CITA

AUTOFORE

Study on the Future Options for Roadworthiness Enforcement in the European Union

WP 700

Cost-Benefit Analyses for Roadworthiness Options

Final Report

Authors: Prof. Dr. Herbert Baum
Prof. Dr. Wolfgang H. Schulz
Dr. Torsten Geißler

University of Cologne, Institute for Transport Economics

January 2007

Content

Executive Summary

1. Methodological Background
1.1 Impact Channels
1.2 Selected Options
1.3 Data Limitations
1.4 Applied Cost-Unit Rates and Traffic Data
1.5 Underestimation Factors

2. Annual Inspection of Passenger Cars
2.1 Current Inspection Regime
2.2 Applied Impact Channels
2.3 Calculation Procedure for the Cost-Benefit Analysis
2.4 Example Calculations
2.4.1 Traffic Safety Effects
2.4.2 Environmental Effects
2.5 Results for the Safety and Environmental Impact
2.6 Cost-Benefit Results and Sensitivity Calculations

3. Additional Inspection of New Electronic Vehicle Components
3.1 Scope of the measure
3.2 Calculation Procedure for Testing of Electronic Systems
3.2.1 Benefits of Inspecting ESP
3.2.2 Costs of Inspecting ESP
3.3 Cost-benefit results

4. Roadside Inspections

5. Inspection for Powered-Two-Wheelers

6. References

Figures

Figure 1: **Impact Channels of Road Worthiness Enforcement Strategies on Economic Costs**

Figure 2: **Applied Impact Channels for the Cost-Benefit Analysis**

Figure 3: **Applied Impact Channels for the Annual Inspection of Passenger Cars**

Figure 4: **Calculation Procedure for Changing the Inspection Frequency**

Figure 5: **Distribution of Vehicle Stock to Vehicle Age (Share in %)**

Figure 6: **Applied Impact Channels for the Cost-Benefit Analysis of ESP Inspection**

Tables

Table 1: **European Cost-Unit Rates for Accident Evaluation in Euro per Accident**
Table 2: **National Cost-Unit Rates for Property Damage Evaluation in Euro per Accident**
Table 3: **Cost-Unit Rates for the Benefit Components**
Table 4: **Road Fatalities 2000-2004 and Number of Accidents involving Personal Injuries 2000-2003**
Table 5: **Accident Forecasts for 2010**
Table 6: **Road Accidents and Consequences in EU-25 for 2003**
Table 7: **Vehicle Stock in Passenger Transport in Million Vehicles**
Table 8: **Stock of Passenger Cars by Age (2004)**
Table 9: **Inspection Fees per Passenger Cars (2004)**
Table 10: **Passenger Car Inspection Test Cycles in the EU-25 (2006)**
Table 11: **Scheme of Old Inspection Regime and New Inspection Regime for Denmark**
Table 12: **Development of the Number of Accidents in Denmark for an Annual Reduction by 2%**
Table 13: **Vehicle Stock and Inspections under different Inspection Regimes**
Table 14: **Estimation of avoidable Accidents in 2010**
Table 15: **Safety Impact (avoided Consequences of Accidents)**
Table 16: **Base Vehicle Data for Calculation of Environmental Impact**
Table 17: **Impact Data for Calculation of Environmental Impact**
Table 18: **Further Environmental Impacts**
Table 19: **Safety Benefits by Annual Inspection of Passenger Cars older than 7 Years (Base Case)**
Table 20: **Safety Benefits for different Reduction Paths of Accidents**
Table 21: **Sensitivity-Analyses for different Starting Years for Annual Inspection (Base Case)**
Table 22: **Safety, other and total Benefits in Million Euro per Year (Base Case)**

Executive Summary

This report summarizes the work, which was performed under the task "Cost-Benefit-Analyses" within Autofore workpackage WP 700. It contains the assessment of the four options, which were recommended in WP 600 for the cost-benefit assessment. The four options are:

- Annual inspection of passenger cars,
- Additional inspection of new electronic vehicle components,
- Roadside inspections of trucks,
- Inspection of powered-two-wheelers.

The most comprehensive cost-benefit analysis was performed for the option "annual inspection of passenger cars", whereas the option means that annual inspection is introduced obligatory for passenger cars older than seven years. The benefit-assessment consists of safety benefits (accident-cost savings, congestion-cost savings), environmental benefits (lower environmental pollution and carbon-dioxide emission of passenger cars with petrol engine) and fuel consumption savings. The final benefit-cost ratio is 2.1, which shows that the introduction of annual inspections for passenger cars older than seven year is beneficial for the EU-25. Concerning the composition of benefits it can be stated that the safety benefits dominate the results. The other benefits (environmental benefits and fuel consumption) account only for one percent of the total benefits. Further potential benefits such as reduction of vehicle-breakdowns could not be integrated in the cost-benefit analysis due to the lack of empirical evidence. Beside the base case extensive sensitivity test have been performed to assure that the results are robust and reliable.

The cost-benefit analysis for additional inspection of electronic vehicle-components refers to the Electronic Stability Program (ESP). It makes use of a recent empirical study for ESP itself. Within Autofore it is assessed, which benefits could be secured if it is assumed that some ESP-system will not function properly. It is shown that the attainable benefits exceed the additional testing costs by the factor 2.6

The other options were considered for cost-benefit assessment. However, cost-benefit analyses were not performed because of the lack of European evidence (especially for roadside inspection) and the poor availability of statistical data for the vehicle-group of powered-two-wheelers.

1. Methodological Background

This section summarizes briefly the methodology of economic assessment of roadworthiness enforcement as outlined in the Workpackage 400 report. It provides an overview over the following elements:

- relevant impact channels,
- selected roadworthiness options,
- data limitations,
- applied cost-unit rates.

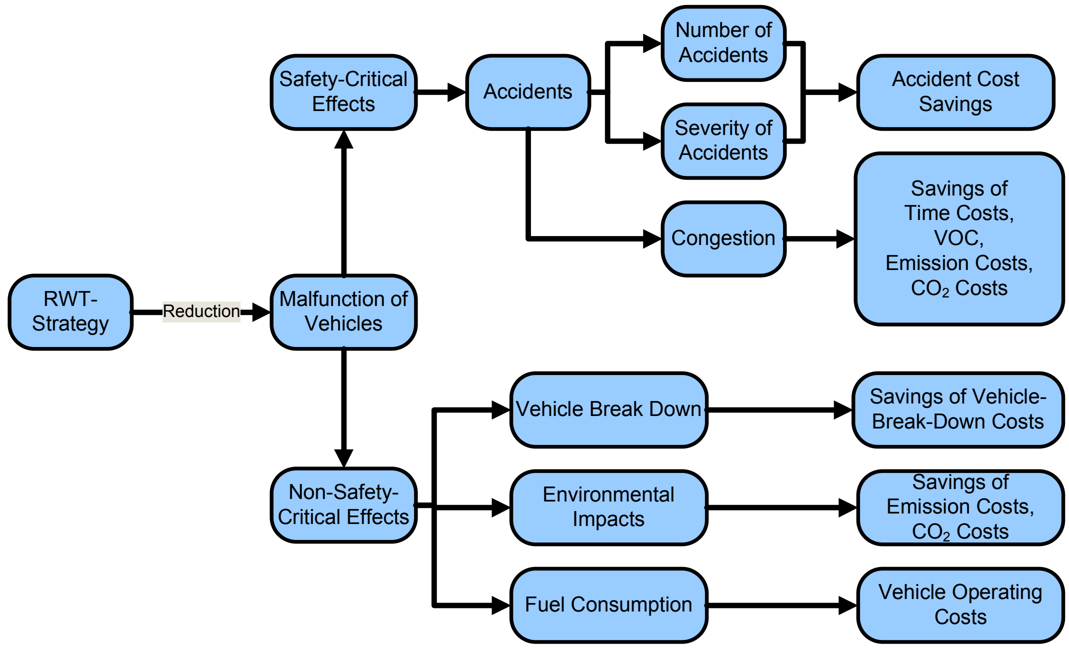
1.1 Impact Channels

Measures of roadworthiness enforcement make the operation of the vehicle safer and more reliable. With that, the measures contribute to socio-economic benefits by several impact channels. Basically, the impact channels can be distinguished between safety-critical effects and non-safety-critical effects. Figure 1 gives an overview over both major impact channels, which are relevant for roadworthiness measures.

Safety-critical effects include the risk of an accident occurring (for example through extended braking stopping distances due to poor brakes, or rear-end collisions due to poor vehicle lighting).

Non-safety critical effects include vehicle breakdowns, emissions and fuel consumption. Vehicle breakdowns due to poor vehicle condition result in costs to the vehicle owner (e.g. towing costs, vehicle-repair costs) and congestion (lost time, vehicle running costs, emissions and CO_2). Badly adjusted engines and exhaust systems result in higher fuel consumption. Increased fuel consumption leads inevitably to rising emission costs and CO_2 costs.

Figure 1: Impact Channels of Road Worthiness Enforcement Strategies on Economic Costs



Source: own presentation

1.2 Selected Options

As result of workpackages 400 and 600 the following measures have been selected for the socio-economic impact assessment:

- frequency change of periodic inspections for passenger cars,
- additional inspection of electronic components,
- roadside inspections of heavy good vehicles,
- wider application of periodic inspection for powered-two-wheelers.

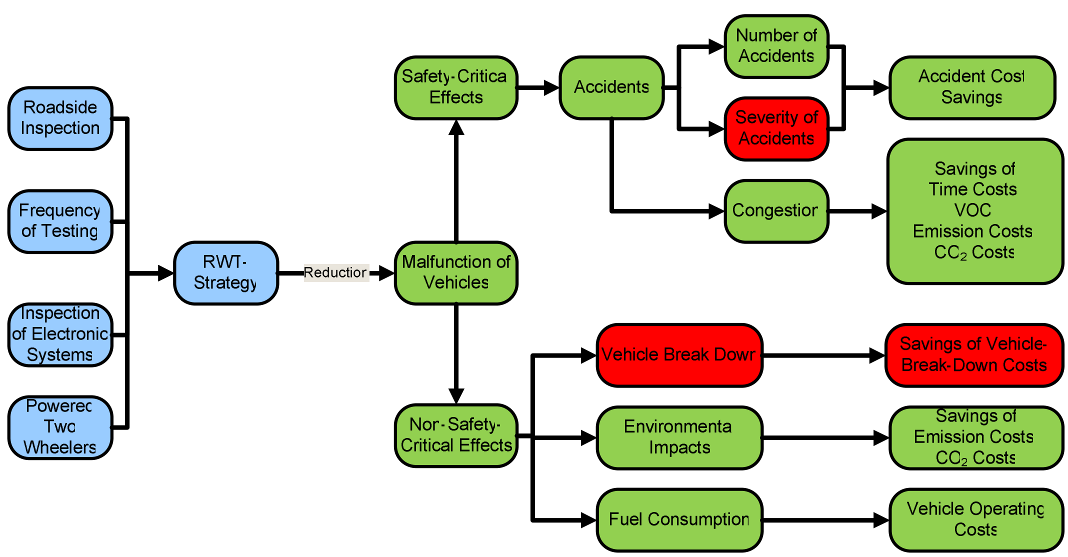
These options were selected because they were identified as measures, which are suitable in the short to medium term. Therefore, as possible starting year for these measures 2010 was chosen.

1.3 Data Limitations

The socio-economic assessment faces some evident data limitations, which have to be considered. Generally, the empirical knowledge over the impact channels is incomplete. The general lack of evidence leads to the consequence that not all possible beneficiary effects (such as avoiding vehicle-breakdowns, lowering of the severity) can be calculated.

Figure 2 shows in green color the impact channels where empirical data is available (for details see WP 400). The red fields represent areas, which can give an important contribution to benefits, but since no empirical evidence is given, it is not possible to include them in the cost-benefit analysis.

