CONTRIBUTION OF PERDIODIC MOTOR VEHICLE INSPECTION (PMVI) TO VEHICLE SAFETY 2012.

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CONTENTS

1. PROJECT FRAMEWORK AND GOALS.

Transportation has become one of the main activities for economical and social development. Mobility plays an important role not only in citizen's life quality, as it allows citizens to move freely around the country, but also in terms of the economic activity as part of the overall market. Transportation enables economic growth and creation of new jobs, having to be sustainable in light of new challenges. The transportation sector represents an important part of the economic activity: in the European Union (EU) it provides a direct job to nearly 10 million people, which represents 5% of the GDP.

However, European transport is at the crossroads. On top of the previous problems of European transportation, new ones arise.

To complete the internal transportation market where there is still important bottlenecks and obstacles, there is a long way ahead to cover. The following question arises: How to meet citizen's wish to travel and the economic need of freight transportation and at the same time anticipate environmental and source limits?

Oil will become scarce in the next decades and it will be frequently obtained from unstable sources. As mentioned recently by the International Energy Agency (IEA) the lower the worldwide success of «decarburizing», the bigger the increase in oil prices. In 2010 the total oil import of the EU almost reached 210.000 million Euros. If oil dependency is not corrected not only travelling but also economic safety could be dramatically influenced, with fatal consequences for inflation, trade balance and global competitiveness.

At the same time the EU has made a call, which the international community has heard, regarding the need to drastically reduce greenhouse emissions (GE) to limit climate change to less than 2ºC. Globally, in order to achieve this aim, the EU needs to reduce the levels of emissions of the 1990's in 80-95%. This reduction must be achieved before 2050 in the context of emission reduction policies of the developed countries. The analysis of the European Commission shows that although stronger reductions may be achieved in other sectors, transportation sector, which is an important source of GE in rise, must reduce at least 60% of the GE by 2050, with respect to the 1990 levels. For 2030 the aim is to reduce GE around 20% below the 2008 levels. Given the significant increase of emissions coming from transportation during the last two decades, this would place the emission levels 8% above the 1990 levels.

Since the first oil crisis 40 years ago, and despite the technological progress, the potential improvement of the profitable energetic efficiency and the political commitment, the transportation system has not essentially changed. Transportation has become more efficient from an energetic point of view, but the transport in the EU still depends on oil and oil derived products to cover 96% of the energy needs. Transport has become less pollutant but due to its volume it is an important source of noise and local environmental pollution. Current transportation system is not sustainable. In the long run, thinking in the next 40 years, transportation cannot continue to develop in the current terms. If we follow the business as usual (BaU) approach, transportation oil dependency could be less than 90% with renewable energy sources that could overcome the marginal target of 10% established for 2020. For 2050, CO_2 emissions from transportation would still remain one third above the 1990 levels. Congestion costs will increase in nearly 50% for 2050. There will be a severe unbalance in accessibility between central and peripheral areas and social costs arising from accidents and noise will also increase.

Although the number of fatalities in road accidents in the EU has reduced in almost half in the previous decade, there were 34.500 mortal victims in 2009. Innovations in the technology field, education and paying special attention to vulnerable road users will play a key role to reduce even more the losses of human lives.

The challenge is to break the dependency of oil in transportation without scarifying its efficiency and compromising mobility. New technologies applied in vehicle systems and traffic regulation is of paramount importance to reduce this effect not only in the EU but also in the rest of the world.

In practice, transport must use less energy and must be cleaner. In addition, it must be able to better exploit facilities and modern vehicles and reduce environmental impact preserving the key natural values of water, land and ecosystems.

In the cities, the shift to a cleaner transport is facilitated by a reduced need of vehicle autonomy and higher demographic density. In addition, there is a great availability of public transport and the possibility to walk or cycle around the city. Cities suffer from traffic congestion, poor air quality and noise exposure. Urban transport is responsible of nearly one fourth of the CO_2 emissions from transport and 69% of the accidents take place in the cities. A key contribution, to significantly reduce oil dependency, is progressive removal of conventional internal combustion engine (ICE) vehicles. Additional benefits would be a reduction in GE, local environmental pollution and noise emission. However, an appropriate infrastructure should be available for the new vehicle in order to charge batteries or refuel.

The interface between long distance freight transport and transport «last mile» must be organized in the most efficient way. The aim is to limit the number of individual deliveries, the most «inefficient» path, to the shortest route. Usage of Intelligent Transport Systems (ITS) contributes to traffic management in real time, thus, reducing lead times and congestion for the last mile delivery. This could be done with low carbon emission urban vans. Using electricity, hydrogen and hybrid technologies not only reduces atmospheric emissions but also noise emissions, allowing freight transport to take place during the night. This would reduce traffic congestion in cities and highways during morning and evening peak hours.

The “WHITE BOOK: Roadmap to a single European Transport policy for a competitive and sustainable transport” from the EUROPEAN COMMISSION establishes ten goals for a competitive and sustainable transport system, between which it is worth highlighting, in the context of road transport:

(1) *“For 2030 reduce to halve the usage of vehicles with «conventional propulsion» in the cities; progressive elimination in the cities for 2050; achieve by 2030 that the main cities do not have emissions of CO_2”.*

(2) *“From here to 2050, achieve the goal of «zero fatalities» in road transport. Attending to this, the EU goal is to reduce to halve the number of road victims for 2020. EU will be established as the leader in road safety and protection in every mode of transport”.*

In order to achieve the previous aims a revision of the current road freight transport, and the degree of convergence regarding, among other things, the fees for the usage of infrastructure, social legislation and safety the incorporation of European legislation into national law of the Member States and their application by them, with a view to further market opening road transport

In this context vehicle inspection is essential for road safety. The European Commission has adopted new measures to reinforce the inspection and expand its reach, as more than five people die each day in the European roads in accidents caused by technical faults.

It has been demonstrated that technical faults in vehicles strongly contribute to accidents. The cause of 6% of passenger vehicle accidents is due to vehicle faults, which represents 2.000 mortal victims. Regarding, motorbikes this proportion builds up to 8%.

The main problem is that there are too many vehicles with technical faults in the roads. Results from recent studies done in UK and Germany show that up to 10% of the passenger vehicles suffer from a fault that would result in vehicle inspection rejection. In addition, several safety vehicle systems are not checked under current inspection standards, such as, the anti-lock brake system (ABS) or the vehicle stability control.

Current regulations from the EU establish minimum standards for vehicle inspection since 1977 and have only undergone minor updates. However, vehicles, technology and driver behavior has gone through a deep change since then.

The main points of the new standard proposal are:

(1) Mandatory inspection along the EU for moped and motorbikes (it is already compulsory in Spain). Their drivers, particularly the young people, are among all the road users, the highest risk group.

(2) Increase the inspection frequency for the oldest vehicles. The number of serious accidents caused by a technical vehicle fault dramatically increases between the fifth and sixth year.

(3) Increase the inspection frequency for passenger vehicles and vans with an exceptionally high mileage. Both types of vehicles would match other high

mileage vehicles such as taxis and ambulances.

(4) Increase the quality of the vehicle inspections establishing common minimum standards for the different vehicle faults, for the technical equipment and for inspectors.

(5) Establish a mandatory control of vehicle electronic safety systems

(6) Control and identification of fraud odometer tampering by establishing recorded odometer readings.

(7) In every case, the proposal provides common minimum standards for vehicle inspection for the EU. The Member States may go beyond these standards.

The main aim of the present work is to analyze contribution of the Periodic Motor Vehicle Inspection (PMVI) in terms of the vehicle safety and environmental impact. This report has updated results from the 2007 report "Contribution of Periodic Motor Vehicle Inspection (PMVI) to Vehicle Safety" to show the impact and contribution of the PMVI in accidents. This report includes motorbikes, moped and light commercial vans and trucks for freight transport highlighting inspection sections and defects, as well as evolution and challenges of PMVI. This report is motivated by the increasing concern in vehicle safety in Spain as well as the need to raise awareness of the importance of PMVI and highlight the challenges of PMVI that will have to meet the European transport sector in the coming years.

Therefore, the aim of this report is to show in terms of Scientific Evidence, thus, based on objective data, contribution of PMVI to vehicle road safety in Spain and technological challenges of PMVI.

This report has been directed by the Research Institute of Vehicle Safety (ISVA) from Carlos III University of Madrid and developed by an expert group in the field.

2. CONTEXT OF THE TECHNICAL INSPECTION OF VEHICLES IN THE EU.

Current regulations in the EU that influence technical vehicle inspection go back to 1977, and from then on only small updates have taken place. EU regulation in vehicle inspection is divided in three main legislation aspects:

- Directive CE establishes a set of minimum standards for periodic motor vehicle inspection (regular control of vehicles prescribed by law). The Directive is applied to passenger vehicles, busses and heavy duty freight vehicles and trailers, but not to moped or motorbikes.

- Directive 2000/30/CE, that complements Directive 2009/40/CE , requires that the technical condition of commercial vehicles is controlled with ordinary technical inspections (technical inspections in road). This Directive establishes additional on-site controls for commercial vehicles.

- Directive 1999/37/CE, regarding vehicle registration regulates emission of registration certificates, its minimum harmonized content and the requirements for mutual recognition.

2.1.- Directive 2009/40/CE.

Directive 2009/40/CE of the European Parliament and Council on May 6th 2009 regarding motor vehicle technical inspection and its trailers, repeals the previous Directive 96/96/CE, from December 20th 1996.

Directive 2009/40/CE establishes minimum standards for periodic motor vehicle inspection: which are periodic controls dictated by law. This Directive is applied for passenger vehicles, busses, heavy vehicles and trailers but not moped or motorbikes.

On July 5th 2010, Directive 2010/48/EU was published and adapts technical progress of Directive 2009/40/CE of the European Parliament and Council regarding motor vehicle and trailer inspection. The aim of the Directive is to try to guarantee that vehicles are subjected to maintenance and inspected to increase road safety and environmental protection. In addition, Directive 2010/48/EU updates Directive 2009/40/CE in terms of vehicle technological progress in order to improve EU motor vehicle inspection. Projects Autofore and Idelsy that deals with future in technical inspection, has played a key role in Directive 2010/48 /EU.

Therefore, Directive 2010/48/EU improves, between others, the following contents of Directive 2009/40/CE:

(1) Given the current state of the art vehicle technology, modern electronic vehicle systems must be part of vehicle inspection.
(2) To improve vehicle inspection harmonization, several test methods for each inspection section are defined.
(3) To provide harmonization and attending to standard coherence reasons a non

exhaustive list of the main reasons for non-approval is established.

(4) Due to the fact that PMVI must cover all of the relevant points for the design, construction and the specific equipment for the inspected vehicle, specific requirements for certain categories of vehicles are set.

(5) The Member States extended the obligation of periodic motor vehicle inspection to other vehicle categories attending to article 5, script e) of Directive 2009/40/CE. To improve inspection, harmonization methods and standards for those vehicle categories are established. Vehicle inspection must be developed using techniques and equipment available today. Vehicle inspection cannot be done using tools to remove or dismantle vehicle components.

(6) Vehicle inspection not only has to cover active or passive safety and environmental protection issues, but must also guarantee that inspection standards and methods are the correct ones, being able to apply other legal requirements.

(7) To improve periodic motor vehicle inspection procedure, inspection results must be shown in the inspection certificate, which must also include the main inspected sections.

Currently, the European Commission is working on a new regulation proposal that repeals Directive 2009/40/CE. The contents of the proposal are:

1. Regarding moped and motorbike inspection.

Motorcyclists are the road users with the highest risk in terms of road safety. Even though the trend is an overall decrease of the number of mortal victims, motorcyclists represent more than 4.500 mortal victims per year. An 8% of the accidents of motorbikes are caused by technical faults or are related to them.

Moped drivers are overrepresented in the number of mortal victims: more than 1.400. Five hundred of these victims were young, between 14 and 21 years old. More than 25.000 moped drivers suffered from serious injuries and nearly 9.000 of them were young people between 14 and 21 years old.

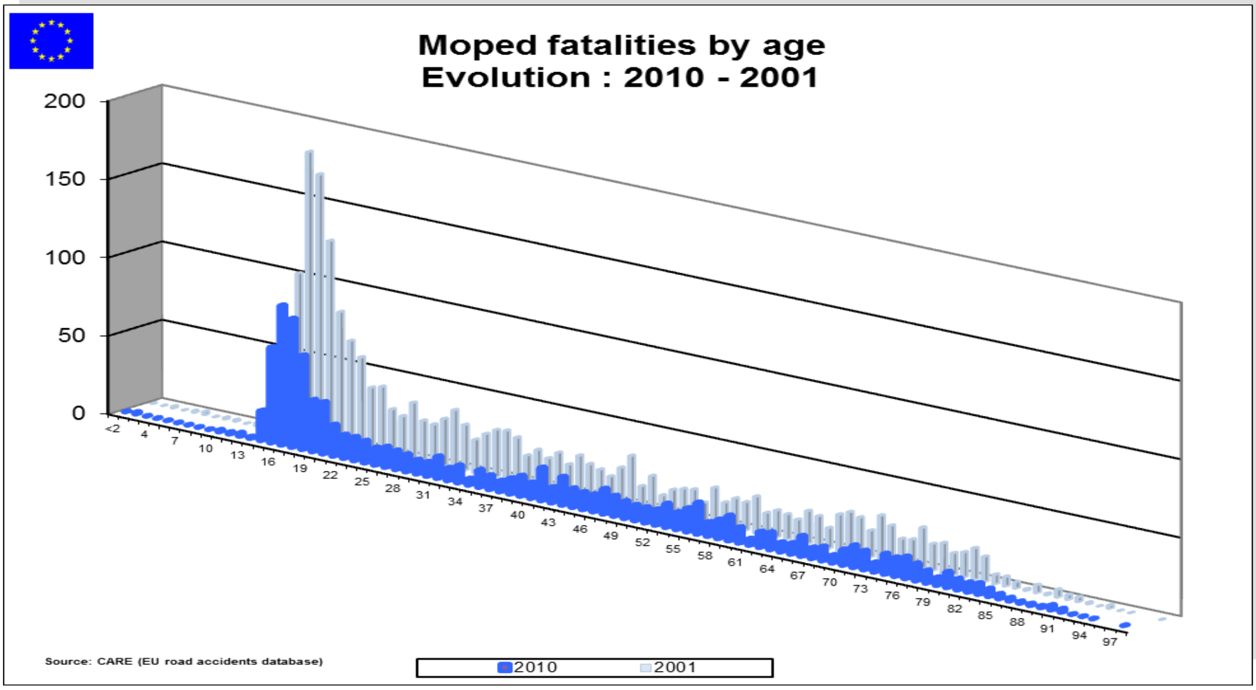

Figure 1. Moped fatalities by age for 2001 and 2010

Therefore, vehicle inspection must be extended to other vehicle categories with a higher road risk, thus, to motor vehicles of two or three wheels (**motorbikes and moped**) and **light trailers** (which weight less than 3,5 tons). Nowadays, both vehicle categories are exempt of the obligations imposed by EU legislation.

In addition, the proposal establishes the limits of the inspection exemptions that the Member States may provide to certain vehicle categories, such as, agricultural vehicles and certain vehicles with a maximum nominal speed of 40 km/h and that are not used for travelling between EU countries.

These exemptions also include vehicles with a historic interest, which have been precisely defined.

2. Regarding technical inspection of older vehicles.

It has been observed a clear correlation between accident severity and vehicle age. An empiric observation proves that between the fifth and sixth year the number of serious accidents (with mortal victims) related with technical faults substantially increases.

The challenge is to offer a suitable technical inspection for the oldest vehicles.

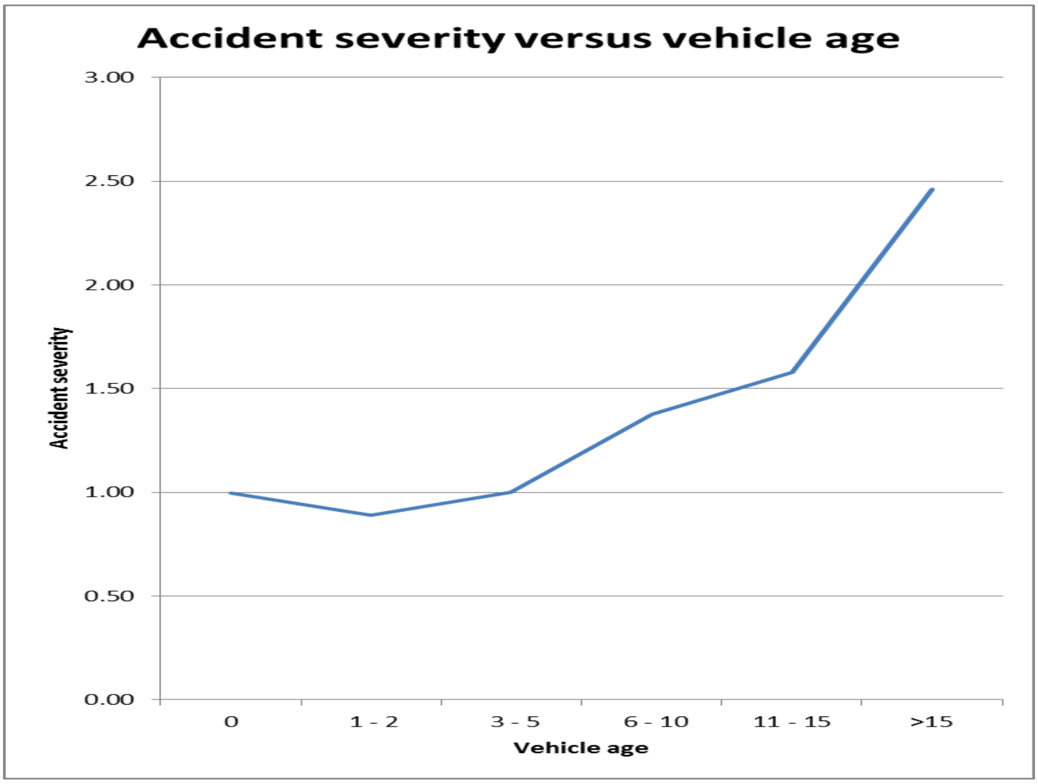

Figure 2. Accident severity versus vehicle age

The aim is to provide a suitable technical inspection for vehicles over six years.

Regarding inspection frequency two aspects must be considered: vehicle age and annual mileage. Therefore, frequency inspection of older vehicles is increased and vehicles with a higher mileage will undergo annual inspections, like in taxis and ambulances.

For some of the vehicle categories, current frequency periodic inspections are considered to be too low to guarantee lack of defects. The proposal is to increase the current standard frequency inspection for three vehicle categories.

- **Passenger cars:** First inspection after 4 years, second after 2 years and afterwards annually. Frequency inspection has shifted from current standard 4-2-2 to a frequency of 4-2-1.
- **Passenger vehicles and light commercial vehicles up to 3,5 tons** that, in the date of first inspection (after 4 years), have achieved a mileage over 160.000 km will undergo annual inspection after the first one. Inspection frequency has shifted from current standard 4-2-2 to 4-2-1.

Table 1. Changes attending to the different countries

New vehicles inspection 4 - 2 - 1 and changes for particular owners			
	Current frequency of inspections*		
Member State	**Passenger cars**	**Motorbikes and mopeds**	**Changes for particular owners**
Austria	3 - 2 - 1	1 - 1 - 1	No changes.
Belgium	4 - 1 - 1	They are not inspected	No changes for passenger cars. Motorbikes and mopeds inspection are introduced.
Bulgaria	3 - 2 - 1	They are not inspected	No changes for passenger cars. Motorbikes and mopeds inspection are introduced.
Cyprus	4 - 2 - 2	They are not inspected	The oldest passenger cars will be inspected annually. Motorbikes and mopeds inspection are introduced.
Czech Republic	4 - 2 - 2	4 - 2 - 2	The oldest passenger cars will be inspected annually. The oldest motorbikes and mopeds will be inspected annually.
Denmark	4 - 2 - 2	4 - 2 - 2	The oldest passenger cars will be inspected annually. The oldest motorbikes and mopeds will be inspected annually.
Estonia	3 - 2 - 2 - 2- 1	3 - 2 - 2 - 2- 1	The passenger cars, motorbikes and mopeds inspections will be annually from the sixth year (but not from the tenth as nowadays).
Finland	3 - 2 - 1	They are not inspected	No changes for passenger cars. Motorbikes and mopeds inspection are introduced.
France	4 - 2 - 2	They are not inspected	The oldest passenger cars will be inspected annually. Motorbikes and mopeds inspection are introduced.
Germany	3 - 2 - 2	2 - 2 - 2	The oldest passenger cars will be inspected annually. The oldest motorbikes and mopeds will be inspected annually.

Greece	4 - 2 - 2	They are not inspected	The oldest passenger cars will be inspected annually. Motorbikes and mopeds inspection are introduced.
Hungary	4 - 3 - 2 - 2	3 - 3 - 2 – 2°⁾	The oldest passenger cars will be inspected annually. The oldest motorbikes will be inspected annually and mopeds inspection is introduced.
Ireland	4 - 2 - 2	They are not inspected	The oldest passenger cars will be inspected annually. Motorbikes and mopeds inspection are introduced.
Italy	4 - 2 - 2	4 - 2 - 2	The oldest passenger cars will be inspected annually. The oldest motorbikes and mopeds will be inspected annually.
Latvia	1 - 1 - 1	1 - 1 – 1°⁾	No changes for passenger cars and motorbikes. Mopeds inspection is introduced.
Lithuania	3 - 2 - 2	1 - 1 - 1	The oldest passenger cars will be inspected annually. No changes for motorbikes and mopeds.
Luxembourg	3,5 - 1 - 1	3,5 - 1 - 1	No changes.
Malta	1 - 1 - 1	They are not inspected	No changes for passenger cars. Motorbikes and mopeds inspection are introduced.
Netherlands	4 - 2 - 2 - 1	They are not inspected	The passenger cars inspections will be annually from the sixth year (but not from the ninth as nowadays). Motorbikes and mopeds inspection are introduced.
Poland	3 - 2 - 1	3 - 2 - 1°⁾	No changes for passenger cars and motorbikes. Mopeds inspection is introduced.
Portugal	4 - 2 - 2 - 1	They are not inspected	The passenger cars inspections will be annually from the sixth year (but not from the ninth as nowadays). Motorbikes and mopeds will be inspected.

Romania	2 - 2 - 2	They are not inspected	The oldest passenger cars will be inspected annually. Motorbikes and mopeds inspection are introduced.
Slovakia	3 -1 - 1	4 - 2 - 2	No changes for passenger cars. The oldest motorbikes and mopeds will be inspected annually.
Slovenia	3 - 2 - 2	3 - 1 - 1	No changes.
Spain	**4 - 2 - 2 – 2 - 1**	**4 - 2 – 2 motorbikes 3 – 2 – 2 mopeds**	The passenger cars inspections will be annually from the sixth year (but not from the tenth as nowadays). The oldest motorbikes and mopeds will be inspected annually.
Sweden	3 - 2 - 1	4 - 2 - 2	No changes for passenger cars. The oldest motorbikes and mopeds will be inspected annually.
United Kingdom	3 - 1 - 1	3 - 1 - 1	No changes.

*) Frequency inspection «frequency 4-2-1» means that the first inspections takes place after 4 years, the next one after 2 years and from then on there is an inspection each year.

°) Nowadays, mopeds are not inspected.

3. The **equipment** used for vehicle inspection must comply with certain minimum requirements that allow an efficient usage of the described inspection methods.

   The availability and technical features of the inspection equipment condition the technical inspection quality. Current legislation of the EU does not describe regulations regarding inspection equipment.

   Therefore, the proposal includes a list of minimum compulsory equipment together with its technical features for vehicle technical inspection.

   A transient period is defined in order to provide a gradual substitution of current inspection equipment that does not comply with the regulations.

4. **Inspectors** that carry out vehicle technical inspection must satisfy a certain level of knowledge and skills and will be adequately trained. The proposal describes the knowledge areas that the candidate to inspector should master as well as a training system. The inspector will have an initial training and afterwards periodic training.

   There will be a transient period so that current inspectors can adapt to the periodic training.

5. The detected faults will be evaluated according to common standards depending on the risk.

   The opinion of the technical state of the vehicle must be harmonized at EU scale and the detected defects or faults must be evaluated attending to a common standard. The Commission adopted in 2010 recommendations for fault evaluation. These recommendations define three categories (minor, important and dangerous) as a function of its consequences for vehicle safety. One or several of these categories are associated with the possible defects listed in the Directive.

   These standards, regarding evaluation of the detected defects and the definition of the categories, are now introduced in the Regulations.

6. **Quality assurance** of the technical inspection activities carried out by the accredited private organisms will be determined by means of national supervision.

   It is mandatory for the Member States to supervise the operational of inspection organs and quality of the inspections done by these organs.

   To guarantee that a high inspection quality is kept during a long period of time, the Member States must guarantee a quality system that covers accreditation, supervision and withdrawal, suspension or cancellation of the authorization to carry out the technical inspections.

7. Registration of **odometer reading** will provide official prove to detect fraud, such as odometer tampering.

   The proposal established a set of clear standards regarding the legal nature of odometer tampering. By means of registering the mileage readings in each vehicle inspection it will be easier to detect fraud. In addition, it will allow sharing this data with other national registrations.

