally with the number of lanes.

  The survey shows that, when expressed per network kilometre, annual M&O expenses for a six-lane or more roads are 2 to 4 times the level of expenses for a 4-lane road. Expenses for 2-lane roads with high traffic are half the expenses of a 4-lane road, whereas expenses for a 2-lane road with low traffic are a quarter of the expenses of a 4-lane road.

- Expense levels for a 4-lane road do not appear to be affected by the level of traffic. For some countries, a comparison of the cases shows that the roads with night-time maintenance have higher expense levels than those with day-time maintenance; this difference does not appear at case level because of the selected sections. Similarly, at country level, mountain roads show higher expense levels than roads in flat terrain, whereas this difference does not appear at case level.

- The breakdown of annual expenses for road M&O differs between the road types. Expenses for routine operation and traffic management clearly increase with traffic levels; expenses for preventive maintenance and rehabilitation clearly increase with the complexity of the road, in particular with the percentage of tunnels and bridges. The latter types of expenses are, in all cases, the largest component of the total expenses with the exception of mountain roads. For such roads, routine operations, winter maintenance, and, to a lesser extent, routine maintenance, account for higher expense levels.

- Despite the higher expense levels per network kilometre, complex and busy roads are clearly more efficient in terms of cost per driven vehicle km. The higher expenses per network km can be amply justified by the economic benefits to the users.

- It appears difficult to relate differences in expense levels between countries to differences in the levels of service provided. While such differences appeared relevant to expense levels for traffic management & operation (coverage of network by traffic management centres, type of information provided, service level in incident management, frequency of patrols, inspections etc.), for other task blocks, such relations between level of service and expenses appear less pronounced.

- It is difficult to assess the impact of differences in the organisation of maintenance and operation tasks on expense levels. As most countries have outsourced most of the work, differences in such practices may influence cost levels less than anticipated when setting up the benchmark.

- The differences in definitions and accounting systems maintained by NRAs appear difficult to overcome. This affects the comparisons made between countries. A more uniform way of recording data across countries would increase the insight provided by future benchmark studies.

- The comparison of examples from each of the 7 cases into which the road network was divided and the macro module results do not provide significant conclusions. The reason being that examples of specific types of road were compared with the entire network, thereby obtaining unreliable results.

- In the future, the micro module must guarantee that the selected road section is representative of its case. The cases must be selected according to a number of defined factors, thereby making sure that the road sections provided by each country are similar and hence meticulously comparable.

4.5 Best practices in maintenance and operations

One of the objectives of the BEXPRAC survey was to gather examples of best practice in the following areas in particular:

- in-house activities versus outsourcing of activities;
- procurement practices for outsourcing, resulting in better value for money;
- the improvement of in-house activities, resulting in better value for money.

4.5.1 In-house versus outsourcing of activities

Almost all organisations in the survey outsource most activities to other parties.
In some cases, such parties are other local government agencies (Ireland), but in most cases, they are private contractors. In most cases, only a small group of in-house workers are employed in day-to-day M&O, in particular for routine operations.
Despite this general overall picture, differences in the structure of the expenses are substantial. The proportion of outsourced work to total expenses ranges from 60% in Denmark and the Netherlands to over 90% in Sweden, Spain, and England.
This wide range may be caused by differences in the way the expenses have been calculated.

Total expenses by category (%)

Country	1. Head office and managing contracts	2a. In-house activities– Labour costs	2b. In-house activities – Non-labour costs	Purchase of out contracted maintenance & operation
AT	8%	6%	11%	74%
CH	1%	10%	6%	84%
DK	6%	13%	21%	60%
ES	3%	0%	0%	97%
FL	8%	2%	1%	89%
IE	1%	16%	55%	29%
IT	13%	13%	3%	71%
NL	5%	19%	15%	61%
SE	7%	1%	1%	91%
UK	1%	0%	0%	99%

Source: Macro module report

The WG observed the following trends:

- Contractors do most of the work on the road.
- There is a decrease in the number of contracts to lower in-house costs, e.g. by combining routine operation, winter maintenance, and routine maintenance.
- The duration of contracts ranges between three and five years.

4.5.2 Procurement strategies

The classic approach is that civil servants in the administration or NRA make the decisions (from the planning stage to the execution of works) and the private contractor executes the works.

In line with the objective of reducing in-house activities, many countries try to find other formats for their (integral) contracts which include:

- performance contracts, whereby more decision-making is left to the contractor while the road administration lays down less technical specifications;
- clarification of roles and responsibilities, leading to a reduction in contractual interface problems;
- partnering contracts in which the NRA enters into a close cooperation with the contractor (e.g. flexibility in changing service levels).

4.5.3 Improvement of in-house activities

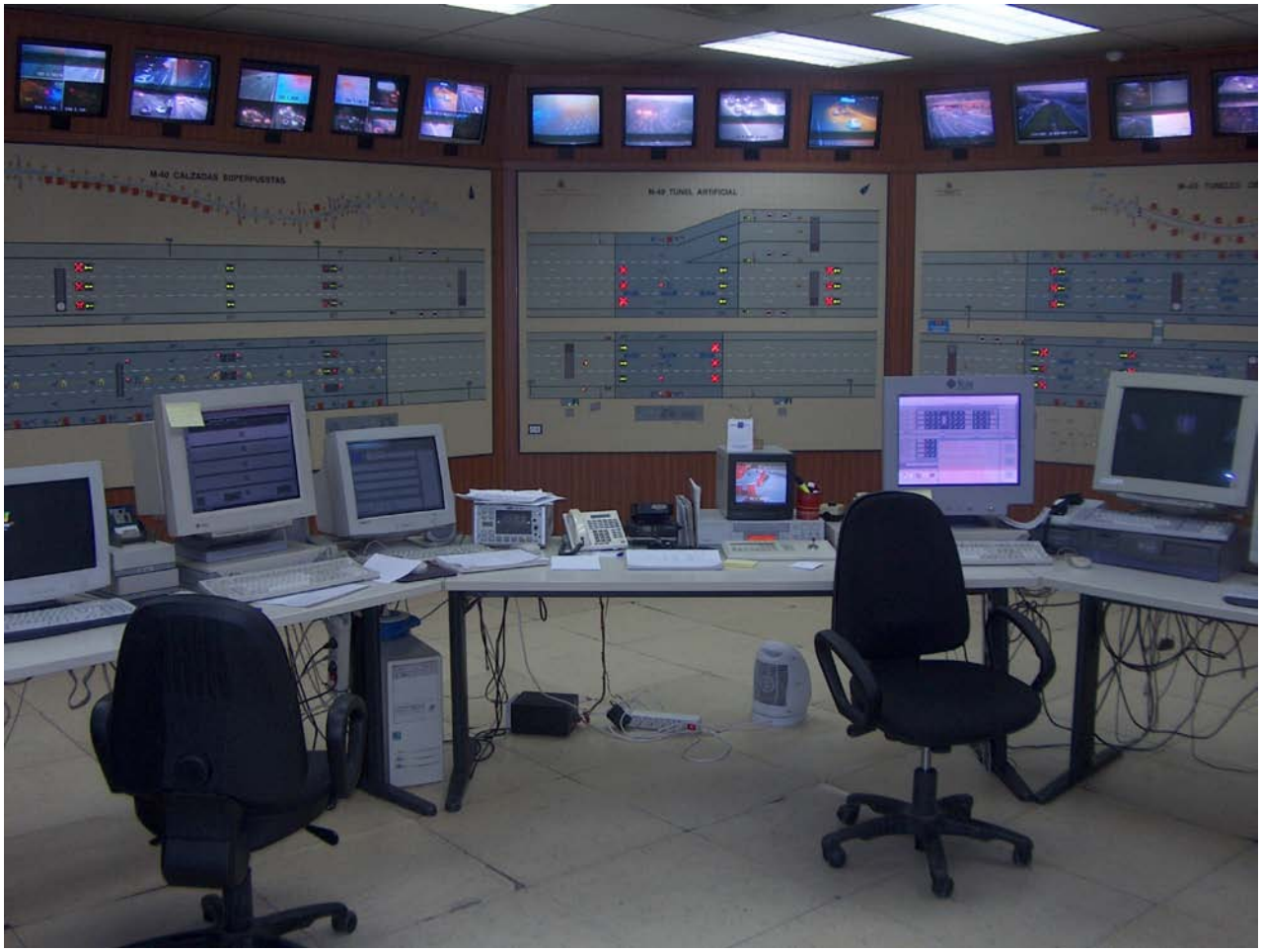
There are various ways of increasing the added value of the NRA's activities. Some of them relate to improving in-house activities, others are more general and may include other parties. The best practices identified relate to the various task blocks, but also to the aspects outside the NRA, i.e. the road users and the environment.

Traffic management and routine operations

As traffic levels increase, traffic management and routine operations become increasingly important. In this respect, many countries have established M&O control rooms in order to detect emergencies, coordinate and manage internal and external resource activities 24hours a day, seven days a week. The control rooms are linked to national and local private radio stations in order to spread traffic information to a wider audience.

Another way of dealing with larger volumes of traffic is hard shoulder running. Using the hard shoulder gives approximately 25% more capacity during peak periods.

In the event of an incident, the control room can close the affected lane. Hard shoulder running has significant cost and environmental benefits: the cost is significantly less than widening the road and does not involve the acquisition of additional land.



Spain: traffic management

Routine maintenance

All operators stress the need for timely, high-quality routine maintenance in order to keep expenditure on preventive maintenance and rehabilitation at an acceptable level.

Winter service

In most countries, the NRAs have warehouses for winter equipment and hold salt in regional centres. Activities are coordinated at district level or higher. Sometimes incentives are built into the contractors' contracts (without creating a major economic risk for the contractors). To this end, the quantity of winter service measures included in the contracts is based on weather statistics. If the contractor carries out 10% more interventions due to adverse weather conditions, the unit prices of the compensation are reduced because the contractor can take advantage of economies of scale (i.e. higher quantities), thereby reducing his costs per unit.

Preventive maintenance and rehabilitation

Because preventive maintenance and rehabilitation accounts for the larger part of expenses, this is clearly a focal point for many NRAs.
Most countries have management systems for pavements and structures such as tunnels and bridges. Periodic measurements are necessary to keep these systems up to date. Some countries combine information from these systems in an overall management system.
Most countries use lifecycle cost analyses as the basis for preventive maintenance.

Reducing the impact of maintenance activities

Various countries have developed strategies to reduce the impact of maintenance activities on the flow of traffic by:

- carrying out maintenance at night, on weekends, and during the summer in urban areas;
- avoiding carrying out maintenance during summer holidays on transit and tourist routes;
- integral planning: to maximise road space usage by carrying out maintenance on pavements, structures, and electromechanical equipment simultaneously as a package;
- setting strategic requirements such as maximum length of maintenance sections and minimum distance between two maintenance sections;
- centrally controlling maintenance programs on the network.