Figure 2: Applied Impact Channels for the Cost-Benefit Analysis



Source: own presentation

For the examined roadworthiness strategies, the data situation concerning the availability and quality is different. The best data situation is given for the frequency of passenger cars. The second-best data situation exists for the introduction of additional testing of ESP.

The data problem for **roadside inspections** is that the empirical evidence of the impacts of roadside inspections to accidents is only given for U.S. data. The U.S. data, however, cannot easily applied to European conditions, because of the different contents of roadside inspection procedure. Further, the general technical conditions of the heavy good vehicles in Europe cannot be compared with the technical conditions of U.S. trucks. Therefore, the research objective for roadside inspections is to find more evidence that is empirical based for accident causation of roadside inspections. The general data for heavy good vehicles (e.g. vehicle stock, number of accidents, number of caused causalities, vehicle-kilometers) is available. The only bottleneck for performing the cost-benefit analysis is the missing impact channel.

Unsatisfactory is the data situation for **powered-two-wheelers**. Like roadside inspections, the main missing data is the empirical causation of inspection measures to the avoidance of accidents, and with that the reduction of fatalities and injuries. Beneath that data lack, the further problem is that for most of the EU-member states relevant traffic data like vehicle-kilometers of motorcycles is not available.

These weaknesses of the empirical verification of impact channels and the incompleteness of the databases for the measures “roadside inspections” and “inspection of powered-two-wheelers” are the reason that the cost-benefit analyses for both will not lead at this stage to trustworthy and reliable results.

Altogether, it can be summarized that the current data situation only allows performing cost-benefit analyses for **“frequency of inspections”** and **“ESP inspection”**. However, it is not possible to estimate all possible benefits for both measures, because of missing values for some of the impact channels. The picture on the cost-side is totally different, because for both measures the used costs of the measures are completely available. Therefore, the cost-side is complete. That means that from statistical point of view there is only significance given that the actual benefits are higher than the estimated benefits, but there is no evidence that the actual costs of both measure might be higher than estimated.

This means altogether that the CBA provides results that are significant for determining the minimum of what can be reached for the society by introduction of new roadworthiness strategies.

1.4 Applied Cost-Unit Rates and Traffic Data

This chapter presents the basic assumptions, the relevant cost-unit rates and databases, which are necessary to perform the cost-benefit analyses for “frequency of inspection” and “inspection of ESP”.

There are following **basic assumptions**, which are described briefly:

- The effects of changing the inspection regime are calculated for the year 2010 in prices and costs for the year 2004.
- The accident cost rates refer to WP400 results.
- The accidents for each country are forecasted to the year 2010. Starting year for the accident forecast is 2003. Following the ARCOS-project an accident reduction by 2% per year is assumed.[1]
- The relations between accident number and fatalities/severe injuries/ slight injuries are derived for each country empirically.
- The failure rates of passenger cars depending on their vehicle-age are given by the Swedish database of Bilprovningen.[2]
- The stock of passenger cars is given by a forecast for 2010 by PROGTRANS[3].
- For most of the EU-25 countries, the vehicle-stock by age is given on an average basis for the year 2004. This data comes from EUROSTAT.[4]
- The inspection costs are based on the results of the CITA-questionnaire 2004. [5]

1 www.arcos2004.com
2 Bilprovningen (Ed.), own empirical research 2006
3 ProgTrans AG, European Transport Report 2004, Basel 2004
4 Strelow, H., Statistics in Focus: Transport, edited by Eurostat and European Communities, data extracted on: 24.07.2006, Luxembourg 2006
5 Cita (Ed.) Annual Questionnaire of Members, Brussels 2006

For the benefits **cost-unit rates** are relevant for safety effects (costs of fatalities, severe and slight injuries), congestion cost-savings, fuel cost-savings and emission cost-savings.

Before the background, that the economic evaluation is focused on the European level, for identical cost unit rates for the monetary evaluation of all effects will be used for all Member States.

It is clear that each Member State has different cost of goods and services. Some studies use cost-adjustment factors related to the difference in labor costs and car costs. These kinds of adjustment factors keep into account that inhabitants of less wealthy EU-Member States will have smaller and cheaper cars than in other States. Perhaps these inhabitants will use less costly equipment in their cars.

That means safety measures in less wealthy EU-Member States will have in terms of monetary values a lower economic benefit than in wealthy EU-Member States.

Here the question arises about the sense and justification of such a proceeding. For an equal judgment on European level of safety measures, which specially aim at the saving of life and avoiding injuries, the proposal of the EU Commission is to use uniform cost unit rates for accidents. Uniform cost unit rates for accidents, furthermore, reflect and support the Community goals of economic and social cohesion.

Table 1 shows the proposed **cost-unit rates for accidents with fatalities, severe injuries and slight injuries**. As mentioned above the cost unit rate are only reflecting the costs of accidents with personal injuries. Therefore, they are not reflecting the costs for the accidents with property damages.

Table 1: European Cost-Unit Rates for Accident Evaluation in Euro per Accident

Type of Accident	Cost Unit Rate per Accident
With fatalities	1,000,000 €
Severe injuries	135,000 €
Slight injuries	15,000 €

Source: European Commission, Proposal for a Directive of the European Parliament and of the Council Amending Directive 1999/62/EC on the Charging of Heavy Goods Vehicles for the Use of certain Infrastructure, Bruxelles 2003; own calculation

As mentioned in WP 400 the cost unit rate is only reflecting the costs of accidents with personal injuries. Therefore, they are not reflecting the costs for the accidents with property damages only. Table 2 gives an overview over the cost unit rates for **property damages** used in Germany, United Kingdom, Sweden and U.S.A.

Table 2: National Cost-Unit Rates for Property Damage Evaluation in Euro per Accident

Countries	Lower Bound – Upper Bound of Property Damage Costs
Germany	10,000 – 30,000 €
United Kingdom	3,200 – 12,500 €
Sweden	1,500 €
USA	1,000 – 10,000 €

Note: Figures are converted to Euro on basis of 1€ = 1 US$ = 0.67 GB£ = 9 SEK and rounded.

Source: Hoehnscheid, K.J., Straube, M., Volkswirtschaftliche Kosten durch Straßenverkehrsunfälle in Deutschland 2000, Wissenschaftliche Informationen der Bundesanstalt für Straßenwesen, Info 12/02; Department for Transport UK, Highways Economics Note No. 1 – London 2001; The Swedish State Institute for Communication Analysis, Översyn av samhälls-ekonomiska kalkylpriciper och kalkylvärden på transport-området, SIKA Report 1999:6, Stockholm 1999; U.S. Department of Transportation, The Economic Costs of Motor Vehicle Crashes 2000, NHTSA Technical report, Washington DC 2002

The suggestion is to use a general cost unit rate for the property damages, which can be assumed as an average value for the EU. Therefore, an amount of 10,000 Euro is proposed as value for the average property damage.

Specific **congestion cost-unit rates** exist for congestion caused by crashes. For crashes with fatalities, the assumed average congestion costs are 10,000 € (ICF Consulting Ltd. 2003, p.13). The high cost unit rate for crashes with fatalities reflects that on average the duration of a fatality crash is higher than an average congestion by crashes with severe or slight injuries.

The **emission** (CO, HC and NOx) are transformed by toxicity factors into NOx-equivalents. As cost-unit rate 365 € per ton of NOx-equivalent is used.

Carbon dioxide (CO_2) is a byproduct of combustion with the harmful effect of climate change. The green house effect is considered separately because CO_2 does not have direct toxic effects. The evaluation of the green house effect is based on the quantification of carbon dioxide. The cost unit rate for one ton of carbon dioxide is 205 €, which represents long-term avoidance costs according to the German Federal Transport Investment Plan (BVWP-03). In the frame of European Commission ExternE programme the green house gas damage costs were ranged between 20 and 63 € for one ton of carbon dioxide (European Commission, ExternE 1998). The proposal is to follow the European Commission, which means to use the cost-unit rate of 63 € for one ton of carbon dioxide.

Within the framework of the CBA, the **cost-unit rates for fuel** are net fuel prices: the fuel price, which has to be paid at the gas station, is lowered by the mineral oil tax and value-added tax and for Germany; furthermore, the contribution for the provision of mineral oil stocks must be taken off. This happens, because taxes and contributions are transfer payments between economic sectors and the government (disbursements for private households and industry, deposits in same amount for the government). 0.30 € per liter is used a fuel cost-unit rate.

Table 3 presents an overview over all cost-unit rates, which are needed for the benefit calculations.

Table 3: Cost-Unit Rates for the Benefit Components

Benefit Component		Cost Unit Rate
Accident Costs	Fatalities	1,000,000 €
	Severe Injuries	135,000 €
	Slight Injuries	15,000 €
	Related Property Damage	10,000 €
	(Accident Caused) Congestion	10,000 €
Emission Costs (per t NOx-equivalent)		365 €
CO_2-Emission Costs (per t CO_2)		63 €
Fuel Consumption Costs (net price per l)		0.30 €

Source: European Commission, Proposal for a Directive of the European Parliament and of the Council Amending Directive 1999/62/EC on the Charging of Heavy Goods Vehicles for the Use of certain Infrastructure, Bruxelles 2003; Aral Kraftstoffpreis-Datenbank, www.aral.de, December 2005; OECD Economic Outlook, No. 77, Paris 2005, p. 157; own calculation

Table 4 presents the current availability of **accident data**. Although the number of road fatalities is given for each country for the year 2004, there is no complete record for the year 2004 available, which gives information on the number of accidents and the split of injuries into serious and slight injuries.

Table 4: Road Fatalities 2000-2004 and Number of Accidents involving Personal Injuries 2000-2003

		Number of Road Fatalities					Number of Accidents involving Personal Injuries in Thousands			
		2000	**2001**	**2002**	**2003**	**2004**	**2000**	**2001**	**2002**	**2003**
Belgium	**BE**	1 470	1 486	1 353	1 162	1 163	49.07	47.44	45.76	43.71
Czech Republic	**CZ**	1 486	1 334	1 431	1 447	1 382	25.45	26.03	26.59	27.32
Denmark	**DK**	498	431	463	432	369	7.35	7.47	7.13	6.75
Germany	**DE**	7 503	6 977	6 842	6 613	5 842	382.95	375.35	362.05	354.53
Estonia	**EE**	204	199	223	164	170	1.50	1.89	2.16	1.93
Greece	**EL**	2 037	1 880	1 634	1 605	1 619	23.00	19.67	16.81	15.75
Spain	**ES**	5 777	5 517	5 347	5 399	4 749	101.73	100.39	98.43	99.99
France	**FR**	8 079	8 162	7 655	5 731	5 530	121.22	116.75	105.47	90.22
Ireland	**IE**	418	412	378	335	379	7.76	6.91	6.63	5.99
Italy	**IT**	6 649	6 691	6 736	5 625	5 625	211.94	235.14	237.81	224.55
Cyprus	**CY**	111	98	94	117	117	2.41	2.39	2.37	2.36
Latvia	**LV**	588	517	518	516	516	4.48	4.77	5.08	5.38
Lithuania	**LT**	641	706	697	709	752	5.81	5.97	6.09	5.97
Luxembourg	**LU**	76	70	62	53	49	0.91	0.77	0.77	0.72
Hungary	**HU**	1 200	1 239	1 429	1 326	1 296	17.49	18.51	19.69	19.98
Malta	**MT**	15	16	16	17	13	0.48	0.51	0.52	0.59
Netherlands	**NL**	1 082	993	987	1 028	804	37.95	35.31	33.54	31.64
Austria	**AT**	976	958	956	931	878	42.13	43.07	43.18	43.43
Poland	**PL**	6 294	5 534	5 827	5 640	5 712	57.33	53.80	53.56	51.08
Portugal	**PT**	1 877	1 670	1 655	1 356	1 294	44.16	44.84	42.22	41.50
Slovenia	**SI**	313	278	269	242	274	8.47	9.20	10.20	11.68
Slovak Republic	**SK**	628	614	610	645	603	7.88	8.18	7.87	8.55
Finland	**FI**	396	433	415	379	375	6.63	6.45	6.20	6.91
Sweden	**SE**	591	583	560	529	480	15.77	15.80	16.95	18.37
United Kingdom	**UK**	3 580	3 598	3 581	3 508	3 368	233.73	229.01	221.75	214.03
EU-25		**52 489**	**50 396**	**49 738**	**45 509**	**43 359**	**1417.59**	**1415.62**		

Source: **European Commission, Directorate-General for Energy and Transport, Energy and Transport in Figures 2005, Part 3: Transport, Brussels 2006**

The proposal is to use as starting data input the year 2003 for the accident data (see table 5). On this basis, it is possible to **forecast the accidents for 2010**.