2.2.- Directive 2000/30/CE: Technical inspections in roadside for commercial vehicles.

Directive 2009/40/CE is complemented with Directive 2000/30/CE of the European Parliament and Council of June 6th of 2000, regarding the technical inspections in roadside of commercial vehicles. This Directive establishes a control of the technical state of the vehicle between periodic inspections. Therefore, it is an additional inspection in roadside for commercial vehicles.

This Directive is based on the premise that one technical inspection during each year is not enough to guarantee that commercial vehicles comply with technical standards during the whole year. In this way, maintenance level of travelling commercial vehicles is checked.

It establishes that the technical inspections in roadside must be carried out without discrimination towards driver nationality or vehicle registration nationality or service of the commercial vehicle. The selection method of commercial vehicles subjected to inspection must be based on a selective approach giving more importance to those vehicles more susceptible of a poor maintenance. Therefore, inspection efficiency would rise and at the same time costs and delays would be reduced.

In the case of major defects, the authorities of the Member States which registered the vehicle must take action attending to the standards.

During technical inspection and technical roadside inspection a vast number of data regarding the vehicles is registered. These data could be used by the different authorities not only to guarantee that the defects are tracked down and specific inspections are scheduled, but to improve policies established in the field of vehicle inspection. In addition, the vehicle technical inspection and road inspection could be more efficient if its technical features and complete vehicle history would be available. This exchange of information is also a key factor when dealing against fraudulent odometer tampering, which has been detected especially in second-hand market.

Attending to the contents of the proposal described in the Regulation draft which the Commission is still working on:

1. Vehicle selection must be based on the operator **risk profile**, thus, concentrating in the riskier companies to reduce load on the companies that keep a correct vehicle state. The profile risk must be based on previous technical inspection results taking into account the number and severity of the detected defects as well as a pondering factor that accounts for providing more weight to the last controls.
2. Nowadays, technical inspections in roadside are applied to commercial vehicles which weight more than 3,5 tons. The proposal extends the obligation to subject **roadside technical inspections to light commercial vehicles** (less than 3,5 tons) and its trailers because those vehicles are the most common in road transport. Those vehicles are not subjected to certain requirements, like training requirements for professional drivers or speed limitation devices. This will redound to a relatively high number of accidents in which these types of vehicles are involved.
3. The **number of technical inspections** in roadside per year and per State Member will be linked to the number of registered commercial vehicles, for a more fair distribution of roadside inspections in the Member States.
4. Roadside technical inspections will be done in several stages. In the first place, an initial inspection of the general vehicle state and documents will be done. In addition, technical inspection certificates or previous roadside inspections will be reviewed. A more detailed roadside inspection may be done depending on the initial inspection results. These detailed inspections may be carried out in mobile units or nearby inspection station.
5. **Securing cargo** must be part of roadside inspection. It is considered that an inadequate secured cargo is a factor that takes place in 25% of truck accidents.
6. Standard harmonization to evaluate roadside inspectors knowledge based on periodic technical inspections requirements and periodic inspection activities will contribute to avoid unequal treatment.

2.3.- Directive 1999/37/CE: Vehicle registration documents.

Directive 1999/37/CE of Council April 29th of 1999, regarding vehicle registration documents, establishes requirements for registration certificate dispatch, mutual recognition and its minimum harmonized content.

Attending to the new proposal of the Regulation draft in which the Commission is working on:

1. Data of registered vehicles must be kept in a national **electronic registry**.

2. **Technical data from vehicle approval**, but which are not always printed in vehicle registration, must be available for inspectors for technical inspection purposes.

3. Vehicle registration system must provide an effective application of technical inspections.

2.4.- The following stages.

The main aim of the Regulation proposal in which the EU is working on, is to improve road safety and contribute to achieve a 50% reduction of the annual number of fatalities in road accidents between 2011 and 2020.

More than 1.200 lives could be saved and more than 36.000 accidents could be avoided.

The economic benefits for society would be over 5.600 million Euros.

In particular, the main three aims of the proposal for vehicle technical inspections are:

1. Improve protection of vulnerable road users, in particular, young people.

2. Create a unique European space for vehicle technical inspection based on harmonized standards for control, equipment, inspector knowledge, defect evaluation and cooperation between the Member States.

3. Reduce the administrative load of road transportation companies that comply with technical requirements of road safety.

   In order to become a law, the proposal must be approved by the European Parliament and the Member States.

In the long term the second stage would be implementing the intercommunity harmonized exchange of data, that connects the existing databases which could be accessed anywhere in the EU to control the exactness of odometer readings. Access to these data in the EU could provide recognition of technical vehicle inspection certificates.

3. CONTEXT OF THE VEHICLE TECHNICAL INSPECTION IN SPAIN.

The General Vehicle Regulation (*Reglamento General de Vehículos*) (GVR) approved by means of Royal Decree-Law 2822/98 on December 23rd of 1998, in section 10, regarding "Vehicle Technical Inspections" states that:

"Registered vehicles or vehicles or in circulation must undergo technical inspections in a periodic motor vehicle inspection (PMVI) station, authorized by the competent authority with the frequency, requirements and exemptions set in Annex I.

Once vehicle identification has been checked, technical inspection will identify the safety vehicle condition attending to road vehicle safety, environmental protection, vehicle modifications, legal marking and, when applicable, validity of certificates for dangerous perishable goods".

Previous paragraphs provide a general idea of the technical inspection contents and which vehicles are subjected to inspection. In addition to periodic inspections demanded by article 5 of Royal Decree-Law 2042/1994, from October 14th, it is required that, prior to vehicle registration, the vehicle must obtain an administrative authorization that validates that the vehicle is in perfect operating conditions.

The Royal Decree-Law 750/2010, from June the 4th, by which motor vehicles, trailers, self-propelled or towed machines, agricultural vehicles, as well as systems and parts of these vehicles obtain the approval, establishes that vehicle approval is the administration authorization.

The administrative authorization mentioned in the GVR is based on vehicle type approval, its parts and components, and is provided by the type approval authority, which in Spain is the Industry, Energy and Tourism Ministry. It must be highlighted that two type approvals can be performed: CE type approval and national type approval.

CE type approval of vehicles, its parts and components is regulated by Directive 2002/24/CE from the European Parliament and Council of March 18th 2002, regarding two or three wheel motor vehicle. This Directive repeals Directive 92/61/CEE of the Council; Directive 2003/37/CE of the European Parliament and Council. Directive 2003/37/CE repeals Directive 74/150/CEE.

In the mentioned Directives the administrative procedure regarding vehicle, parts and components type approval is detailed. It is important to highlight that, being CE type approvals, endow a reciprocal recognition between the Member States of the European Economic Area.

These Directives have been included in the Spanish legislation by means of updating annexes of Royal Decree-Law 2028/1986, of June 6th regarding standards for application of certain directives from CE.

On the other hand, national type approval was regulated by Royal Decree-Law 2140/1985, October the 9th, which regulated the type approval of automobile vehicles, trailer and semi-trailers and parts and components of these vehicles. This Royal Decree-Law was applied to vehicles which were not included in the application field of mentioned EU directives and to vehicles to which such directives did not come into effect.

The CE type approval field had an important expansion since approval of the mentioned Directive 2007/46/CE. This directive substituted Directive 70/156/CEE, from the Council, from February 6th of 1970, regarding the legislation approach of the Member States for type approval of motor vehicles and its trailers. The directive was modified several times because CE type approval was only mandatory for a specific vehicle category (vehicle category M_1). Directive 2007/46/CE goes further onwards and regulates CE type approval for vehicle categories M, N and O.

Directive 2007/46/CE was introduced in the Spanish law by means of Order ITC/1620/2008, from June 5th, updating annexes I and II of the Royal Decree-Law 2028/1986. Including this Order has led to the need of repealing the Royal Decree-Law 2140/1985, aim covered by RD 750/2010

However, the most important item is regulation of the documentary and administrative requirements that must be complied for the different vehicle type approvals. Firstly, for CE type approval applied for vehicles included inside the scope of EU directives. Secondly, for national type approval, applied for vehicles not included inside the scope of EU directives. For vehicles in the scope of EU directives, national type approval may be approved in accordance to the Royal Decree-Law up to the date established in the directives. From then on, CE type approval is mandatory.

However, section 5 of Royal Decree-Law 750/2010 considers, as a particular application, cases of vehicles for which there is no mandatory application of CE type approval and are not included in its annexes, or which due to their lay-out can only have type approval with exemptions. In these cases, the type approval authority can apply exemptions prior to vehicle registration or before usage. The previously mentioned article 5, lists six cases as well as the exemptions for each one of them. In such cases, the administrative authorization is done in terms of vehicle technical inspection in a PMVI station.

Therefore, there are certain vehicles that have been approved by the type approval authority of the Ministry of Industry, Energy and Tourism so as not to comply or partially comply with certain technical requirements regarding road vehicle safety and environmental protection. These exemptions must be registered in the exemption type approval certificate and, if applicable, in the type approval documentation of the vehicle. These conditions and exemptions may also be described in the PMVI certificate delivered by the PMVI station prior to vehicle registration so that future vehicle inspections know the particular conditions of the vehicle.

In addition, reference of the mentioned paragraphs of section 10 of GVR to legislation described in annex I of GVR, and in particular to Royal Decree-Law 224/2008 in which the different types of inspection that can be done in periodic motor vehicle inspection (PMVI) stations are described, leads to a broader approach. It must be highlighted that the inspection scope regarding vehicle modification inspection is legislated by Royal Decree-Law 866/2010, from July 2nd, being limited by Vehicle Modification Manual. However, vehicle modification is ruled by the Vehicle Modification Manual, as specified in section 8 of the mentioned Royal Decree-Law.

Royal Decree-Law 224/2008, from February the 15th, describes general standards regarding installation and operation of vehicle technical inspection stations. This standard was a consequence of the appeals of unconstitutionality promoted by Cataluña, Asturias, Aragon and Castilla La Mancha and the subsequent judgment of the Constitutional Court that declared that article 7.2 of Royal Decree-Law 7/2000 violated the autonomic competences in the field of industry, as it imposed administrative authorization as enabling individuals to provide vehicle technical inspection service.

Furthermore, judgments from the Administrative Appeal Court of the Supreme Court of October 3rd in 2006, as well as the judgments from October 4th of 2006 in appeal number 95/2003, partially disabled the content of the Royal Decree-Law 833/2003 of June 27th, which regulates the technical requirements that PMVI stations have to comply with so as to be authorized in order to develop the inspection activity.

The Royal Decree-Law 833/2003 repeals several articles of the Royal Decree-Law 1987/1985 regarding general standards of installation and operation of PMVI stations. Some of the requirements mentioned in the repealed articles were substituted by some of the articles disabled by the judgments of the Supreme Court.

In order to comply with the requirements established in Directive 96/96/CE of the Council there was a need to re-establish the operating requirements to by complied by the PMVI stations that would endow an homogenous and high quality vehicle technical inspection in the whole nation without damaging the autonomous community legal competences.

In addition, it was also considered convenient in terms of clarity and transparency to unify in this Royal Decree-Law 224/2008 all legislation in the field. In this Royal Decree-Law it was included the articles, annexes and appendix existing in the Royal Decree-Law 1987/1985. In addition, it was revised and updated so that it would be coherent with the rest of the existing vehicle legislation.

On the other hand, Royal Decree-Law 866/2010 from July 2nd, which regulates vehicle modifications processing, approved a new and complete regulation in this scope based on the practical experience obtained from the previous law (Royal Decree-Law 736/1998) that regulated vehicle modification processing. In addition, the new regulation takes into account laws of European Union in order to improve vehicle passive and active safety and environmental protection.

Finally, to complete the description of the legislation scope that regulates vehicle technical inspection in Spain, Royal Decree-Law 711/2006 from June 9th, that modifies certain Royal Decree-Laws regarding periodic motor vehicle technical inspection (PMVI) and vehicle type approval, its parts and components and also modifies General Vehicle Regulation (GVR) approved by the Royal Decree-Law 2822/1998 from December 23rd, establishes the vehicle categories that must undergo PMVI as well as the frequency inspection, as shown in the following table.

Table 2. Vehicle frequency inspection established by Royal Decree-Law 711/2006

Motorbikes, Three-Wheeled Vehicles, quadricycles , quads, 3 wheel moped and light quadricycle	Mopeds	Passenger cars, motor-homes and campers	Ambulances, school bus service (up to 9 passenger seats, including the driver)	Freight transport ≤ 3500 kg	Rental car and driving school car (up to 9 passenger seats, including the driver) (motorbikes included)
					
1st INSPECTION	**1st INSPECTION**	**1st INSPECTION**	**1st INSPECTION**	**1st INSPECTION**	**1st INSPECTION**
Before the **4th YEAR**	Before the **3rd YEAR**	Before the **4th YEAR**	Before the **1st YEAR**	Before the **2nd YEAR**	Before the **2nd YEAR**
NEXT INSPECTIONS	**NEXT INSPECTIONS**	**NEXT INSPECTIONS**	**NEXT INSPECTIONS**	**NEXT INSPECTIONS**	**NEXT INSPECTIONS**
+ 4 years **biennial**	+ 3 years **biennial**	4 -10 years **biennial**	Up to 5 years **annual**	2 to 6 years **biennial**	2 to 5 years **annual**
		+ 10 years **annual**	+ 5 years **biannually**	6 a 10 years **annual**	+ 5 years **biannually**
				+ 10 years **biannually**	
Busses and coaches	**Freight transport > 3500 kg**	**Towed caravans MAM >750 kg**	**Agricultural tractor**	**Special civil engineering vehicles speed > 25 km/h**	**Electric conversion equipment Circus machinery**
					
1st INSPECTION	**1st INSPECTION**	**1st INSPECTION**	**1st INSPECTION**	**1st INSPECTION**	**1st INSPECTION**
Before the **1st YEAR**	Before the **1st YEAR**	Before the **6th YEAR**	Before the **8th YEAR**	Before the **4th YEAR**	Before the **4th YEAR**
NEXT INSPECTIONS	**NEXT INSPECTIONS**	**NEXT INSPECTIONS**	**NEXT INSPECTIONS**	**NEXT INSPECTIONS**	**NEXT INSPECTIONS**
Up to 5 years annual	**0 - 10 years annual**	**+ 6 years biennial**	**8 – 16 years biennial**	**From 4 to 10 years biennial**	**From 4 to 6 years biennial**
+ 5 years biannually	**+ 10 years biannually**		**+ 16 years annual**	**+ 10 years annual**	**+ 6 years annual**

The previously described complex legislation field shows the need of a document that establishes the inspection procedure as well as inspection criteria. This document is the Inspection Handbook Procedure to conduct vehicle inspection for PMVI stations (*"Manual de Procedimiento de Inspección de las Estaciones ITV"*).

In January 2012 the last revision, the 7^{th}, has been published. The wording of this new version of the Handbook is based on previous experience. In addition, it has been applied Directive 2009/40/CE from May 6^{th}, regarding inspection of motor vehicles and its trailers. Annex II of Directive 2009/40/CE was modified by Directive 2010/378/EU regarding evaluation of detected defects during inspections. It must be highlighted that these documents have been taken into consideration regarding technical inspection procedure as it is established that inspections should be: "relatively simple, quick and cheap".

On the other hand, the current accreditation process done by ENAC to the companies that carry out vehicle inspection, as regulated by Royal Decree-Law 224/2008, include recommendations from this organization as well as those described in standard UNE-EN-ISO/IEC 17020. The Inspection Handbook must consider the definition of inspection described by the previous standard: "exam of a designed product, service, process or installation and conformity level with specific or general requirements, based on a professional judgment". Therefore, the concept of "professional judgment" allows, when there is no objective criterion, a possible duality when marking a defect.

In addition, last revision of the Inspection Handbook includes a new section (section V), regarding Non periodical Inspections, which is divided in the following chapters:

1. Vehicle modifications.
2. Inspections prior to vehicle registration.

4. CURRENT VEHICLE TECHNICAL INSPECTION IN SPAIN

In Spain there are currently 363 periodic motor vehicle inspection (PMVI) stations with 928 inspection lanes. There has been a change in the management model in several autonomous communities, expanding and modifying, in some cases, the franchised model or shifting from the franchised model to the administrative authorization model. This has led to a strong increase in the number of inspection stations, being most of them, not included in this book as some of them are in the process of obtaining ENAC accreditation. In some Autonomous Communities ENAC accreditation process is a requirement to obtain administrative authorization that allows the PMVI station to operate and in others it is allowed that PMVI stations provisionally operate until they are approved. The PMVI stations are distributed along Spain either taking into account vehicle fleet density and placed in areas that allow vehicle owners easy access (franchised model) or attending to market criterion (authorization model).

In the following table the number of PMVI stations and number of inspection lanes attending to Autonomous Community are shown. Data from 2007 is compared with data updated to 2012.

Table 3. Evolution of the number of PMVI stations and number of inspection lanes per Autonomous Community (Updated to September 2012 vs. September 2007).

Region	Number of inspection stations 2007/2012	Number of inspections lanes 2007/2012
Andalucía	49/60	149/200
Asturias	8/9	26/40
Aragón	15/27	29/46
Baleares	7/7	16/16
Cantabria	3/7	7/18
Extremadura	10/12	17/21
Canarias	14/14	37/37
Castilla y León	38/40	65/74
Cataluña	44/47	93/102
Murcia	8/8	19/19
Castilla la Mancha	27/41	57/85
Madrid	17/23	66/85
Navarra	4/8	11/18
Rioja	4/4	7/7
Galicia	19/23	59/65
País Vasco	8/8	23/23
Ceuta	1/1	2/2
Valencia	25/26	83/87
Total	**301/16,0965**	**766/945**

These stations provide inspection service to a vehicle fleet which is constant rise:

Table 4. Vehicle fleet attending to the type of vehicle (Updated to December 2011).

TYPE OF VEHICLE	**VEHICLE FLEET AT December 31st 2011**	**PERCENTAGE DISTRIBUTION**
Trucks and vans	5.060.791	16,18%
Buses and coaches	62.358	0,20%
Passenger cars	22.277.244	71,24%
Motorbikes and mopeds	2.798.043	8.95%
Agricultural Tractors	195.960	0,63%
Trailers and semi-trailers	415.568	1,33%
*Other Vehicles	459.117	1,47%
TOTAL	**31.269.081**	**100,00%**

Being the relationship between population and vehicle fleet since 1984:

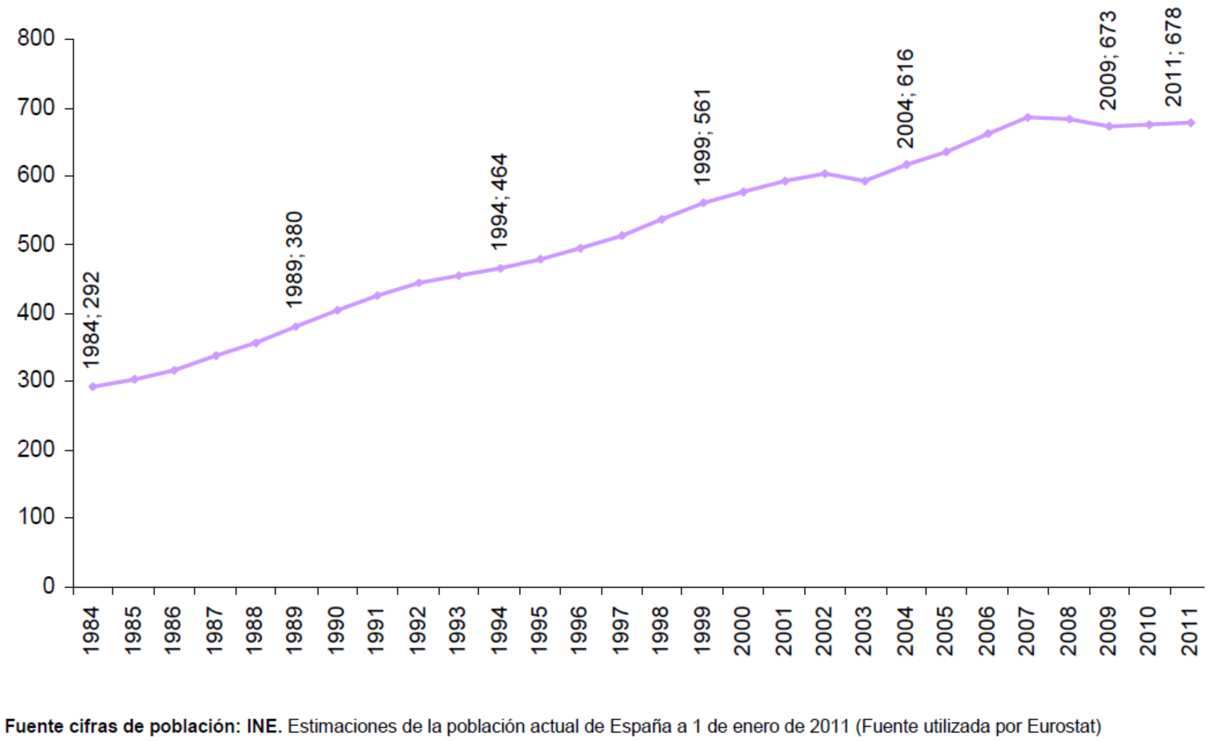

Figure 3. Relationship between the number of inhabitants and vehicle fleet since 1984

Periodic inspection results provided by the Ministry of Industry, Energy and Tourism for 2011 are shown in the following table.

Table 5: Periodic motor vehicle inspections (PMVI) in 2011 (Source: MINETUR).

2011 PERIODIC MOTOR VEHICLE INISPECTION STATISTICAL DATA

INSPECTED VEHICLE SYSTEMS AND DEFECTS		VEHICLE TYPE: MOTORBIKES AND MOPEDS	PASSENGER CARS	REST OF PASSENGER CARS	FREIGHT TRANSPORT MAM≤3500 kg	FREIGHT TRANSPORT MAM>3500 kg	BUSES AND COACHES	TRAILERS AND SEMITRAILERS	AGRICULTURAL TRACTORS	OTHER VEHICLES	TOTAL
		DEFECTS									
CHAPTER 1 *IDENTIFICATION*	MiD	29.698	845.136	13.828	293.210	47.974	5.496	22.351	80.429	7.480	1.345.602
	MaD	22.600	94.799	1.782	43.239	11.610	1.094	7.275	13.342	3.234	198.975
CHAPTER 2 *BODY, STRUCTURE AND CHASSIS INSPECTION*	MiD	21.313	1.071.915	18.506	505.142	92.387	14.550	27.509	84.210	8.906	1.844.438
	MaD	23.294	193.455	4.287	121.768	29.776	4.660	10.927	16.799	3.421	408.387
CHAPTER 3 *VEHICLE INSIDE COMPONENTS INSPECTION*	MiD	9.787	198.196	1.463	104.544	17.577	3.019	7.597	20.742	1.358	364.283
	MaD	12.656	222.666	3.611	77.541	7.930	2.988	2.994	179	1.061	331.626
CHAPTER 4 *INSPECTION OF LIGHT AND SIGNAL SYSTEM*	MiD	49.163	2.485.198	55.208	921.113	168.443	19.479	75.958	110.119	14.488	3.899.169
	MaD	70.137	658.054	12.102	267.087	49.361	4.264	24.300	41.867	10.644	1.137.816
CHAPTER 5 *POLLUTANT EMISSIONS*	MiD	18.241	391.073	5.935	163.547	31.048	3.540	14.977	26.563	1.949	656.873
	MaD	51.271	538.775	7.813	136.186	15.114	1.317	6.090	74	2.098	758.738
CHAPTER 6 *INSPECTION OF THE BRAKE SYSTEM*	MiD	16.774	921.542	16.827	367.326	83.814	10.438	89.487	4.943	2.915	1.514.066
	MaD	17.262	486.590	7.106	240.650	78.600	9.321	73.237	6.288	2.980	922.034
CHAPTER 7 *INSPECTION OF STEERING SYSTEM*	MiD	2.763	329.406	4.962	150.754	24.219	2.856	14.095	17.341	2.307	548.703
	MaD	6.656	201.999	4.140	113.361	29.979	3.043	13.446	5.304	1.802	379.730
CHAPTER 8 *INSPECTION OF AXLES, WHEELS, TIRES AND SUSPENSION*	MiD	8.075	189.277	3.671	66.754	11.403	1.848	6.986	32.193	2.164	322.371
	MaD	23.520	674.511	14.535	277.492	37.772	4.860	29.084	6.079	2.853	1.070.706
CHAPTER 9 *INSPECTION OF ENGINE AND TRANSMISSION*	MiD	11.212	1.430.435	23.517	506.769	57.325	6.441	1.899	10.457	2.687	2.050.742
	MaD	16.936	252.818	3.307	92.075	14.584	1.455	6.721	736	997	389.629
CHAPTER 10 *OTHERS*	MiD	4.744	215.015	2.660	115.017	9.990	1.435	3	5.974	495	355.333
	MaD	39.529	136.721	4.335	53.882	29.810	9.725	2.249	3.227	4.496	283.974
TOTAL DEFECTS	MiD	171.770	8.077.193	146.577	3.194.176	544.180	69.102	260.862	392.971	44.749	12.901.580
	MaD	283.861	3.460.388	63.018	1.423.281	304.536	42.727	176.323	93.895	33.586	5.881.615
TOTAL VEHICLES – **FIRST INSPECTION**	**Favorables**	694.742	9.075.059	232.244	2.224.714	399.247	63.643	244.026	395.961	53.631	13.383.267
	Rejected	152.642	1.997.971	38.166	713.457	139.079	19.154	76.281	53.971	14.641	3.205.362
	Rejection rate %	**18,01**	**18,04**	**14,11**	**24,28**	**25,84**	**23,13**	**23,81**	**12,00**	**21,45**	**19,32**
TOTAL VEHICLES – **OTHERS INSPECTIONS**	**Favorables**	133.193	1.800.523	39.710	634.977	126.088	17.629	66.531	45.473	12.809	2.876.933
	Rejected	6.583	108.103	2.333	44.351	10.553	1.620	8.696	951	721	183.911
	Rejection rate %	**4,71**	**5,66**	**5,55**	**6,53**	**7,72**	**8,42**	**11,56**	**2,05**	**5,33**	**6,01**

Next, the number of inspections and absenteeism results is provided attending to the passenger vehicle fleet, light commercial trucks and motorbikes and moped. These three types of vehicles are the ones which have been selected for the report.