Workforce safety

Workers on construction sites are protected by temporary concrete or steel barriers. Advance signalling warns motorists of works, lane closures, and road narrowing. In the case of longer road works, average speed enforcement cameras and flashing speed warning signs are used.

Dialogue with road users

NRAs have successfully collected enhanced information through dialogue and communication with different stakeholder groups. NRAs are, therefore, trying to adjust standards to meet stakeholders' demands and to determine their customers' expectations on a regular basis.
It is important to be able to explain to customers what NRAs can provide and the basis for their decisions regarding the level of maintenance and operations they offer.

Energy efficiency

Various NRAs have recently changed their way of working to increase energy and environmental efficiency. Road lighting, for instance, has been restricted during night hours and energy-efficient lighting has been introduced. This has resulted in power savings and a reduction in CO_2 emissions. It has been estimated that the power savings will pay for the cost of installation within 10 years.

Economic efficiency of the road transport system

It is worth comparing the expenses borne by the NRAs and those borne by the road users. When expenses are linked to the km driven by users, the M&O expenses borne by the NRAs are on average around €6 per 1,000 km (with a total range of between €4 and €22).
For the same 1,000 km, the expenses for the use of a medium passenger car are around €200 excluding depreciation of the car or €400 including the depreciation of the car.
This means that even a slight increase in M&O expenses on highways with a view to providing a better level of service would not result in a significant increase in the overall cost of road transport. It is essential that this issue be taken into account when drawing up NRA policies.

4.6 Model for a network

The consultant's main job was to collect and harmonise a vast amount of data and practices and to deliver its analyses using standard ratios for expenses on different roads.

The consultant was not tasked with building a model to explain and/or forecast M&O expenses for different situations. The consultant was tasked with providing data that would allow for the identification of the main factors driving expenses and confirming—or not as the case may be—whether some of the initial assumptions were right.

When the survey started, it was known from experience and former studies, that expenses were linked at least to the length and width (cross-section) of the road and the traffic volume.

For this reason, the consultant was asked to standardise expenses per 4-lane equivalent km on the one hand and per km driven by the road user on the other. The number of lanes was taken into account without considering the type of road and the percentage of structures (as in other former studies, one HGV counted for 2.5 passenger cars).

This was, of course, only a normative approach ex-ante and did not allow for accurate comparisons. Nevertheless, it significantly reduced the dispersion of the collected data from one country to another.

The WG's final report includes further sensibility analyses and a modelling scheme described in appendix 6.

This model was built on the basis of the data collected and cannot provide output that is of better quality than the available input used.

The calculation of the M&O expenses using the model differs by between -27% and +37% from the data collected in the different countries. While this result is not excellent, it is acceptable for a first attempt at building a model.
With updated and complete data, it would probably be possible to explain the expenses within a range of between -20% and +20%.

It also appears that in order to improve the model, a more in-depth analysis is needed on the countries' specific environmental issues, expenses on structures, and the depreciation of assets with short lifetimes.

5 Possible ways forward

Three different ways to bring forward the BEXPRAC study were envisaged:

- the termination of BEXPRAC ('termination')
- the conducting of a second BEXPRAC study ('BEXPRAC 2')
- a contribution to CEDR's strategic plan for task 3 on long-term investments ('join task 3')

5.1 The termination of BEXPRAC

This way forward is feasible since the BEXPRAC project has, on the whole, met the assigned objectives within the allocated timeframe. The objectives were:

1 To obtain references in order to better justify budget allowances

This objective has been met. There are clear references on how the types of cross-section, the presence of structures, the level of traffic, and the level of services provided to road users have an impact on the budget required for maintenance and operations**.**
A tentative model could be built to rationalise M&O expenses within a range of +/-30%, despite considerable differences in the definition of tasks and missing data.

2 To ascertain maintainable levels of service and prioritise rules within a given budget

This objective has been partly met. The BEXPRAC results provide indications and strong hints, but no fixed rules or prescriptions. BEXPRAC clearly shows that when the level of maintenance is low, road user satisfaction is also low. No direct link could be established between the actual expense levels of a network and its physical condition. A longer-term view of individual road sections would be needed to establish whether lower levels of service would automatically result in lower or higher lifecycle costs. This kind of analysis was outside the scope of BEXPRAC.

As far as prioritisation is concerned, it was found that high-traffic roads have the lowest maintenance costs per vehicle kilometre. From the point of view of society, this would appear to be money well spent; money is certainly better spent here than on the maintenance of low-traffic 2-or 4-lane roads.

3 To obtain references in order to define performance targets

This objective has been met. By comparing information from 13 networks, BEXPRAC provides references on many aspects of the maintenance and use of road sections. It provides information on how the practices and expenses of a particular road administration compare to those of its peers. These references can later be used to define performance targets.

4 To improve performance levels by sharing best practices

The BEXPRAC process has resulted in sharing a wealth of information on how road administrations work with contractors, how they deal with various maintenance tasks, and what the results are in terms of expenses and user satisfaction. Whether the objective of improving performance levels has been met will depend on whether this information is used or not in the future.

Conclusion for option 1:

The termination of the BEXPRAC project is the quickest and cheapest way forward in terms of further expenses and effort for CEDR and the NRAs.
However, in terms of return on investment, it would be a pity to lose the understanding and momentum developed between members.

5.2 A second BEXPRAC study

This way forward could be considered if a limited number of NRAs were to express their willingness to carry on the efforts to integrate and enlarge a common European database. These renewed efforts would be based on the consideration that further analyses are essential in order to make full use of the BEXPRAC results in the day-to-day processes and activities of the NRAs.

A common European survey could be carried out on the TERN and TEN-T road networks to share road maintenance costs and habits for particular highways with similar functional characteristics. This undertaking would be in line with CEDR's mission and objectives.

Valuable results could be achieved with a second BEXPRAC, which would ideally focus more on the type of data collected in the micro module. This data would have to be properly incorporated into the study through deeper and more detailed *on-site* interviews and would have to be based on a larger number of kilometres with four (or a maximum six) lanes.

To obtain more accurate results, a second BEXPRAC would have to ensure, right from the start, that participating countries harmonise their analytical accounting methods and allocate their expenses to homogenous road sections or network subsets. It would be of little interest and a waste of time, money, and energy, to include in a second BEXPRAC NRAs that do not meet these prerequisites.

The analysis of expenses would have to be clearly disaggregated by tasks, task blocks, and purpose (road and pavement, bridges, tunnels, environment, and others) on clearly defined sets of road sections with comparable characteristics.

To increase the relevance of the comparisons, it would be essential to collect data concerning asset values and the lifetime of the considered network.

Finally, user satisfaction would have to be measured using similar methods on the compared road sections. The European Road Users Survey (ERUS) carried out by CEDR should be taken as an example.

Appendix 5 lists the recommendations of the WG members for the eventuality that a second BEXPRAC is launched.

Conclusion for option 2:

A second BEXPRAC study might be useful and appealing in terms of improving the present findings. However, its return on investment would be low in the short term.
Such a study could be launched in a few years time, once the accounting practices of the participating NRAs have been harmonised.

5.3 A contribution to CEDR's strategic plan for task 3 on asset management

This way forward could be considered because most of the data and benefits collected within the framework of the BEXPRAC project match the objectives of task 3 of CEDR's second strategic plan for the years 2009–2013.

Preventive maintenance and road improvements account for the largest proportion of expenses in many countries. In order to optimise the forecasting of these expenses, WG BEXPRAC would have to join task group 3, which will deal with long-term investments in road infrastructure. The objectives of task 3 are detailed in Appendix 7.

The suggestions, hints, and lessons learned from BEXPRAC would have to be used to improve and enhance the results of asset management programmes by fostering NRAs' collaboration and data sharing, as well as by fostering them particularly on the International Road Networks of European interest.

The countries participating in BEXPRAC have gained valuable experience in commonly defining task blocks and in defining expenses of the different types of roads in their networks.

The NRAs may use the European database for their own future analyses and *ad-hoc* benchmarks that are performed autonomously by a limited number of NRAs. Consequently, the database should be periodically updated by the participating NRAs. The tables in appendix 3 of this report could be a template for the minimum amount of data to collect every year in each participating country.

The best way to integrate the knowledge gained in BEXPRAC into task group 3 remains to be defined.

Conclusion for option 3:

The know-how and the experiences gained in BEXPRAC must be integrated into CEDR's priority activities defined by SP2. The best way to integrate this work would be to assign a clear role in task 3 for the definition of adequate tasks and task blocks which could be used in the accounting systems of the NRA and could be attributed to particular stretches of the road network.

France: applying road marks

5.4 Comparison of the ways forward

The advantages and disadvantages of the three ways forward outlined above are summarised in the table below.

The three ways forward were analysed in conjunction with the criteria of costs and efforts required to reach the set goals, the feasibility of achieving the goals, the return on investment within BEXPRAC, and conformity with CEDR's mission and strategy.

The results of the evaluation are given in the table below, where +++ means 'excellent' and --- 'very poor'

	Termination	BEXPRAC 2	Join task 3
Costs and efforts	+++	---	+
Feasibility	+++	---	++
Return on investment	+	+	+++
CEDR's strategy	---	+	+++

The BEXPRAC working group therefore agrees that the best way forward would be to use the knowledge and the data acquired in BEXPRAC within the objectives set for task 3 in CEDR's strategic plan for 2009–2013 and recommends this option to the GB.

6 Conclusions

The **B**enchmark of **Ex**penditures and **Prac**tices of maintenance and operation was launched on the initiative of France at CEDR's Governing Board meeting in Ljubljana on 22 April 2008 with 13 NRAs volunteering to participate.

BEXPRAC was the first ever benchmark of road maintenance and operation costs undertaken at European level. Many at the time felt that it was impossible to compare costs for the networks and listed a number of reasons to underline their point of view. The remarks and comments of the sceptics were taken on board and most of them were indeed encountered during the BEXPRAC project.

Nevertheless, it can now be said that despite all the difficulties encountered, the BEXPRAC study has met nearly all of its objectives which were:

1 to obtain references in order to better justify budget allowances;
2 to ascertain maintainable levels of service and prioritise rules within a given budget;
3 to obtain references in order to define performance targets;
4 to improve performance levels by sharing best practices.

BEXPRAC was completed within the allocated budget (less than €500,000) and almost within the allocated timeframe of 18 months after the starting date of 15 September 2008.

Even though most of the BEXPRAC objectives have been met, some questions could not be answered completely due to the methodology used and insurmountable differences in task definitions, practices, and accounting methods in the participating countries.

The collection of data in the countries and their synthesis constituted the backbone of the BEXPRAC work. The results are now available to all CEDR members in the form of a wealth of figures and procedures from which each country can choose.