According to the French ARCOS project, there are several future development scenarios possible:

- Accidents will decrease according to the trend (straight line projection);
- Accidents will encounter a barrier to continuously decreasing numbers (return to an asymptote) due to risk compensation and poor driver behavior;
- Accident development will reflect an enduring change in driver behavior.

Basically, it can be expected that the trend towards lower accident numbers and fewer fatalities will continue.

Table 5: Accident Forecasts for 2010

EU-Member State		Number of Accidents			
		Base Year	2010 0% Reduction	2010 2% Reduction	2010 5% Reduction
Belgium	BE	43,708	43,708	37,944	30,523
Denmark	DK	6,749	6,749	5,859	4,092
Germany	DE	354,534	354,534	307,780	214,934
Greece	EL	15,751	15,751	13,674	9,549
Spain	ES	99,987	99,987	86,801	60,617
France	FR	90,220	90,220	78,322	54,695
Ireland	IE	5,985	5,985	5,196	3,628
Italy	IT	224,553	224,553	194,940	136,134
Luxembourg	LU	720	720	625	436
Netherlands	NL	31,635	31,635	27,463	19,179
Austria	AT	43,426	43,426	37,699	26,327
Portugal	PT	41,495	41,495	36,023	25,156
Finland	FI	6,907	6,907	5,996	4,187
Sweden	SE	18,365	18,365	15,943	11,134
United Kingdom	UK	214,030	214,030	185,805	129,754
Czech Republic	CZ	27,320	27,320	23,717	16,563
Estonia	EE	1,931	1,931	1,676	1,171
Cyprus	CY	2,370	2,370	2,057	1,437
Latvia	LV	5,083	5,083	4,413	3,082
Lithuania	LT	5,965	5,965	5,178	3,616
Hungary	HU	19,976	19,976	17,342	12,110
Malta	MT	13,979	13,979	12,136	8,475
Poland	PL	51,078	51,078	44,342	30,966
Slovenia	SI	11,676	11,676	10,136	7,079
Slovakia	SK	8,551	8,551	7,423	5,184
Total EU 25		1,345,994	1,345,994	1,168,492	820,027

Source: Care-Database, Brussels 2006; own estimations

Following the ARCOS project, it can be assumed that the number of accidents should decrease by 2% per year. However, since this forecast is rather subject to variation to alternative cases will also be considered. These alternatives assume no reduction of accidents (=0%) and an annual accident reduction by 5%. Table 5 gives an overview over the different accident reduction paths.

Table 6: Road Accidents and Consequences in EU-25 for 2003

EU-Member State		Number of			
		Accidents	Fatalities	Severe Injuries	Slight Injuries
Belgium	BE	43,708	1,162	8,949	56,345
Denmark	DK	6,749	432	3,921	4,491
Germany	DE	354,534	6,613	85,740	376,430
Greece	EL	15,751	1,605	2,550	18,187
Spain	ES	99,987	5,399	27,332	123,303
France	FR	90,220	5,731	20,262	95,667
Ireland	IE	5,985	335	1,193	7,069
Italy	IT	224,553	5,625	44,328	272,302
Luxembourg	LU	720	53	309	743
Netherlands	NL	31,635	1,028	9,207	28,769
Austria	AT	43,426	931	9,132	47,749
Portugal	PT	41,495	1,356	4,639	50,619
Finland	FI	6,907	379	9,088	n.a.
Sweden	SE	18,365	529	4,925	22,178
United Kingdom	UK	214,030	3,508	34,474	252,625
Czech Republic	CZ	27,320	1,447	5,809	29,629
Estonia	EE	1,931	164	416	2,123
Cyprus	CY	2,370	117	387	1,973
Latvia	LV	5,083	516	882	4,498
Lithuania	LT	5,965	709	1,191	6,075
Hungary	HU	19,976	1,326	4,365	22,262
Malta	MT	13,979	17	192	979
Poland	PL	51,078	5,640	10,475	53,425
Slovenia	SI	11,676	242	2,738	13,965
Slovakia	SK	8,551	645	1,856	9,465
Total EU 25		**1,345,994**	**45,509**	**294,360**	**1,500,871**

Source: Care-Database, Brussels 2006

For the relations between accidents and fatalities, accidents and severe injuries, accidents and slight injuries the country-specific relations are used. Therefore, it is only necessary to reduce the accidents towards 2010. The reduction of fatalities, severe injuries and slight injuries is calculated based on the **country-specific relations** for the years 2003 (see table 6).

The used number of passenger cars is given by the ProgTrans forecast for 2010 shown in table 7.

Table 7: Vehicle Stock in Passenger Transport in Million Vehicles

EU-Member States		Number of Passenger Cars in Million	
		2002	2010
Belgium	BE	4.80	5.20
Denmark	DK	1.90	2.10
Germany	DE	44.60	47.10
Greece	EL	3.60	4.90
Spain	ES	18.70	22.30
France	FR	30.60	32.80
Ireland	IE	1.40	1.90
Italy	IT	33.80	36.90
Luxembourg	LU	0.30	0.30
Netherlands	NL	6.90	7.70
Austria	AT	4.00	4.50
Portugal	PT	3.60	4.30
Finland	FI	2.20	2.50
Sweden	SE	4.10	4.40
United Kingdom	UK	30.00	34.20
Czech Republic	CZ	3.60	4.50
Estonia	EE	0.40	0.50
Cyprus	CY	0.30	0.30
Latvia	LV	0.60	0.80
Lithuania	LT	1.20	1.40
Hungary	HU	2.60	3.30
Malta	MT	0.20	0.20
Poland	PL	11.00	14.00
Slovenia	SI	0.90	1.10
Slovakia	SK	1.30	1.70
Total EU 25		**212.80**	**238.90**

Source: ProgTrans AG, European Transport Report 2004, Basel 2004

Table 8 gives an overview over the **stock of passenger cars by age**. Regarding the age of the vehicle fleet, most Eastern European new Member States displayed a relatively high proportion of old vehicles: in the Czech Republic, nearly three quarters of the registered passenger cars were more than 10 years old. In Estonia and Poland, this proportion was of 69 % and 56 %

respectively. On the contrary, Luxembourg had the highest share of vehicles less than two years old (27 %). One fifth of Hungary's passenger car fleet belonged to this age class too.

Table 8: Stock of Passenger Cars by Age (2004)

EU-Member States		By Age in percent			
		less than 2 years	from 2 to 5 years	from 5 to 10 years	more than 10 years
Belgium	BE	14.5	24.5	31.7	29.3
Denmark	DK	16.3	22.9	28.9	31.9
Germany	DE	14.4	21.9	33.1	30.6
Greece	EL	n.a.	n.a.	n.a.	n.a.
Spain	ES	14.6	22.1	23.9	39.4
France	FR	14.3	22.4	31.1	32.2
Ireland	IE	17.3	31.7	37.2	13.8
Italy	IT	13.6	21.7	25.8	38.9
Luxembourg	LU	26.7	28.8	26	18.5
Netherlands	NL	13.5	22.1	33.3	31.1
Austria	AT	13.8	20.3	32.4	33.5
Portugal	PT	n.a.	n.a.	n.a.	n.a.
Finland	FI	12,5	16	24,5	47
Sweden	SE	11.6	18.6	29.2	40.6
United Kingdom	UK	19.3	25.4	33.8	21.5
Czech Republic	CZ	10.2	15.7	0	74.1
Estonia	EE	6.8	8.5	16.1	68.6
Cyprus	CY	8.7	11.9	34.3	45.1
Latvia	LV	n.a.	n.a.	n.a.	n.a.
Lithuania	LT	n.a.	n.a.	n.a.	n.a.
Hungary	HU	20.5	15.7	18.2	45.6
Malta	MT	n.a.	n.a.	n.a.	n.a.
Poland	PL	7.2	12.2	24.6	56
Slovenia	SI	n.a.	n.a.	n.a.	n.a.
Slovakia	SK	n.a.	n.a.	n.a.	n.a.

Annotation: n.a..= not available
Source: Strelow, H., Statistics in Focus: Transport, edited by Eurostat and European Communities, data extracted on: 24.07.2006, Luxembourg 2006

Unfortunately, a distribution of the total stock of passenger cars to the vehicle age is not possible for following EU-Member States: Greece, Portugal, Malta, Latvia, Lithuania, Slovenia and Slovakia.

The suggestion is to use for Greece, Portugal and Malta an average value based on the data of the South-European countries Italy and Spain. For Latvia, Lithuania, Slovenia and Slovakia it seem justifiable to use average values for the distribution of the vehicle stock to the vehicle age derived by Czech-Republic, Estonia, Hungary and Poland.

Table 9: Inspection Fees per Passenger Cars (2004)

EU-Member State		**Inspection Costs in Euro per inspected vehicle without taxes**
Belgium	BE	24.5
Denmark	DK	53.8
Germany	DE	40
Greece	EL	36
Spain	ES	31
France	FR	55
Ireland	IE	48.4
Italy	IT	35
Luxembourg	LU	20.9
Netherlands	NL	n.a.
Austria	AT	37
Portugal	PT	24.63
Finland	FI	49
Sweden	SE	33
United Kingdom	UK	52.49
Czech Republic	CZ	50
Estonia	EE	30
Cyprus	CY	n.a.
Latvia	LV	n.a.
Lithuania	LT	n.a.
Hungary	HU	20.18
Malta	MT	n.a.
Poland	PL	21.29
Slovenia	SI	35
Slovakia	SK	n.a.

Annotations: n.a.:= not available
Source: Cita-Questionnaire

Table 9 shows the result of the Cita-questionnaire upon the **inspection fees for passenger cars**. The inspection fees cover both the technical inspection and emission testing. The average inspection fee is 35 €.

1.5 Underestimation Factors

In order to identify the overall economic advantages of roadworthiness strategies, it is necessary to confront the derived benefits with the system costs. If the benefits are higher than the costs (benefit-cost ratio above 1), the examined roadworthiness strategy is favorable from a socio-economic perspective. However, the interpretation of the presented benefit-cost ratio has to consider the **underestimation of benefits**[6], which was worked out in WP 400and which can be summarized as follows:

- The official databases for accidents structurally underestimate the number of accidents with passenger cars. The underestimation ratio for EU-15 is on average that only 70% of actual accidents are seized in the official databases.

- For accidents with personal injuries the property damage is not considered in the accident cost calculations. This effect was addressed by adjusting the cost unit rates. Whereas the adjustment by 10,000 € represents a conservative estimation of the economic consequences.

- Accidents without personal injuries but with property damages only are not recorded by the official accident databases. An adjustment is not possible, because there is no indication available about a realistic number for these kinds of accidents.

- Important benefits like reduction of accident severity, reduction of vehicle-breakdowns and congestions due to vehicle-breakdowns could not be calculated, because there was no empirical evidence given on the relations of inspection regime to these benefits.

- The used cost unit rates represent an average value derived over all type of accidents.

6 ICF Consulting, Cost-Benefit Analysis of Road Safety Improvements, London 2003

- As explained for the accident costs a uniform cost-unit rate is used, but for the calculation of the costs, the actual cost figures for each country are used. That means that countries with inspection fees above the European average inspection fee have an underestimated benefit-cost ratio and countries with an inspection fee below the average will have an overestimation of the benefit-cost ratio.