4.1.- Passenger vehicles.

The **number of passenger vehicles that should have gone through a periodic**

inspection during **year 2011** rises to **14.388.299**, which represents 64,59%[1] of the total vehicle fleet of 22.277.244. The **real number of performed inspections** has been **11.073.030.**

1 The percentage of passenger vehicle fleet which had to be inspected in 2008 was 55,79%. The current percentage gives an idea of the progressive aging of vehicle fleet.

Table 6. Vehicle fleet attending to the type of vehicle and vehicle age (Updated to December 2011)

VEHICLE FLEET AT DECEMBER 31st 2011 ATTENDING TO VEHICLE TYPE AND REGISTRATION YEAR								
REGISTRATION YEAR	TRUCKS AND VANS	BUSES AND COACHES	PASSENGER CARS	MOTORBIKES AND MOPEDS	AGRICULTURAL TRACTORS	TRAILERS AND SEMI-TRAILERS	OTHER VEHICLES	TOTAL
Before 1991	775.343	8.488	2.685.876	688.300	15.665	61.932	46.678	4.282.282
1991	101.474	634	238.849	78.008	1.421	8.842	6.879	436.107
1992	115.088	798	320.760	69.351	1.156	8.952	5.818	521.923
1993	87.259	663	291.843	35.123	627	6.403	4.031	425.949
1994	100.622	768	401.365	25.034	1.148	8.648	4.012	541.597
1995	109.743	1.281	400.411	23.032	2.439	10.202	5.663	552.771
1996	131.138	1.780	522.215	22.137	2.602	10.276	6.047	696.195
1997	168.216	2.405	684.725	32.211	4.227	12.856	7.921	912.561
1998	202.759	2.631	906.724	44.283	5.755	15.892	11.258	1.189.302
1999	247.981	3.295	1.160.729	56.257	8.271	17.904	15.301	1.509.738
2000	250.317	2.905	1.197.935	58.849	9.465	20.562	17.215	1.557.248
2001	249.405	3.161	1.275.461	55.993	10.661	20.729	19.938	1.635.348
2002	239.523	2.955	1.203.465	55.556	10.990	21.198	23.243	1.556.930
2003	275.705	3.018	1.311.070	68.838	12.367	23.398	31.172	1.725.568
2004	312.806	3.519	1.475.491	115.174	14.744	24.990	45.940	1.992.664
2005	358.358	4.046	1.521.357	210.225	17.222	25.374	53.737	2.190.319
2006	366.111	3.749	1.510.863	264.932	18.470	28.124	50.748	2.242.997
2007	365.504	4.108	1.468.979	276.299	20.949	30.075	44.967	2.210.881
2008	203.161	3.799	1.053.892	216.738	15.067	22.805	18.014	1.533.476
2009	129.503	2.946	924.090	138.133	5.534	11.431	10.399	1.222.036
2010	140.808	2.574	934.185	140.037	7.163	11.924	12.340	1.249.031
2011	129.967	2.835	786.959	123.533	10.017	13.051	17.796	1.084.158
TOTAL	**5.060.791**	**62.358**	**22.277.244**	**2.798.043**	**195.960**	**415.568**	**459.117**	**31.269.081**

The **rate of absenteeism of passenger vehicle fleet**, that is, vehicles that were not inspected but should have, attending to mandatory vehicle inspection frequency, is for this year of **23,04%.** This means that at least 3.315.269 passenger vehicles were not inspected, but should have been inspected.

Absenteeism causes were deeply analyzed in 2007 report. The conclusion was that between 4th and 10th year one inspection is not done. It must be highlighted that even though vehicles must be inspected in the 4th year, as established by law, the percentage of completion of going through vehicle inspection in the 4th year (vehicle age) is only around 50%. Between 25% and 30% of the vehicle fleet carry out their first inspection during the fifth year.

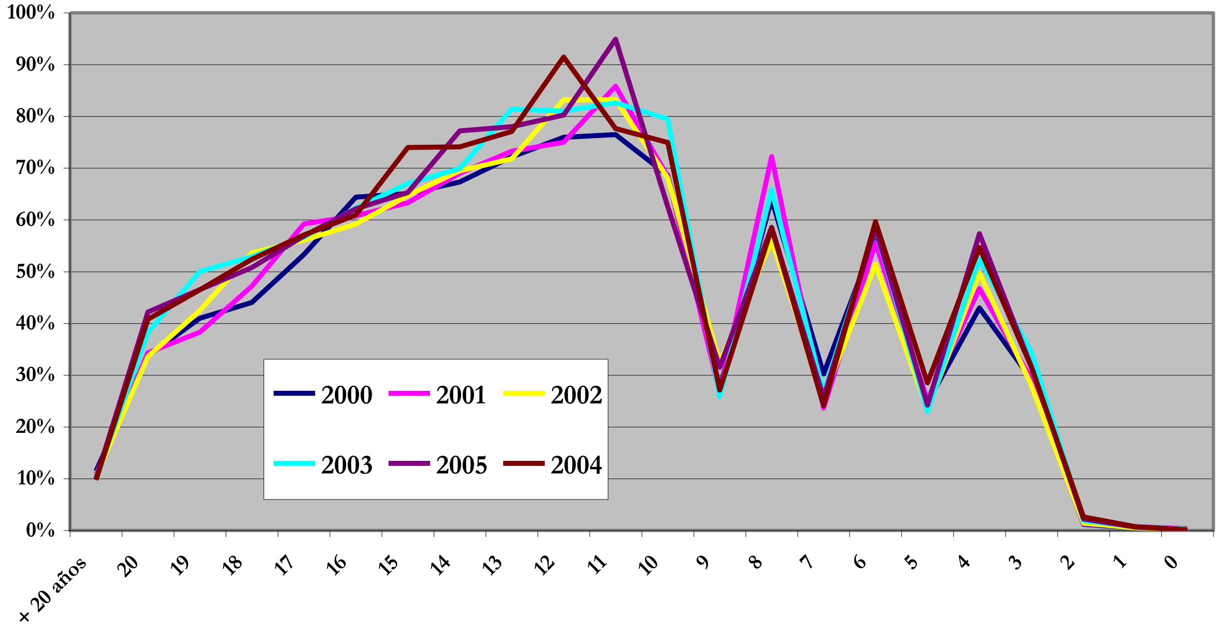

Figure 4. Rate between the registered vehicles and the inspected passenger vehicles that have to be inspected attending to vehicle age.

It can also be observed that an important percentage of vehicles are subjected to first inspection before being mandatory, that is, during the third year of the vehicle age. The same behavior has been found during the sixth and seventh year and the eighth and ninth year. This "saw-tooth" trend is motivated by the biennial frequency inspection, which is established by the Spanish legislation. The result is that approximately 42% of the passenger vehicle fleet with vehicle age between 4 and 10 years lose one inspection during that period, thus, being inspected three times instead of the four regulated by law.

The previously explained "saw-tooth" trend disappears on the tenth year because frequency inspection shifts to be annual. In addition, it also seen that as vehicle age increases the level of inspection compliance is gradually, almost linearly, reduced; being these vehicles the most dangerous for vehicle safety and less environmentally friendly.

4.2.- Light commercial truck.

National light commercial van fleet attending to 2011 data provided by the Traffic General Centre (TGC) rises to 2.314.595 vehicles. On the other hand, light commercial trucks (payload below 999 kg.) rises to 1.844.642 vehicles. It must be highlighted that the TGC classifies commercial vehicles attending to its payload, whereas during inspection, vehicles are distinguished attending to their maximum allowable mass (MAM) (below or over 3.500 kg). Therefore, it has been compared light commercial vehicles with payload up to 999 kg (commercial vans and trucks) with vehicles inspected with MAM below 3.500 kg. Although technically it is possible to find vehicles with this MAM with higher payloads the percentage of the fleet outside this estimation is small, and in any case, estimations are on the safe side.

Inspection frequency established by the current legislation for light commercial vehicles is first inspection during the second year, biennial inspection between the second and sixth year, annual between the sixth and tenth year and biannual for vehicles with more than 10 years age. The **number of commercial vans** required to be subjected to inspection during **2011** rises to **2.885.713** and of **light commercial trucks** rises to **2.037.795**, having done **2.938.171** inspections. Therefore, the absenteeism rate for light commercial transport vehicles is 40,32% (1.985.337 mandatory inspections were not done).

Table 7. National van fleet attending to nominal payload and age (Updated to December 2011)

NATIONAL VAN FLEET AT DECEMBER 31st 2011 ATTENDING TO NOMINAL LOAD (in kg) AND REGISTRATION YEAR					
REGISTRATION YEAR	**Up to 499 kg**	**From 500 to 749 kg**	**From 750 to 999 kg**	**More than 999 kg**	**TOTAL**
Before 1991	219.355	171.572	72.908	85.920	549.755
1991	22.129	38.581	8.719	9.610	79.039
1992	22.645	50.449	9.471	8.811	91.376
1993	16.763	39.652	7.579	5.681	69.675
1994	15.146	45.676	8.017	6.355	75.194
1995	11.649	40.467	6.934	6.326	65.376
1996	9.478	40.099	7.254	5.303	62.134
1997	9.669	41.389	9.823	5.572	66.453
1998	10.437	47.131	12.479	5.877	75.924
1999	12.781	56.329	15.907	7.344	92.361
2000	14.626	46.767	14.237	7.016	82.646
2001	13.181	49.268	13.612	10.727	86.788
2002	13.346	47.523	11.219	11.810	83.898
2003	15.249	49.739	14.844	14.562	94.394
2004	19.403	53.680	18.936	17.424	109.443
2005	20.882	66.534	20.918	17.905	126.239
2006	18.347	68,553	19.294	15.805	121.999
2007	19.382	64.493	19.778	22.128	125.781
2008	13.346	39.119	12.129	14.965	79.559
2009	7.143	26.166	8.217	7.118	48.644
2010	5.496	33.132	11.625	11.938	62.191
2011	5.864	33.329	10.799	15.734	65.726
TOTAL	**516.317**	**1.149.648**	**334.699**	**313.931**	**2.314.595**

4.3.- Motorbikes and mopeds.

The General Vehicle Regulation (GVR) (Real Decree-Law 2822/98) that was effective on July 27th of 1999 established the obligation to register the moped, not only the new ones but the older ones. The regulation established that this vehicle registration should be done under a certain schedule, being the last one on January 27th of 2002. The following table shows the evolution of the vehicle fleet since then. Nowadays, there are 2.229.418 vehicles, from which vehicle age is not known. Therefore, it is not possible to find out how many should have been inspected during 2011.

Table 8. Evolution of the moped fleet (Updated to December 2011)

YEAR	NUMBER OF MOPEDS	EVOLUTION WITH RESPECT TO THE PREVIOUS YEAR
2002	2.044.242	
2003	2.143.593	4,86
2004	2.242.046	4,59
2005	2.311.773	3,11
2006	2.343.124	1,36
2007	2.430.414	3,73
2008	2.410.685	-0,81
2009	2.352.205	-2,43
2010	2.290.207	-2,64
2011	2.229.418	-2,65

The national motorbike fleet in 2011 rises to 2.798.043 vehicles attending to TGC data. Considering the inspection frequency established by legislation, the **number of motorbikes required to be inspected** during **year 2011** rises to **1.180.136**, which represents 42,17% of the fleet.

The **number of inspections of moped and motorbikes** during year 2011 was **847.384**. Assuming that the percentage of moped required to pass inspection is equivalent to the percentage of motorbikes in the same situation (42% of the fleet, 940.147 mopeds) it is found that the absenteeism rate of these vehicles is **60%** (more than 1.200.000 required inspections were not done).

5. RESULTS OF PERIODIC TECHNICAL INSPECTIONS IN SPAIN

In the present chapter results of the periodic vehicle inspections are deeply analyzed. In particular, inspection results of passenger vehicles, motorbikes and mopeds and light commercial vehicles (below 3.500 kg) are shown. The main aim is identify which vehicle system concentrates the biggest amount of defects. In addition, it will be analyzed the possible relationship between vehicle age and the defects identified by the inspector.

The analysis has been done following the stages:

1. Definition of the sample.
2. Analysis attending to inspection result.
3. Analysis attending to vehicle age.
4. Analysis attending to major and minor defects.
5. Analysis attending to major defects.

To achieve the mentioned aim, inspection results for the three types of vehicles are available.

5.1.- Definition of the sample.

In the report entitled "Contribution of Periodic Motor Vehicle Inspection (PMVI) to Vehicle Safety" a sample of passenger vehicles was analyzed. The present report analyzes contribution of PMVI to vehicle safety for the following types of vehicle:

- Passenger vehicles.
- Motorbikes and mopeds.
- Light commercial vehicle for good transport. Light commercial vehicles are those with maximum allowable mass (MAM) below 3.500 kg.

On the other hand in order to extract conclusive results, an inspection period between January 1st and December 31st of 2011 has been selected. The selected inspections come from Madrid inspected vehicles. In addition, the selected inspections correspond only to periodic inspections because criterions for second inspection are not the same ones as for periodic ones. Regarding vehicle age, the chosen vehicles cover a broad sample of vehicles between 4 and 15 year old vehicles.

In Table 8 the number of analyzed inspections attending to vehicle, motorbikes and mopeds and light commercial vehicles are shown.

Table 9. Number of inspections attending to vehicle age.

Vehicle age	TOTAL		
	Passenger cars	Motorbikes and mopeds	Light duty commercial truck
Less than 4 years	172230	16084	25122

From 4 to 6 years	164151	14329	18384
From 6 to 8 years	139586	6197	25851
From 8 to 10 years	124862	4542	21956
From 10 to 15 years	358984	6017	46497
Mora than 15 years	136494	6935	23805
Total inspections	1096307	54104	161615

These inspections represent with respect to the total number of inspections of 2011, for each type of vehicle:

- Passenger vehicles: 1.096.307 inspections done with respect to a total of 11.073.030 inspections done in Spain, thus, represents 9,9% of the population.
- Motorbikes and mopeds: 54.104 analyzed inspections over a total of 847.384 inspections done in Spain, thus, represents 6,4% of the population.
- Light commercial: 161.615 of analyzed inspections over a total of 2.938.171 inspections done in Spain, thus, represents 5,5% of the population.

Although each one of the samples is differently represented, in all of the analyzed vehicles the selected sample allows obtaining significant statistical results.

5.2.- Defects and inspection result.

In this report special attention has been paid to analysis of vehicle defects. The defects established by the Handbook Procedure to conduct vehicle inspection for PMVI stations are:

- Minor defect (MiD): It is a defect that does not compromise vehicle safety. The user may drive the vehicle temporary until it is repaired.
- Major defect (MaD): It is a defect that seriously threatens vehicle safety and pedestrians or the environment. Vehicles with one serious defect will have an inspection results of "rejected". These vehicles will have to be repaired and go back to the inspection stations to check that the defect has been corrected.
- Dangerous defects (DD): The defect has a direct immediate effect in vehicle safety. In these cases the vehicle will have to leave the PMVI station in a breakdown lorry.

Attending to these definitions the following inspection results are found:

- Favorable: The vehicle does not have defects.
- Favorable with minor defects: The inspector identified, at least, one minor defect.
- Rejected: The inspector detected, at least, one major defect.
- Negative: The inspected identified one dangerous defect.

5.3.- Analysis attending to inspection result

5.3.1.- Passenger vehicles

Passenger vehicles have a relatively reduced percentage of negative inspections (0,27%), as depicted in Figure 5. On the other hand, most of the vehicles either had a favorable inspection or favorable with minor defects. Only 19,4% of the passenger vehicles had a rejected inspection result.

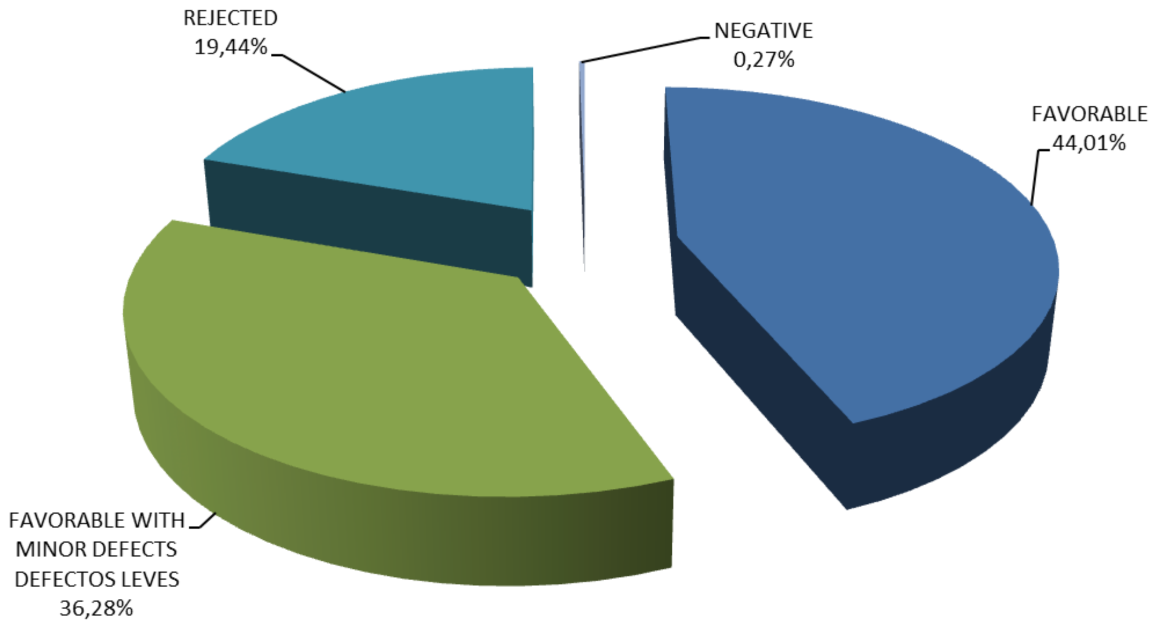

Figure 5. Distribution of percentage inspection result for passenger vehicles

5.3.2.- Motorbikes and mopeds.

This section analyzes the inspection result of motorbikes and mopeds. In Figure 6 percentage distribution of motorbikes and mopeds inspection results are shown. It can be seen that 70% of these vehicles had a favorable inspection result in the analyzed period.

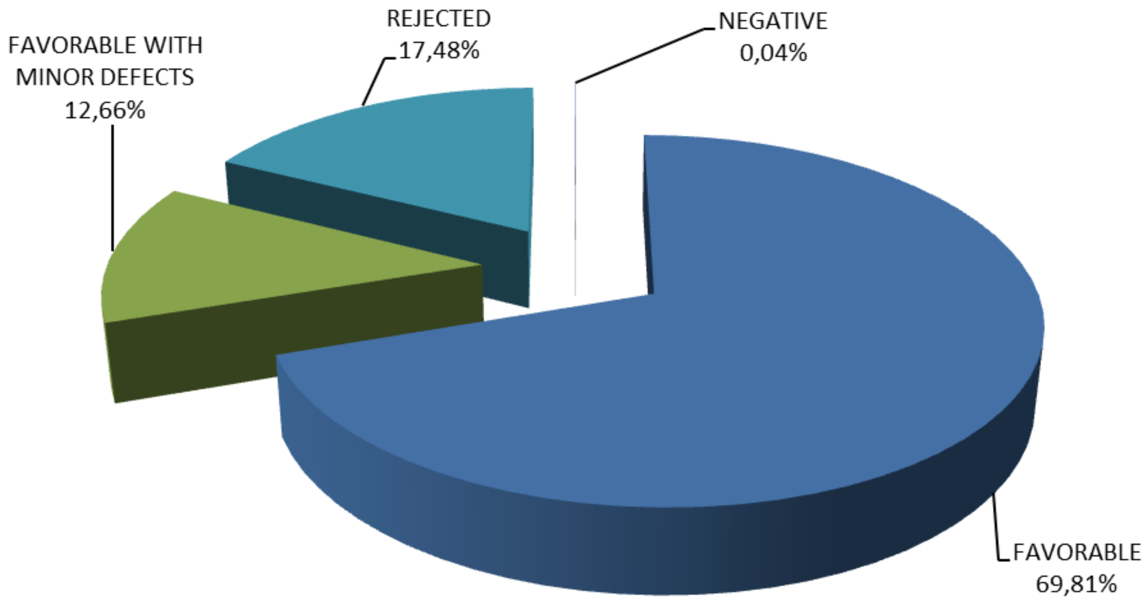

Figure 6. Distribution of percentage inspection result for motorbikes and mopeds

It can also be observed that the number of negative inspections, that is, inspections in which the vehicle had to be removed with a breakdown lorry is very small.

5.3.3.- Light duty commercial vehicles.

In the case of light duty commercial vehicles it is observed that high percentage of these vehicles have a favorable with minor defects inspection result.

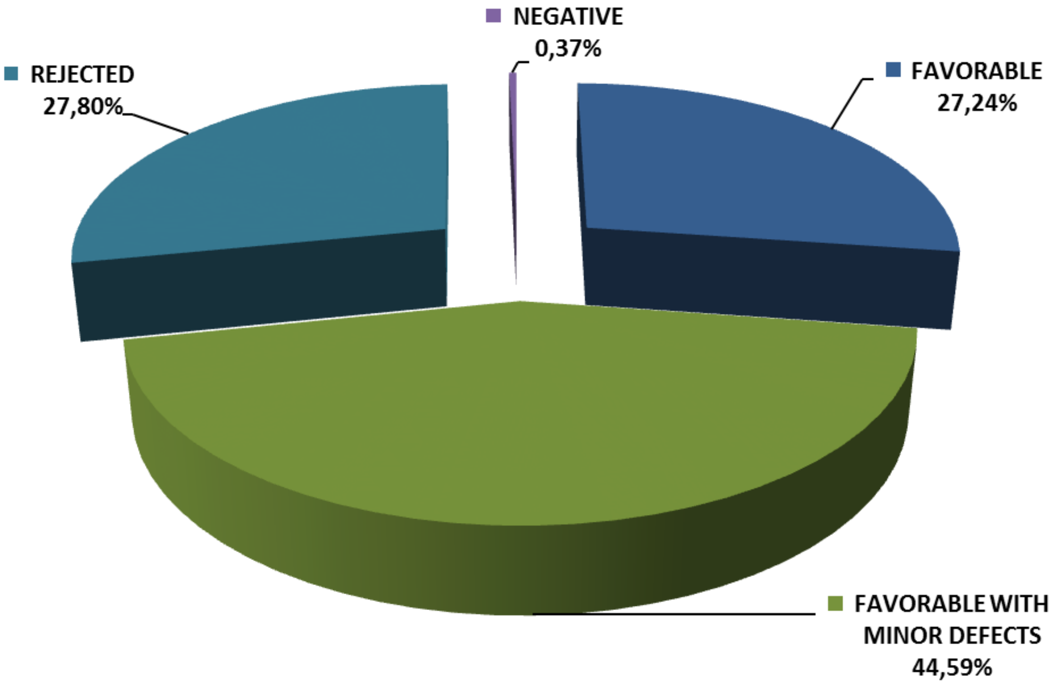

Figure 7. Distribution of percentage inspection result for light duty commercial vehicles

5.4.- Analysis attending to vehicle age

One of the most interesting points regarding vehicle inspection is the relationship between vehicle age and vehicle inspection result. An analysis of this relationship has been done for the three types of vehicles.

5.4.1.- Passenger vehicles.

For passenger vehicles it can be outlined (view Figure 8) that the older the vehicle is the bigger the amount of negative and rejected inspection results are.