The conclusion of the BEXPRAC study constitutes a first step in the benchmarking process at European level. To ensure that the work done and the results obtained are not forgotten in the near future and to ensure that a return on investment is guaranteed, the members of WG BEXPRAC analysed the best way to bring BEXPRAC forward. They analysed three different scenarios and concluded that the best solution would be to integrate the results and lessons learnt during BEXPRAC into the more general framework of task 3 of CEDR's strategic plan for the years 2009–2013. This would ensure that the definition of tasks and the system of allocating expenses to relevant stretches of roads are performed in such a way that they remain easily comparable.

To conclude, BEXPRAC collected data from the participating NRAs and synthesised this data in such a way as to make M&O expenses comparable. However, the output data can never be more precise than the input data. All figures mentioned in this report must therefore be considered with caution, as comparisons may not always be based on the same assumptions. This is the main reason why the BEXPRAC members recommend the harmonisation of the definition of tasks and accounting systems before any further efforts are put into a second BEXPRAC study.

We would like to thank the Directors of Roads for having initiated this first-ever comparative study of maintenance and operation expenditure and practices. It was a great adventure for all participants, who overcame many obstacles on both the technical and the accounting side. Thanks to their commitment and enthusiasm, BEXPRAC proved that maintenance and operation expenditure is comparable.

7 Request

The GB members are requested to discuss and amend the present report as they see fit and to approve that the report (or an amended version thereof) be published on CEDR's official website in line with CEDR's 10-step procedure for final reports.

Appendix 1: Scope and nomenclature of maintenance and operation tasks

PRODUCTION TASKS

Task block	Elementary task
Traffic management	Traffic management
	Tunnels operation
	Information to road users
Routine operation	Patrolling
	Rescue/emergency actions
	Temporary markings for road works
Winter service (WS)	WS patrolling
	Road salting and snow clearing tours
	Weather services
Routine maintenance	Routine maintenance of roads
	Routine maintenance of tunnels
	Routine maintenance of bridges
	Routine maintenance of retaining walls
	Maintenance of drainage appliances (i.e.: cleaning out ditches, levelling down shoulders, maintenance of water collection and treatment appliances)
	Vegetation maintenance (mowing, chemical treatment and plant care)
	Cleaning (except for service or rest areas)
	Inspections
Maintenance of road signs and markings	Static and dynamic
Maintenance of restraint and safety equipment	

If available

Other equipment	Maintenance of emergency calls network
	Cleaning, maintenance, and extension of service/rest areas
	Land and building property – maintenance and operation expenses
	Real estate – rehabilitation
	Traffic lights (maintenance and operation expenses)
	Road lighting (maintenance and operation expenses)

INVESTMENTS

Preventive maintenance and rehabilitation	Preventive maintenance of pavements
	Preventive maintenance and rehabilitation of tunnels
	Preventive maintenance and rehabilitation of bridges and walls
Improvement works	Safety improvement works
	Environmental improvement works (against noise and other forms of pollution)
	Other improvement works (service/rest areas, car parks, vegetation...)

SUPPORT TASKS

Task block	Elementary task
Field support services	Management
	Accounting
	Management control
	Quality control
	Purchasing/procurement
	Land and building property – management
	Legal support
	Equipment – management and maintenance
	Human resources – management
Central support services (administration and engineering)	Same functions as above plus project design and works supervision

OUT-OF-SCOPE ACTIVITIES

In the micro module, the following activities were excluded from the scope in order to avoid complicated or biased comparisons:

- Central support services (administration and engineering): to avoid arbitrary breakdowns of the related charges;
- Intense works of roadway or structure rehabilitation and renovation: to avoid considering exceptional charges that could distort micro comparisons between subsets.

Appendix 2: Range and itemisation of expenses

This study is based on expenses and charges from the fiscal year 2007 (or multi-annual estimated averages for items subject to high fluctuations from year to year, such as winter service, purchase or storage of heavy materials). All amounts to be computed and expressed in constant €2007.

This appendix aims to provide an illustrative basis for listing the items to be considered.

Item	Entry
Wage bill	Net salaries
	Bonuses and allowances (overtime or stand-by pay, incentives, long-service bonus etc.)
	Social security charges (paid by the employer)
Overheads	Office supplies, equipment, and furniture
	Consumption of fluids except for road operation and maintenance works water, gas, electricity
	Clothing and individual equipment
	Telecom equipment and subscriptions (phones, radios)
	Computing hardware purchases
	Computing software and outsourced support services
	Building charges
	Rent or annual rental value of buildings
	Building insurance/business liability insurance/vehicle insurance
	Continuing education of the workforce
Purchase of consumables or materials	De-icing agents, crash barriers, sand etc. Small operation material (e.g. marker cones) Structural materials: concrete, asphalt, aggregates…. Electricity for road lighting
Machines and vehicles (purchase and renting)	Handling equipment, workshop, garage
	Maintenance machines and special vehicles
	Trucks and vans
	Lights vehicles
	Fuel, lubricants, and other consumables
Outsourced maintenance and operation	Purchase of maintenance and operation services

Item	Entry
Depreciation of tangible assets	Machines, buildings
Depreciation of intangible assets	Such as non–current software
Others	Studies expenses, expenses for legal advice
	Financial charges

NB: Assessing depreciation charges (for buildings, machines, vehicles etc.) was no easy matter for a state agency subject to administrative accounting. In this case, the appropriate and more convenient solution was:

- *for non-rented buildings: to consider systematically an estimated rental value (by reference to the same category—offices, hangars, workshops—in the vicinity);*
- *for non-rented machines and vehicles: to simply charge the annual expense flow for renewal (i.e. yearly purchase of machines and vehicles). The reasoning was that on a large scale (e.g. for maintenance of a large national network), the amount should be steady enough to be significant. For smaller units, it was necessary to compute an average over five years in order to resolve possible volatility;*
- *all items with shorter depreciation periods were charged as a purchase for that year.*

Some other entities (such as concession holders) preferred to communicate depreciation charges as they are entered in their accounting system. In any case, the consultant was expected to make sure the data was fully comparable and to avoid counting double (e.g. adding together rental value and depreciation charge…).

Appendix 3: Summarised breakdown of M&O expenses by task block and by purpose (2007)

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		AT - Real tolls						inh/sqkm	organis		&	of which in need of maintenance		
Length (km)	2062	5 % Single, 76% Dual, 9% Dual+			83.3%	7.4%	9.3%	99	& policy		others	4.0%	6.0%	9.0%
avrg nb 4Leq	1.08	Traffic management	7.7	**7.2**	7.2					3.2	3.2	3.8	0.0	0.0
extra lgth ramps	18.00%	Routine operation	78.2	**73.4**	39.4	8.2	25.7			32.6	32.6	21.0	49.4	123.4
AADT	36182	Winter service	37.8	**35.5**	35.5					15.8	15.8	18.9	0.0	0.0
HGV (%)	12.60%	Routine maintenance	44.7	**41.9**	31.8	2.4	7.6			18.6	18.6	17.0	14.7	36.6
nb days <0°C	92	Maint road signs and markings	18.7	**17.5**	17.5					7.8	7.8	9.3	0.0	0.0
user satisfaction	63	Maintenance safety equipment	3.8	**3.6**	3.6					1.6	1.6	1.9	0.0	0.0
AIC ind (not GDP)	115	Prev. Maint. & rehabilitation	327.2	**277.3**	195.0	50.2	25.8		6.3	123.3	120.5	104.0	300.9	123.7
		TOTAL excl. improvement	**518.0**	**456.4**	**330.0**	**60.9**	**59.1**		**6.3**	**202.9**	**200.1**	**176.1**	**364.9**	**283.6**
Head office € million	72.80	**Improvement works**	491.9	**416.8**	182.6	30.8	140.9	31.9	30.7	185.3	157.5	97.4	184.4	676.3
Head office (%)	8%	***TOTAL incl. improvement***	**1009.9**	**873.2**	**512.6**	**91.7**	**200.0**	**31.9**	**37.0**	**388.2**	**357.5**	**273.5**	**549.3**	**960.0**

High expenses for environment and others, to be considered separately

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		CH - Public						inh/sqkm	organis		&	of which in need of maintenance		
Length (km)	1764	20% Single, 75% Dual, 5% Dual+			73.4%	15.2%	11.4%	183	& policy		others	2.0%	5.0%	3.0%
avrg nb 4Leq	0.93	Traffic management	19.3	**17.5**	17.5					9.8	9.8	13.4	0.0	0.0
extra lgth ramps	10.00%	Routine operation	73.5	**70.0**	24.8	9.6	31.8	1.1	2.7	39.2	37.1	18.9	35.5	156.3
AADT	38941	Winter service	16.5	**16.0**	16.0					9.0	9.0	12.2	0.0	0.0
HGV (%)	7.20%	Routine maintenance	48.7	**47.2**	32.0	3.1	8.1	0.3	3.6	26.4	24.2	24.4	11.6	39.9
nb days <0°C	98	Maint road signs and markings	5.1	**4.7**	4.7					2.7	2.7	3.6	0.0	0.0
user satisfaction	79	Maint safety equipment	17.6	**16.4**	16.4					9.2	9.2	12.5	0.0	0.0
AIC ind (not GDP)	118	Prev. Maint. & rehabilitation	333.8	**311.3**	90.3	111.4	28.0	4.3	77.3	174.4	128.7	68.9	411.1	137.7
		TOTAL excl. improvement	**514.5**	**483.1**	**201.8**	**124.2**	**67.9**	**5.7**	**83.6**	**270.7**	**220.7**	**154.0**	**458.1**	**333.9**
Head office € million	8.2	**Improvement works**	233.2	**217.4**	78.7	30.0	45.9	22.9	39.9	121.8	86.6	60.0	110.9	225.8
Head office (%)	1%	***TOTAL incl. improvement***	**747.7**	**700.6**	**280.4**	**154.2**	**113.8**	**28.6**	**123.5**	**392.5**	**307.3**	**214.0**	**569.0**	**559.7**

High expenses for environment and others, to be considered separately

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		DK - Public									&	of which in need of maintenance		
Length (km)	3790	68% Single, 29% Dual, 3% Dual+			97.7%	1.9%	0.4%				others	60.0%	2.3%	0.0%
avrg nb 4Leq	0.68	Traffic management	8.3	**6.6**	6.6					1.7	1.7	1.7	0.0	0.0
extra lgth ramps	7.00%	Routine operation	13.4	**10.7**	9.4	0.1	1.2			2.7	2.7	2.4	1.7	77.1
AADT	15940	Winter service	29.9	**23.9**	23.9					5.9	5.9	6.1	0.0	0.0
HGV (%)	12.20%	Routine maintenance	68.9	**55.2**	45.7	8.8	0.6			13.7	13.7	11.6	115.9	37.7
nb days <0°C	79	Maint road signs and markings	8.3	**6.7**	6.7					1.7	1.7	1.7	0.0	0.0
user satisfaction	67	Maintenance safety equipment	2.2	**1.8**	1.8					0.4	0.4	0.4	0.0	0.0
AIC ind (not GDP)	112	Prev. Maint. & rehabilitation	42.9	**34.3**	16.3	18.0				8.5	8.5	4.1	236.3	0.0
		TOTAL excl. improvement	**173.9**	**139.1**	**110.3**	**27.0**	**1.8**			**34.6**	**34.6**	**28.1**	**353.8**	**114.8**
Head office € million	8.1	**Improvement works**	5.9	**4.7**	4.7	0.0	0.0			1.2	1.2	1.2	0.0	0.0
Head office (%)	6%	***TOTAL incl. improvement***	**179.8**	**143.8**	**115.0**	**27.0**	**1.8**			**35.8**	**35.8**	**29.3**	**353.8**	**114.8**