2. Annual Inspection of Passenger Cars

2.1 Current Inspection Regime

The relevant legal starting point for the inspection of passenger cars is the **EU Directive 96/96/EC** (Directive on the approximation of the laws of the Member States relating to roadworthiness tests for motor vehicles and their trailers). Directive 96/96/EC establishes minimum vehicle testing frequencies.

The suggestion is to introduce annual inspections for passenger cars older than seven years. When the proposal is to test cars older than seven years annually, these annual inspection will start in year 8. In terms of Directive 96/96 /EC, this would mean that the current testing periodicity of passenger cars of 4/2/2/2… would be changed to 4/2/2/1….

The **applied impact study** for the cost-benefit analysis (CBA) of this option is:

“Arbeitsgruppe “§29/§47a StVZO”, Überprüfung der Untersuchungsfristen (§29 in Verbindung mit Anlage VIII StVZO), Berlin 2002.”

To understand the scope of the proposed changes in the periodicity, it might be helpful to look at the current inspection frequencies for passenger cars. Table 10 represents the current inspection frequencies for passenger cars in EU-25.

Table 10: Passenger Car Inspection Test Cycles in the EU-25 (2006)

		Year after start of operation of vehicle										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**…**
Belgium	BE				S	T	T	T	T	T	T	T
Denmark	DK				S		T		T			
Germany	DE			S		T		T		T		
Greece	EL				S		T		T		T	
Spain	ES				S		T		T		T	T
France	FR				S		T		T		T	
Ireland	IE				S		T		T			
Italy	IT				S		T		T			
Luxembourg	LU			S	T	T	T	T	T	T	T	T
Netherlands	NL			S	T	T	T	T	T	T	T	T
Austria	AT			S		T	T	T	T	T	T	T
Portugal	PT				S		T		T	T	T	T
Finland	FI			S		T	T	T	T	T	T	T
Sweden	SE			S		T	T	T	T	T	T	T
United Kingdom	UK			S	T	T	T	T	T	T	T	T
Cyprus	CY	n.a.										
Czech Republic	CZ				S		T		T		T	
Estonia	EE			S		T		T		T	T	T
Hungary	HU	S			T			T		T		T
Latvia	LV	S	T	T	T	T	T	T	T	T	T	T
Lithuania	LT			S		T		T		T		T
Malta	MT	n.a.										
Poland	PL			S		T	T	T	T	T	T	T
Slovak Republic	SK			S	T	T	T	T	T	T	T	T
Slovenia	SI			S		T		T		T		T
EU 96/96					S		T		T		T	

Annotations: S = First inspection after start of operation
T = Next obligatory vehicle inspection after S
n.a. = not available
UK data refer to Great Britain only

Source: **CITA (Ed.), General Questionnaire 2004, Brussels 2005; DEKRA Automobil GmbH (Ed.), International Strategies for Accident Prevention, Technical Road Safety – DEKRA Technical Paper 58/05, Stuttgart 2005, p. 21; Autofore, WP200; own research**

The findings of table 10 are the following:

- The **base case** with the new periodicity 4/2/2/1 is relevant for following countries: Denmark, Germany, Greece, Spain, France, Ireland, Czech Republic, Estonia, Hungary, Lithuania and Slovenia. A change of the inspection regime will cause for these countries additional costs (inspection costs), but also additional benefits.

- The other EU-Member States (Belgium, Luxembourg, Netherlands, Austria, Finland, Sweden, Great Britain, Italy, Portugal, Latvia, Poland and Slovak Republic) will have neither additional costs nor additional benefits, because they have an annual inspection regime for passenger cars. However, it has to be clear that their **current annual regime is beneficial,** because all positive effects of annual inspections (e.g. lower accidents, lower emissions) are realized in these countries. For the AUTOFORE research approach the relevant objective is to find out the additional benefits and costs coming up from a change in the inspection regime. It is not the research objective to derive the actual benefits and costs of the inspection regimes, which are in use, but to determine the additional benefits and additional costs.
- For some smaller countries (Cyprus and Malta) it is not possible to perform a CBA, because there is no data about their current inspection regime available.

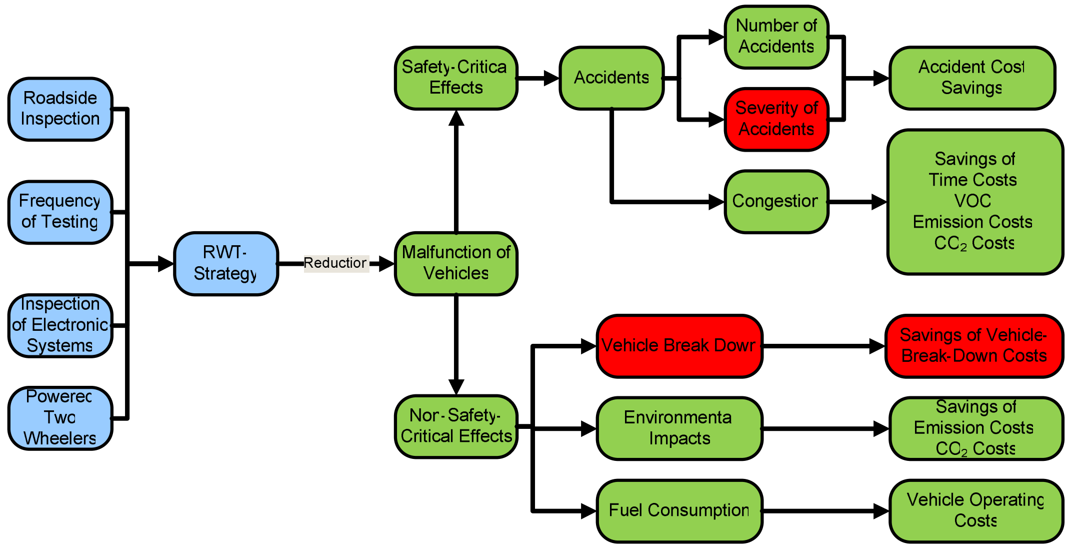
2.2 Applied Impact Channels

A change in the periodicity of the inspection leads to:

- Traffic Safety Relevant Effects,
- Environmental Effects.

Figure 3 shows in green color, which safety and environmental effects can be considered within the CBA due to the given data.

Figure 3: Applied Impact Channels for the Annual Inspection of Passenger Cars



Source: own presentation

2.3 Calculation Procedure for the Cost-Benefit-Analysis

The calculation procedures for the traffic safety relevant effects and for environmental effects are different. Therefore, the main CBA is first completed for the traffic safety relevant effects and then with an add-on the environmental effects are calculated and integrated into the overall results.

The calculation procedure is illustrated by the figure 4.

The calculation procedure reveals that the most detailed data are needed for the calculation of the safety benefits. There are three starting points, which are:

- safety performance,
- vehicle fleet,
- vehicle inspection regime.

The starting point of the safety performance is the road safety situation in the year 2003 (e.g. fatalities, severe injuries, slight injuries). The forecast of the safety performance in the year 2010 has to consider that road safety will continue to improve, because for example of transport policy measures. As a base case, a **two percent annual reduction of injury accidents** can be assumed. For sensitivity reasons, the options “no accident reduction” and “five percent accident reduction” will be tested subsequently. Relevant for the accident effects of annual inspection are the accidents due technical defects of passenger cars. Therefore, the empirical share of accidents due to technical defects is needed. For this empirical results from a German in-depth-study are applied.[7] This study indicates that the share of technical defects is in a minimum case 2.5% and in a maximum case 9.1%.[8] The average share is 5.8%, which is used for the base case. For assessing the safety improvement potential it has also to be considered that not all technical defects, which cause an accidents, can be detected by vehicle inspections. In line with the German in-depth-study, a detection rate of 60% will be applied.[9] These calculation steps lead to the maximum avoidable accidents and casualties due to technical defects.

The reduction potential has to be connected to the **vehicle-fleet conditions**. Relevant starting points are given by the stock of passenger cars and its age-distribution. Moreover, it is relevant how the failure rate is related to the vehicle-age. With this information, it can be calculated, which share of vehicles is older than seven years, and which share of defects accounts for vehicles older than seven years.

The third pillar contains with the **vehicle-inspection regime**. The switch to annual inspections from year eight on leads to a change in the number of vehicle-inspections. This difference can be used in several ways. First, it determines the costs of additional inspections. Second, it determines to what extent the safety potential can be realized.

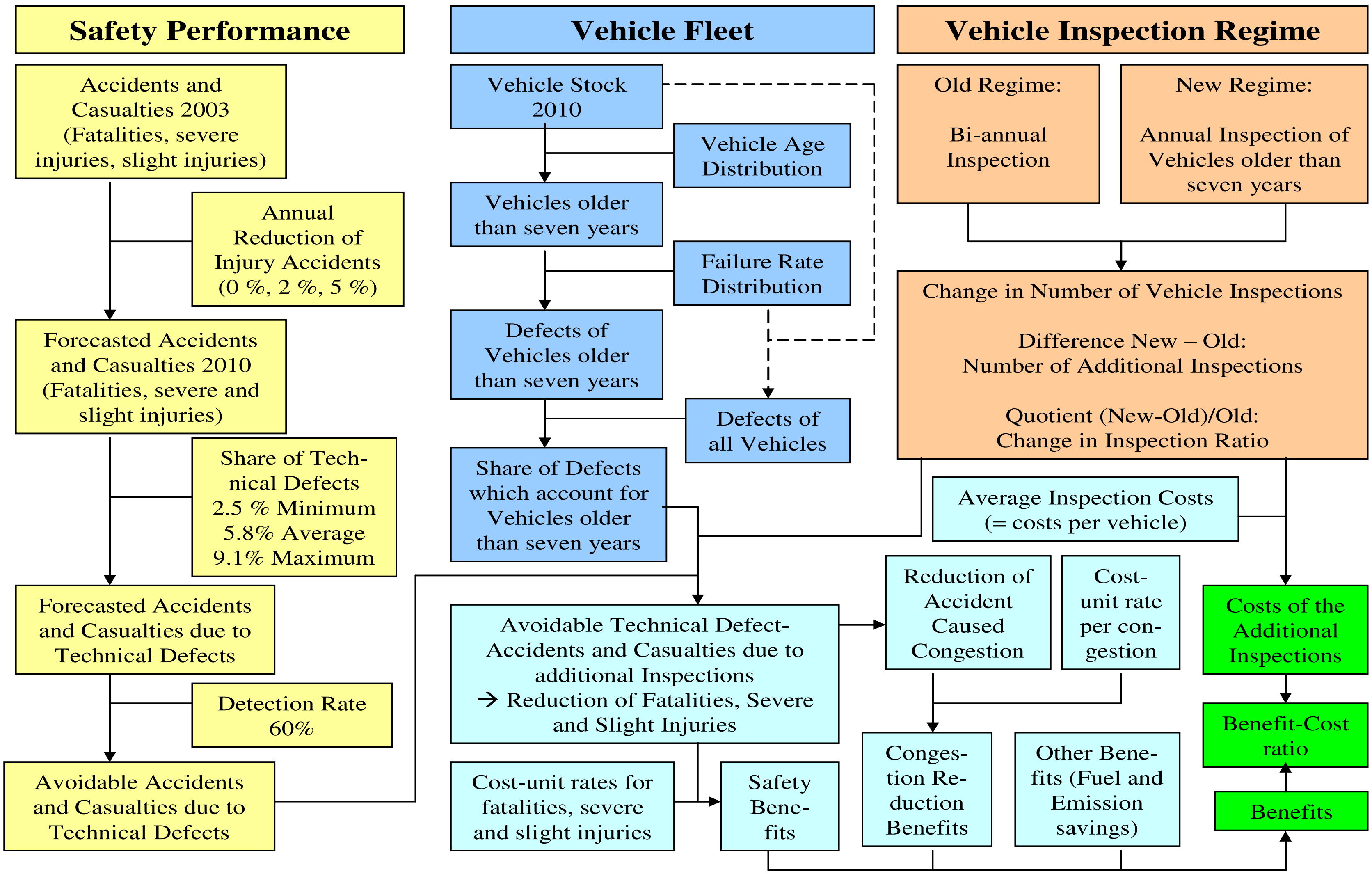
---

[7] Arbeitsgruppe “§29/§47a StVZO”, Überprüfung der Untersuchungsfristen (§29 in Verbindung mit Anlage VIII StVZO), Berlin 2002

[8] Arbeitsgruppe “§29/§47a StVZO”, Überprüfung der Untersuchungsfristen (§29 in Verbindung mit Anlage VIII StVZO), Berlin 2002

[9] Arbeitsgruppe “§29/§47a StVZO”, Überprüfung der Untersuchungsfristen (§29 in Verbindung mit Anlage VIII StVZO), Berlin 2002

Figure 4: Calculation Procedure for Changing the Inspection Frequency



The three information pillars are connected in order to estimate the **technical defect-accidents and casualties**, which can be avoided due to additional inspections. The subsequent reduction of fatalities, severe and slight injuries is than evaluated and monetarized with cost-unit rates for each type of casualty. The results are the safety benefits. Beneath the safety benefit the accident reduction will also lead to a reduction of congestion. The congestion cost-saving can be calculated by using an European average congestion cost-unit rate. Further benefits due to the increased number of inspected passenger cars are the fuel- and emission-savings, because the additional inspections covers regularly also the inspection of the exhaust system. Based on a German in-depth-study the potential for the reduction of fuel consumption and emission for petrol passenger cars are given. [10]With that it is possible to calculate the monetary benefits.