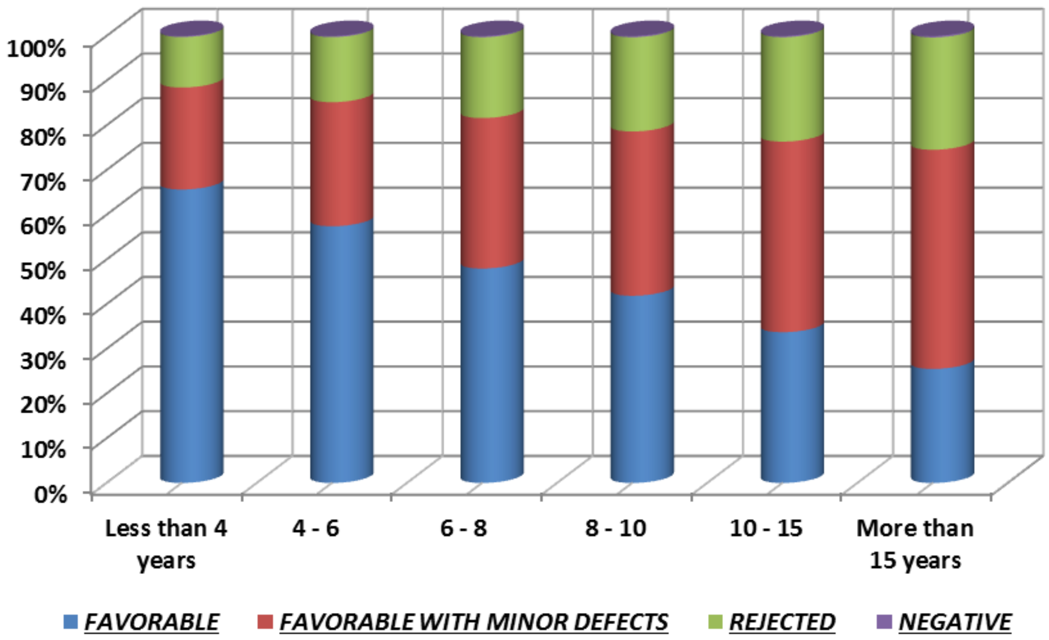

Figure 8. Passenger vehicle inspection results attending to vehicle age

5.4.2.- Motorbikes and mopeds.

Although in the case of motorbikes and mopeds the decrease in the number of favorable inspections with vehicle age is not so aggressive as in passenger vehicles it is observed that older vehicles have less number of favorable inspections (view Figure 9).

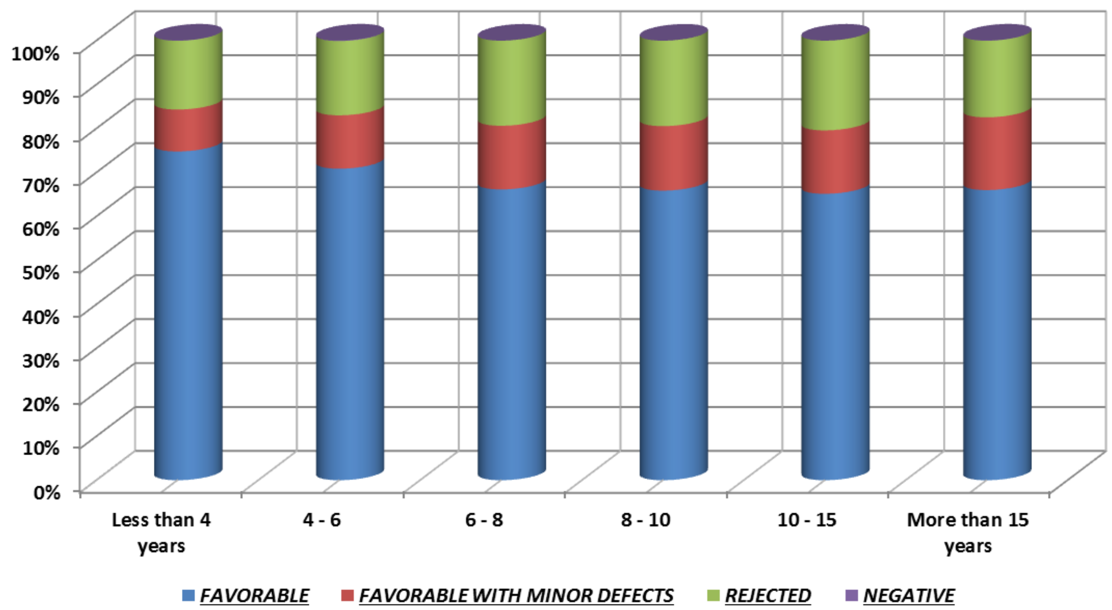

Figure 9. Motorbike and mopeds inspection results attending to vehicle age

5.4.3.- Light duty commercial vehicles.

In the case of light duty commercial vehicles it can be seen that, globally, there is a bigger proportion of favorable inspections with minor defects. In addition, this inspection results increases with vehicle age, as depicted in Figure 10. It must be highlighted that favorable inspections decrease with vehicle age. Finally, the older the vehicle the bigger the percentage of rejected vehicles.

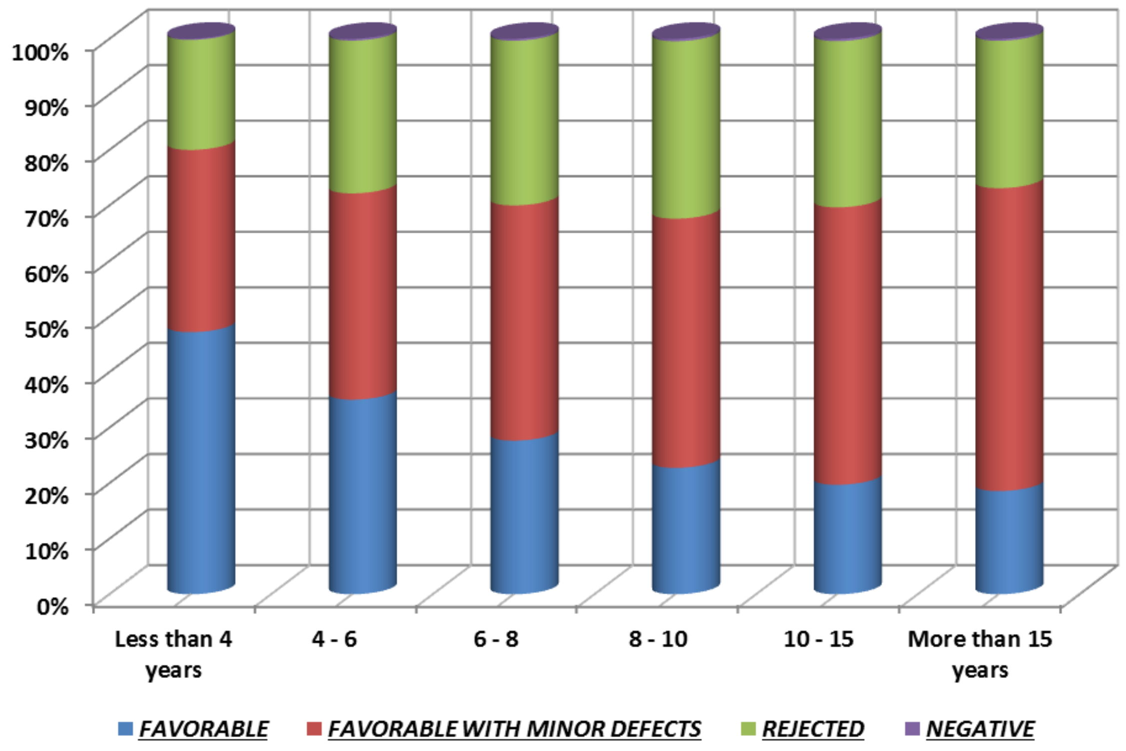

Figure 10. Light duty commercial vehicles inspection result attending to vehicle age

5.5.- Analysis attending to major and minor defects.

The aim of this section is to analyze the distribution of defects detected by the inspector attending to vehicle age for each of the analyzed vehicles.

5.5.1.- Passenger vehicles.

In Figure 11 it can be found that the number of minor defects increases with vehicle age, thus, decreasing the percentage of major defects. It must be highlighted that if during vehicle inspection one major defect is identified, then the inspection result is rejected. Therefore, a reduction in the number of major defects with vehicle age does not imply a reduction in the number of rejected vehicles during inspection. In fact, in the previous section, results show that older vehicles have more reject inspection results. Thus, during those inspections less major defects were detected and more minor defects were identified. This shows that the vehicle systems suffer from a progressive degradation.

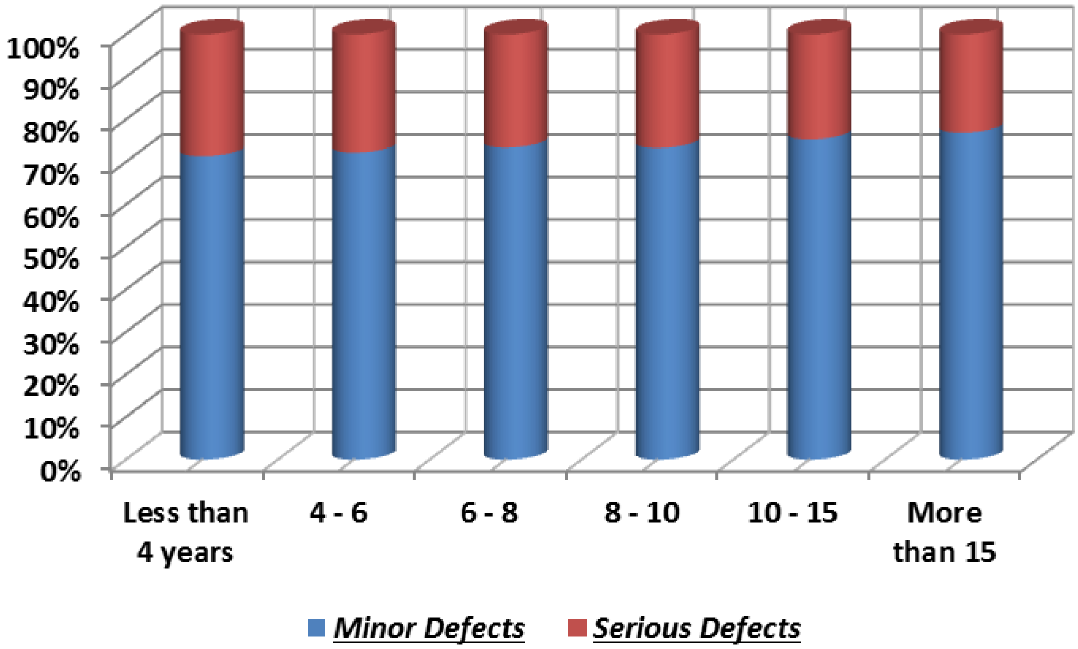

Figure 11. Passenger vehicle inspection defects attending to vehicle age

5.5.2.- Motorbikes and mopes.

For motorbikes and mopeds the number of major defects decreases with vehicle age, as depicted in Figure 12. Therefore, conclusions are the same ones as those explained in the previous section.

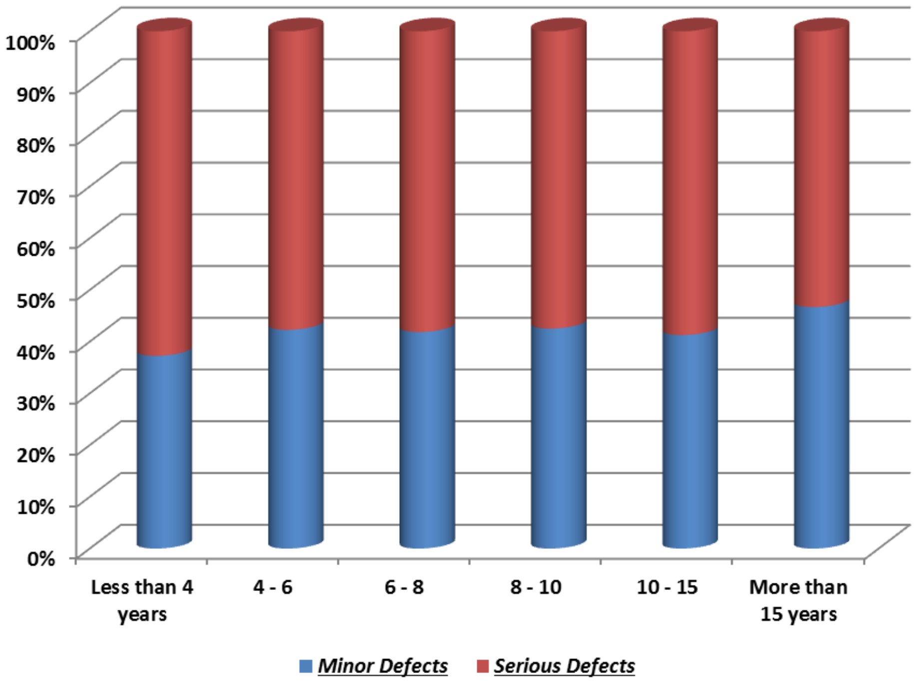

Figure 12. Motorbikes and mopeds defects attending to vehicle age.

5.5.3.- Light duty commercial vehicles

Although in Figure 13 an increasing trend in the number of minor defects with vehicle age can be identified, from Figure 13, it was found that the percentage of rejected inspections increases with vehicle age, thus, revealing a progressive degradation of the vehicle.

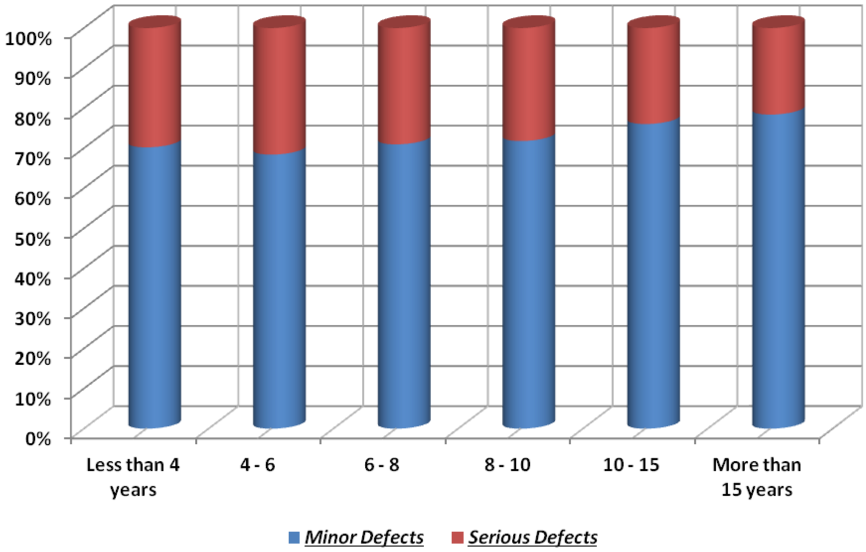

Figure 13. Light duty commercial vehicle inspection defects attending to vehicle age

5.6.- Analysis attending to major defects.

It is not only interesting to find the percentage distribution between minor and major defects but in which vehicle systems, major defects are concentrated.

5.6.1.- Passenger vehicles.

For passenger vehicles the highest percentage of major defects is concentrated in chapter four and eight of the PMVI Inspection Handbook. These chapters correspond to lights (chapter 4) and axles, wheels and suspension (chapter 8).

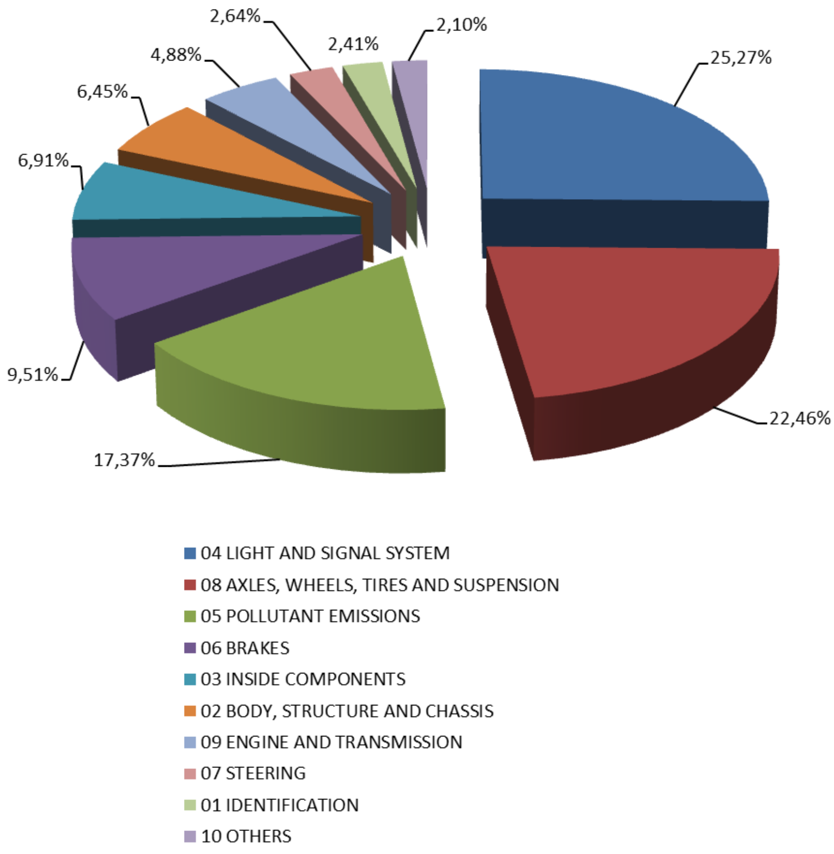

Figure 24. Percentage distribution of the major defects detected in each of the PMVI Inspection Handbook for passenger vehicles

Regarding, chapter 4 (lights and signal system) it is found that the biggest percentage of identified major defects is in dip and main beam lights, as depicted in Figure 15.

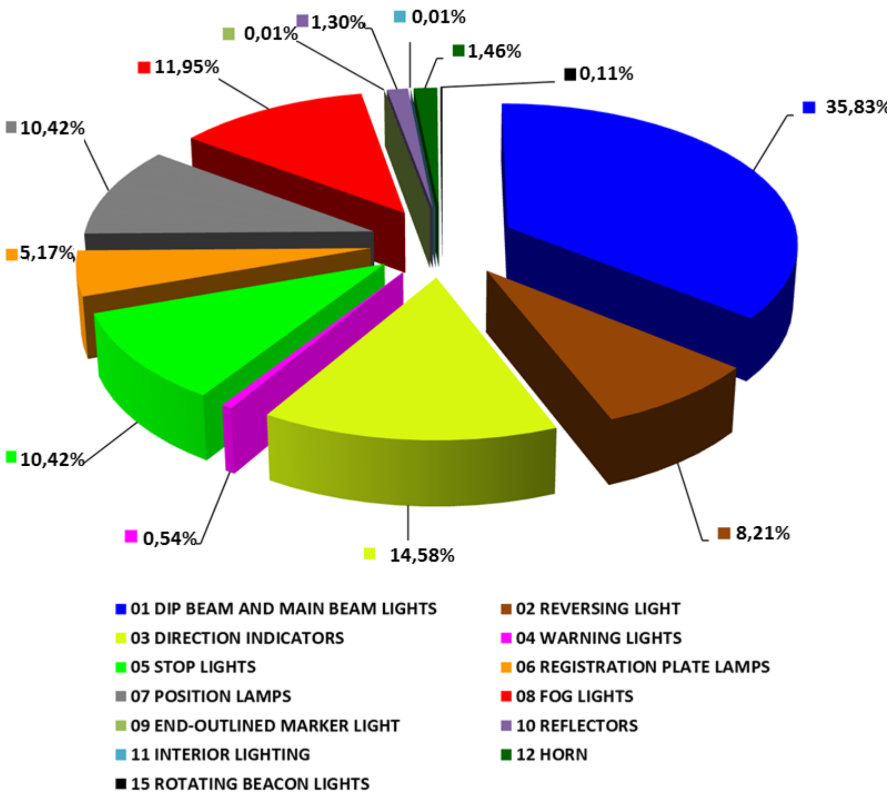

Figure 35. Percentage of major defects in chapter 4 of lights and signal system for passenger vehicles

As shown in Figure 16 the biggest percentage of major defects takes place in tires.

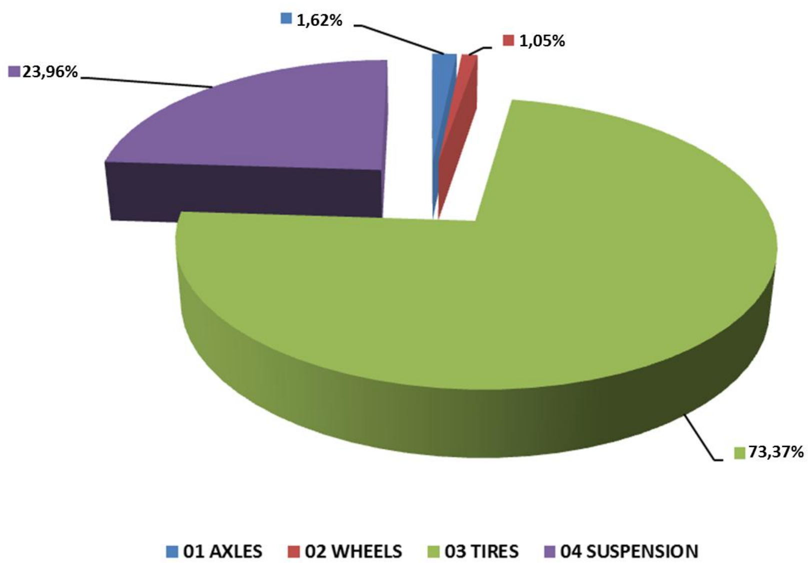

Figure 46. Percentage of major defects detected in chapter 8 of axles, wheels, tires and suspension in passenger vehicles.

It is interesting to know if the distribution of major defects regarding vehicle lights and tires has followed a trend with vehicle age. Regarding vehicle lights it has been found that vehicles with 10 or 15 years show a bigger percentage of defects than newer vehicles. In fact, it can be seen that percentage of defects in dip and main beam lights increase with vehicle age.

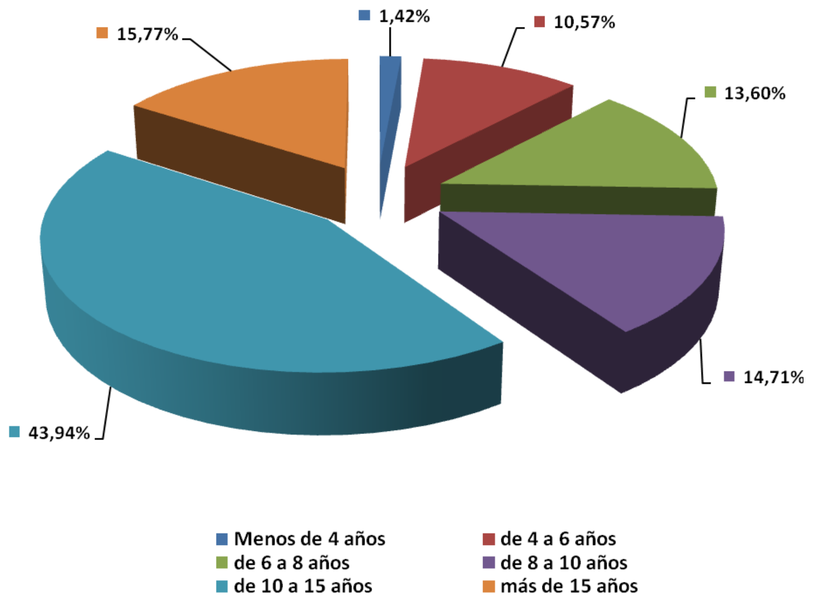

Figure 57. Vehicle age evolution of the percentage of major defects in dip and main beam lights in passenger vehicles

Tire defects with vehicle age follow a similar trend, as depicted in Figure 18.

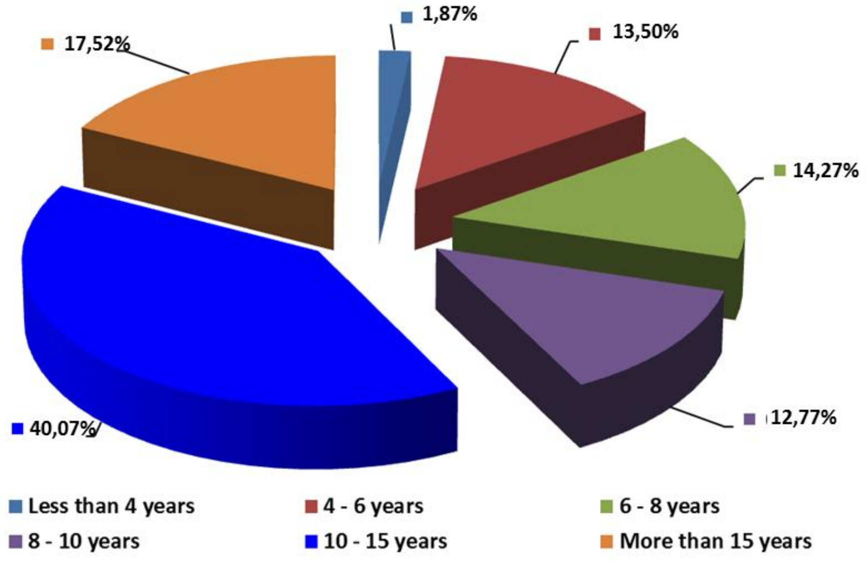

Figure 18. Percentage distribution of major defects in tires in passenger vehicles with vehicle age

5.6.2.- Motorbikes and mopeds.