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		ES - Public									&	of which in need of maintenance		
Length (km)	24,185	66% Single, 30% Dual, 4% Dual+			96.6%	2.7%	0.7%				others	4.5%	3.5%	0.0%
avrg nb 4Leq	0.69	Traffic management	0.2	**0.1**						0.0	0.0			
extra lgth ramps	7.00%	Routine operation	111.1	**95.8**						4.0	4.0			
AADT	13438	Winter service	46.8	**40.3**						1.7	1.7			
HGV (%)	16.40%	Routine maintenance	105.0	**90.6**						3.7	3.7			
nb days <0°C	75	Maint road signs and markings	48.0	**41.4**						1.7	1.7			
user satisfaction		Maintenance safety equipment	9.5	**8.2**						0.3	0.3			
AIC ind (not GDP)	100	Prev. Maint. & rehabilitation	397.2	**342.4**						14.2	14.2			
		TOTAL excl. improvement	**717.9**	**618.8**						**25.6**	**25.6**			
Head office € million	n/a	**Improvement works**	265.0	**228.5**						9.4	9.4			
Head office (%)		***TOTAL incl. improvement***	**982.9**	**847.3**						**35.0**	**35.0**			

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		FL - Public									&	*of which in need of maintenance*		
Length (km)	824	0% Single, 56% Dual, 44% Dual+			95.6%	3.7%	0.7%				others	*10.0%*	*2.0%*	*0.0%*
avrg nb 4Leq	1.23	Traffic management	6.0	**5.1**	5.07					5.6	5.6	5.9	0.0	0.0
extra lgth ramps	8.00%	Routine operation	7.4	**6.5**	5.05	0.70	0.70			7.2	7.2	5.9	21.1	114.2
AADT	65254	Winter service	3.8	**3.4**	3.35					3.7	3.7	3.9	0.0	0.0
HGV (%)	21.20%	Routine maintenance	35.6	**30.0**	25.86	1.55	2.27	0.29		33.2	32.9	30.0	46.8	369.8
nb days <0°C	54	Maint road signs and markings	19.4	**16.1**	16.12					17.9	17.9	18.7	0.0	0.0
user satisfaction	61	Maintenance safety equipment	3.0	**2.5**	2.52					2.8	2.8	2.9	0.0	0.0
AIC ind (not GDP)	111	Prev. Maint. & rehabilitation	38.7	**32.1**	16.06	8.58	7.49			35.7	35.7	18.6	258.8	1223.4
		TOTAL excl. improvement	**113.9**	**95.6**	**74.0**	**10.8**	**10.5**	**0.3**		**106.1**	**105.8**	**85.9**	**326.6**	**1707.5**
Head office € million	8.2	**Improvement works**	0.0	**0.0**						0.0	0.0	0.0	0.0	0.0
Head office (%)	9%	***TOTAL incl. improvement***	**113.9**	**95.6**	**74.0**	**10.8**	**10.5**	**0.3**		**106.1**	**105.8**	**85.9**	**326.6**	**1707.5**

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		FR - Public									&	*of which in need of maintenance*		
Length (km)	11734	45% Single, 52% Dual, 3% Dual+			98.2%	1.3%	0.4%				others	*15.0%*	*8.0%*	*0.7%*
avrg nb 4Leq	0.81	Traffic management	39.7	**36.7**						3.1	3.1			
extra lgth ramps	8.00%	Routine operation	0.0	**0.0**						0.0	0.0			
AADT	23318	Winter service	32.3	**29.4**						2.5	2.5			
HGV (%)	13.7%	Routine maintenance	340.8	**313.1**						26.7	26.7			
nb days <0°C	32	Maint road signs and markings	0.0	**0.0**						0.0	0.0			
user satisfaction	**73**	Maintenance safety equipment	0.0	**0.0**						0.0	0.0			
AIC ind (not GDP)	113	Prev. Maint. & rehabilitation	173.0	**158.8**						13.5	13.5			
		TOTAL excl. improvement	**585.8**	**538.0**						**45.8**	**45.8**			
Head office € million	n/a	**Improvement works**	48.6	**41.0**						3.5	3.5			
Head office (%)		***TOTAL incl. improvement***	**634.4**	**579.0**						**49.3**	**49.3**			

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		HU - Public									&	of which in need of maintenance		
Length (km)	7528	89% Single, 10% Dual, 1% Dual+			98.7%	1.3%	0.0%				others	10.0%	40.0%	0.0%
avrg nb 4Leq	0.57	Traffic management	11.0	**9.1**	9.14					1.2	1.2	1.2	0.0	
extra lgth ramps	8.0%	Routine operation	36.4	**30.3**	27.92	2.41				4.0	4.0	3.8	25.3	
AADT	10883	Winter service	21.5	**17.9**	17.91					2.4	2.4	2.4	0.0	
HGV (%)	13.00%	Routine maintenance	35.1	**29.3**	27.06	2.20				3.9	3.9	3.6	23.1	
nb days <0°C	100	Maint road signs and markings	4.6	**3.8**	3.83					0.5	0.5	0.5	0.0	
user satisfaction		Maintenance safety equipment	3.0	**2.5**	2.52					0.3	0.3	0.3	0.0	
AIC ind (not GDP)	61	Prev. Maint. & rehabilitation	41.3	**34.4**	22.14	12.26				4.6	4.6	3.0	128.7	
		TOTAL excl. improvement	***152.9***	***127.4***	***110.5***	***16.9***				**16.9**	**16.9**	**14.9**	**177.1**	
Head office € million	n/a	**Improvement works**	0.0	**0.0**						0.0	0.0	0.0	0.0	
Head office (%)		***TOTAL incl. improvement***	***152.9***	***127.4***						**16.9**	**16.9**	**0.0**	**0.0**	

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		IE - Public									&	*of which in need of maintenance*		
Length (km)	5335	88% Single, 10% Dual, 1% Dual+			99.4%	0.4%	0.1%				others	*23.0%*	*11.0%*	*0.0%*
avrg nb 4Leq	0.56	Traffic management	0.1	**0.1**	0.10					0.0	0.0	0.0	0.0	0.0
extra lgth ramps	2.00%	Routine operation	6.9	**6.9**	6.90					1.3	1.3	1.3	0.0	0.0
AADT	14716	Winter service	8.8	**8.8**	8.80					1.6	1.6	1.7	0.0	0.0
HGV (%)	8.70%	Routine maintenance	25.5	**24.5**	21.07	1.23	2.21			4.6	4.6	4.0	52.3	361.8
nb days <0°C	23	Maint road signs and markings	16.2	**15.6**	15.60					2.9	2.9	2.9	0.0	0.0
user satisfaction	46	Maintenance safety equipment	2.7	**2.1**	2.10					0.4	0.4	0.4	0.0	0.0
AIC ind (not GDP)	114	Prev. Maint. & rehabilitation	17.0	**16.0**	9.44	6.56				3.0	3.0	1.8	279.8	0.0
		TOTAL excl. improvement	**77.2**	**74.0**	**64.0**	**7.8**	**2.2**			**13.9**	**13.9**	**12.1**	**332.1**	**361.8**
Head office € million	0.9	**Improvement works**	0.0	**0.0**						0.0	0.0	0.0	0.0	0.0
Head office (%)	0%	***TOTAL incl. improvement***	**77.2**	**74.0**	**64.0**	**7.8**	**2.2**			**13.9**	**13.9**	**12.1**	**332.1**	**361.8**

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		IT - Public									&	*of which in need of maintenance*		
Length (km)	21040	82% Single, 18% Dual, 0% Dual+			91.6%	6.0%	2.4%				others	*33.0%*	*9.0%*	*30.0%*
avrg nb 4Leq	0.59	Traffic management	12.7	**12.7**	12.66					0.5	0.5	0.6	0.0	0.0
extra lgth ramps	6.00%	Routine operation	264.3	**242.5**	223.25	13.32	5.37	0.55		9.9	9.9	9.9	9.1	9.1
AADT	8543	Winter service	35.6	**32.1**	32.07					1.3	1.3	1.4	0.0	0.0
HGV (%)	11.00%	Routine maintenance	115.5	**106.0**	84.35	7.79	13.36		0.49	4.3	4.3	3.8	5.3	22.7
nb days <0°C	4	Maint road signs and markings	40.4	**33.6**	33.63					1.4	1.4	1.5	0.0	0.0
user satisfaction	**53**	Maintenance safety equipment	26.5	**22.5**	22.53					0.9	0.9	1.0	0.0	0.0
AIC ind (not GDP)	100	Prev. Maint. & rehabilitation	339.6	**283.0**	261.81	5.55	15.32	0.32		11.5	11.5	11.7	3.8	26.0
		TOTAL excl. improvement	**834.6**	**732.4**	**670.3**	**26.7**	**34.1**	**0.9**	**0.5**	**29.9**	**29.8**	**29.9**	**18.1**	**57.9**
Head office € million	124	**Improvement works**	171.6	**143.0**	143.00					5.8	5.8	6.4	0.0	0.0
Head office (%)	14%	***TOTAL incl. improvement***	**1006.2**	**875.4**	**813.3**	**26.7**	**34.1**	**0.9**	**0.5**	**35.7**	**35.7**	**36.2**	**18.1**	**57.9**

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		NL - Public						inh/sqkm			&	of which in need of maintenance		
Length (km)	3198	16% Single, 72% Dual, 12% Dual+			96.3%	3.1%	0.6%	390			others	11.0%	2.0%	0.0%
avrg nb 4Leq	0.97	Traffic management	113.8	**100.0**	99.98					29.5	29.5	30.7	0.0	0.0
extra lgth ramps	8.00%	Routine operation	107.0	**94.0**	90.45	2.99	0.58			27.8	27.8	27.7	28.8	28.8
AADT	52427	Winter service	22.0	**19.3**	19.35					5.7	5.7	5.9	0.0	0.0
HGV (%)	17.50%	Routine maintenance	124.1	**109.0**	37.72	15.59	10.39	45.34		32.2	18.8	11.6	150.4	518.2
nb days <0°C	51	Maint road signs and markings	28.0	**24.6**	24.56					7.3	7.3	7.5	0.0	0.0
user satisfaction	70	Maintenance safety equipment	15.9	**14.0**	13.99					4.1	4.1	4.3	0.0	0.0
AIC ind (not GDP)	117	Prev. Maint. & rehabilitation	375.0	**329.4**	178.81	73.22	48.81	28.58		97.3	88.9	54.8	706.7	2434.1
		TOTAL excl. improvement	**785.9**	**690.4**	**464.9**	**91.8**	**59.8**	**73.9**	**0.0**	**203.9**	**182.1**	**142.5**	**886.0**	**2981.1**
Head office € million	39.8	**Improvement works**	34.0	**29.9**	24.94			4.91		8.8	7.4	7.6	0.0	0.0
Head office (%)	6%	***TOTAL incl. improvement***	**819.9**	**720.2**	**489.8**	**91.8**	**59.8**	**78.8**	**0.0**	**212.8**	**189.5**	**150.2**	**886.0**	**2981.1**