2.4 Example Calculations

For both traffic safety effects and environmental effects it seems useful to demonstrate the calculation steps of the CBA by country examples. As case studies Denmark and Italy are chosen. This selection was random. However, the results of these case studies cannot be used as relevant results for these countries itself, because the calculation is an European average calculation. The results are European average results and not specific values for Denmark and Italy.

2.4.1 Traffic Safety Effects

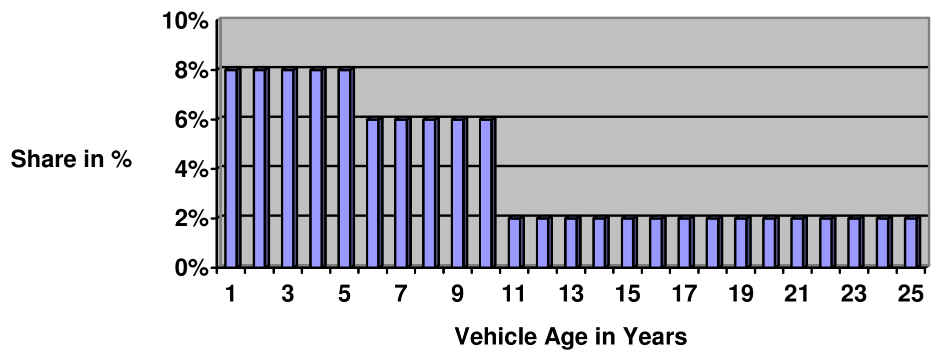
In the following, the evaluation procedure is illustrated for Denmark to enable a deeper understanding of the logic of the calculation.

10 BAST (Ed.), Abgasuntersuchung Dieselfahrzeuge, Berichte der Bundesanstalt für Straßenwesen, Heft F41, Bergisch Gladbach 2003; BAST (Ed.)., Abgasuntersuchung – Erfolgskontrolle: Ottomotor – G-Kat, in: Berichte der Bundesanstalt für Straßenwesen, Fahrzeugtechnik, Heft F 37, Bergisch Gladbach 2001

The calculation steps are as follows:

1. Denmark has in 2002 a passenger car stock of 1.9 Million vehicles. For 2010 the forecasted value is 2.1 Million passenger cars. The vehicle stock has following distribution to vehicle age as given in figure 5.

Figure 5: Distribution of Vehicle Stock to Vehicle Age (Share in %)



Source: **Strelow, H., Statistics in Focus: Transport, edited by Eurostat and European Communities, data extracted on: 24.07.2006, Luxembourg 2006; own calculation**

2. The current inspection regime of Denmark and the new inspection regime over a time-period of 25 years is given by table 11.

   The table above shows that inspections of passenger cars older than 7 years will not start additional benefits in year 8, because the current inspection regime has an obligatory inspection in year 8. For Denmark the additional benefits are generated by additional inspections in the years 9, 11, 13, 15, 17, 19, 21, 23 and 25.

   For example the German situation is different, because annual inspection for passenger cars older than seven years will start in the year 8, because under the current inspection regime obligatory inspection is not given for the year 8. So the benefits for Germany due to additional benefits are realized in the years 8, 10, 12, 14, 16, 18, 20, 22 and 24.

Table 11: Scheme of Old Inspection Regime and New Inspection Regime for Denmark

Year	Old Inspection Regime (1:= inspection, 0:= no inspection)	New Inspection Regime (1:= inspection, 0:= no inspection)
1	0	0
2	0	0
3	0	0
4	1	1
5	0	0
6	1	1
7	0	0
8	1	1
9	0	1
10	1	1
11	0	1
12	1	1
13	0	1
14	1	1
15	0	1
16	1	1
17	0	1
18	1	1
19	0	1
20	1	1
21	0	1
22	1	1
23	0	1
24	1	1
25	0	1

Source: own presentation

3. The current inspection regime of Denmark leads in total to 837,060 passenger cars, which are inspected in one year. 44% of the vehicle stock are inspected every year on average. Changing the inspection regime to an annual inspection frequency for passenger cars older than 7 years increases the number of inspected passenger cars up to 1,315,720 vehicles. That means that on average 69% of the passenger car stock are inspected every year.

4. Taking only the number of passenger cars older than 7 years into account for calculating the safety effects, the inspected number of vehicles under the current regime is 555,380 passenger cars. Due to the change in the inspection regime 1,034,040 passenger cars, which are older than 7 years, are inspected then totally. This should certainly make 478,660 additional inspected passenger cars, because of the change in the periodicity of the inspection regime. Moreover, for passenger cars older than seven years, the number of inspected vehicles increases with a growth rate of 86% (e.g the calculation is as follows: ((1,0340,40 – 555,380)/555,380)·100). This growth rate, obviously, represents for Denmark a significant impact in terms of the amount of vehicles caused by the change within the inspection frequency.

5. Denmark has 6,749 accidents in 2003. Table 12 gives the development of the accident until 2010 by assuming an annual reduction of accidents of 2%.

Table 12: Development of the Number of Accidents in Denmark for an Annual Reduction by 2%

Year	Number of Accidents
2003	6,749
2004	6,614
2005	6,482
2006	6,352
2007	6,225
2008	6,101
2009	5,979
2010	5,859

Source: own calculation

Using the empirically derived German share for accidents caused by technical defects, which is for the minimum case 2.5% and for the maximum case 9.1%, 147 accidents are caused by technical defects (minimum case) and 533 accidents are caused by technical defects for the maximum case in 2010. Under the defined base case, which represents a share of technical defects of 5.8%, the number of accidents due to technical defects amount up to 340.

6. This steps lead to the result: how many accidents of the total number of accidents caused by technical defects can be reduced to the annual periodicity of inspections for vehicles older than seven years. The calculation is as follows (see ***Relation 1***):

(Relation 1)

$$Acc_{2010} \cdot TD \cdot RED \cdot RAT \cdot DefVeh = \text{Number of reduced accidents}$$

With:

Acc_{2010}	: =	Number of accidents of passenger cars in Denmark in the year 2010
TD	: =	Percentage share of accidents caused by technical defects
$Acc_{2010} \cdot TD$	: =	Number of accidents caused due to technical defects in the year 2010
RED	: =	Empirical derived reduction ratio for the percentage share of accidents, which can be reduced by annual inspection, RED = 0.6
RAT	: =	Ratio for number of additional inspections (new minus old) and number of inspections under the old regime
DefVeh	: =	Percentage share reflecting how many of all defect passenger cars belong to the period with annual inspections.

With real data the numbers are:

(Relation2)

$$5{,}859 \cdot 0.058 \cdot 0.6 \cdot \left(\frac{1{,}034{,}040 - 555{,}380}{555{,}380} \right) \cdot 0.84 = 148$$

In 2010, we have 5,859 accidents in Denmark. Using the ratio of 5.8%, which is the share of accidents caused by technical defects, the total number of accidents caused by technical defects is 340. The number of accidents caused by technical defects (=340 accidents) multiplied with 0.6 are the number of accidents, which can be avoided, because the accident relevant technical defect would be be detected by the additional inspections. With this assumption, that the German success rate of 60% could be adapted to Denmark, 204 accidents could be avoided.

However, the country specific successes of avoiding accidents by introducing annual inspections depend on the two impacts: the additional number of inspected vehicles and the number of vehicles with defects within the annual inspection period. The without-situation (no annual inspection for passenger cars older than 7 years) leads to 555,380 passenger cars, which are older than 7 years and inspected. The change to annual inspection increases the number of inspected passenger cars older than 7 years up to 1,034,040 vehicles by additional inspected vehicles of 478,660 passenger cars. The increase in additional inspected vehicles is under-proportional. Therefore, 204 accidents are multiplied with the growth rate of 0.86. At this calculation step, the avoidable accidents are now 175 accidents.

Beneath the impact of the change in the number of inspected vehicles, the distribution of vehicles with defects over the lifespan of vehicles is relevant. Therefore, the empirical distribution shares of vehicles with technical defects of the Swedish database[11] are used. In Denmark 84% of all vehicles with technical defects are older than 7 years. That means that the annual inspection starting in year 8 covers 84% of all passenger cars with defects. Therefore, the remaining number of avoidable accidents, which is 175, has to be multiplied with 0.84. The reliable, not-overestimating number of avoidable accidents for Denmark therefore is 148. Altogether, the result is that due the change of the frequency **148 accidents with passenger cars can be avoided**. The avoided accidents are accidents, which normally would be caused by a technical defect.

7) For Denmark in terms of **sensitivity**, a shift of the starting year of annual inspections to the year seven means that 88.2% of all defect passenger cars will be inspected. In terms of the ***Relation 2,*** this means that the value for DefVeh and for RAT will be changed, but all other variables remain constant. Due to the fact that an earlier beginning of annual inspection, definitely, will lead to a higher number of inspected vehicles

[11] Bilprovningen (Ed.), own empirical research 2006

(the share for the inspected vehicles with defects is 88.2%), the number of avoidable accidents will increase.

To illustrate the point, a shift to the year six of the annual inspections lead to the result that 91.9% of all defect passenger cars will be inspected.

With year five as starting year for annual inspections the share increases to 95.1%.

What are the general findings:

- The ***Relation 3*** uses for the variable DefVeh as value 1. With that the results represents the number highest number of accidents, which can be avoided by inspecting all passenger cars, which have a technical defect. For Denmark the concrete number is 175.

(Relation 3)

$$5{,}859 \cdot 0.058 \cdot 0.6 \cdot \left(\frac{1{,}034{,}040 - 555{,}380}{555{,}380} \right) \cdot 1 = 175.35$$

- Further starting with the base case - that all vehicles older than seven years are inspected - it can be stated that an earlier start for annual inspection will lead to an **increasing number of avoidable accidents**. Increasing additional avoidable accidents means that as more of passenger cars are inspected, an additional number of avoidable accidents contributes more to the overall number of avoidable accidents.

8) Now, having the number of reduced accidents, it is possible to calculate the safety effects related to the annual inspection for passenger cars older than seven years. Denmark has a relation between number of accidents and road fatalities in the year 2003 of 0.064 fatalities per accidents. The relation for severe injuries is 0.581 severe injuries per accident. The relation for slight injuries is 0.665 slight injuries per accidents. These relations are different for each EU-Member States. The assumption is now that the values for the relations in 2003 can be used for the 2010 accidents, which means that the structural relation between

fatalities and accidents and between injuries and accidents will not be changed in the next years. Nevertheless, the country specific relations reflect the circumstances that due to important accident factors (e.g. quality of road infrastructure, average vehicle-speed, and driver-behavior) remarkable differences between the EU-Member States do exist. These special impacts are considered by using the specific relations.