Percentage distribution of major defects identified in motorbikes and mopeds is depicted in Figure 19.

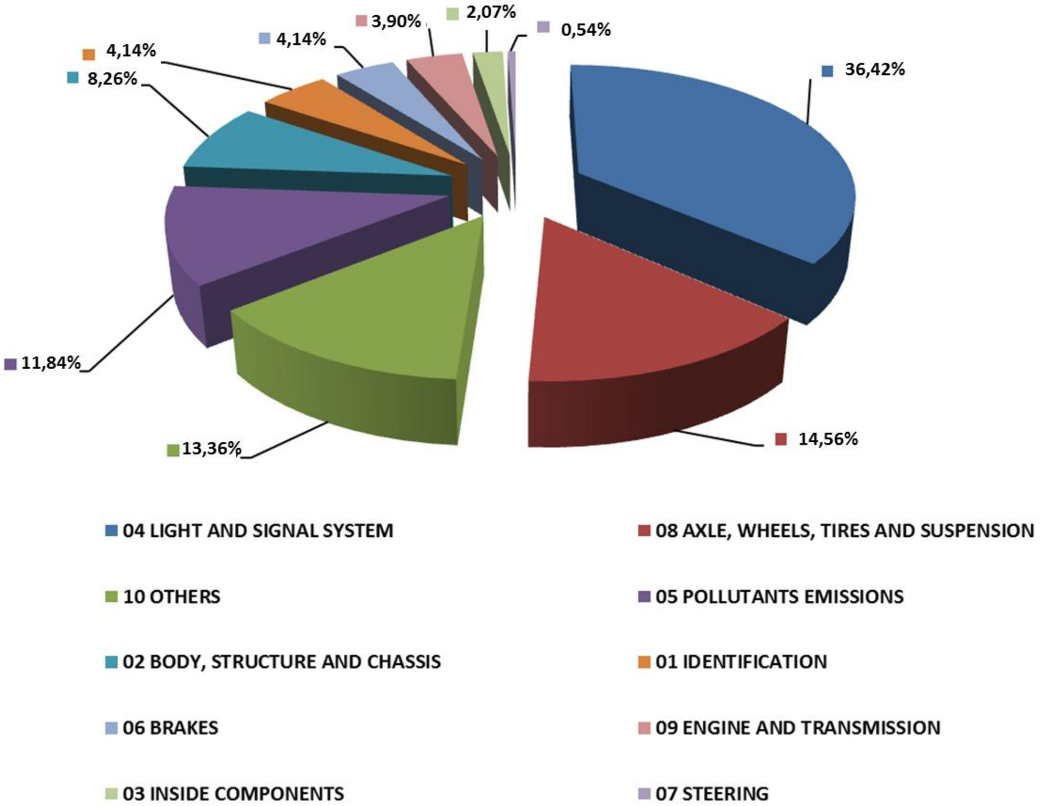

Figure 69. Percentage of major defects identified in motorbikes and mopeds

From Figure 19 it can be found that the biggest percentage of major defects is concentrated in vehicle lights followed by axles, wheels, tires and suspension. Percentage distributions of defects of vehicle lights are shown in Figure 20. The biggest percentage of defects in motorbike and moped is in reflectors.

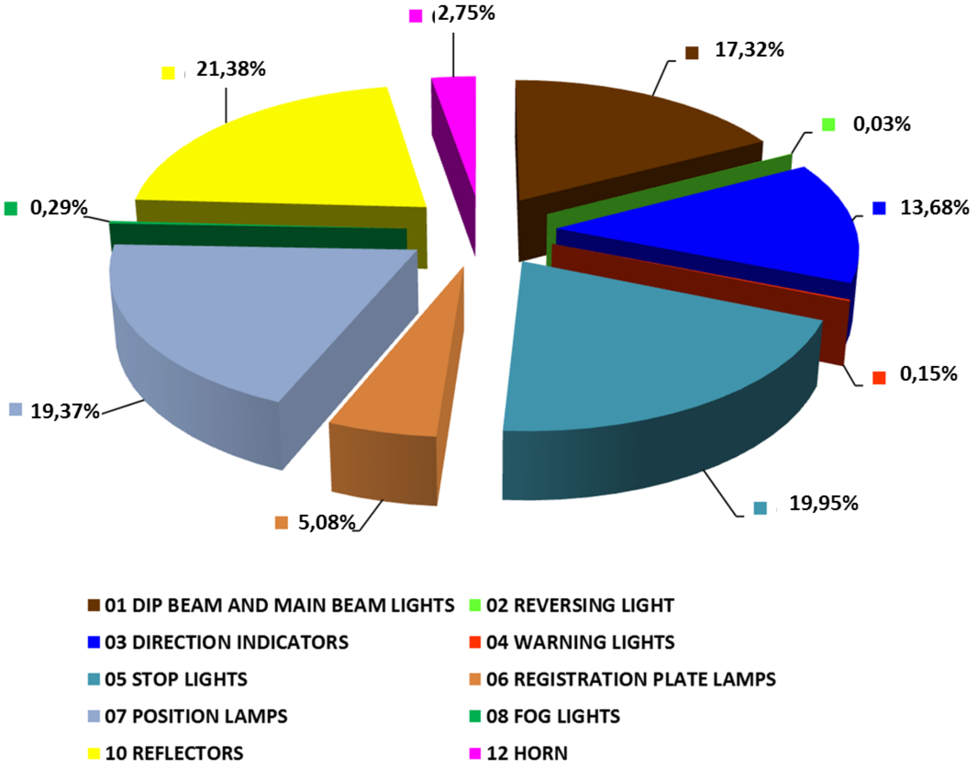

Figure 20. Percentage distribution of major defects detected in motorbikes and mopeds lighting system

Trend between reflector defects and vehicle age is represented in Figure21.

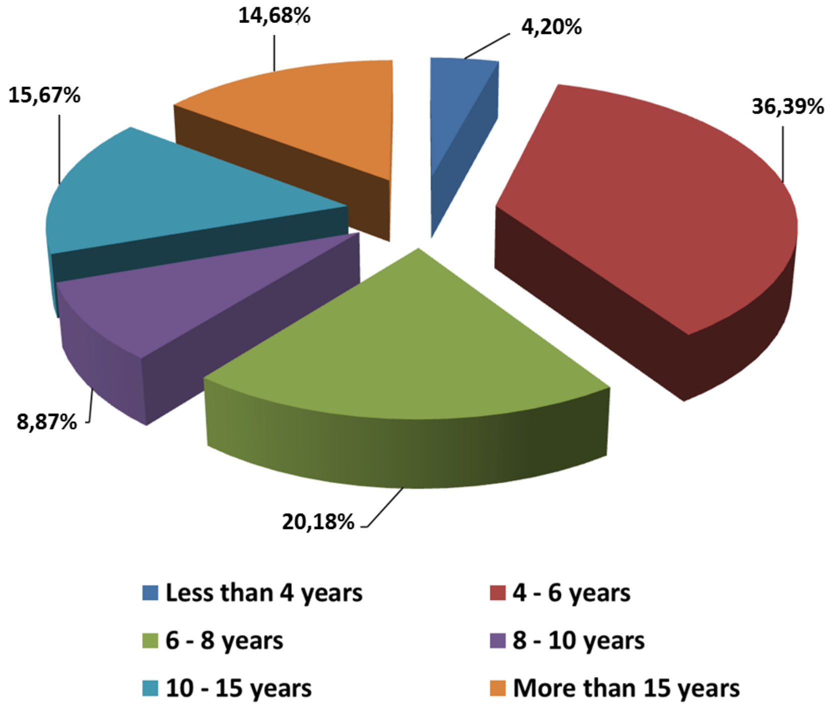

Figure 21. Percentage distribution of major defects of motorbikes and mopeds reflectors with vehicle age

The biggest percentage of major defects of reflectors take place in motorbikes and mopeds which have between 4 and 6 years.

5.6.3.- Light duty commercial vehicles.

For light duty commercial vehicles the biggest amount of major defects is concentrated in vehicle lights, as depicted in Figure 22. Lighting major defects represents 26% of the identified major defects. The second most found major defect is in axles, wheels, tires and suspension.

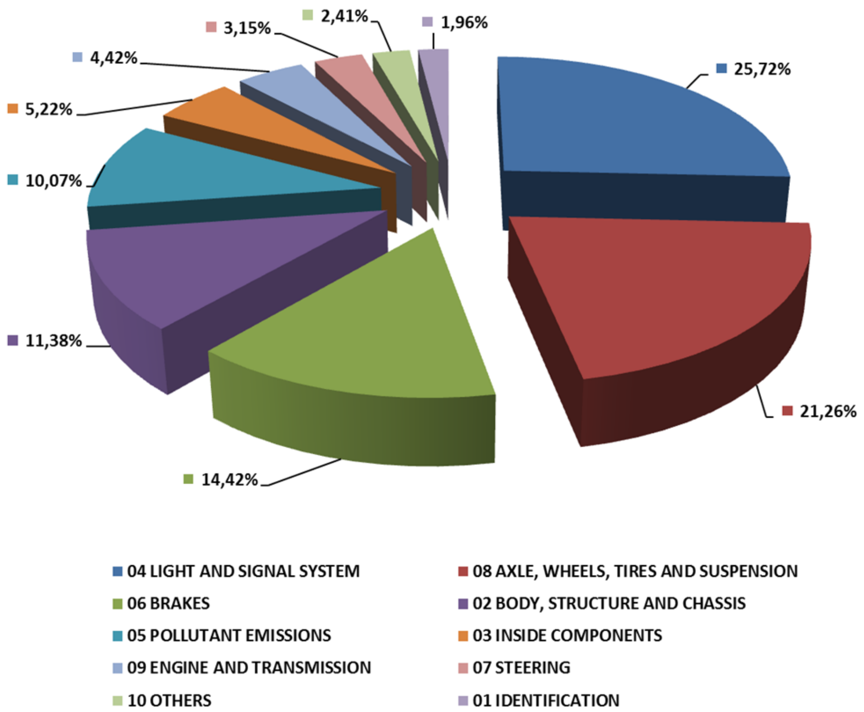

Figure 22. Percentage of major defects in light duty commercial vehicles

From the identified major defects, these concentrate in dip and main beam lights, as shown in Figure 23.

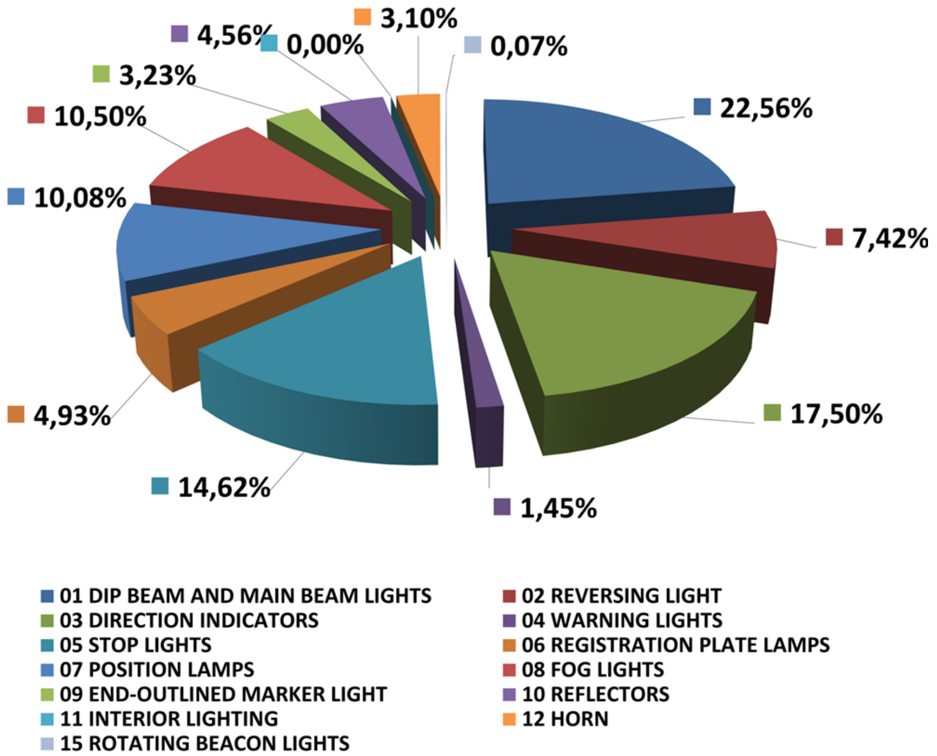

Figure 73. Percentage of major defects detected in the light duty commercial vehicle lighting system

Analyzing the trend of dip and main beam lights with vehicle age it is observed that the percentage of major defects increases for vehicles between 4 and 15 years (view Figure 24).

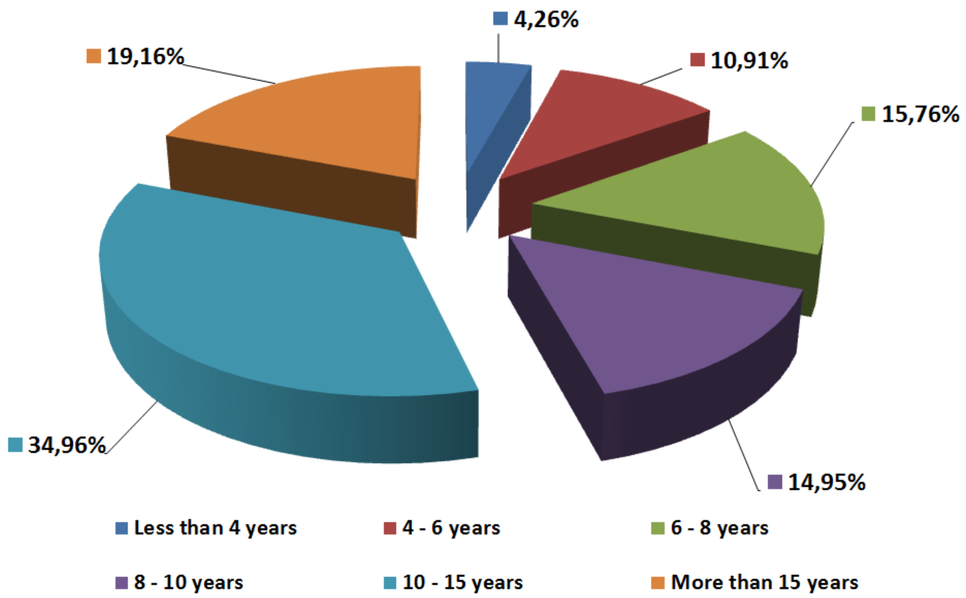

Figure 24. Percentage of major defects in dip and main beams of light duty commercial vehicles with vehicle age

5.7.- Comparative analysis of the analyzed sample.

5.7.1.- Attending to inspection result.

Figure 25 shows a comparative analysis of inspection result for the analyzed sample.

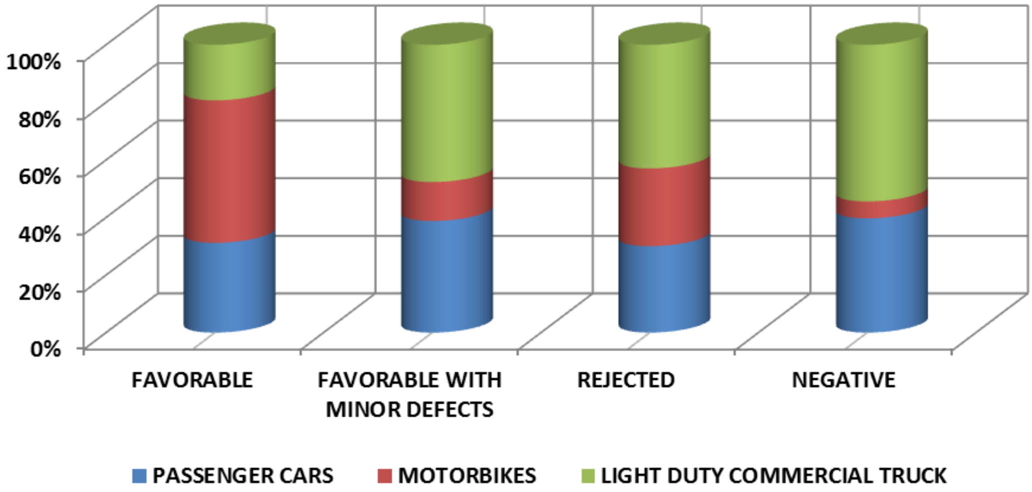

Figure 85. Comparative analysis of inspection result for analyzed sample

From Figure 25 it is found that light duty commercial vehicles have a bigger percentage of rejection, negative and favorable with minor defects inspection results with respect to the complete simple. It is also seen that the biggest percentage of favorable inspection results is in motorbikes and mopeds.

5.7.2.- Attending to vehicle age.

A comparative analysis of the inspection result attending to vehicle age has been performed. Results are shown in Figure 26. For clarity, the selected values correspond to the most extreme vehicle age values, that is, for vehicles with less than 4 year and for vehicles with more than 15 years.

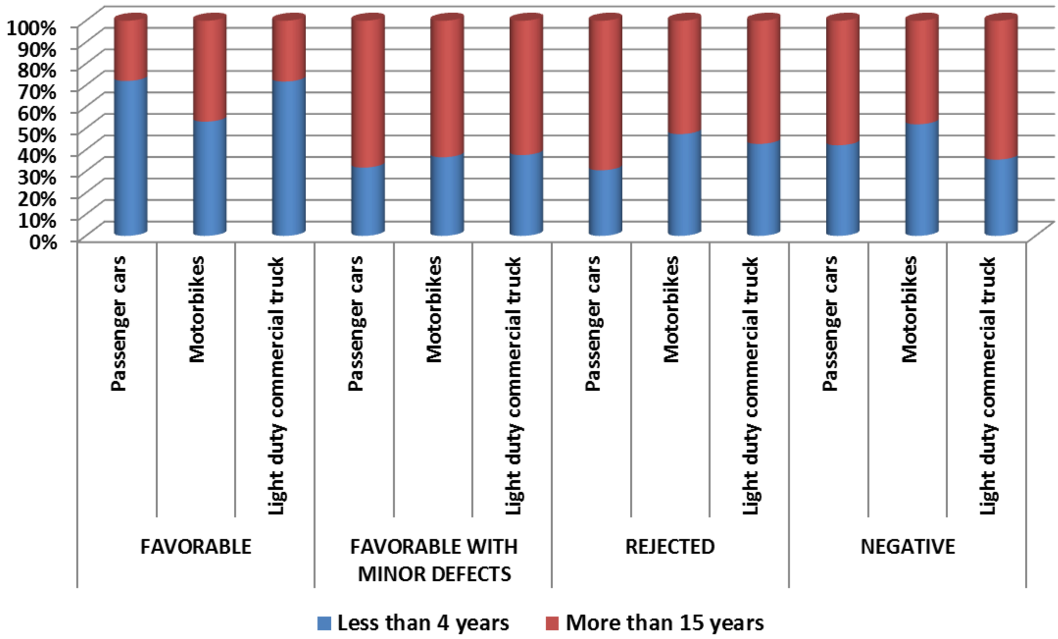

Figure 9. Comparative analysis of the inspection result attending to vehicle age

For the three analyzed type of vehicles it is observed that there is a bigger percentage of favorable inspections for newer vehicles. However, when the inspection result is favorable with minor defects, unfavorable and negative the trend is reversed, thus, older vehicles have more defects. Therefore, older vehicles have more defects and therefore they are statistically more dangerous.

5.7.3.- Attending to major defects.

In the previous sections it was found that the number of passenger vehicles with major defects concentrated in vehicle lighting (chapter 4 of the Inspection Handbook) and in axles, wheels, tires and suspension (chapter 8 of the Inspection Handbook). Regarding motorbikes and mopeds the percentage of major also falls in both vehicles systems. Light commercial duty vehicles also have the biggest percentage of major defects in vehicles lights and in axles, wheels, tires and suspension. To compare major defects in the three types of vehicles three major defects have been selected: vehicles lights, axles, wheels, tires and suspension and brakes.

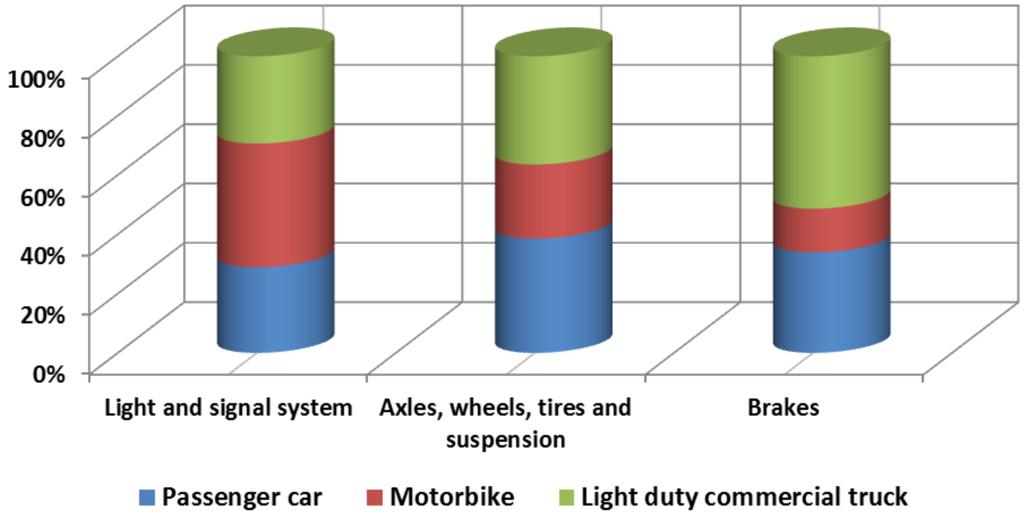

Figure 107. Comparative analysis of inspection result attending to major defects

The comparative analysis, shown in Figure 27 reveals that comparing the three types of vehicles, the biggest percentage of major defects in brakes takes place in light duty commercial vehicles. In addition, it is found that that passenger vehicles have the biggest percentage of major defects in axles, wheels, tires and suspension, while motorbikes and mopeds in lights.

6. ANALYSIS OF VEHICLE ROAD SAFETY.

Vehicle inspection is of paramount importance in terms of road vehicle safety. Taking into account that each day there are more than five fatalities in accidents caused by technical failures, the European Commission wants to reinforce vehicle inspection and expand it.

Vehicle technical defects contribute in an important way to accidents. From the total of vehicle accidents, **6%** of them are due to vehicle technical defects, representing 2.000 fatalities. This rate increases to **8%** in the case of motorbike accidents.

The main problem is that in the roads there are too many vehicles with technical defects. Some recent reports from United Kingdom and Germany point out that up to 10% of the automobile vehicles suffer form a technical defect that yields a rejection inspection result. In addition, the current inspection standards do not require a control of certain vehicle faults that do have severe consequences in vehicle safety, such as ABS or stability electronic control.

Current EU regulation that describes the minimum standards by which vehicles should be inspected was defined in 1977. Since then, small updates have only been included. However, driver's behavior and vehicle technology has deeply changed since then.

The new regulation proposal aim is to save more than 1.200 lives per year and avoid more than 36.000 accidents involving technical vehicle defects.

In words of Vicepresident Siim Kallas, responsible of Transports, *«If we drive a car that is not in good conditions to be driven we become a danger to ourselves, family, co-workers, etc. In fact, we put in danger other road users. It is not difficult to understand. We do not want potentially lethal vehicles in our roads.»*

Attending to the latest figures published by the European Commission, the reduction rate of the number of fatalities considerably slowed down in 2011 (-2%), after a promising reduction in the whole EU during the last decade (a mean of -6%). In fact, some Member States of the EU, such as Germany and Sweden, that performed well in vehicle safety, now have seen how the number of road vehicle fatalities is increasing. In other states such as Poland and Belgium, already lagging behind in road safety, the number of road vehicle fatalities has increased. It still remains the problem of motorbikes, for which the number of road fatality accidents still does not diminish after more than a decade.

Siim Kallas, European Transport Commissioner, has declared: *«These figures are an alarm signal. It is the slowest fatality road accident reduction in a decade. 85 people die in the European roads each day. This is unacceptable. We have to considerably intensify the efforts done at national and EU scale to achieve the aim of reducing to halve the number of road accident fatalities from today to 2020. I will address the Ministers of the Member States to collect information regarding national road safety action plans for 2012. I want to be sure that, even during the most difficult economic era, this crucial work is not strayed. At EU level I propose that during 2012 we focus in motorbikes to reverse the current trend and reduce the number of motorcyclists fatalities in road accidents »*

The following table shows the progress of the number of fatalities registered since 2001. The figures include the whole EU and also include the most recent data from 2011.