High expenses for environment and others, to be considered separately

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		PT - Sh tolls										of which in need of maintenance		
Length (km)	654	1% Single, 96% Dual, 3% Dual+			93.6%	6.2%	0.2%							
avrg nb 4Leq	1.01	Traffic management	2.6	**2.1**						3.3				
extra lgth ramps	5.00%	Routine operation	9.0	**7.4**						11.4				
AADT	18072	Winter service	0.3	**0.3**						0.4				
HGV (%)	10.00%	Routine maintenance	7.2	**5.9**						9.1				
nb days <0°C	1	Maint road signs and markings	1.7	**1.4**						2.1				
user satisfaction	n/a	Maintenance safety equipment	0.4	**0.3**						0.5				
AIC ind (not GDP)	82	Prev. Maint. & rehabilitation	4.8	**4.0**						6.1				
		TOTAL excl. improvement	**25.9**	**21.4**						**32.8**				
Head office € million	n/a	**Improvement works**	0.7	**0.6**						0.9				
Head office (%)		***TOTAL incl. improvement***	**26.7**	**22.0**						**33.7**				

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		**SE - Public**									&	*of which in need of maintenance*		
Length (km)	8046	59% Single, 40% Dual, 1% Dual+			98.4%	1.5%	0.1%				others	*8.0%*	*0.0%*	*15.0%*
avrg nb 4Leq	0.67	Traffic management	16.3	**14.1**	14.05					1.6	1.6	1.6	0.0	0.0
extra lgth ramps	5.0%	Routine operation	18.0	**14.6**	8.65	4.76	1.19			1.7	1.7	1.0	35.9	163.3
AADT	8163	Winter service	66.5	**54.1**	54.05					6.1	6.1	6.2	0.0	0.0
HGV (%)	14.30%	Routine maintenance	28.9	**23.5**	14.81	7.14	1.51			2.7	2.7	1.7	53.8	207.8
nb days <0°C	151	Maint road signs and markings	7.4	**6.1**	6.05					0.7	0.7	0.7	0.0	0.0
user satisfaction	66	Maintenance safety equipment	4.7	**3.8**	3.78					0.4	0.4	0.4	0.0	0.0
AIC ind (not GDP)	112	Prev. Maint. & rehabilitation	117.4	**95.5**	68.43	23.78	3.24			10.8	10.8	7.9	179.5	445.3
		TOTAL excl. improvement	**259.1**	**211.5**	**169.8**	**35.7**	**5.9**			**24.0**	**24.0**	**19.6**	**269.2**	**816.3**
Head office € million	18.4	**Improvement works**	0.0	**0.0**						0.0	0.0	0.0	0.0	0.0
Head office (%)	9%	***TOTAL incl. improvement***	**259.1**	**211.5**						**24.0**	**24.0**	**0.0**	**0.0**	**0.0**

MAIN DRIVERS		Expenses	including	excluding	road&pvmt	bridges	tunnels	environt	others	without VAT & overheads 1,000 €/km				
		Task blocks and items	VAT	VAT	no struct			excl.noise	excl.real		without	/1,000 km	/1,000 km	/1,000 km
			€ million	€ million	€ million	€ million	€ million	barrier	estate	ALL	environt	no struct	bridges	tunnels
Network under survey		**UK - Public**						inh/sqkm	organis		&	*of which in need of maintenance*		
Length (km)	7235	12% Single, 49% Dual,39% Dual+			97.2%	2.8%	0.1%	250	& policy		others	*1.0%*	*3.0%*	*0.0%*
avrg nb 4Leq	1.11	Traffic management	9.2	**7.8**	7.82					1.1	1.1	1.1	0.0	0.0
extra lgth ramps	16.00%	Routine operation	130.4	**111.0**	106.47	3.88	0.62			15.1	15.1	15.0	19.1	153.5
AADT	46506	Winter service	21.5	**18.3**	18.28					2.5	2.5	2.6	0.0	0.0
HGV (%)	12.50%	Routine maintenance	304.3	**258.9**	172.21	86.11	0.62			35.3	35.3	24.2	423.1	153.5
nb days <0°C	37	Maint road signs and markings	9.3	**7.9**	7.94					1.1	1.1	1.1	0.0	0.0
user satisfaction	68	Maintenance safety equipment	11.6	**9.9**	9.87					1.3	1.3	1.4	0.0	0.0
AIC ind (not GDP)	134	Prev. Maint. & rehabilitation	266.9	**227.2**	146.02	70.36	2.49	5.53	2.76	31.0	29.9	20.5	345.7	614.1
		TOTAL excl. improvement	**753.2**	**641.0**	**468.6**	**160.3**	**3.7**	**5.5**	**2.8**	**87.5**	**86.4**	**65.8**	**787.9**	**921.2**
Head office € million	14.2	**Improvement works**	594.2	**505.7**	338.18	167.55				69.0	69.0	47.5	823.2	0.0
Head office (%)	1%	***TOTAL incl. improvement***	**1347.4**	**1146.7**	**806.8**	**327.9**	**3.7**	**5.5**	**2.8**	**156.5**	**155.4**	**113.3**	**1611.1**	**921.2**

High expenses for environment and others, to be considered separately

Appendix 4: Main Data and Ratios (2007)

COUNTRY DATA	AT	CH	DK	ES	FL	FR	HU	IE	IT	NL	PT	SE	UK	TOTAL
ECONOMY					*Belgium*								*all UK*	
Population 2007 (million)	8,3	7,5	5,5	44,5	10,6	63,4	10,1	4,3	59,1	16,4	10,6	9,1	60,8	**310**
Surface area (1,000 sq km)	84	41	43	506	31	552	93	70	301	42	92	450	243	**2548**
Density (million/sq km)	**99**	**183**	**128**	**88**	**342**	**115**	**109**	**61**	**196**	**390**	**115**	**20**	**250**	**122**
GDP index 2007 (EU=100)	124	137	120	106	118	109	63	150	101	131	76	122	119	
AIC index 2007 (EU=100)	**115**	**118**	**112**	**100**	**111**	**113**	**61**	**114**	**100**	**117**	**82**	**112**	**134**	
Currency exchange rate 2007	1	0,610	0,134	1	1	1	0,004	1	1	1	1	0,108	1,461	
Currency exchange rate 2009	1	0,660	0,134	1	1	1	0,0036	1	1	1	1	0,095	1,100	
VAT %	**20,0%**	**7,6%**	**25,0%**	**16,0%**	**21,0%**	**19,6%**	**20,0%**	**21,5%**	**20,0%**	**19,0%**	**20,0%**	**25,0%**	**15,0%**	
CLIMATE														
nb days/year below 0 ° C	**92**	**98**	**79**	**75**	**54**	**32**	**100**	**23**	**4**	**51**	**1**	**151**	**37**	
Town	Vienna	Bern	Odense	Madrid	Antwerp	Lorient	Budapest	Dublin	Genoa	Rotterdam	Lisbon	Stockholm	Liverpool	
ROAD NETWORKS														
Total paved public roads (IRF) (km)	107 000	71 000	72 000	676 000	153 000	951 000	196 000	96 600	488 000	126 000	77 000	427 000	420 000	**3 860 600**
ROADS within scope of Bexprac (km)	**2 062**	**1 764**	**3 790**	**24 185**	**824**	**11 734**	**7 528**	**5 335**	**21 040**	**3 198**	**654**	**8 046**	**7 235**	**97 395**
Toll motorway outside scope of Bexprac				2 972		8 500	260		5 700		1 500			**18 932**

MACRO AGGREGATED NETWORK DATA Recalculated values															
LENGTH	**AT**	**CH**	**DK**	**ES**	**FL**	**FR**	**HU**	**IE**	**IT**	**NL**	**PT**	**SE**	**UK**	**AVR-1**	**AVR-2**
TOTAL NETWORK LENGTH (km)	**2 062**	**1 764**	**3 790**	**24 185**	**824**	**11 734**	**7 528**	**5 335**	**21 040**	**3 198**	**654**	**8 046**	**7 235**	**unw**	**weight**
single carriageway 1 to 4 lanes (%)	5,2%	19,8%	67,5%	65,6%	0,0%	44,6%	89,2%	88,5%	81,8%	15,6%	1,3%	59,2%	12,1%	**42%**	**61%**
dual carriageway 4 or - lanes (%)	76,3%	74,6%	29,4%	30,6%	56,0%	51,9%	10,1%	10,5%	18,2%	72,4%	95,4%	39,6%	49,0%	**47%**	**33%**
dual+ carriageway 5 or + lanes (%)	18,5%	5,6%	3,1%	3,9%	44,0%	3,6%	0,8%	0,9%	0,0%	12,0%	3,3%	1,2%	38,9%	**10%**	**6%**
Dual equivalent length (4Leq)	**1,08**	**0,93**	**0,68**	**0,69**	**1,23**	**0,81**	**0,57**	**0,56**	**0,59**	**0,97**	**1,01**	**0,67**	**1,11**	**0,72**	
of which length bridges (%)	7,4%	15,2%	1,9%	2,7%	3,7%	1,3%	1,3%	0,4%	6,0%	3,1%	6,2%	1,5%	2,8%	**4,1%**	**3,2%**
of which length tunnels (%)	9,3%	11,4%	0,4%	0,7%	0,7%	0,4%	0,0%	0,1%	2,4%	0,6%	0,2%	0,1%	0,1%	**2,0%**	**1,2%**
additional length ramps (%)	**18,0%**	**10,0%**	**7,0%**	**7,0%**	**8,0%**	**8,0%**	**8,0%**	**2,0%**	**6,0%**	**8,0%**	**5,0%**	**5,0%**	**16,0%**	**8,3%**	**7,5%**