The result for Denmark is that 148 accidents can be avoided with that the number of fatalities is lowered by 9. That means that 86 severe injuries can be avoided in 2010. The number of slight injuries, which can be avoided, is on average 98.

9) The monetary evaluation is the next step of the evaluation procedure. It is the multiplication of the quantitative figures (number of reduced fatalities, number of reduced severe injuries, number of reduced slight injuries) multiplied with the related cost-unit rate. The cost-unit rates are presented in table 1. For fatalities the cost-unit rate is 1 Million Euro, for serious injuries it is 135,000 Euro, and for slight injuries 15,000 Euro. The total safety benefits are 24 Million Euro.

10) The next benefit, which is calculated, are the congestion costs savings due to the avoiding of accidents. Therefore, the number of avoided accidents has to be multiplied with the congestion cost-unit rate, which is 10,000 Euro. Why 10,000 Euro? For crashes with fatalities on the European level, the assumed average congestion costs are 15,000 Euro. 5,000 Euro are the average cost-unit rate for the congestions due to accidents with personal injuries (ICF Consulting Ltd. 2003). The higher cost-unit rate for crashes with fatalities reflects that on average the duration of a fatality crash is higher than an average congestion by crashes with severe or slight injuries.

Unfortunately, there is no opportunity to split the accidents, which can be avoided in Denmark, into numbers of crashes with fatalities. The deglomeration of the avoided fatalities is not clear and obvious.

Therefore, the assumption is to use an average value. The average value is 10,000 Euro. The avoided congestions costs are: 148 accidents avoided multiplied with 10,000 Euro. The result is 1,48 Million Euro congestion cost savings.

11) For Denmark we have now 25.5 Million Euro benefits. The safety effect has a dominating share of 94.1%.

12) The number of additional inspected passenger cars is 478,660 vehicles. The used average cost-unit rate for inspections is 35 Euro per inspection. The result is that there are total inspection costs of 16.75 Million Euro.

13) The benefit-cost ratio for Denmark is with that 1.5 (base case).

2.4.2 Environmental Effects

The evaluation procedure for the possible emission savings follows the given methodological framework and empirical findings in WP 400.

It is only possible to estimate the effects for emission reductions for passenger cars with petrol exhaust.

As example, the emission savings for Italy are calculated:

1) Due to the annual inspection for passenger cars older than 7 years in Italy 9.6 Million passenger cars will be inspected additionally. The share of petrol cars on the total vehicle stock is 76.5 percent. That means that 7.3 million passenger cars of the 9.6 Million additional inspected vehicles use petrol.

2) The average vehicle-kilometer per passenger car is in Italy 10,190 km per year. Each EU-Member States has individual values. Therefore, in the overall analysis the country-specific values are used. Denmark has with 18,571 km per vehicle per year the highest value. Hungary has with 7,879 km per vehicle per year the lowest value. However, it is clear that passenger cars with petrol will have lower annual vehicle-kilometers per

year than diesel passenger cars. The available data makes it not possible to derive specific diesel and petrol vehicle-kilometer data for each European country.

3) The average vehicle-kilometers per year are multiplied with the additional inspected petrol passenger cars. For Italy, the inspected petrol passenger cars reach 74 billion km as total vehicle-kilometers per year.

4) To derive the quantities of NOx-, HC- and CO-emissions emission factors are used. The emission factor for NOx is 0.0845 g per km, for HC the emission factor has the value 0.0663 g per km, and the emission factor for C0 is 0.9808 g per km. The reduction which is reachable is a lowering of 6% of NOx-emission, 12% lowering of HC-emissions and 13% lowering of CO.

5) For Italy, we have in total savings of 377 tons of NOx-emissions, 592 tons of HC-emissions and 9,489 tons of CO-emissions.

6) The HC and CO-emissions are now transformed into NOx-units. The toxicity factor for HC is 1.5 and for CO the toxicity factor is 0.003. The result for Italy is savings of 1,294 tons of NOx-units.

7) The cost-unit rate for NOx-units is 365 Euro per ton. The result is 0.47 Million Euro emission costs can be saved for Italy.

8) The next step is to determine the CO_2-emission savings. The emission factor is 134.6389 g per km. In total, we have for Italy 20,040 tons of CO_2-emissions, which can be avoided. The cost-unit rate for CO_2-emissions is 63 Euro per ton. 1.3 Million Euro can be saved by CO_2-emission savings.

9) Fuel savings are also possible. The average fuel consumption is to be 8 liter per 100 km. The reduction potential is 2%. 12 Million liter can be saved. Using a fuel price of 0.3 Euro per liter the fuel savings are 3.6 Million Euro.

10) The total benefits for Italy by emission- and fuel savings are 5.3 Million Euro.

2.5 Results for the Safety and Environmental Impact

The main objective of this chapter is to give an overview over the traffic data, which is used for the quantification of the safety and environmental impact calculations. The focus is on the base case, which means that only traffic data for the countries of the base case is published (Denmark, Germany, Greece, Spain, France, Ireland, Italy, Czech Republic, Estonia, Lithuania, Hungary, Slovenia).

Obviously, the most important data for the assessment of safety and environmental impacts is the change in the number of inspected vehicles. The base case assumes that the annual inspection is introduced for vehicles older than seven years, which means that the annual inspection frequency will start with year 8.

The additional number of inspected vehicles depends mainly on the expected vehicle stock in 2010. The annual inspection starts with year 8. Therefore, it has to be determined how many passenger cars older than seven years are inspectted under the old inspection regime. This question can be solved only under the knowledge of the vehicle-age distribution. The best case might be to have the vehicle-age distribution, which is relevant for 2010. Unfortunately, a dynamic vehicle-stock development models is not available. However, a second-best case is possible, because with table 8 the vehicle-age distribution for the vehicle stock in 2004 is available. This distribution can be adapted for the year 2010. With that adaptation, it is possible to determine the number of inspected vehicles for passenger cars older than seven years presented in table 13.

Table 14 reflects the process of calculating the avoidable accidents as formalized with introduced ***Relation 1***, but with a slight different order to make the understanding of this calculation step easier. Therefore, ***Relation 4*** is:

(Relation 4)

$$Acc_{2010} \cdot TD \cdot DefVeh \cdot RED \cdot RAT = \text{Number of reduced accidents}$$

Column (1) is Acc_{2010}, the number of accidents of passenger cars in EU-Member States. The column (2) in table 14 represents the product of Acc_{2010} with TD. TD is the assumed share of technical defects, which is for the base case 5.8%. The column (3) is the product of data in column (2) multiplied with DefVeh, which reflects the percentage share how many of all defect passenger cars belong to the period with annual inspections. Each EU-Member State has a different value for DefVeh, because DefVeh depends on the vehicle-age structure (see table 8).

Column (4) in table 14 is the results of the values in column (3) multiplied with RED and RAT. RED is a constant, because RED is the empirical derived reduction ratio for the percentage share of accidents, which can be reduced by annual inspection. The value for RED is 0.6. Contrary to RED, RAT has for each EU-Member State a different value, because RAT reflects the percentage-change in the number of inspected passenger cars older than seven years.

Table 13: Vehicle Stock and Inspections under different Inspection Regimes

Relevant Member States		Vehicle Stock in 2010	Number of inspected Passenger Cars older than seven Years in 2010		Difference (2)-(1)
		Number of Passenger Cars (Million Vehicle)	Old Inspection Regime (1)	New Inspection Regime (2)	Additional inspected Passenger Cars
Denmark	DK	2.10	555,380	1,034,040	478.660
Germany	DE	47.10	10,804,740	23,766,660	12.961.920
Greece	EL	4.90	1,382,290	2,648,940	1.266.650
Spain	ES	22.30	10,918,080	11,984,020	1.065.940
France	FR	32.80	9,009,067	16,682,080	7.673.013
Ireland	IE	1.90	405,080	686,280	281.200
Italy	IT	36.90	10,506,660	20,066,220	9.559.560
Czech Republic	CZ	4.50	1,556,100	3,334,500	1.778.400
Estonia	EE	0.50	375,200	391,300	16.100
Lithuania	LT	1.40	497,257	978,740	481.483
Hungary	HU	3.30	922,680	1,865,160	942.480
Slovenia	SI	1.10	390,702	769,010	378.308
Total		**158.8**	**47,323,236**	**84,206,950**	**36,883,714**

Source: own calculations

Table 14: Estimation of avoidable Accidents in 2010

Relevant Member States		Total Number of Accidents in 2010 (1)	Number of Accidents caused by Technical Defects		Number of avoidable Accidents (4)
			All Passenger Cars (2)	Passenger Cars older than seven Years (3)	
Denmark	DK	5,859	340	286	148
Germany	DE	307,780	17,851	14,877	10.708
Greece	EL	13,674	793	690	379
Spain	ES	86,801	5,034	4,384	257
France	FR	78,322	4,543	3,815	1.950
Ireland	IE	5,196	301	213	89
Italy	IT	194,940	11,307	9,815	5.358
Czech Republic	CZ	23,717	1,376	1,328	911
Estonia	EE	1,676	97	93	2
Lithuania	LT	5,178	300	282	164
Hungary	HU	17,342	1,006	915	561
Slovenia	SI	10,136	588	553	321
Total		**750.622**	**43,536**	**37,250**	**20,847**

Source: own calculations

Table 15 shows that the avoided accidents are needed for the calculation of the avoided consequences of accidents. Obviously, the calculation of avoided fatalities, avoided severe injuries and avoided slight injuries is only possible, if there is any empirical relation available between the number of accidents and the related causalities of accidents. The needed empirical based relations, however, are given by table 6. Table 6 gives an overview over the accident, fatalities and injuries in 2003 for each EU-member State. With this table, it is possible to calculate country-specific ratios as follows: fatalities per accident, severe injuries per accident, and slight injuries per accidents. These ratios are used for table 15 to estimate how many fatalities and injuries can be avoided, if the change of the inspection regime leads to reduction of accidents.

These quantitative accident effects can be transformed in monetary value. Clearly, it is necessary for this step to use the European cost-unit rates for accident evaluation in Euro per accident. The cost-unit rates represent table 1.

Table 15: Safety Impact (avoided Consequences of Accidents)

Relevant Member States		Avoided Number of			
		Accidents	Fatalities	Severe Injuries	Slight Injuries
Denmark	DK	148	9	86	98
Germany	DE	10,708	200	2,590	11,369
Greece	EL	379	39	61	438
Spain	ES	257	14	70	317
France	FR	1,950	124	438	2,067
Ireland	IE	89	5	18	105
Italy	IT	5,358	134	1,058	6,497
Czech Republic	CZ	911	48	194	988
Estonia	EE	2	0	1	3
Lithuania	LT	164	20	33	167
Hungary	HU	561	37	123	625
Slovenia	SI	321	7	75	384
Total		**20,848**	**637**	**4,747**	**23,058**

Source: own calculations

The safety impact, indeed, seems to be the most important effect due to the changing of the inspection regime. However, additional number of inspected vehicles will also result in environmental savings. The basic vehicle data, which is needed for the calculation of the environmental impacts, is given in table 16.