Table 10. Traffic fatal accidents by country

State Member	**Fatalities per million population**			**Evolution of fatalities**		
	2001	**2010**	**2011 (provisional)**	**2001-2010**	**Annual average reduction**	**2010-2011 (provisional)**
Belgium	145	**75**	77	-45 %	-6 %	4 %
Bulgaria	124	103	88	-23 %	-3 %	-15 %
Czech Republic	130	76	73	-40 %	-5 %	-4 %
Denmark	81	46	40	-41 %	-6 %	-18 %
Germany	85	45	49	-48 %	-7 %	10 %
Estonia	146	58	75	-61 %	-10 %	29 %
Ireland	107	47	42	-49 %	-7 %	-13 %
Greece	172	**111**	97	-33 %	-4 %	-13 %
Spain*	136	**54**	50	-50 %	-9 %	-6 %
France	134	**62**	61	-51 %	-8 %	0 %
Italy*	125	**68**	65	-42 %	-6 %	-4 %
Cyprus	140	**75**	88	-39 %	-5 %	18 %
Latvia	236	**97**	80	-61 %	-10 %	-18 %
Lithuania	202	**90**	92	-58 %	-9 %	-3 %
Luxembourg	159	**64**	70	-54 %	-8 %	13 %
Hungary	121	**74**	64	-40 %	-6 %	-14 %
Malta	41	**36**	41	-6 %	-1 %	13 %
Netherlands*	62	**32**	33	-46 %	-7 %	2 %
Austria	119	**66**	62	-42 %	-6 %	-6 %
Poland	145	**102**	109	-29 %	-4 %	7 %
Portugal	163	**79**	74	-44 %	-6 %	-6 %
Romania	109	**111**	94	-3 %	0 %	-15 %
Slovenia	140	**67**	69	-50 %	-7 %	1 %
Slovakia	114	**68**	59	-40 %	-5 %	-6 %
Finland	84	**51**	54	-37 %	-5 %	6 %
Sweden	66	**28**	33	-54 %	-8 %	18 %
United Kingdom*	61	**31**	32	-47 %	-7 %	5 %
UE	**112**	**62**	**61**	**-43%**	-6 %	**-2 %**

* Preliminary data based on the last available data. Estimations from UK and the Netherlands are from January to September. Estimations of Italy and Spain are based on data collected by Police, except in urban areas.

During the last decade there have been significant advances in the framework of the European Road Safety Action 2011-20. Road accident fatalities have reduced to nearly 45% and more than 125.000 lives have been saved.

The number of fatalities in road accident in the EU has decreased, by average, 6% per year. There have been years during which this reduction has reached 11% (2010).

Analyzing the trend as a function of the type of user it can be found that although the number of fatalities between drivers, pedestrians, cyclists and moped riders has decreased since 2001, did not occur among motorbikers.

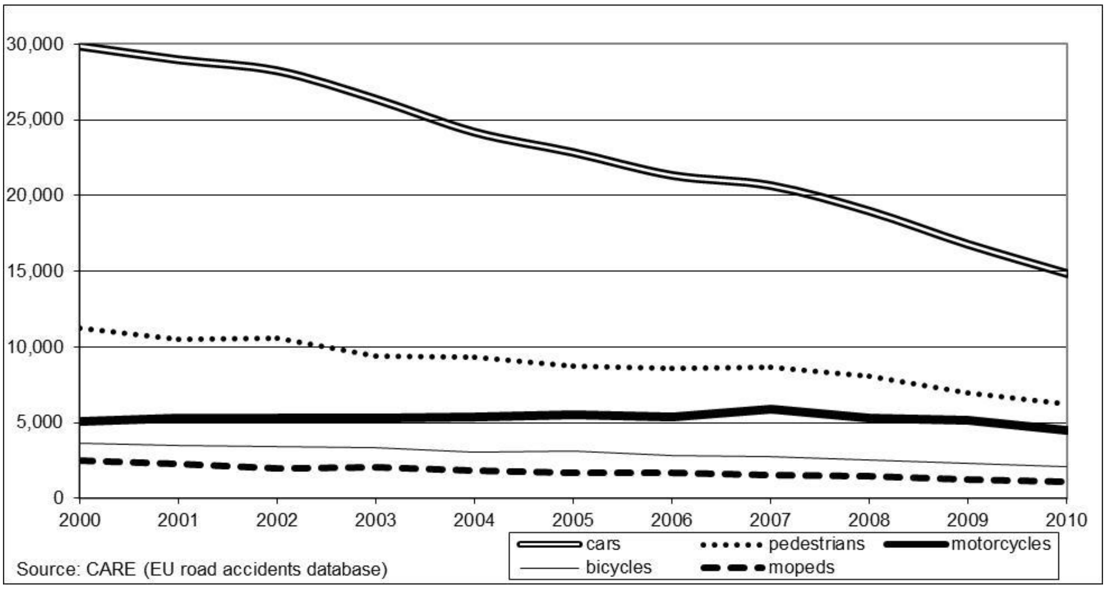

Figure 118. Trend of accidents with fatalities in the EU (all users) between 2000 and 2010

In July 2010, the Commission adopted ambitious plans to reduce to halve the number of fatalities in the European roads along the following ten years. The proposals for road safety 2011-2020 range from establishing thorough standards for vehicle safety to an improvement in users vehicle safety knowledge. The Commission is collaborating with the Member States to apply this program.

The road safety action establishes a combination of initiatives focused in improving vehicles, infrastructures and road user behaviour.

There are seven strategic aims:

- **Better safety measures for vehicles.**

A lot has already been done during the period between 2001 and 2010, regarding vehicle «passive» safety systems, such as the seatbelt and airbags. Between 2011 and 2020 a set of new measures of «active safety» will be implemented such as:

- Compulsory electronic stability control (in passenger vehicles, busses and trucks to reduce the risk of rollover and unstable manoeuvres).
- Compulsory lane keeping system (for trucks and busses).
- Compulsory emergency automatic braking system (for trucks and busses).
- Compulsory seatbelt reminder (for passenger cars and trucks).
- Compulsary limiting speed system for light duty commercial vans and vehicles (already exists for trucks).
- For electric vehicles, the Commission will present a set of specific measures to establish safety technical standards.
- The Commission will study the possibility of extending the application of driver advanced systems (like collision warning systems), adapting them for commercial and private vehicles.

Since 2003, the EU law has been reinforced in order to reduce injuries to the most vulnerable group of population, such as pedestrians or cyclists. This could be achieved by establishing compulsory energy absorption elements in the front part of the vehicles as well as blind spot mirrors. New measures will have to be studied in this field.

On the other hand, the Commission will reinforce the EU legislation regarding vehicle technical inspection to establish a reciprocal recognition of these inspections. In this way vehicle inspections done in a Member State will be recognized as valid by others Member States.

- **Construction of safer roads.**

- **Development of intelligent vehicles.**

- **Strengthening of training and licensing.**

- **Better compliance of legislation.**

- **Reduction of injuries.**

- **Preferential attention to motorbikers.**

The Commission will be especially focused in motorbikers and other two-wheel vehicles. While in other type of vehicles for transportation there has been an important reduction of the number of accidents with fatalities and injuries with time, figures do not show the same trend in motorbikers.

A set of European measures are proposed for two-wheel vehicles:

- Installation of safety measures such as, compulsory installation of advanced braking systems and automatic activation of dipped beams. Another important measure is avoidance of manipulation of speed limiter (to avoid elimination of speed limit control) for certain two-wheel vehicles.
- Establish new technical standards regarding protecting equipment (such as the clothing) and study the viability of including airbags to motorbikes.
- Extend the EU legislation regarding vehicle technical inspections to motorbikes and other two-wheel vehicles (currently lacking in the legislation).

6.1.- Road safety situation in Spain.

In this section the historic evolution of accidents is analyzed attending to the following criteria:

- Attending to the type of victim.
- Attending to the type of vehicle.
- Attending to the type of accident.
- Attending to the time of the year.
- Attending to the vehicle technical state.
- Attending to the type of victim.

Next, results of accidents attending to the type of vehicle and most probable cause are shown. The aim is to analyze the possible relationship between the cause of the accident and the detected defects during vehicle technical inspection.

Along the last years there has been a significant reduction in the number of fatalities, accidents with fatalities and serious injuries in road, as shown in the following table.

Table 11. Evolution of the number of accidents with fatalities, fatalities and serious injuries (Source: TGC)

	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008	Year 2009	Year 2010	Year 2011
Road fatal accidents	3624	3452	3377	3415	2992	2813	2601	2415	1928	1696	1547	1338
Fatalities	4241	4067	3967	3993	3464	3268	2989	2741	2180	1903	1729	1479
Severely injured	18989	18944	18693	19493	15008	15304	15141	13542	11363	8975	7841	7069

Values shown in the previous table have been represented, as depicted in the following figure.

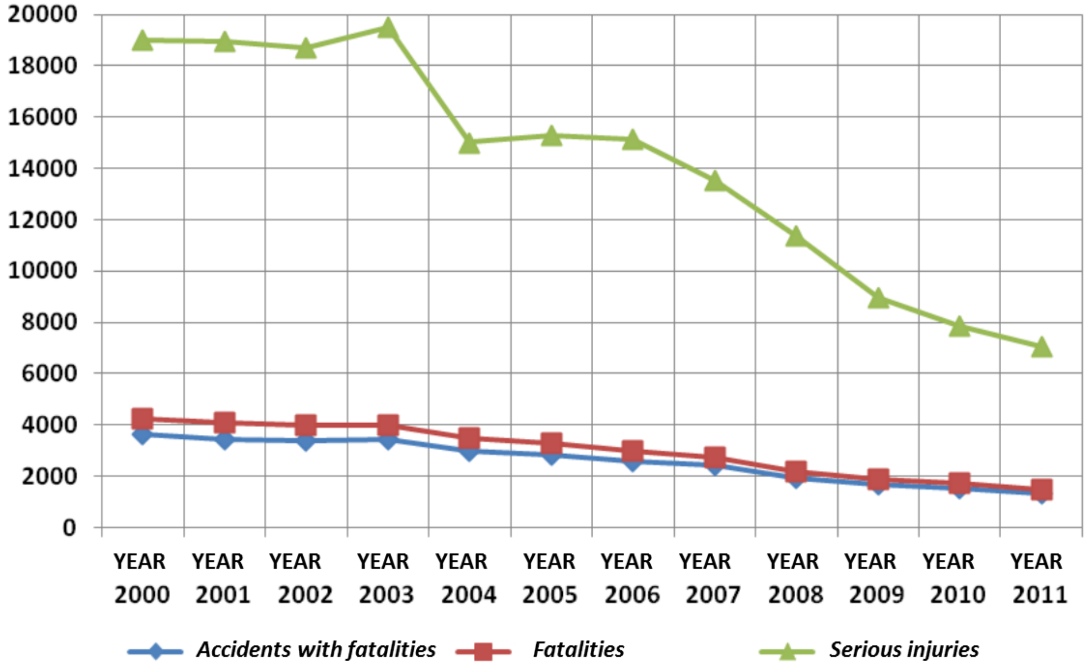

Figure 12. Evolution of the number of accidents with fatalities, fatalities and serious injuries

A detail of the time evolution of the number of fatalities is shown in Figure30.

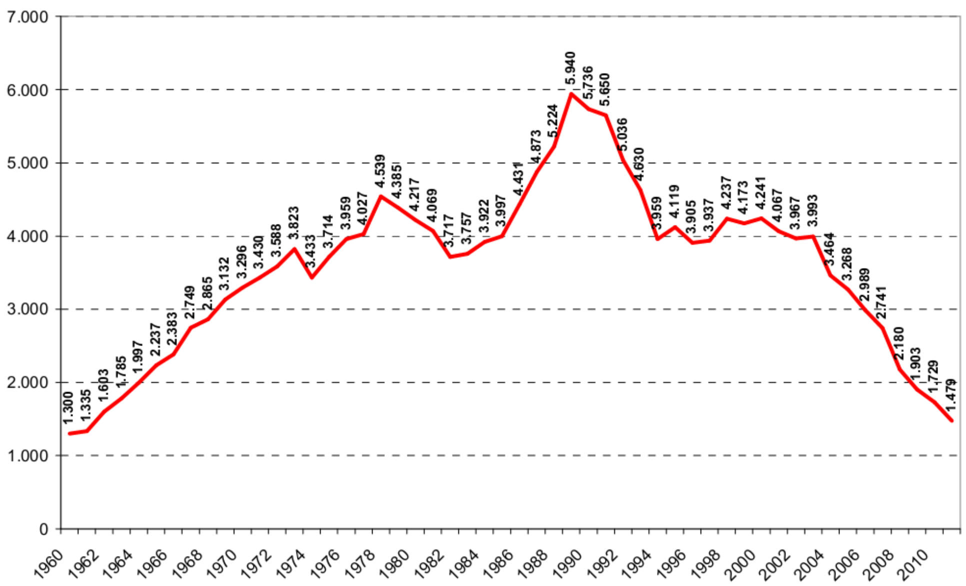

Figure 30. Evolution of the number of fatalities (Source: DGT)

6.1.1.- Attending to the type of vehicle

The historic evolution of the number of fatalities in road attending to the type of vehicle is shown in Table 12.

Table 12. Evolution of the number of fatalities in road attending to the type of vehicle (Source: Traffic General Centre - TGC)

	Year 2000	Year 2005	Year 2009	Year 2010	Year 2011
Moped	227	142	73	44	32
Motorbike	259	319	284	244	235
Passenger cars	2730	2021	1044	1006	824
Van	239	172	128	92	78

Graphic representation of the values shown in Table 12 is depicted in Figure 31.

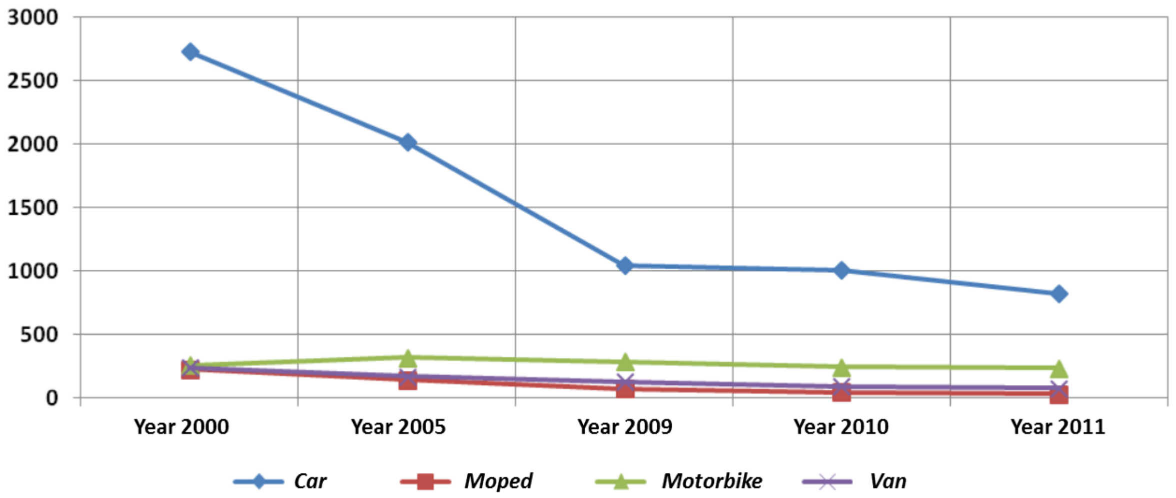

Figura 13. Evolución temporal del número de víctimas mortales según tipo de vehículo (Fuente: Traffic General Centre - TGC)

The biggest number of fatalities takes place in passenger vehicles with 824 fatalities, which represents 56% of the fatalities. The second type of vehicle that registers a bigger value of the number of fatalities are the motorbikes, with 235 fatalities, which represents 16% of the total. With respect to 2010 there has been a reduction of the number of fatalities in 18% for passenger vehicles, in 3,7% in motorbikes and in a 15% in vans.

Taking as a reference year 2000 the decrease in the number of fatalities is even bigger. Therefore, in the case of passenger vehicles there has been a reduction of 70%, 86% in the case of mopeds, 9% in the case of motorbikes and 67% in the case of vans. Thus, with respect to year 2000 there has been a reduction in the number of fatalities in passenger vehicles, mopeds and vans of at least 67% whereas the lowest reduction has been for motorbikes with a 9%.

6.1.2. Attending to the type of accident

In Table 13 the number of fatalities attending to the type of accidents is shown.

Table 13. Evolution of the number of fatalities attending to the type of accident (Source: Traffic General Centre - TGC)

	Year 2000	Year 2005	Year 2009	Year 2010	Year 2011
Head-on collision	751	635	316	307	330
Side collision	131	98	44	37	24
Broadside collision	738	564	281	271	197
Multiple collision and Rear-end collision	347	247	153	173	131
Run-off-road collision	1642	1235	752	619	540
Other type of accident	181	154	142	124	80
Pedestrian hit and run accident	376	297	169	157	147
Rollovers	75	38	46	41	30
Total per year	4241	3268	1903	1729	1479

In Figure 32 a graphic representation of the data shown in Table 13 is shown.

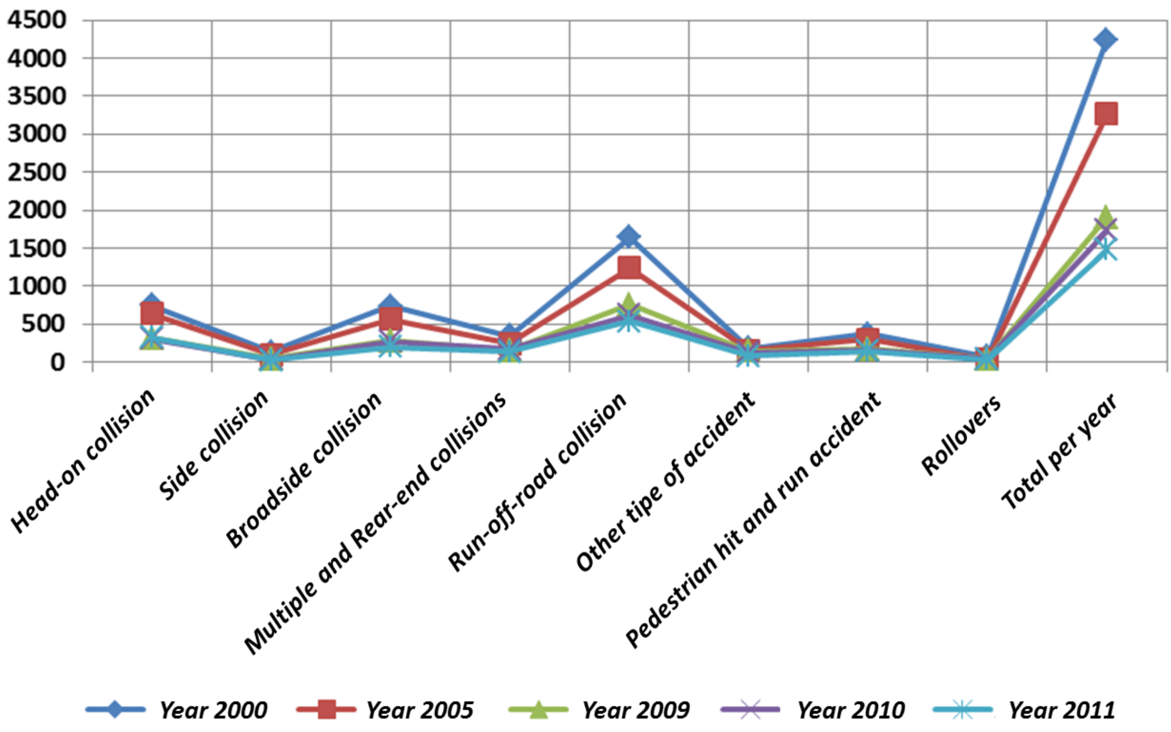

Figure 32. Evolution of the number of fatalities attending to the type of accident (Source: Traffic General Centre - TGC)

From the data it has been found that the run-off-road collision is still the most common accident with fatalities during 2011. The only type of accident that has increased with respect to 2010 is head on collision, registering an increase of 8%. This type of accidents is relatively frequent in conventional roads. In fact, in this type of road 24% of the accidents have been head on collisions.

With respect to 2000, although there has been a reduction of the number of head on collisions, this type of accident has had the lowest reduction (56%). However, side impacts have been reduced in an 82%, angle impacts in a 73% and run-off-road in 67%.

6.1.3. Attending to the time of the year

Although during summer time it is when there are more average day victims, in 2011, a total of 5,2 fatalities per day were registered assuming a reduction of 9 fatalities per day in comparison with 2000, as depicted in Figure 33.

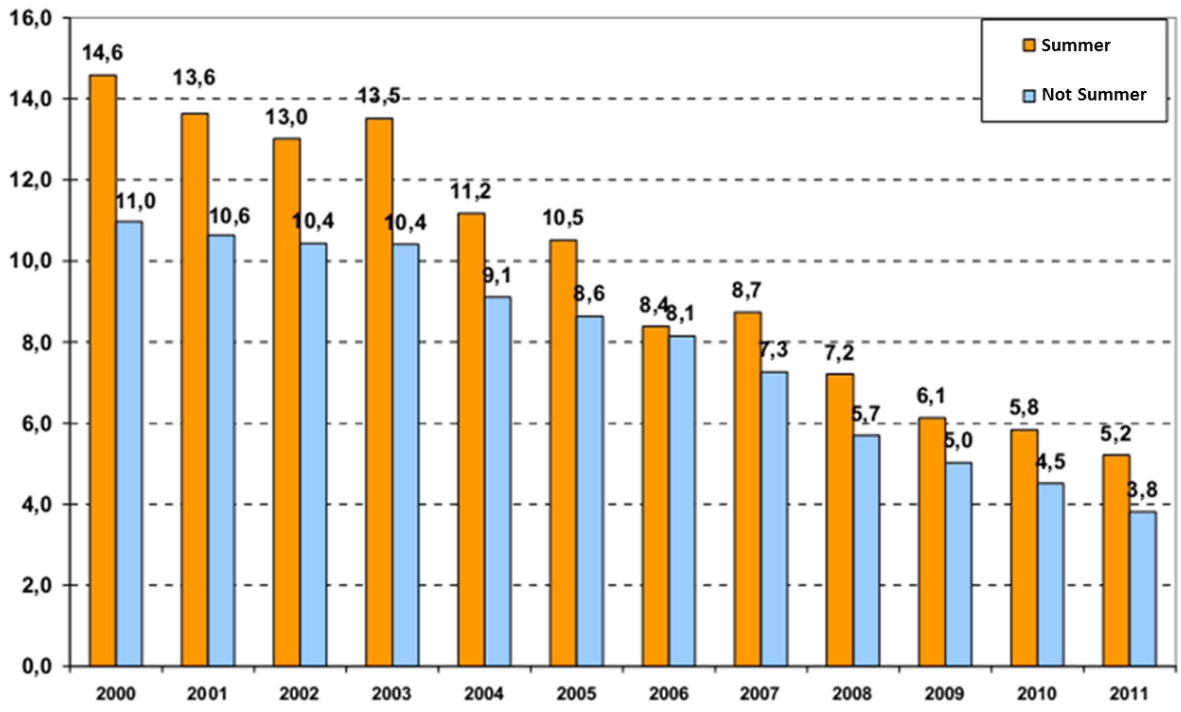

Figure 33. Average day number of fatalities in road accidents (Source: Traffic General Centre - TGC)

6.1.4. Attending to the vehicle technical state

The percentage of vehicles involved in road accidents with victims as a function of vehicle technical state condition is depicted in Figure 34.

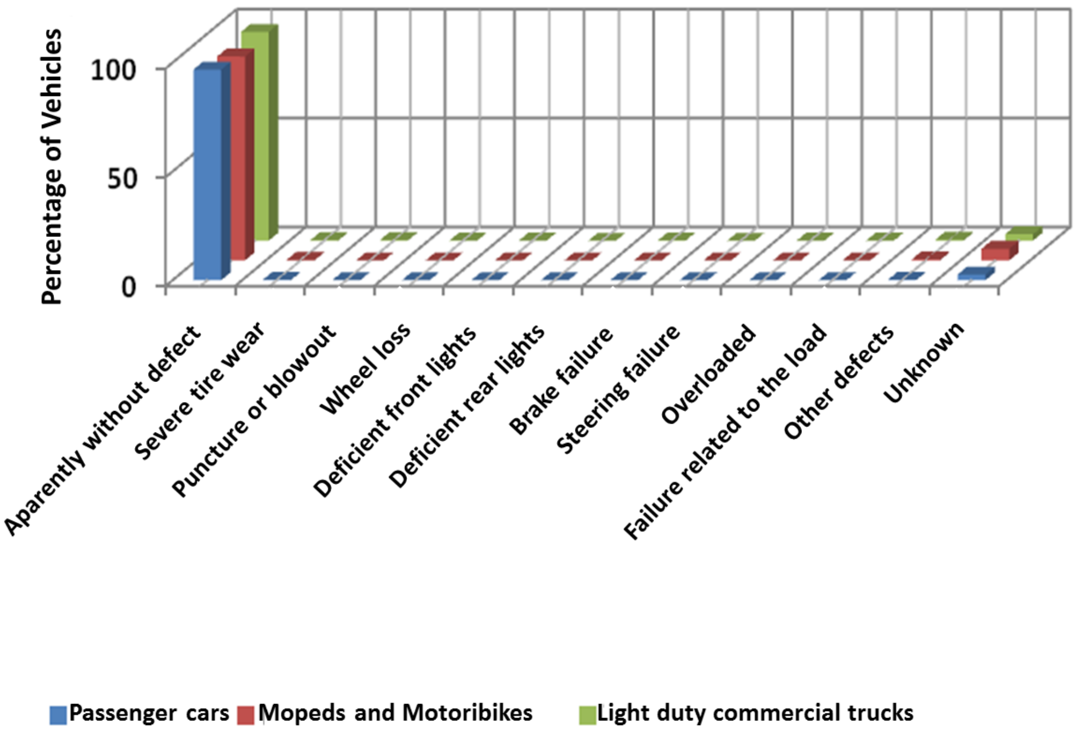

Figure 14. Percentage of vehicles involved in road accidents with victims attending to the vehicle technical state
(Source: Traffic General Centre - TGC)

Therefore, a high percentage of the vehicle involved in road accidents with victims apparently did not have any defect.