TRAFFICS un-weighted AADT	**AT**	**CH**	**DK**	**ES**	**FL**	**FR**	**HU**	**IE**	**IT**	**NL**	**PT**	**SE**	**UK**	**AVR-1**	**AVR-2**
single carriageway 1 to 4 lanes	12 500,00	6 500,00	8 500,00	5 700,00		10 000,00	8 700,00	10 200,00	6 000,00	12 500,00	6 000,00	3 600,00	10 000,00	**8 350,00**	**6 962,65**
dual carriageway 4 or - lanes	30 800,00	43 000,00	27 500,00	22 900,00	45 000,00	29 500,00	26 800,00	54 000,00	20 000,00	50 000,00	17 400,00	14 000,00	25 000,00	**31 223,08**	**27 237,92**
dual carriageway 5 or + lanes	65 000,00	99 000,00	68 500,00	70 000,00	91 000,00	100 000,00	56 000,00			119 400,00	42 000,00	41 000,00	85 000,00	**76 081,82**	**82 969,60**
Average network un-weighted	**36 182,36**	**38 941,31**	**15 939,91**	**13 437,54**	**65 253,77**	**23 318,39**	**10 882,70**	**14 716,37**	**8 542,61**	**52 426,83**	**18 072,04**	**8 163,02**	**46 505,91**	**26 223,19**	**18 228,84**
average HGV %	0,13	0,07	0,12	0,16	0,21	0,14	0,13	0,09	0,11	0,18	0,10	0,14	0,13	**0,13**	
weighted AADT W = 2,5	*43 020,83*	*43 146,97*	*18 856,92*	*16 743,17*	*86 004,48*	*28 110,32*	*13 004,83*	*16 636,86*	*9 952,14*	*66 188,88*	*20 782,84*	*9 913,99*	*55 225,77*	*31 376,05*	

Quality of the network	**AT**	**CH**	**DK**	**ES**	**FL**	**FR**	**HU**	**IE**	**IT**	**NL**	**PT**	**SE**	**UK**
Pavement in need of maintenance (%)	**4,0%**	**2,0%**	**60,0%**	**4,5%**	**10,0%**	**15,0%**	**10,0%**	**23,0%**	**33,0%**	**11,0%**		**8,0%**	**1,0%**
Bridges in need of maintenance (%)	**6,0%**	**5,0%**	**2,3%**	**3,5%**	**2,0%**	**8,0%**	**40,0%**	**11,0%**	**9,0%**	**30,0%**		**0,0%**	**3,0%**
Tunnels in need of maintenance (%)	**9,0%**	**3,0%**	**0,0%**	**0,0%**	**0,0%**	**0,7%**	**0,0%**	**0,0%**	**30,0%**	**60,0%**		**15,0%**	**0,0%**
user satisfaction index CEDR 2006	**63**	**79**	**67**	**n/a**	**61**	**73**	**n/a**	**46**	**53**	**70**	**n/a**	**66**	**68**

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

MACRO OPERATION AND MAINTENANCE EXPENSES

Consultants values without VAT

by task blocks € million/year	AT	CH	DK	ES	FL	FR	HU	IE	IT	NL	PT shdw	SE	UK	TOTAL
Traffic management & routine operation	82	88	17	96	12	37	39	7	255	194	10	29	119	**983**
Winter service	36	16	24	40	3	29	18	9	32	19	0	54	18	**299**
Routine maint. inc. signs & safety equip.	63	68	64	140	49	313	36	43	162	148	8	33	277	**1403**
Prev. maint. & rehbilitation	277	311	34	342	32	159	34	16	283	329	4	96	227	**2146**
TOTAL	**457**	**483**	**139**	**619**	**96**	**538**	**127**	**74**	**732**	**690**	**21**	**212**	**641**	**4830**
of which outsourced expenses	*218*	*363*	*81*	*619*	*84*	*249*	*127*	*21*	*454*	*388*	*21*	*188*	*627*	***3441***
Improvements (entirely outsourced)	**417**	**217**	**5**	**229**	**0**	**41**	**0**	**0**	**143**	**30**	**1**	**0**	**506**	**1588**
Total incl improvements	**874**	**701**	**144**	**847**	**96**	**579**	**127**	**74**	**876**	**720**	**22**	**212**	**1147**	**6418**
of which outsourced expenses	*635*	*581*	*86*	*847*	*84*	*289*	*127*	*21*	*597*	*418*	*22*	*188*	*1133*	***5029***
outsourced expenses (%)	*73%*	*83%*	*60%*	*100%*	*88%*	*50%*	*100%*	*29%*	*68%*	*58%*	*100%*	*89%*	*99%*	*78%*
budget availability	+	+ +	=	=	=	=	=	=	=	=	=	=	=	

Recalculated values without VAT *per network km and per year*

by task blocks 1,000 €/year/route km	AT	CH	DK	ES	FL	FR	HU	IE	IT	NL	PT shdw	SE	UK	AVR-1	AVR-2
Traffic management & routine operation	39,6	49,6	4,6	4,0	14,1	3,1	5,2	1,2	12,1	60,7	14,5	3,6	16,4	**17,6**	**10,1**
Winter service	17,2	9,1	6,3	1,7	4,1	2,5	2,4	1,6	1,5	6,0	0,5	6,7	2,5	**4,8**	**3,1**
Routine maint. Inc. signs & safety equip.	30,6	38,7	16,8	5,8	59,0	26,7	4,7	8,0	7,7	46,2	11,6	4,2	38,3	**22,9**	**14,4**
Prev. Maint. & rehbilitation	134,3	176,5	9,1	14,2	39,0	13,5	4,6	3,0	13,5	103,0	6,1	11,9	31,4	**43,1**	**22,0**
TOTAL O&M without improvements	**221,7**	**273,9**	**36,7**	**25,6**	**116,1**	**45,8**	**16,9**	**13,9**	**34,8**	**215,8**	**32,7**	**26,3**	**88,6**	**88,4**	**49,6**
of which outsourced expenses	105,7	205,9	21,5	25,6	102,3	21,2	16,9	4,0	21,6	121,4	32,7	23,4	86,6		
ratio O&M €/1,000*driven km	16,79 €	19,27 €	6,31 €	5,22 €	4,88 €	5,39 €	4,26 €	2,58 €	11,16 €	11,28 €	4,96 €	8,83 €	5,22 €	**8,16 €**	**7,50 €**
ratio O&M €/1,000*w eighted dr km HGV=5	14,12 €	17,39 €	5,34 €	4,19 €	3,70 €	4,47 €	3,56 €	2,28 €	9,58 €	8,93 €	4,31 €	7,27 €	4,40 €	**6,89 €**	
Improvements	**202,2**	**123,2**	**1,3**	**9,4**	**0,0**	**3,5**	**0,0**	**0,0**	**6,8**	**9,3**	**0,9**	**0,0**	**69,9**	**32,8**	**16,3**
ratio improv. €/1,000*driven km	15,31 €	8,67 €	0,22 €	1,93 €	0,00 €	0,41 €	0,00 €	0,00 €	2,18 €	0,49 €	0,14 €	0,00 €	4,12 €	**2,57 €**	**1,59 €**

Estimated normative ASSET value without VAT

€ million/network km	AT	CH	DK	ES	FL	FR	HU	IE	IT	NL	PT shdw	SE	UK
Road & equipment (*)	13,6	8,6	4,9	5,3	22,1	6,5	2,9	3,0	3,1	10,9	9,0	4,8	19,7
+ interchanges and ramps	2,5	0,9	0,3	0,4	1,8	0,5	0,2	0,1	0,2	0,9	0,4	0,2	3,2
+ bridges + 50 M€/km	3,7	7,6	0,9	1,3	1,8	0,7	0,6	0,2	3,0	1,5	3,1	0,8	1,4
+ tunnels + 150M€/km	13,9	17,1	0,6	1,1	1,0	0,7	0,0	0,2	3,6	0,9	0,3	0,1	0,1
TOTAL	**33,7**	**34,2**	**6,8**	**8,1**	**26,7**	**8,3**	**3,8**	**3,4**	**9,8**	**14,2**	**12,8**	**5,9**	**24,3**
Dual equivalent asset values	***4,2***	***4,3***	***0,9***	***1,0***	***3,3***	***1,0***	***0,5***	***0,4***	***1,2***	***1,8***	***1,6***	***0,7***	***3,0***
ratio O&M/assets (%)	0,66%	0,80%	0,54%	0,32%	0,43%	0,55%	0,45%	0,40%	0,35%	1,52%	0,26%	0,44%	0,36%
ratio outsourced O&M/assets (%)	0,31%	0,60%	0,31%	0,32%	0,38%	0,25%	0,45%	0,12%	0,22%	0,86%	0,26%	0,39%	0,36%
ratio improvements/assets (%)	0,60%	0,36%	0,02%	0,12%	0,00%	0,04%	0,00%	0,00%	0,07%	0,07%	0,01%	0,00%	0,29%
ratio all outsourced expenses/assets (%)	0,91%	0,96%	0,33%	0,43%	0,38%	0,30%	0,45%	0,12%	0,29%	0,92%	0,26%	0,39%	0,64%

(*) normative costs : 2 M€/km for a single carriageway, 8 M€/km for a simple dual 4 lane motorway
40M€/km for a complex 6 lanes+ motorway (urban site, environment, dynamic trafic management equipements)

Appendix 5: Recommendations for a future survey

The lessons from the present benchmark should be taken into account in future benchmarks. On the basis of these lessons, WG BEXPRAC recommends starting with a smaller number of networks/countries and a small set of homogenous road sections.
The first step in such a benchmark must confirm and/or update the core system of common definitions presented in appendixes 1 and 2, on which all participating road administrations must agree. This system should start with clear definitions of the various aspects and a limited number of road sections. It should also include rules on how the national (financial and analytical) accounting systems need to be translated to meet the needs of this core system.

Countries' recommendations

Many of the WG members have given their views on possible improvements of the present benchmark; these recommendations are presented below without comments because some goals differ from one country to another.

Austria

- One of the most important prerequisites in order to ensure that the condition of pavements and the condition of structures is comparable between countries is to define common European performance indicators.
- For the comparison of data from different countries, it is important that each expenditure is allocated in accounts to a particular asset in each country.
- It would be useful to find a way to compare the level of service for routine operations, winter service, and routine maintenance between European countries.

Switzerland

- Use a more detailed and homogenous database and descriptions in future benchmarks.
- Consider only motorways or only highways in the comparison at network level.
- Do not consider emergency actions and rescue operations under routine operations, but separately.
- Collect information on the databases used in the management system.

Italy

- The roads taken into consideration should be similar in length, number of tunnels and bridges, tolling system etc.
- Deepen the analysis of outsourcing practices, by taking into account:
  - annual versus multi-year (three-year) contracts
  - single-service versus multi-service versus global-service contracts
  - bill of quantities versus performance-based (results of maintenance) contracts
  - levels of service provided, possibly related to an expressed fee
- Include benchmarks on the funding of roads (public or private, 'real' toll or 'shadow' toll, on cost-cap basis or on historical data basis, etc.) and related processes.

- Include an analysis of the ratio between annual maintenance expenses and total asset value of the infrastructure; and in relation to the reproduction value (not including the expenses for land or for inserting infrastructure in the environment). Grouping of NRAs according to such a ratio.