Table 16: Base Vehicle Data for Calculation of Environmental Impact

Relevant Member States		Number of additional Inspected Passenger Cars	Share of Petrol Cars in %	Average Annual Vehicle-Kilometers per Passenger Car in km	Total Billion Vehicle-Kilometers of additional inspected Passenger cars with Petrol
Denmark	DK	478,660	92.6	18,571	8.2
Germany	DE	12,961,920	81.5	10,764	113.7
Greece	EL	1,266,650	77.7	10,204	10.0
Spain	ES	1,065,940	64.7	8,655	6.0
France	FR	7,673,013	56.9	13,140	57.4
Ireland	IE	281,200	86.0	10,000	2.4
Italy	IT	9,559,560	76.4	10,190	74.4
Czech Republic	CZ	1,778,400	84.3	8,667	13.0
Estonia	EE	16,100	85.8	12,000	0.2
Lithuania	LT	481,483	77.7	9,127	3.4
Hungary	HU	942,480	85.6	7,879	6.4
Slovenia	SI	378,308	77.7	9,091	2.7
Total		**36,883,714**	**--**	**--**	**297.8**

Source: own calculations

There is only empirical evidence on the reduction of emissions for passenger cars with petrol.[12] Therefore table 16 determined the number of additional passenger car with petrol by using the average share of petrol passenger cars of the total passenger car stock of each country. The result is the number of passenger cars with petrol. This number is multiplied with the average annual vehicle-kilometers per passenger car. The result of this multiplying is the total amount of vehicle-kilometers of additional inspected passenger cars with petrol. These passenger cars are relevant for the possible environmental savings. Using the total vehicle-kilometers of additional inspected petrol-cars allows, in a first step, to determine the reduction of NOx-, HC- and CO-emissions. As stated in WP 400, reduction factors and emission factor have to be applied to quantify the emission savings in tons. The toxicity factors for NOx, HC and CO make it possibility to transform all emissions in unity, which is named NOx-equivalent. The NOx-equivalents, hence, can be multiplied with the monetary cost-unit rate, which is represented in table 3.

Table 17: Impact Data for Calculation of Environmental Benefits

Relevant Member States		Reduction of Emissions in Tons			
		NOx	**HC**	**CO**	**NOx-Equivalent**
Denmark	DK	41.7	65.5	1,049.6	143,1
Germany	DE	576.5	904.7	14,499.0	1,977,1
Greece	EL	50.9	79.9	1,280.6	174,6
Spain	ES	30.3	47.5	761.1	103,8
France	FR	290.9	456.4	7,314.9	997,5
Ireland	IE	12.3	19.2	308.3	42,0
Italy	IT	377.3	592.1	9,488.9	1,293,9
Czech Republic	CZ	65.9	103.4	1,656.7	225,9
Estonia	EE	0.8	1.3	21.1	2,9
Lithuania	LT	17.3	27.2	435.4	59,4
Hungary	HU	32.2	50.6	810.5	110,5
Slovenia	SI	13.5	21.3	340.7	46,5
Total		**1,509.6**	**2,369.1**	**37,966.8**	**5,177.2**

Source: own calculations

12 BAST (Ed.)., Abgasuntersuchung – Erfolgskontrolle: Ottomotor – G-Kat, in: Berichte der Bundesanstalt für Straßenwesen, Fahrzeugtechnik, Heft F 37, Bergisch Gladbach 2001

Environmental savings, which are relevant too, are also the reduction of carbon dioxide and fuel reductions, whereby fuel reductions represents an important contribution to the general economic objective of resource savings. These effects are shown in table 18.

Table 18: Further Environmental Impacts

Relevant Member States		Carbon Dioxide Savings in Tons	Fuel Savings in Million Liter
Denmark	DK	2,217	1,3
Germany	DE	30,621	18,2
Greece	EL	2,704	1,6
Spain	ES	1,607	1,0
France	FR	15,448	9,2
Ireland	IE	651	0,4
Italy	IT	20,040	11,9
Czech Republic	CZ	3,499	2,1
Estonia	EE	45	0,0
Lithuania	LT	920	0,5
Hungary	HU	1,712	1,0
Slovenia	SI	720	0,4
Total		**80,183**	**47.6**

Source: own calculations

2.6 Cost-Benefit Results and Sensitivity Calculations

The **base case** for the CBA can be characterized as follows:

- annual inspection for passenger cars older than 7 years,
- annual accident reduction up to 2010 by 2 percent,
- 5.8 percent share of accidents caused by technical defects.

Beneath the “base case”, **minimum and maximum cases** are defined, which are only different to the base case in the share of accidents caused by technical defects. The minimum case uses as share of accidents caused by technical defects 2.5 percent. The share of accidents caused by technical defects for the maximum case is 9.1 percent.

The **safety benefits** for the base case are given by table 19. In total, the safety benefits amount to 2 billion Euro.

Table 19: Safety Benefits by Annual Inspection of Passenger Cars older than 7 Years (Base Case)

Relevant Member States		Safety Benefits in Million Euro per Year due to				
		Reduction of Fatalities	Reduction of Severe Injuries	Reduction of Slight Injuries	Congestion Cost-Savings	Total
Denmark	DK	9.55	12.44	2.46	1.48	25.93
Germany	DE	201.73	375.49	284.23	107.08	968.53
Greece	EL	39.02	8.90	10.94	3.79	62.65
Spain	ES	14.01	10.18	7.92	2.57	34.68
France	FR	125.08	63.49	51.68	19.50	259.75
Ireland	IE	5.01	2.56	2.62	0.89	11.08
Italy	IT	135.56	153.37	162.43	53.58	504.94
Czech Republic	CZ	48.71	28.08	24.69	9.11	110.59
Estonia	EE	0.20	0.07	0.07	0.02	0.36
Lithuania	LT	19.70	4.75	4.18	1.64	30.27
Hungary	HU	37.60	17.77	15.63	5.61	76.61
Slovenia	SI	6.72	10.92	9.61	3.21	30.46
Total		**642.89**	**688.02**	**576.46**	**208.48**	**2115.85**

Source: own calculation

The **annual accident reduction** and **starting year of the annual inspection** are identified as critical variables. Therefore, two **sensitivity analyses** are undertaken:

- possible accident developments,
- different starting years for annual inspection.

The following table 20 represents the results for the minimum case, base case and the maximum case for **three possible accident developments**:

- accidents will be reduced until 2010 by 2% per year (=base case),
- accidents will not be reduced (=0% reduction per year),
- accidents will be reduced by 5% per year.

Table 20: Safety Benefits for different Reduction Paths of Accidents

Accident Reduction / Share of Technical Defects	Accident Reduction by 0% per year	Accident Reduction by 2% per year	Accident Reduction by 5% per year
Minimum Case	1,050 Mill. Euro	912 Mill. Euro	734 Mill. Euro
Base Case	2,437 Mill. Euro	2,116 Mill. Euro	1,702 Mill. Euro
Maximum Case	3,826 Mill. Euro	3,325 Mill. Euro	2,672 Mill. Euro

Source: own calculation

The influence of **different starting years** for the annual inspection is tested for the case that the accident reduction is 2% per year. Conceptually, the earlier the annual inspection starts the larger the benefits, which can be realized. This is also reflected in the following table 21. It shows that the benefits grow when the start of annual inspection is shifted towards a lower vehicle age. On the other hand, it is clear that this change is connected with higher total inspection costs.

Table 21: Sensitivity-Analyses for different Starting Years for Annual Inspection (Base Case)

	Starting Year 8	Starting Year 7	Starting Year 6	Starting Year 5
Benefits	2,116 Mill. Euro	2,217 Mill. Euro	2,319 Mill. Euro	2,507 Mill. Euro
Number of additional inspected passenger cars per year	36.8 Mill. vehicles	42.6 Mill. vehicles	45.9 Mill. vehicles	54.1 Mill. vehicles
Benefits per additional inspected car	58 Euro	52 Euro	51 Euro	46 Euro

Source: own calculation

Beside the safety benefits, the **environmental effects** have to be considered. The environmental benefits consist of reduction of CO-, HC- and NOx-emissions, reduction of carbon dioxide and fuel consumption savings. Table 22 gives an overview over the safety benefits, other benefits and total benefits. The result is that the safety benefits are the most important benefits. Environmental savings do exist, but they only play a minor role.

Table 22: Safety, other and total Benefits in Million Euro per Year (Base Case)

	Benefits in Million Euro		Total Benefits
	Safety Benefits	Other Benefits (Emission, CO2-Emission, Fuel Consumption)	
Denmark	25.93	0.60	26.53
Germany	968.53	8.34	976.87
Greece	62.65	0.74	63.39
Spain	34.68	0.44	35.12
France	259.75	4.21	263.96
Ireland	11.08	0.18	11.26
Italy	504.94	5.46	510.40
Czech Republic	110.59	0.95	111.54
Estonia	0.36	0.01	0.37
Lithuania	30.27	0.27	30.54
Hungary	76.61	0.47	77.08
Slovenia	30.46	0.20	30.66
Total	2,115.85	21.86	2137.71

Source: own calculation

The total benefits for the introduction of annual inspections for passenger cars older than seven years are 2.1 billion Euro, which represents an amount equal to a one percent reduction of external costs of road traffic in EU-15. The total costs, which have to be confronted with the benefits, are the product between additional number of inspected vehicles and the average cost-unit rate for passenger car inspection. The average cost-unit rate for passenger car inspections is 35 Euro per passenger car without any taxes. The total costs are 1.3 billion Euro. The benefit-cost ratio is 1.6 for the base case.

However, the structural underestimation of the accident number in the official accident database has to be considered (see section 1.5). Applying the values as given by the ICF-Study means that the benefits have to be multiplied with the factor 1.3.[13] This adjustment is widely accepted, and it is justified until the data problems in the European accident statistics are solved. However, the adjustment leads to the **final benefit-cost-ratio of 2.1**, which demonstrates that a change in the frequency of inspections of passenger cars is highly beneficial from a societal point of view.

Each additional Euro spend for the introduction of annual inspection for passenger cars older than seven years lead to an overall economic benefit of about 2 Euro. Therefore, the change in the inspection frequency is justified.

Furthermore, it has to be seen, that due to empirical lacks it was not possible to calculate all relevant benefits. That leads to the conclusion that the actual amount of benefits should be certainly higher. However, these benefits could not be calculated because of missing empirical data. It also serve to illustrate the range of issues for future cost-benefit analyses of roadworthiness measures.

[13] ICF Consulting, Cost-Benefit Analysis of Road Safety Improvements, London 2003

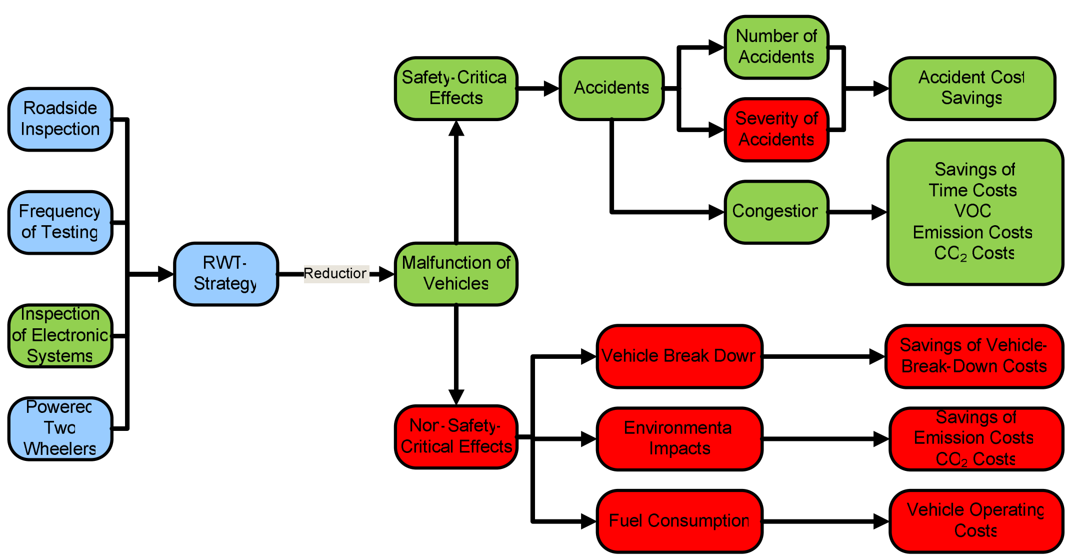
3. Additional Inspection of New Electronic Vehicle Components

3.1 Scope of the measure

Electronic systems become more and more widespread within the vehicle fleet. With that, it becomes necessary to guarantee that the benefits, which result from the application of electronic systems, remain during the lifetime of the vehicle. A pilot measure is the inclusion of electronic systems in periodic testing which is applied in Germany since April 2006. The most prominent examples among the tested systems are Anti-lock braking system, airbags, cruise control and ESP. Since ESP represents a system with an advanced market penetration and evident safety impacts, it is applied in this case study as representative for the complete group of electronic systems.