Ignoring the vehicle technical state “Apparently without defects”, “Other defects” and “Unknown” a relationship between the vehicle technical state and vehicle age can be found, as shown in Figure 35.

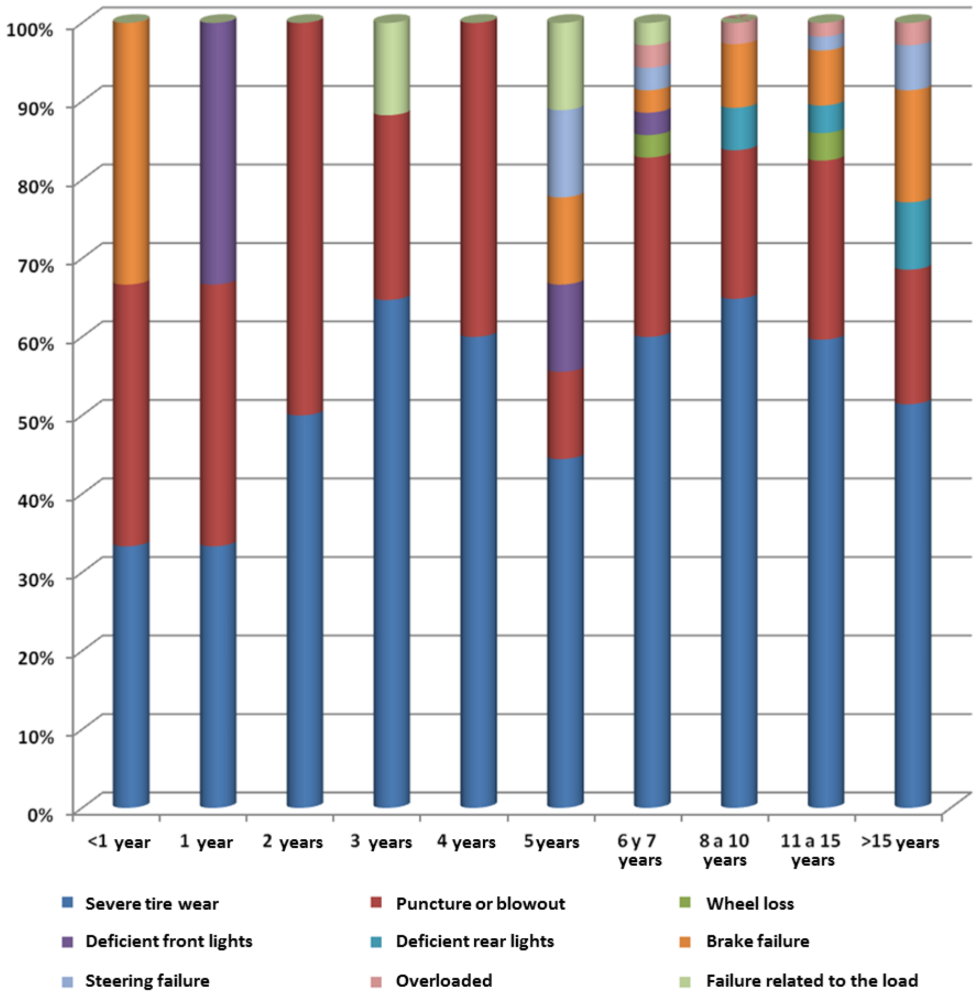

Figure 15. Vehicle technical state of vehicle involved in road accidents attending to vehicle age. (Source: Traffic General Centre - TGC)

The most observed defect in most accidents, and for all vehicle ages, it was found to be worn out tires. Regarding Figure 35, taking into account that most vehicles are passenger vehicles and bearing in mind that first vehicle inspection is done during the fourth year it can be seen that the effect of worn out tires is reduced. However, for older vehicles it is found that the trend is reversed and a bigger percentage of vehicles with worn out tires are involved in road accidents. For vehicles with age over 8 years it can be seen that the trend changes again, reducing the vehicles with worn out tires involved in accidents.

7. ESTIMATION OF THE REDUCTION OF THE NUMBER OF ACCIDENTS DUE TO VEHICLE TECHNICAL INSPECTION

The aim of this section is to evaluate the avoided accidents due to periodic motor vehicle inspection (PMVI). In addition, the aim is to estimate the reduction in the number of accidents that could be achieved if PMVI would have been done in the whole required vehicle fleet.

7.1.- Mathematical model

In the report done during 2007 entitled "Contribution of Periodic Motor Vehicle Inspection (PMVI) to Road Safety" several mathematical models were proposed based on the report entitled "Study of the Future for Roadworthiness Enforcement in the European Union (AUTOFORE)". The aim is to evaluate the impact of PMVI in the reduction of the number of accidents by means of the inspected vehicles and the number of detected defects in these vehicles, as depicted in Figure 36.

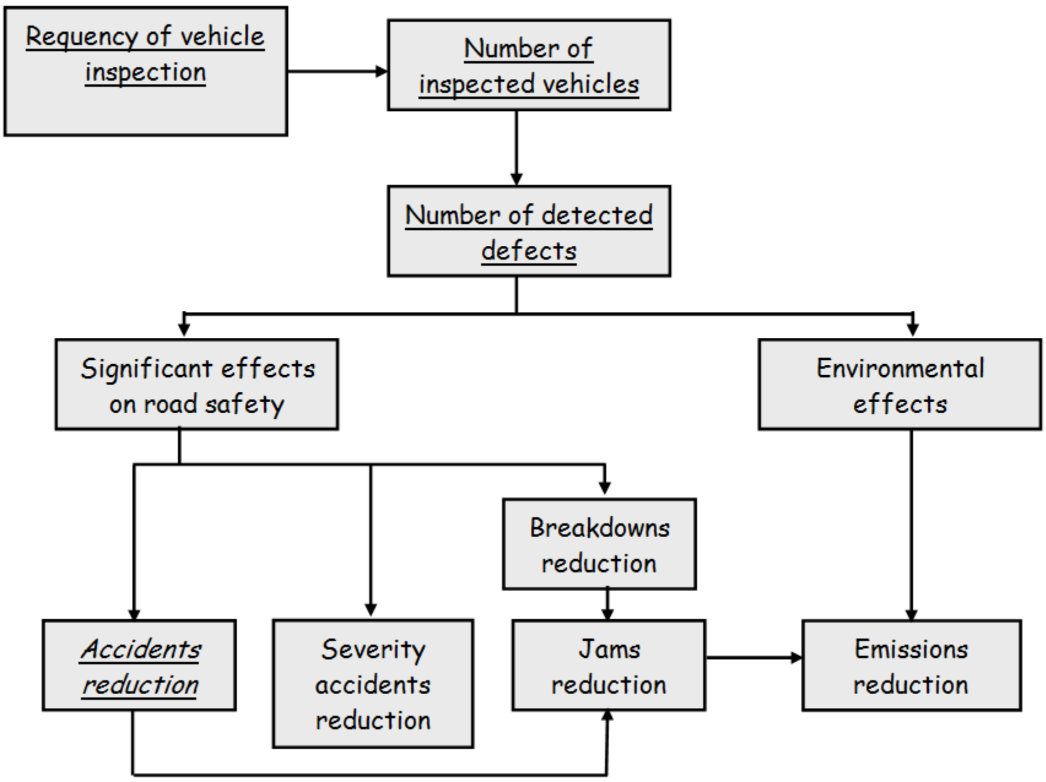

Figure 16.Contribution of the Periodic Motor Vehicle Inspection

The mathematical model used in the previous report is summarized. This model is executed in four steps.

➢ **Step 1:**

In the first place it is necessary to evaluate the number of avoided accidents due to Periodic Motor Vehicle Inspection (PMVI). The number of avoided accidents (AA) is computed by means of the following method:

In the following table the number of avoided accidents (AA) is computed. Firstly, the number of accidents in which the involved vehicles had any defect (AD) was found. The number of accidents (NA) times the rejection rate (RR) yields the number of accidents with defects (AD). This is done under the hypothesis: the probability of having a defect in a crashed vehicle is the same one as in the whole inspected vehicle sample. Finally, for countries EU-27 taking as calculation year 2001 it is admitted that 60% of the accidents are caused by defects that could have been avoided.

Table 14. Estimation of the avoided accidents

Steps	**Number of accidents**
(1) Number of accidents: NA	NA
(2) Accidents with vehicle defects: AD (2.1) Rejection rate: RR %	=NA·RR·0.01
(3) Avoided Accidents : AA (3.1) It is estimated that 60% of the accidents caused by vehicle defects could have been avoided.	=AA·0.6

Taking as an example year 2010 in Spain the explained method will be applied. All of the accidents will be taken into account without distinguishing by vehicle age. During that year the number of accidents with victims was 85.503. During that year a total of 15.781.313 vehicles were inspected and 3.121.752 were rejected. Therefore, the rejection rate is 19,78%.

Table 15. Estimation of the avoided accidents for year 2010

Steps	**Number of accidents**
(1) Number of accidents:	85.503
(2) Accidents with vehicle defects: AD (2.1) Rejection rate: RR %	16.913=85.503·19,78·0,01
(4) Avoided Accidents (4.1) It is estimated that 60% of the accidents caused by vehicle defects could have been avoided.	**10.147**

From Table 15 it can be found that **10.147 accidents during 2010 could have been avoided** due to contribution of Vehicle Technical Inspection.

- **Step 2:**

From the statistical data of accidents the number of fatalities by accident (FA) and the number of injured by accident (IA) are found.

- **Step 3:**

Knowing the number of avoided accidents, the number of fatalities and injured that could have been avoided can be computed by multiplying the number of avoided accidents and the number of fatalities per accident and the number of injured per accident, respectively.

$$\text{Avoided fatalities}=\text{Avoided accidents}\cdot\text{Fatalities per accident}$$

$$\text{Avoided injuries}=\text{Avoided accidents}\cdot\text{Injured per accident}$$

- **Step 4:**

The parameters previously obtained allow finding the ratios that measure the contribution of vehicle technical inspections to reduce accidents, fatalities and injured.

$$\frac{\text{Avoided accidents}}{\text{N}^{\text{o}}\text{of inspections}};\frac{\text{Avoided fatalities}}{\text{N}^{\text{o}}\text{of inspections}};\frac{\text{Avoided injured}}{\text{N}^{\text{o}}\text{of inspections}}$$

All of the defined parameters are computed for each year. In addition, it can be measured the influence of the change in the number of inspections from one year to another one by means of the elasticity parameter:

$$\text{Elasticity}=\frac{\text{Variation in the number of fatalities}}{\text{Variation of the number of inspections}}$$

7.2.- Relationship between the vehicle technical inspections and road accidents

Applying the method described in the previous mentioned report and explained in the previous section to vehicle inspection data of 2011 an estimation of the contribution of vehicle technical inspection to road safety can be computed:

Table 16. Impact of vehicle technical inspection in road safety

	NI	RR (%)	AV	F/AV	I/AV	AA	AI	AF	COST
PASSENGER CARS	11.073.030	18,04	66.030	14,79	965,39	7.147	6.900	106	192,18
VANS	2.938.171	24,28	8.984	14,55	669,63	1.309	876	19	30,17
MOTORBIKES AND MOPEDS	847.384	18,01	26.662	15,83	1045,83	2.881	3.013	46	83,36
TOTAL	**14.858.585**		**101.676**			**11.337**	**10.789**	**170**	305,71

Being for each vehicle:

- NI: Number of inspections (Source MINETUR)
- RR (%): Rejection rate (%).
- AV: Accidents with Victims (Source TGC)
- F/AV: Fatalities per 1.000 Accidents with Victims (Source TGC)
- I/AV: Injured per 1.000 Accidents with Victims (Source TGC)
- AA: Avoided Accidents due to PMVI.
- AI: Avoided Injured due to PMVI.
- AF: Avoided Fatalities due to PMVI.
- COST: Economic estimation of the of the avoided accidents in millions of Euros (Source: Report BASMA 2006, FITSA). It is estimated that the per unit human costs are **1.025.690 Euros in the case of fatalities and around 12.140 Euros in the case of injured.**

Thanks to the inspections done during this year **at least 11.000 accidents have been avoided, nearly 11.000 injured have been avoided and 170 fatalities have been avoided.** Considering only the costs[2] that figures represent an economic benefit of **306 M€** and taking into account the vehicles that were not inspected but had to be:

Table 17. Avoided accidents due to periodic motor vehicle inspection

	ABSENTEEISM	AA	AI	AF	COST
PASSENGER CARS	3.315.269	2.140	2.066	32	57,54
VANS	1.985.337	884	592	13	20,39
MOTORBIKES AND MOPEDS	1.200.000	4.080	4267	65	118,05
TOTAL	**6.500.606**	**7.104**	**6.925**	**109**	**195,97**

A total of **7.100 accidents, 7.000 injured and 110 fatalities could have been avoided** with a saving of **200 M€.**

[2] Road accident cost must take into account additional parameters such as the vehicle diminished value, damage of the road, costs of the emergency rescue, additional time employed by the other road users due to the accident, etc.

8. EVOLUTION AND CHALLENGES OF PERIODIC MOTOR VEHICLE INSPECTION

Vehicle technical inspection is the main tool that the Administration has to ensure that vehicles remain roadworthy keeping, in a reasonable way, the technical features with which were designed. The aim is to minimize the negative consequences arising from using motor vehicles, such as, road accidents, pollutant emissions and jams.

Therefore, there is an aspect to which efforts should be devoted to: adapt to vehicle technology evolution.

8.1.- Vehicle electronic systems.

The automotive industry has always been pioneer in the application of new technologies to their products. The high level of competition between the sector companies has led to a strong technical development from which other economic sectors have benefited. In the past years advances in the electronic computing field have led to a true revolution in design and vehicle capabilities.

Figure 17. Main vehicle systems managed with electronics.

The electronic components in vehicles have greatly improved several vehicle systems. In particular, those being inspected during PMVI, such as, occupant protection and reduction of pollutant emissions.

Electronic systems such as the anti-lock brake system (ABS), the electronic stability program (ESP) and active restraint systems (ARS) are considered to be the most important to be inspected, not only due to the great number of these systems in the current vehicle market but also due to their impact in vehicle safety.

1. Description of some of the vehicle electronic systems:

These electronic vehicle systems are safety systems designed to protect vehicle occupants. The first two (ABS and ESP) are active safety brake systems.

The third system (ARS) is the generic name given to pyrotechnic seat belts and airbags. Both of these systems have the same goal: provide an effective occupant restraint.

- **ABS: (Antilock Brake System).** The ABS controls the brake force applied in each wheel avoiding total locking during braking. Bearing in mind that the tire has more grip while turning rather than when locked, the ABS system allows reducing the stopping distance, especially during emergency braking. While the tires are not locked vehicle control is kept and the driver can effectively steer during braking.

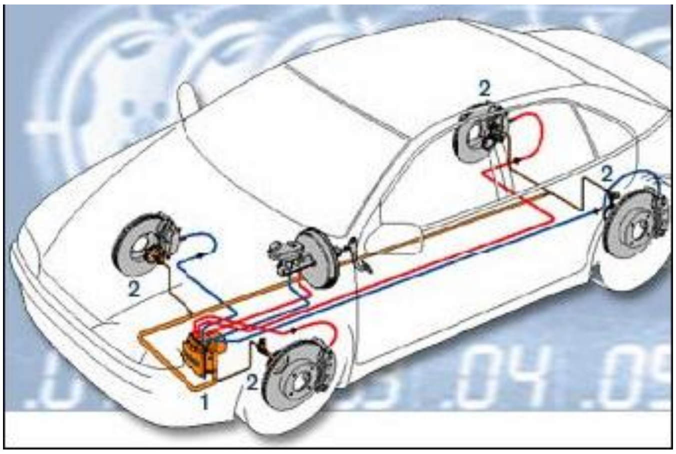

Figure 18. Layout of the main ABS components.

- **ESP: (Electronic Stability Program).** The ESP applies a brake force in the appropriate wheels to achieve the path the driver commands with the steering wheel during dangerous lateral slip. The vehicle can describe an understeering or oversteering cornering behavior.

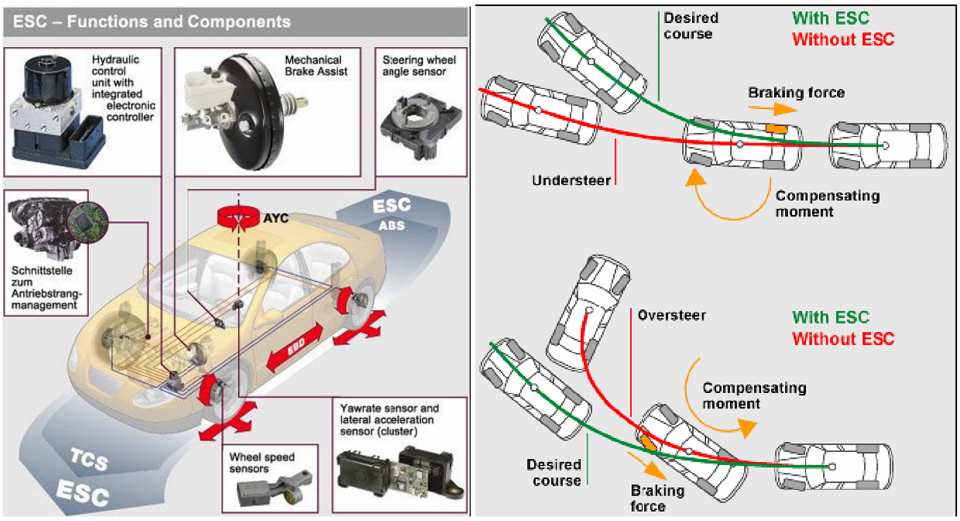

Figura 19. Elementos integrantes y esquema de funcionamiento de un ESP.

- **ARS: (Active Restraint Systems).** The active restraint systems that can be found on a vehicle are pyrotechnic seat belts and airbags. An electronic control unit manages these systems. Attending to impact sensors the electronic control unit decides on the activation of the ARS. The ARS contributes to occupant restraint during collision avoiding passengers from being thrown out from the vehicle and from impacts with other occupants or interior vehicle parts.

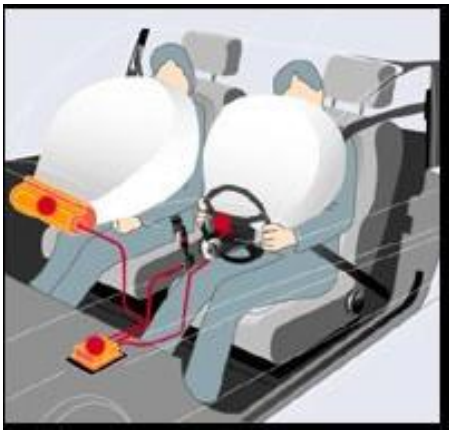

Figure 40. Airbag operation and pyrotechnic seat belt parts.

Although the electronically managed systems have internal checking's that verify their correct operation, different studies have shown that there might be non detected errors.

The report IDELSY (Initiative for Diagnosis of Electronic Systems in motor Vehicles for PTI) described several statistics like the following:

- The German road assistance service annually recovers around 3,5 millions of broken down vehicles. From the assisted vehicles during 2001, 36% of the vehicles had a defect in the electronic system. These type of vehicle defects affects all type of vehicle brands and manufacturers no matter the vehicle age.

When one of these systems detects an error the error is registered in the electronic control unit (ECU). In necessary, the error is shown to the driver by means of warning lamp known as MIL (Malfunction Indication Lamp).

Project IDELSY tested 2.234 vehicles. In the tested vehicles there was found a percentage of errors related to ECU communication. The percentage of detected faults were distributed as follows:

- ABS / ESP: 14%
- Airbag: 21%
- Vehicle lighting control: 24%
- Engine control: 44%

During 2009, ISVA (Institute of Motor Vehicle Safety) with the sponsoring of FITSA (Technological Institute Foundation for Road Safety) carried out a study entitled “Study for the incorporation of electronic diagnosis in passenger vehicle PMVI .” The report describes what type of vehicles should be controlled by means of electronic diagnosis during periodic motor vehicle inspection (PMVI). The most convenient vehicles are the passenger vehicles (type M1). In addition, the report analyzes the possibility of including in the Inspection Handbook the procedures and requirements needed to verify such technology.

Currently European Project ECSS (Electronic Controlled Safety System) in which ISVA takes part is being launched.

Attending to the current law vehicle, manufacturers can decide on which system errors must be shown to the driver and which are only registered in the ECU.

On the other hand, internal checks of the electronic systems is effective to detect error that directly influence on the management electronic system, but fault detection that influence on mechanic actuators might result less effective.

These data justify the need to do additional inspections on electronic managed systems being PMVI the best framework to do it.

The inspection of electronic systems has to be done by means of a connection between the general vehicle electronic system and the diagnostic systems. Before, vehicle manufacturers used non standard connectors that made difficult the connection of diagnosis equipments to the electronic vehicle system, thus being necessary to use a dongle. Nowadays, new legislation regarding vehicle emission pollutants (OBD, OBDII and EOBD) have forced manufacturers to use a standard connector known as DLC (Diagnostic Link Connector) defined in SAE-J1962. This connector is found in front of the drivers knees.

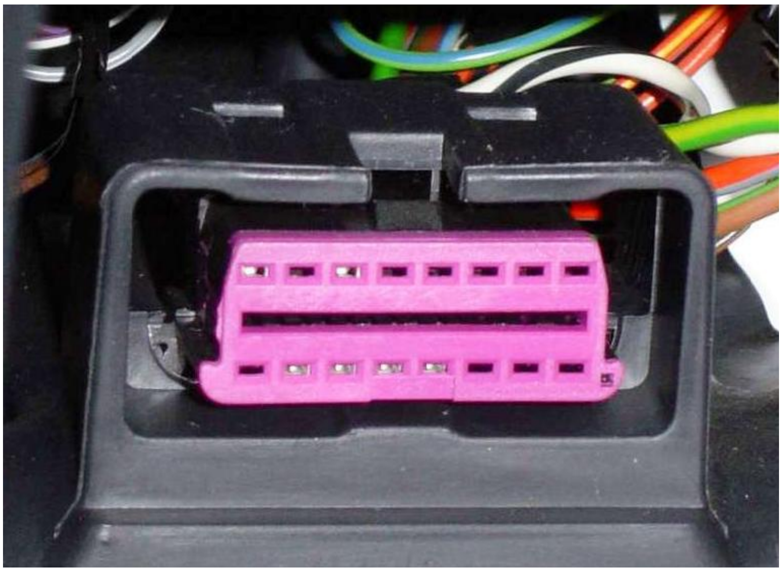

Figure 4120. Connector DLC (Diagnostic Link Connector)

The project IDELSY has shown that approximately 80% of the vehicles manufactured since 1999 could be inspected by means of the standard diagnosis systems connected to the vehicle DLC. This value widely exceeds most of the current mechanical inspected systems.

On the other hand, after the improvements introduced in the standard diagnosis systems, the average diagnosis time, is around ten minutes. Therefore, diagnosis inspection in the vehicle inspection framework is feasible.

By means of connector DLC together with the suitable communication protocol allows analyzing the electronic control unit. Different types of inspection can be proposed. The different inspection suggestions were analyzed in the report IDELSY yielding the following proposal:

- Identify the presence of the system.
- Visual check of the system and inspection of the pertinent malfunction indication lamp.
- Reading of the error codes stored in the system ECU.
- Real time reading of the data from the sensors.
- Simulate the operation with real activation of the actuators.

These tests have a rising complexity, and therefore, follow a sequential order.

Although the project IDELSY and the report done by ISVA proved that electronic diagnosis in periodic motor vehicle inspection is feasible generalization of this process still has some difficulties:

- On one hand, the existence of these systems as well as it's operation are not legislated, and therefore, standardization is not needed (with the exception of engine management modules (ECE/98/69) that led to connectors DLC).
- The development of these electronic systems play a key role in the know-how of

- the manufacturers which leads them to protect them avoiding free access to the registered data.
- The evolution of the regulations regarding vehicle inspection is very slow in comparison with vehicle technical progress. A significant example is that in 2007 there wasn't a European regulation regarding the existence of airbag in terms of vehicle inspection.