The Netherlands

- Further research in this area would be useful. This next step could be more restricted in terms of scope (less detail), but include more countries.
- Lessons from the present survey:
  - More information was requested than was actually used.
  - It would be better to have fewer task blocks and better descriptions of the task definitions.
  - More contact is needed between the NRAs and the consultant in terms of understanding the definitions.
- Be exact on what to compare:
  - Have internal costs been included? If so, what are these internal costs?
  - What is the reason for cost differences?
  - Specific attention should be paid to the expenses of bridges/flyovers and tunnels.
  - Specific attention should be paid to variable maintenance (i.e. preventive maintenance & rehabilitation).
  - Indicate early what type of information is needed, so that road administrations can prepare.

Spain

- Question the equivalence of '1 km of a two lane road=0.5 km of a 4-lane road' since the maintenance expenses for motorways (2+2 lanes) are usually more than double the expense of the maintenance of a conventional road (1+1 lane).
- Regarding the impact due to the difference of living costs, the factors applied to each country should be considered in a way that costs can be compared and criteria that have been used can be explained.
- Routine maintenance and routine operation tasks should be included in only one group since it is complicated to assess the different concepts in a separate way.
- In each case, explain the level of services provided in each network so the information is comparable.
- Relate preventive maintenance and improvement (extraordinary conservation) with the road, structures, and slope management systems that define and prioritise these actions.
- Analysed system: since 2008, a 20-year concession system has been implemented for 1,000 km of state-owned motorways. This system regulates intervention in the event of accidents/incidents, as well as ordinary and extraordinary conservation throughout 41 indicators with the corresponding penalties if the demanded thresholds are not achieved or if the response time is exceeded.
- Reconsider the micro module in such a way that each of the selected road sections is representative of the case in which they are included. The cases must be selected in accordance with a number of factors that allows the road sections provided by each country to be compared in a rigorous way.

Overall common recommendations

This survey has clearly shown that there is a benefit to carrying out benchmark studies. It has resulted in a wealth of information on the way in which various road maintenance and operation activities are being carried out, and has provided an insight into the structure of expenses in relation to various factors both between networks and within a given network.

Nevertheless, it is also clear that improvements will be necessary if such a benchmark is to be repeated. An important aspect in this respect is that common definitions are needed. Such definitions relate to various aspects, such as:

- road maintenance and operation activities: make sure all participants have the same definition of these activities;
- levels of service: make sure all participants have the same understanding of the way in which the level of service is described;
- expenses: make sure all participants collect information to calculate expenses according to a uniform definition, even if such expenses are made by others and/or are not charged to the NRA;
- conditions and intervention levels: make sure there is a common understanding of the condition of roadways and structures, and that intervention levels can be translated into a common definition.

If agreement is reached on a common set of definitions, a future benchmark would further benefit from homogeneity of the road networks or road sections to be compared, in terms of cross-section, traffic levels, topography, climate etc. The higher the level of homogeneity, the more comparable the results and the better the explanation of differences will be.

It is therefore recommended that a common framework for comparing practises in road maintenance and operations in European countries be created. This common framework could be a kind of core system around which every NRA develops its own management system for expenses for maintenance and operation, but with complete compatibility with the basic description of expenses/level of service needed by the core system. It is clear that a definition of a core system would have to be fully agreed between the NRAs.

In order to define the core system, some improvements on the present benchmark must be explored:

Improvements regarding assessment of expenses

- *Breakdown in activity blocks*: The accounting system must consider not only budget expenses, but also agent costs, particularly as regards in-house production. The list and definition of task blocks are to be agreed. Task blocks can also distinguish asset elements such as pavement, bridges, and tunnels. The level at which these figures can be made available must be agreed. The consolidation of the figures must be done at the right level to define maintenance and operation policy.

- *Management and overhead expenses:* Generally speaking, the expenses about which least is known are those expenses relating to management and overheads (buildings, technical support network, monitoring contractors). If it is not possible to allocate these expenses to activity task blocks, such as operation, routine maintenance, preventive maintenance etc., a minimum breakdown of overhead activities should at least be adopted. For instance: monitoring contracts, general management (maintenance policy, expenses control), and technical network.

- *Link with network characteristics:* All expenses must be allocated to one of the defined case standards (4 lanes, 4 lanes high traffic, 6 lanes).

- *Unit prices for some standard activity:* Depending on the importance of the particular tasks, some unit prices may be monitored.

Appendix 6: Modelling Scheme

1. General results

The whole network under survey covers a length of nearly 100,000 km and the sum of annual maintenance and operation expenses in 2007 represents €4,800 million, excluding VAT (all monetary values in this section are without VAT). In addition, €1,600 million was spent on improvements, an item which has been left out of the sensibility analyses, but in some cases may have an incidence on the preventive maintenance and rehabilitation expenses.

For the total M&O expenses, the following average ratios apply:

- If only physical length is taken into account, the average expense unweighted by network length is €88,000/km and per year, with figures ranging from €14,000 for Ireland to €270,000 for Switzerland (nearly 1 to 20);
- If a standard dual 4-lane equivalent length is considered (4Leq without specific weights for tunnels, bridges, and interchanges), the average expense unweighted by length is €95,000/km 4Leq, with figures ranging from €25,000 to €300,000 (1 to 12);
- If a dual 4-lane asset value equivalent length is considered, the average expense unweighted by length is around €44,000/km DeqAV, with figures ranging from €20,000 to €120,000 (1 to 6);
- If expenses are linked to the driven km, the average expense is €8.2 per 1,000 driven km, with figures ranging from €2.6 to €19.3 (1 to 7.5);
- If expenses are linked to the weighted driven km (1 HGV = 2.5), the average expense is €5.5 per 1,000 weighted driven km, with figures ranging from €2.3 to €17.4 (1 to 7.6).

Therefore, at the general level of the networks, the major explaining factors for M&O expenses are network length, asset value, and driven km; however, lane length may influence some task blocks like winter maintenance, and the proportion of HGVs may influence the preventive maintenance and rehabilitation of pavements.

The average M&O expense for a standard dual 4-lane motorway without major structures and with an AADT of 30,000 veh/day, is approximately €44,000/km/year, or €8.2 per 1,000 unweighted driven km.

These figures are consistent with other former surveys, particularly the French 2007 audit.

2. Sensibility analysis

The general approach does not reduce the dispersion of the expenses below a range between 1 and 6 among participating countries.

For a more in-depth analysis, M&O expenses are considered by task blocks and by destination and compared to possible additional drivers.

Overheads

When available, overheads vary from 0% to 14% among the countries; such variations come from differences in the internal accounting practices which means that they can probably not be related to network characteristics. As a consequence, overheads are excluded from the detailed analyses.

Environmental expenses

Some countries (mainly AT, CH, and NL) have identified huge M&O expenses for environmental care; these expenses are made according to national policies and probably appear in other task blocks (improvements) or special investment programs in other countries. For this reason, they are excluded from the model.

'Other' expenses

Some countries (mainly AT and CH) have identified huge expenses for 'other expenses'. These expenses are mainly related to real estate and are probably included (totally or in part) in the overheads for other countries (this seems clear for CH were head office expenses are only 1%); as overheads are out of scope of the detailed analyses, 'others' are also excluded from the models.

Cross-sections

Average expenses vary disproportionately to the number of lanes: expenses for a single carriageway are less than half those for dual 4-lane motorways; expenses for dual+ motorways are more than twice those for dual 4-lane motorways.

Traffic

Traffic is an important expense driver. For a given cross-section, the M&O expenses (without structures) are almost proportional to traffic volumes. It was not possible on the basis of the available data, to identify whether the proportion of HGVs has a clear effect. However, the models give better results with weighted AADT; more detailed analyses would probably show an incidence on pavement maintenance and rehabilitation expenses.

Structures

The expenses for bridges and tunnels are much higher than for normal road sections and these expenses increase even more for structures in need of maintenance. Due to expense allocation differences, these values vary greatly.

Climate

Climate mainly affects winter service expenses. Not only snow, but also ice has to be considered. This is why the number of days when the temperature is below 0° C was used as a driving factor. Winter service on structures does not seem to be more expensive than the average at network level (it is cheaper in tunnels, but more expensive on bridges). Winter service on dual+ road sections seems no more expensive than on normal dual roads, probably as a result of traffic intensities.

Level of service

Levels of service are major M&O expense drivers. They are measured using user satisfaction indexes.

Asset values

When BEXPRAC started, the asset values of the networks were not included in the survey. However, normative evaluations would appear to suggest that they are major maintenance expense drivers.
It would also be useful to take into account the lifetime of different kinds of assets, particularly the dynamic traffic management device, to explain higher M&O expenses in some countries like NL.

Population density

Population densities range from 20 to almost 400 and cannot be related directly to expenses. They are, however, major drivers for environment issues.

GDP/AIC

The GDP, or preferably the AIC index, gives a good indication of the level of 'acceptable' expenses for different purposes in the different countries; it could be used for the comparisons but this needs a more in-depth analysis of the outsourced expenses.

Models for expense estimation

On the basis of the existing data and the sensibility tests, it is possible to try to come up with explanatory models for the M&O expenses.

However, such an attempt was never made at international level. The first results therefore remain tentative and need to be updated over time with more homogeneous data definitions and allocations by task block and by destination.

At the present stage, the breakdown of expenses according to task blocks was done differently by the various countries (some countries could not even provide such a breakdown) with the exception of winter maintenance. It would, therefore, have been of no interest to try to make a model with expenses broken down according to detailed task blocks.

The breakdown by destination (roads, bridges, tunnels, environment, and others) was not available for all countries (and in those cases where it was available, it was probably based on allocation principles that differed from country to country). However, it provides some relative figures and some indications of the expense increase due to structures in need of maintenance.

Finally, models were built to explain **at network level** the M&O expenses for roads, bridges, and tunnels, and separately for the winter service expenses, without overheads, and without specific expenses for environment, real estate, and others. Although improvement expenses were also kept out of the scope of the model, their amount is given as they may have an incidence on the preventive maintenance and rehabilitation expenses.