Figure 6 shows in green color the benefits that can be calculated at the current stage of knowledge for the additional inspection of ESP.

Figure 6: Applied Impact Channels for the Cost-Benefit Analysis of ESP Inspection



Source: own presentation

3.2 Calculation Procedure for Testing of Electronic Systems

3.2.1 Benefits of Inspecting ESP

The following calculations make use of a recent study on the benefits of ESP. The study was conducted by Baum and Grawenhoff.[14] This study summarizes the evidence on the safety impact of ESP and calculates safety benefits from that base. The applied impact channels are the number of accidents and congestion. Hence, the benefit calculations consider the reduction of fatalities and injuries, the reduction of property damage for accidents with injuries and the reduction of accident caused congestion.

The study leads to the following key results under the assumption ESP is fully applied in the car fleet of EU-25:

- about 4,000 fatalities per year can be avoided,
- about 100,000 (severe and slight) injuries per year can be avoided,
- the resulting benefits – composed of the effects above mentioned - amount to approximately 10 bill. EUR per year.

The benefits of 10 bill. EUR represent the number upon which the following calculation of the inspection benefits is based. The following assumptions are applied here:

- ESP will not function properly in 7% of all passenger cars. That means 0.7 Billion Euro benefits cannot be reached.
- The car stock used in this study is 212.496 Million cars in the year 2003 for EU-25.
- On average in the EU-25 with the current inspection regime 41% of the passenger cars are inspected.
- The additional inspection of ESP leads to an assumed detection ratio of 80%, which is based on empirical testing inspections in Germany.

---

14 Baum, H., Grawenhoff, S., Cost-Benefit-Analysis of the Electronic Stability Program (ESP), Cologne 2006.

That means that 230 Million Euro of ESP benefits can be recovered by additional inspection of ESP during the obligatory vehicle inspection procedure.

3.2.2 Costs of Inspecting ESP

The **costs of the additional inspection of ESP** can be calculated as follows: The hardware (e.g. Bosch KTS 520), which is necessary to perform the test, costs 2000 Euro. The average lifetime of this hardware is 5 years. From this follows that the hardware costs have to be spread over 5 years. The yearly costs can be calculated by the annuity method.

The calculation of the yearly costs is as follows:

$$\text{Annual Costs} = \text{Investment Costs} \cdot \frac{i \cdot (1+i)^n}{(1+i)^n - 1}$$

With:

i:= interest rate

n:= economic lifetime, here 5 years.

The interest rate is determined with 3%. The resulting yearly costs are 437 Euro. Now we need the total average costs of the yearly hardware costs. It is assumed that 25 test per day can be performed. The number of working days per year is 200 days. That means with one hardware component 5,000 tests can be performed per year. The total annual average hardware costs per test are 0.087 Euro per test. The assumption for the additional labor costs is 0.80 Euro per test. The total costs per test are near to one Euro. The additional inspection costs are 87.1 Million Euro.

3.3 Benefit-Cost Results

Based on the expected total amount of ESP benefits for an 100% equipment of passenger cars with this system, it can be expected that 230 Million € benefits can be reached due to the fact that system failures of ESP can be avoided by making the inspection of ESP to an obligatory element of periodical vehicle inspection. The costs coming up from the additional inspection effort are 87.1 Million €. The benefit-cost ratio for the additional testing of ESP is 2.6.

4. Roadside Inspections

The third option, which is considered for roadworthiness enforcement, is to increase the number of roadside inspected heavy good vehicles. Council Directive 2000/30/EC specifies the content and minimum number of roadside checks on the mechanical condition of commercial road vehicles. Relevant for roadside inspection might be also Directive 95/50/EC specifying roadside checks for vehicles carrying dangerous goods.

The existing experience and country-specific checks of heavy good vehicles indicates that there is a substantial lack of compliance with the above-mentioned Directives. Therefore, it can be expected that an increase of the number of roadside inspections will give a significant improvement to the safety situation of commercial vehicles.

The economic assessment has to consider that roadside inspection will have not only safety effects related to the technical condition of the vehicle. The roadside inspection will not only focus on the vehicle condition, but also on the inspection of maximum driving hours and rest periods. Therefore, further Council regulations (for example 561/2006/'EC in connection with 3820/85/EC and 3821/85/EC: specifying requirements for maximum driving hours and rest periods; regulation on recording equipment in road transport and on requirements for construction, testing, installation and inspection of digital tachographs) have to be considered, because additional economic benefits can be expected by inspection these special items.

Nevertheless, the main relevant effect caused by roadside inspection is the safety effect. Safety effect means that the number of accident can be reduced. With that, the number of fatalities, severe and slight injuries and the number of congestion due to truck accidents are lowered. Unfortunately, cause-effect relations between number of roadside inspections and reduction of accidents, reduction of fatalities and injuries are only available for the United States. The available data from the Federal Motor Carrier Safety Administration indicates following relations:[15]

- one inspected truck leads to reduction of 0.0053 accidents,
- one inspected truck avoids 0.0004 fatalities,
- one inspected truck avoids 0.0036 injuries (severe and slight injuries together).

However, this data record does not match to the European conditions in terms of inspection content, inspection intensity and further in terms of general vehicle and traffic conditions. Performing a cost-benefit analysis for roadside inspection based on the US data, which is critical from an European standpoint, means to obliterate the cost-benefit results for the first two options.

Indeed, there is a strong need to come up with empirical results for the European effectiveness of roadside inspections. Therefore, it is necessary to enforce the research on the causation between roadside inspections and safety effects. The available data of current roadside inspection has a structural deficit because it not representative and with that it has no empirical evidence.

5. Inspection for Powered Two Wheelers

The fourth option, which is considered for roadworthiness enforcement, is to apply the periodic testing regime also to Powered Two Wheelers (PTW, i.e. mopeds and motorcycles). Actually, this is already the case in several member states. As WP 530 reports, twelve member states test motorcycles periodically while only a few countries (Great Britain, Spain, Czech Republic, Slovenia) include mopeds into periodic testing. The remaining countries do not practice periodic testing for PTW or there is no information about the testing available.

---

[15] Federal Motor Carrier Safety Administration (Ed.), FMCSA Safety Program Performance Measures, Intervention Model: Roadside Inspection and Traffic Enforcement Effectiveness Assessment, Washington D.C. 2002; Federal Motor Carrier Safety Administration (Ed.), FMCSA Safety Program Effectiveness Measurement: Intervention Model: Roadside Inspection and Traffic Enforcement Effectiveness Annual Report for 2001, 2002 and 2003, Washington D.C. 2004; Federal Motor Carrier Safety Administration (Ed.), How Effective are Roadside Inspections and Traffic Enforcements?, Washington, D.C. 2005

PTW inspection appears to be a feasible approach to improve the safety performance of mopeds and motorcycles. Obviously, powered two wheelers are exposed to significantly higher accident risks than other vehicle groups. The fatality risk of motorcycle riders – expressed in fatalities per billion vehicle-kilometers – is about five times higher than the fatality risk of passenger car drivers. Concerning periodic testing, it is important which share of PTW accidents is due to technical defects. Evidence is given by MAIDS (Motorcycle Accidents In-Depth Study, http://maids.acembike.org/). Technical defects account for 5.1% of all accidents, most of them related to tire or wheel problems. The share of 5.1% is comparable to the base case value of technical defects for passenger cars (5.8%). Besides that, empirical findings from Germany suggest even higher shares. It is reported that 13% of the motorcycles and 30% of the mopeds exhibit accident causing technical defects.

Although there is evidence on the share of technical defects, the WP partners do not recommend a cost-benefit analysis on PTW at the current state of knowledge. This judgment is mainly based on the substantial data gaps. For quite a number of member states information on traffic performance (vehicle-km) of powered two wheelers is not available. This makes it difficult for motorcycles and at least impossible for mopeds to undertake a cost-benefit analysis, which comes up with credible results. On the other hand, PTW inspection might represent a favorable measure in the context of roadworthiness enforcement. Therefore, we recommend this option for further investigation when data that is more reliable is available.

6. References

Aral Kraftstoffpreis-Datenbank, www.aral.de, December 2005

Arbeitsgruppe "§29/§47a StVZO", Überprüfung der Untersuchungsfristen (§29 in Verbindung mit Anlage VIII StVZO), Berlin 2002

ARCOS (Action de recherche pour une conduite sécurisée), Paris 2005, www.arcos2004.com

BAST (Ed.), Abgasuntersuchung Dieselfahrzeuge, Berichte der Bundesanstalt für Straßenwesen, Heft F41, Bergisch Gladbach 2003

BAST (Ed.)., Abgasuntersuchung – Erfolgskontrolle: Ottomotor – G-Kat, in: Berichte der Bundesanstalt für Straßenwesen, Fahrzeugtechnik, Heft F 37, Bergisch Gladbach 2001

Baum, H., Grawenhoff, S., Cost-Benefit-Analysis of the Electronic Stability Program (ESP), Cologne 2006.

Bilprovningen (Ed.), own empirical research 2006

Care-Database, Brussels 2006

Cita (Ed.) Annual Questionnaire of Members, Brussels 2006

CITA (Ed.), General Questionnaire 2004, Brussels 2005

DEKRA Automobil GmbH (Ed.), International Strategies for Accident Prevention, Technical Road Safety – DEKRA Technical Paper 58/05, Stuttgart 2005, p. 21

Department for Transport UK, Highways Economics Note No. 1 – London 2001

European Commission, Directorate-General for Energy and Transport, Energy and Transport in Figures 2005, Part 3: Transport, Brussels 2006

European Commission, Proposal for a Directive of the European Parliament and of the Council Amending Directive 1999/62/EC on the Charging of Heavy Goods Vehicles for the Use of certain Infrastructure, Bruxelles 2003

Federal Motor Carrier Safety Administration (Ed.), FMCSA Safety Program Performance Measures, Intervention Model: Roadside Inspection and Traffic Enforcement Effectiveness Assessment, Washington D.C. 2002

Federal Motor Carrier Safety Administration (Ed.), FMCSA Safety Program Effectiveness Measurement: Intervention Model: Roadside Inspection and Traffic Enforcement Effectiveness Annual Report for 2001, 2002 and 2003, Washington D.C. 2004

Federal Motor Carrier Safety Administration (Ed.), How Effective are Roadside Inspections and Traffic Enforcements?, Washington, D.C. 2005

Hoehnscheid, K.J., Straube, M., Volkswirtschaftliche Kosten durch Straßenverkehrsunfälle in Deutschland 2000, Wissenschaftliche Informationen der Bundesanstalt für Straßenwesen, Info 12/02

ICF Consulting, Cost-Benefit Analysis of Road Safety Improvements, London 2003

MAIDS (Motorcycle Accidents In-Depth Study, http://maids.acembike.org/)

OECD Economic Outlook, No. 77, Paris 2005, p. 157

ProgTrans AG, European Transport Report 2004, Basel 2004

Strelow, H., Statistics in Focus: Transport, edited by Eurostat and European Communities, data extracted on: 24.07.2006, Luxembourg 2006

The Swedish State Institute for Communication Analysis, Översyn av samhälls-ekonomiska kalkylpriciper och kalkylvärden på transport-området, SIKA Report 1999:6, Stockholm 1999

U.S. Department of Transportation, The Economic Costs of Motor Vehicle Crashes 2000, NHTSA Technical report, Washington DC 2002