The main conclusions of the ISVA were:

- The tests done for AIRBAG, ABS and ESC are feasible and of possible application in the current PMVI stations modifying the diagnosis equipments.
- Given the rate of usage of electronically controlled safety systems in the vehicle fleet, such as ABS (50,3%), airbag (70,9%) and ESC (12,6%) and the number of errors detected during the diagnosis with the on board diagnosis system (OBD), it is recommended to check regularly the state of these systems in periodic motor vehicle inspection, as in other safety components, when determined by the Administration.
- The number of vehicles in which error codes have been detected in the analyzed systems (airbag, ABS and ESC) represent 24,7% of the inspected, with comparable results to those obtained in project IDELSY.
- The control of the electronic systems could have saved 3 lives in 2007. In addition 36 millions of Euros could have been saved up.
- The technical feasibility of the electronic diagnosis is fairly high, regarding access to connector OBD, communication protocols and diagnosis tools. Access to connectors OBD requires in 67% of the vehicles to remove some elements in order to connect the diagnosis equipment and in 9% of the mentioned vehicles a simple tool is needed.
- The average time employed to do an electronic inspection during the tests was 5 minutes. However, in a real scenario it could take between 2 and 13 minutes. The electronic inspection is increased when a removal of some panel or an additional tool is needed.
- The establishment of electronic PMVI would have a total annual cost of approximately 23 M€. The rate benefit/cost would be 1,54.

If electronic diagnosis systems want to be generally established in periodic motor vehicle inspection (PMVI), some previous steps are needed in order to make tests easier. One of these tests is creating a database with the specific features of the vehicle being inspected.

On the other hand, the trend of the next generation of vehicle should be better prepared to be inspected by third party companies, being necessary to modify design process, type approval and market output of the new vehicles.

The initiatives to be taken in this direction are clear and need of manufacturer collaboration. Thus, a specific regulation that considers PMVI as an essential part of the vehicle life cycle is needed.

The main points of this regulation should include:

- Introduction of modifications in the type approval of new vehicles with tests that prove the inspection capability by third party companies.

- Manufacturers should use standard electronic communication systems and this should be a requirement for vehicle type approval.
- Manufacturers should create a database of the specific features of each vehicle that could influence the inspection process. These databases should be able to be accessed by third party companies.

8.2.- Electric and hybrid vehicles.

The integration of hybrid and electric vehicles to the Spanish vehicle fleet implies a possible change in the inspection procedure and defects in terms of Periodic Motor Vehicle Inspection. (PMVI). In particular, due to the technology available in these vehicles and baring in mind that such technology substantially modifies certain vehicle systems (drive system, braking system, etc.) it is highlighted the need of a possible modification of the Inspection Handbook. Therefore, the challenges that PMVI will encounter are deeply analyzed. For additional information the authors refer the readers to the report "Report of Periodic Motor Vehicle Inspection for Electric Vehicles" done by the Research Institute of Vehicle Safety (ISVA) from Carlos III University of Madrid in collaboration with FITSA.

Figure 42. Plug-in hybrid vehicle in London
(Source: "*Guía del vehículo eléctrico"*)

The electric and hybrid vehicle have, between others, three systems that distinguish them from internal combustion engines (ICE): transmission system, energy storage and brake system. These systems are already deeply inspected in the current PMVI for ICE vehicles. However, in electric and hybrid vehicles these three systems are clearly different and therefore are a challenge for PMVI. In any case inspection must still follow the statements described in the Inspection Handbook for PMVI:

- Inspection must be as simple and direct as possible.
- During the inspection process vehicle components and parts will not be dismantled.
- The tools and equipment used during inspection will be the appropriate ones in order to check the vehicle system.

➢ **Battery inspection**

Batteries are mainly used as an energy source to start-up the engine, to light and for operating auxiliary systems. Conventional vehicles with ICE have lead batteries that provide a voltage of 12V in passenger vehicles. The electric vehicles also have batteries to store the energy but have specific features. The main difference between the batteries in conventional vehicles with respect to those installed in electric vehicles is that in the latter ones voltage is between 200 and 400V. This results in stricter safety requirements in terms of vehicle inspection.

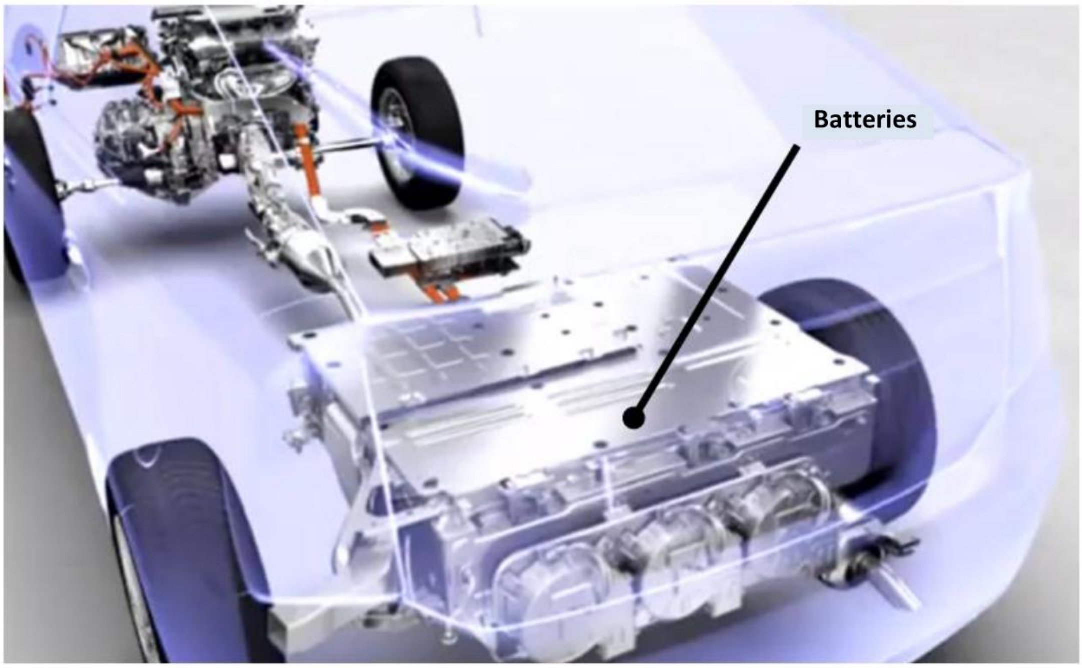

Figure 43. Battery location in a Toyota Prius. (Source: Toyota).

The regulation UNE-EN 50342-1 regarding "Lead-acid starter batteries. Part 1: General requirements and methods of test" establishes the test procedures for these type of batteries allowing to find its electric features, such as, electric efficiency, life cycle and safety. These tests include battery capacity test and cold start-up. The former test verifies if the nominal data of the battery: capacity (Ah), voltage (V) and current at cold start-up (A) are correct. The second test verifies the available current of the battery in cold conditions. Another important feature of the battery is its life cycle. A set of resistance to corrosion, resistance in cycles, water consumption, acceptance of load, load conservation and vibration resistance tests is carried out. In the particular case of electric vehicles the downsize is that different types of batteries may be used in contrast with conventional vehicles that only use a lead-acid battery. For each type of battery there is a specific UNE standard that establishes how to test the different electric features.

It is worth highlighting that the batteries employed in electric vehicles are usually of lithium, which has a great volatility. Therefore, there is an explosion risk when it mixes with oxygen. For this reason, electric vehicle batteries are usually enclosed in a cooled highly resistant case. This requires of further safety concern in terms of vehicle inspection.

Nowadays, inspection of batteries of ICE vehicles is described attending to the Inspection Handbook section “9.1. General estate of the engine” in chapter 9 “Engine and transmission”.

Depending on the battery location it could be visually inspected in a pit, car elevator or just opening the vehicle front hood. By means of visual inspection it is recommended to check the battery clamping to the vehicle chassis, the lack of leakage of cooling liquid (if it applicable), the state of the battery terminals and connections, the case state, the switch (it applicable), the fusses (if applicable) and ventilation (if applicable). The inspection of batteries in hybrid and electric vehicles entails a greater danger compared with ICE vehicles due to the voltage. The level of voltage of the batteries employed in hybrid and electric vehicles requires of training and special tools. In addition, battery location is not standard in all vehicles and sometimes is placed right at the bottom of the vehicle chassis being very difficult its inspection.

On the other hand, it is worth highlighting that the battery of an electric or hybrid vehicle plays a more important role in comparison to vehicles with ICE. In particular, in the case of electric vehicles the battery constantly provides voltage to the other vehicle systems and therefore, requires of verifying other technical issues other than the visual ones. In fact, one of the most relevant features is the battery state of charge (SoC), which could become part of the inspection process. However, a quick charge system would be needed. In addition, a difficulty arises in terms of the different connectors and possible difficulties of accessing to the battery terminals.

Therefore, battery inspection of an electric vehicle could follow a similar procedure as that established for ICE vehicles, that is, carry out a visual inspection. In this case the proposed inspection procedure for electric vehicle batteries is:

For electric and hybrid vehicles battery inspection could be done in a pit, car elevator or at Ground level, attending to battery location and using the appropriate protection against high voltage. Visual inspection will include:

- Inspection of battery clamping to the vehicle chassis, the lack of leakage of cooling liquid (if it applicable), the state of the battery terminals and connections, the case state, the switch (it applicable), the fusses (if applicable) and ventilation (if applicable).
- If the battery cannot be visually directly inspected a visual inspection around the battery will be done.

Next, the drawbacks of inspection of batteries of electric vehicles are shown. In addition, differences in terms of inspection with respect to a conventional ICE vehicle are outlined:

Drawbacks of visual inspection of batteries in electric vehicles:

- Voltage of batteries of electric vehicles is higher than those in conventional ICE and therefore, special protection is required.
- Battery location is not standard and trying to find it during inspection delays the inspection.
- More batteries increase the inspection time.
- It might be difficult to access the batteries.

Additional required inspection elements:

- None if safety equipment for inspectors is not taken into account.

Time required for inspection:

- Inspection will take longer than standard inspection for conventional ICE vehicles.

Procedure difficulty:

- Low.

Occupational risk:

- Average.

As stated before, it is recommended to check in the case of electric vehicle (EV) the behaviour of the battery in terms of quick charging. A possible procedure is described in the standard UNE-EN 61982-3:2002:

In the case of electric vehicles, after visual inspection and with the battery at 40% of its state of charge (SoC) the battery has to be quickly charged up to 80% of its SoC. Afterwards, the stored energy must be measured.

This test has a set of drawbacks and difficulties which are:

Drawbacks of the quick charge procedure for EV batteries:

- The EV batteries can be different between them of have different electric features and therefore, the provided Wh will be different.
- The EV has to be connected to a quick charge system. Nowadays, vehicle connectors do not have a standard shape, thus, a set of different connectors must be available.
- The inspector has to handle a high voltage element.
- The battery terminals do not always have an easy access. In this case the inspector would have to remove the protection panels, which increases electrocution risk and increases inspection time.

Additional required inspection elements:

- A quick charge system.
- Equipment to measure battery state of charge.

Time required for inspection:

- It takes longer than for conventional vehicles.

Procedure difficulty:

- Very high.

Occupational risk procedure:

- Very high.

➢ Electric powertrain

The electric vehicles have an electric motor and an inverter circuit (power converter AC/DC).

In an electric motor there are different losses that increase temperature:

- Magnetic losses due to stray currents and material hysteresis cycle.
- Mechanical losses due to mechanical engine operation. These losses are due to friction (bearing friction) and ventilation.
- Additional losses that cannot be included in the previous ones. They approximately represent 1% of the engine power at full load.

This increase of the temperature can heat up its components, particularly the insulators, and therefore condition battery life cycle. The main aim of the insulation in electric motors is to separate components that are at different voltages. The insulation quality usually conditions the reliability of the engine operation.

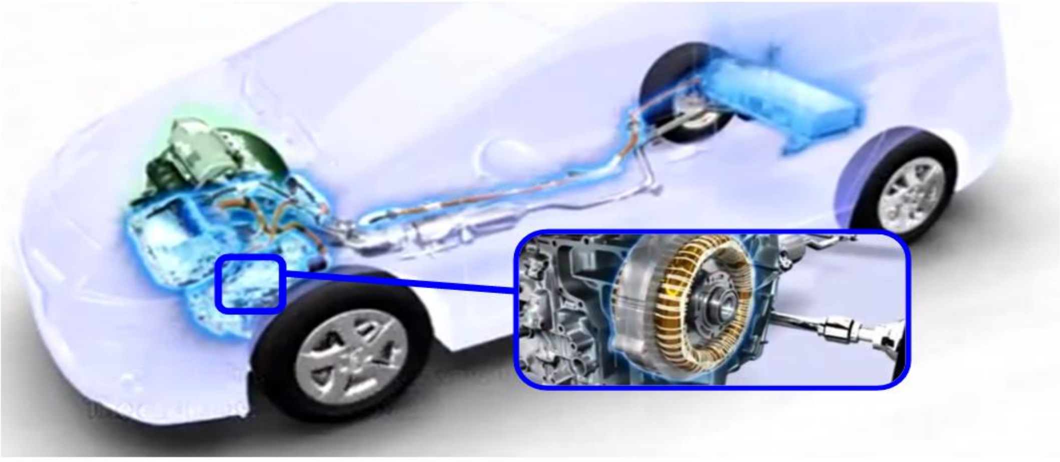

Figure 44. Electric engine of a Toyota Prius. (Source: Toyota)

Nowadays, there are different testing equipment and measurements that are used to evaluate the insulation of electric motors. However, most of these type of tests cannot possibly be done during periodic motor vehicle inspection due to the required time and, in some cases, dismantling of the electric motor is needed. In addition, it is worth highlighting that the inverter circuit is the main source of electromagnetic emissions (EMI, ElectroMagnetic Intereferences). At international level, the standards published by IEC organization regarding electromagnetic compatibility are standard IEC/TR60785 (Rotating machines for electrical road vehicles) and standard IEC/TR60786 (Controllers for electric road vehicles). At European level Directive 2004/104/EC of Electromagnetic Compatibility is also important.

Nowadays, the Inspection Handbook does not include any section regarding electric powertrain inspection and, therefore, electric vehicle inspection is a big challenge.

The electric powertrain should be included as a new inspection point for electric vehicles. Taking into account all of these comments inspection procedure of electric powertrain should be:

Powertrain inspection in electric vehicles should be done in a pit, car elevator or at ground level with the appropriate equipment to protect inspectors against high voltage. By means of a visual inspection it will be inspected:

- The protection panels must not be opened, dismantled or without the clamping components and should not be damaged.

The features of this test are:

Drawbacks of visual inspections of the electric powertrain:

- The appropriate safety equipment must be used in order to be protected against electrocution. In addition, inspectors must be specifically trained.

Additional required inspection elements:

None if safety equipment for inspectors to handle high voltage is not taken into account.

Time required for inspection:

- It cannot be compared with conventional ICE vehicles because there is no electric powertrain inspection.

Procedure difficulty:

- Low.

Occupational risk procedure:

- Average.

➢ Brake system

The inspection of the brake system for electric and hybrid vehicles is also a challenge for periodic motor vehicle inspection (PMVI). Nowadays, the inspection of hydraulic and pneumatic brakes is described in Chapter 6 of the Inspection Handbook. Regarding the service brake the Inspection Handbook establishes that the vehicle brake system must be able to control the vehicle movement and stop it in a safe, quick and efficient way no matter the payload, speed, upgrade or downgrade. In addition, the service brake must provide an adjustable action on the brake system which must brake all of the vehicle wheels. The brake performance is measured attending to three parameters: brake imbalance, brake force fluctuation and brake efficiency.

On the other hand, electric and hybrid vehicles have two brake systems: the conventional hydraulic brake system and the regenerative brake. The regenerative brake does not provide enough brake force to stop the vehicle when high decelerations are required and, therefore, its action is complemented with the hydraulic brake system. In addition, the regenerative brake not only reduces vehicle speed but also converts the vehicle kinetic energy in electric energy which is afterwards stored in a battery, if it is not completely charged. The challenge of PMVI is how to inspect this brake system in order to identify braking deficiencies in the brake system.

Therefore, a possible way of evaluating the brake efficiency could be:

> The battery state of charge should not be highest so that the regenerative brake can operate. During the brake test of the drive axle the resultant brake force in such axle will be sum of the one due to the mechanical brake and the one due to the regenerative.
>
> Repeat the brake test with a similar pedal force and with the battery completely charged. In this case the brake force is only provided by the hydraulic system. The difference between the brake force of this test and the previous test for the drive axle would provide the regenerative force.

To evaluate the brake force of the mechanical conventional brake it must be guaranteed that:

> For the vehicles in which the regenerative system is part of the brake system and therefore cannot be disconnected the battery state of charge must be high enough so as to avoid that the regenerative brake is not activated and only the conventional mechanical brake operates.
>
> For the vehicles in which the regenerative brake system can be disconnected from the brake system the inspector will disconnected it in order to evaluate the brake efficiency and imbalance due to the mechanical conventional brake system.

In addition, the rest of the components of the brake system have to be inspected:

- Rigid pipes: It must be checked if
    - They have defects, are damaged or with corrosion. Special attention must be paid if they are broken.
    - There are leakages in the pipes or connections paying special attention to

continuous leakage.

  - Clamping of rigid pipes to the vehicle chassis is adequate or if there is risk of disengagement.
  - Location of the rigid pipes affects their integrity.

- Flexible pipes: By means of visual inspection it will be checked the same mentioned points as the rigid pipes.
- Drum and disc brakes: By means of visual inspection it will be checked if:
  - There is an excessive wear of the active surface paying special attention to cracks.
  - Grease of oil.
  - Damaged clamping.
- Cables, rods, levers and connections. It will be inspected if:
  - There are damaged cables, tangled, worn out or with excessive corrosion.
  - If the cable joints or rods are damaged.
  - If there is any type of restriction to free movement of the brake system.
  - If there are abnormal movements of levers, rods or connections that would show a mismatching or excessive wear.

The features of this test in comparison with the current brake system inspection in conventional ICE vehicles are:

Drawbacks of visual inspections of the electric powertrain:

- The battery of the vehicle has to be completely charged to check the mechanical brake efficiency and to avoid activation of the regenerative brake system. This implies that a charge system with different connectors might have to be available and inspection time could increase.
- The battery should be discharged up to a certain percentage to prove the regenerative brake efficiency.

Required additional inspection elements:

- A charge system with different connectors.
- An equipment to measure the SoC of the battery.

Time required for inspection:

- It will take longer than the current inspection procedure.

Procedure difficulty:

- Average.

Occupational risk procedure:

- Average.

- **Pollutant emissions**

In the case of electric vehicles this inspection does not apply. Regarding hybrid vehicles, they are provided with a switch for “inspection mode” that would allow the internal combustion engine to run and measure the values of emissions.

9. CONCLUSIONS

Summing up the present report, it has been found that:

1º. Vehicle inspection is of paramount importance in terms of road vehicle safety. It is proved that **technical defects in vehicles** contribute to accidents: **6%** of the accidents are due to technical defects, which represents **2.000 fatalities in the European Union** and even more injured. This rate rises to **8%** in the case of motorbikes.

2nd. In the case of **Spain** and based on inspection and accident data in year 2011:

a. Thanks to the inspections carried out during this year at least **11.000 accidents**, approximately **11.000 injured** and **170 fatalities** have been avoided. In terms of economic benefit this represents at least **300 M€** and if vehicles that should have undergone inspection but were not inspected are considered, then at least additional **7.100 accidents, approximately 7.000 injured and 110 fatalities could have been avoided.** This would have provided an additional benefit of **200 M€.**
b. The number of **passenger vehicles** that should have undergone periodic motor vehicle inspection during year 2011 should have been 14.388.299, which represents a 64,59% of the total vehicle fleet (22.277.244) and the **number of inspections done** has been **11.073.030.**
c. The **absenteeism rate of passenger vehicles** not being inspected is for this year of **23,04%** (At least 3.315.269 passenger vehicles were not inspected)
d. The national fleet of **light duty commercial vehicles** for year 2011 was 3.845.306 vehicles. Taking into account the frequency inspection for these type of vehicles the first inspection should be done during the second year, biennial between the second and sixth year, annual between the sixth and tenth year and biannual for vehicles with more than ten years. The number of light duty commercial vehicles that should have undergone inspection during 2011 rises to 4.923.508, having **inspected 2.938.171.** Therefore, the absenteeism rate for these type of vehicles is **40,32%** (A total of 1.985.337 compulsory inspections were not done).
e. Regarding **motorbikes** the national motorbike fleet for year 2011 was 2.798.043 vehicles. Considering the frequency inspection for motorbikes 1.180.136 motorbikes (42,17%) should have undergone inspection.
f. The number of **mopeds and motorbike inspections** during year 2011 was **847.384.** Assuming that the percentage of mopeds that should be inspected is equivalent to the percentage of motorbikes in the same situation (42% of the vehicle fleet, 940.147 mopeds) there would be an absenteeism rate of **60%** (more than 1.200.000 compulsory inspections were not done).
g. There is a great expectation of an important reduction of the absenteeism by means of Project ITICI to control periodic motor vehicle inspection absenteeism.
h. It has been found that for light duty commercial vehicles there is a greater percentage of inspections with defects (rejected, negative and favorable with minor defects) rather than favorable inspections. The biggest percentage of favorable inspections is concentrated in motorbikes and mopeds.

i. It has been proved that **older vehicles** have **more defects,** and therefore, are statiscally unsafe vehicles.

j. In the case of passenger vehicles the biggest percentage of major defects is concentrated in chapter four and eight of the Inspection Handbook of PMVI. These chapters refer to vehicle lights (chapter 4) and axles, wheels, tires and suspension (chapter 8). In the case of motorbikes and mopeds the percentage of major defects also falls in both chapters, as well as in light duty commercial vehicles.

k. The passenger vehicles and light duty commercial vehicles have the biggest percentage of major defects in dipped and main beam lights and in tires. Most major defects of motorbikes and mopeds are in reflectors and tires.

l. The biggest number of fatalities takes place in passenger vehicles with 824 fatalities, which means that passenger vehicle accumulate 56% of the fatalities. The second type of vehicle that has registered a high number of fatalities is the motorbike with 235 fatalities, which is 16% of the total. With respect to 2010 passenger vehicles have reduced the number of fatalities in 18%, mopeds in 27%, motorbikes 27% and vans in 15%.

m. Take year 2000 as a reference the drop in the number of fatalities is even bigger. Thus, in the case of passenger vehicles there has been a reduction of 70%, in the case of mopeds in an 86%, in the case of motorbikes in a 9% and in the case of vans in a 67%. Therefore, with respect to year 2000 passenger vehicles, mopeds and vans have reduced the number of fatalities in at least 67% whereas the smallest drop has been on motorbikes with a 9%.

3rd. There are too many vehicles with technical defects in the roads. Some recent reports from UK and Germany show that **10% of the passenger vehicles have a defect that would result in a rejection result in periodic motor vehicle inspection.** In addition, the current regulation does not require a control of some of the electronic vehicle systems (such as ABS and electronic stability program) that, however, have a great impact in vehicle safety.

4th. The current regulation in the EU by which the minimum regulations establish vehicle inspection, is from 1977. Since then, small modifications of the regulation have been done. However, vehicles, driver behavior and technology have deeply changed since then. Taking into account that **each day there are more than five fatalities in EU roads in accidents caused by technical faults** the European Commission will adopt new regulations to reinforce vehicle inspection. the main points of the new regulation proposal are:

- Compulsory inspection in the whole EU for mopeds and motorbikes (it is already compulsory in Spain).
- **Increase frequency inspection** for older vehicles.
- Increase frequency inspection for passenger vehicles and vans with an exceptional **high mileage**.
- Increase the vehicle inspection quality by establishing common minimum regulations for equipment and inspectors.
- Compulsory inspection of vehicle electronic safety systems.
- Control against mileometer tampering.

5th. The **motorbikers** are the road users with a bigger risk. This goes against the general trend of a global decrease of the number of fatalities, which still represent more than 4.500 fatalities each year in the EU. An 8% of the accidents with motorbikes are due to defects or have some relationship with them.

6th. There have been more than **1.400 fatalities of moped drivers.** Five hundred of these victims were young people between 14 and 21 years old. More than 25.000 moped drivers were seriously injured and nearly 9.000 of them were between 14 and 21 years old.

7th. It has been found a clear **correlation between the severity of the accident and the involved vehicle age.** An empirical observation has proved that between the fifth and sixth year the number of serious accidents (with fatalities) with technical defects has substantially increased. The challenge is to provide an adequate motor vehicle inspection for the older vehicles.

8th. For some types of vehicles, **the current motor vehicle inspection frequency is considered to be too low** to guarantee lack of defects. The proposal increases the minimum requirements regarding periodic motor vehicle inspection frequency for three vehicle categories.

9th. Nowadays, road vehicle inspection is applicable to commercial vehicles of more than 3,5 tons. The proposal extends this requirement to light duty commercial vehicles (with less than 3,5 tons) and their trailers. The reason is that these type of vehicles cover a wide range of kilometres in order to transport merchandise. These vehicles are not subjected to specific requirements such as professional training for drivers or installation of speed limiter. Therefore, light duty commercial vehicles are involved in a great number of accidents.

10th. The main aim of the proposed regulation in which the Commission is working on is to improve road safety and contribute to reduce the annual number of fatalities in road traffic accidents in 50% between 2011 and 2020. **More than 1.200 fatalities and 36.000 accidents could be avoided**. The **economic benefit** for society would rise up to more than **5.600 millions of Euros.**

In addition, Periodic Motor Vehicle Inspection has the following challenges:

- Develop inspection procedures for new power drive vehicles.
- It has become a need to include electronic safety systems as part of vehicle inspection.
- Develop procedures for specific inspection for older vehicles.

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