The models give a rough evaluation of M&O expenses per year and per km for the following destinations and tasks:

a) M&O expenses for road and pavement

- *single carriageway per network km (without structures and WS)*

E_s = 8 k€ x (1 + add-l- ramps) x (weighted AADT/8 000) x (1 + 0.5 x share-pvmt-need-maint)

- *dual carriageway 4 lanes per network km (without structures and WS)*

E_d = 39 k€ x (1 + add-l-ramps) x (weighted AADT/30 000) x (1 + 0.5 x share-pvmt-need-maint)

- *dual+ 5 lanes or more per network km (without structures and WS)*

E_{d+} = 72 k€ x (1 + add-l-ramps) x (weighted AADT/80 000) x (1 + 0.5 x share-pvmt-need-maint)

- *overall multiplier for road and pavement expenses*

S = average country satisfaction index/average all countries in survey sat. index

b) M&O expenses for structures

- *additional expenses for bridges per km bridge*

E_b = 150 k€ x (nb-lanes/4 (=4Leq)) x (1 + 6 x share-bridges-need-maint)

- *additional expenses for tunnels per km tunnel*

E_t = 800 k€ x (nb-lanes/4 (=4Leq)) x (1 + 4 x share-tunnels-need-maint)

- *overall multiplier for structure expenses*

S = average country satisfaction index/average all countries in survey sat. index

c) M&O expenses for winter service

- *additional expenses for winter service on single carriageway*

E_{ws} = 0.025 k€ x (1 + add-l-ramps) x (number-days-below 0° C capped at 100)

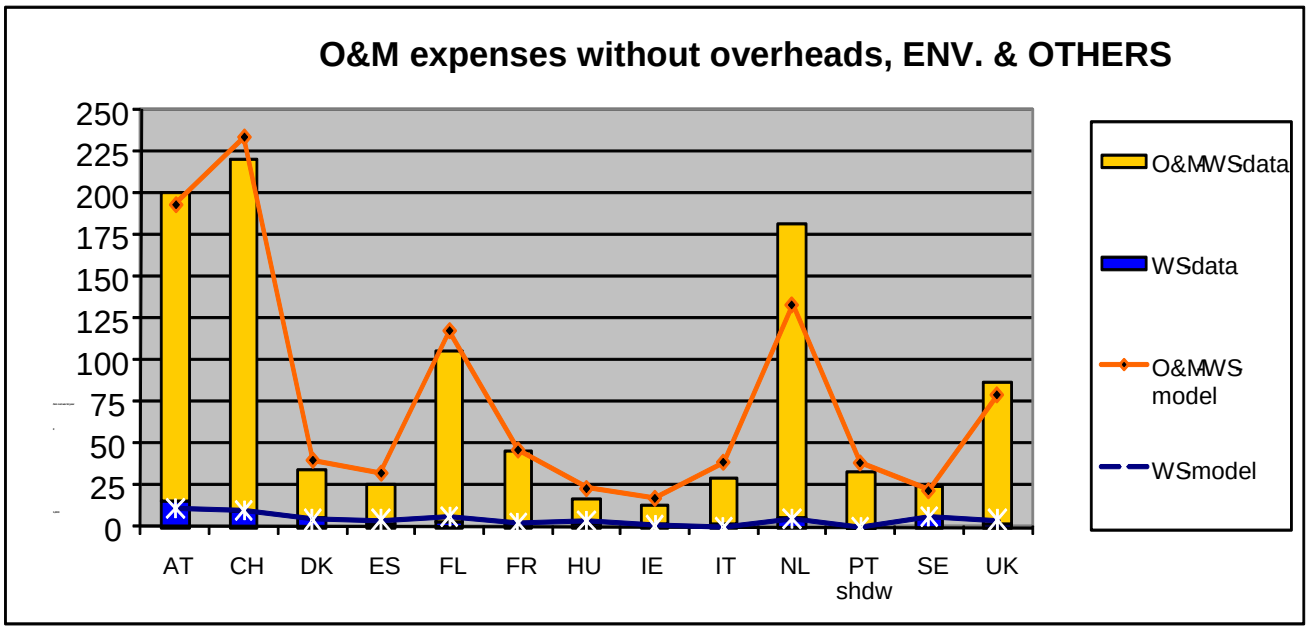
- *additional expenses for winter service on dual c (both dual & dual+)*

E_{wd} = 0.11 k€ x (1 + add-l-ramps) x (number-days-below 0° C capped at 100)

When applied to the networks under survey, taking into account the shares of the different cross-sections, these models give the results summarised in the table and in the figure below:

		M&O EXPENSES €1,000 without VAT/year/network km MODEL and collected DATA									
	User satisfaction index	Traffic Management, Operation, Routine Maintenance, Preventive maintenance & rehabilitation		Winter service		SUB-TOTAL			Overheads Environment & Others	TOTAL O&M	*Improvements*
		DATA	MODEL	DATA	MODEL	DATA	MODEL	MODEL/DATA	DATA	DATA	*DATA*
AT	**63**	**184.3**	182.2	15.8	11.5	**200.1**	**193.7**	**0.97**	21.7	**221.8**	*202.2*
CH	**79**	**211.7**	224.0	9.0	10.3	**220.7**	**234.3**	**1.06**	53.2	**273.9**	*123.2*
DK	**67**	**28.7**	35.9	5.9	4.4	**34.6**	**40.3**	**1.16**	2.1	**36.7**	*1.3*
ES	***64***	**23.9**	28.1	1.7	4.4	**25.6**	**32.5**	**1.27**	0.0	**25.6**	*9.4*
FL	**61**	**102.1**	111.6	3.7	6.4	**105.8**	**118.0**	**1.12**	10.3	**116.1**	*0.0*
FR	***64***	**43.3**	43.9	2.5	2.5	**45.8**	**46.4**	**1.01**	0.0	**45.8**	*3.5*
HU	***64***	**14.5**	19.5	2.4	3.7	**16.9**	**23.2**	**1.37**	0.0	**16.9**	*0.0*
IE	**46**	**12,1**	16.6	1.6	0.8	**13.7**	**17.4**	**1.27**	0.2	**13.9**	*0.0*
IT	**53**	**28.5**	38.9	1.3	0.2	**29.8**	**39.0**	**1.31**	5.0	**34.8**	*6.8*
NL	**70**	**176.4**	128.2	5.7	5.3	**182.1**	**133.5**	**0.73**	33.7	**215.8**	*9.3*
PT	***64***	**32.4**	38.5	0.5	0.1	**32.9**	**38.6**	**1.17**	0.0	**32.9**	*0.9*
SE	**66**	**17.9**	15.7	6.1	6.3	**24.0**	**21.9**	**0.91**	2.3	**26.3**	*0.0*
UK	**68**	**83.8**	75.3	2.5	4.3	**86.3**	**79.5**	**0.92**	2.3	**88.6**	*69.9*
AVRG	**64**	**73.8**	73.7	4.5	4.6	**78.3**	**78.3**	**1.00**	10.1	**88.4**	*32.8*

Note: - For ES, FR (public network), HU, and PT, non available satisfaction indexes are set at the average 64
- The costs of winter maintenance depend heavily on the chosen city with a given number of days with temperatures below 0° C



For each country, the figures given by the models have to be adapted, mainly in consideration of budgetary constraints, specific policies regarding environment and real estate, allocation between task blocks (and improvement versus rehabilitation), overhead evaluation, VAT, and, if relevant, currency exchange rate.

Comments on the differences DATA - MODEL

- **AT**

Under- estimation by 3%*: an important under-estimation for winter service is possibly due to higher country-wide requirements than those prevailing in Vienna, which was taken as reference.*

- **CH**

Over-estimation by 6%*: possibly due to allocation differences for real estate (outside the scope of the model); the currency exchange rate might also influence the comparison.*

- **DK**

Over-estimation by 16%*: maintenance expenses seem low with 60% of pavements in need of maintenance; possible differences in definitions between countries.*

- **ES**

Over-estimation by 27%: *user satisfaction index n/a (set at average), some TM&RO expenses out of the survey (separate directorate), average climate conditions, rather than those of Madrid, could influence the results.*

- **FL**

Over-estimation by 12%*: NL has similar conditions but better structures, conditions, and probably different traffic management and environment policies.*

- **FR**

The model fits quite well, but the user satisfaction index for the public network was set at an average.

- **HU**

Over-estimation by 37%*: user satisfaction index n/a (set at average) but might be lower, looking at the GDP/AIC index.*

- **IE**

Over-estimation by 27%*: very low user satisfaction index, low population density.*

- **IT**

Over-estimation by 31%*: user satisfaction index n/a for the public network only (probably lower than 53). M&O expenses for bridges and tunnels very low compared to other countries (possibly a great number of short structures without ventilation and sophisticated safety devices).*

- **NL**

Under- estimation by 27%*: conditions and policies comparable with FL in terms of high population density (= environment expenses), specific water protection issues, mobile bridges, important part of dynamic systems with short life cycles (=annual depreciations); very high expenses for bridges and tunnels in need of maintenance; low expenses for improvements = possibly allocation differences with other countries on rehabilitation expenses.*

- **PT**

Over-estimation by 27%*: user satisfaction index n/a (set at average) but might be lower, looking at the GDP/AIC index.*

- **SE**

Under- estimation by 9%*: dual roads with lower traffic than other countries (= higher fixed expenses); high expenses for tunnels in need of maintenance; low expenses for improvements = possibly allocation differences with other countries on rehabilitation expenses; the currency exchange rate might also influence the comparison.*

- **UK**

Under- estimation by 8%: *high expenses for improvements = possibly allocation differences with other countries on rehabilitation expenses; the currency exchange rate might also influence the comparison.*

Appendix 7: Task 3 on asset management (long-term investments in road infrastructure)

Task 3 on asset management: Long-term investments in road infrastructure

1. Summary of the task

Global lifecycle costs are progressively being taken into account and must be compared with the taking into account of traffic management measures as part of a global strategy for long-term investment, in which the construction of infrastructures is only one single element.
There might be certain similarities between both the targets and the strategy for task 1. The knowledge gathered in task 1 will probably have important effects on the targets of this task. Work on this task shall therefore only start once task 1 is completed.

2. Goals to be achieved

The objective of this work shall be to get value for money through efficient comprehensive asset management.

3. Strategy to reach the goal

- Define the concept of long-term cost management while distinguishing between the types of cost that must be taken into account and the duration of the life cycle under consideration.
- Examine the influence of the various types of organisation (direct management, delegated management, long-term performance contracts etc.) on the possibility of optimising the following cycle: initial investment, supplementary investment, major repairs, ongoing maintenance.
- Determine the conditions for calculating global costs (discount rate, financial restrictions, risks of insufficient maintenance etc.) without forgetting any of the actors involved: public authorities, operators, users, residents, etc.

4. Expected output at the end of the task

- Summary report on the effective management of long-term investments;
- Guide to best practices in Europe.

5. Existing work in other organisations or institutions

PIARC has been looking at this issue for several years now. The results of this work were presented at the roads congress in Durban, South Africa. PIARC's TC D.1 is currently examining the question of management of road infrastructure assets closely but is restricting its work to technical aspects only.

6. Added value created by CEDR

The work done by CEDR will focus on aspects that relate specifically to Europe, such as the population's sensitivity to pollution caused by road traffic and to demands for appropriate quality.

7. Human resources to perform the task in person*months

It is estimated that between 100 and 150 person days will be required to complete this task.

8. Financial resources (other than NRA manpower, printing, and translation)

No other additional financial resources are envisaged at present.

9. Time schedule

This task will start in 2010.
The analysis phase will take approximately 6 months to complete.
It is estimated that the best practice guide and the final report will be produced by early 2012.

10. Countries interested in actively participating with a representative

Belgium-Flanders, Denmark, Hungary, Iceland, Ireland, Italy, and Spain

11. Countries willing to take over the leadership of the task

The leadership will be decided in 2010.

Ref: CEDR report 2010/03 TDManagement2010 / BEXPRAC

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