Study on the inclusion of light trailers and two- or three-wheel vehicles in the scope of the periodic roadworthiness testing

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Final report

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Definitions and abbreviation list

Deficiencies:
As set out by Directive 2014/45/EU: Technical defects and other instances of non-compliance found during a roadworthiness test.

Minor deficiencies:
As set out by Directive 2014/45/EU: Defects that do not have a significant effect on vehicle safety or on the environment. In the case of minor deficiencies only, the test shall be deemed to have been passed, the deficiencies shall be rectified, and the vehicle shall not be re-tested.

Major deficiencies:
As set out by Directive 2014/45/EU: Defects that may prejudice the safety of the vehicle or have an impact on the environment or put other road users at risk, or other more significant non-compliances. In this deficiency category in this report, the following are also included: dangerous deficiencies constituting a direct and immediate risk to road safety or having an impact on the environment and which justify possible prohibition of use of the vehicle on public roads.

In the case of major deficiencies, the vehicle shall be deemed to have failed the test. The Member State or the competent authority shall decide on the period during which the vehicle in question may be used before it is required to undergo another roadworthiness test. The subsequent test shall take place during a period defined by the Member State or competent authority but not later than two months following the initial test.

In the case of dangerous deficiencies, the vehicle shall be deemed to have failed the test. The Member State or the competent authority may decide that the vehicle in question must not be used on public roads and that authorisation for its use in road traffic must be suspended for a limited period of time, without any new registration procedure, until the deficiencies are rectified and a new roadworthiness certificate is issued testifying that the vehicle is in roadworthy condition.

Fatalities[1]:
Persons fatally injured as reported by the country. Death within 30 days of the road accident; confirmed suicide and natural death are not included.

Seriously injured:
Seriously injured as reported by the country. Injured (although not killed) in the road accident and hospitalized at least 24 hours.

Slightly injured:
Injured (although not killed) in the road accident and hospitalized less than 24 hours or not hospitalized. (European Commission 2015).

Victim:
This term is used in the text to refer either to fatalities, seriously injured persons or slightly injured persons.

[1] This footnote applies to the definitions “Fatalities”, “Seriously injured” and “Slightly injured”.https://ec.europa.eu/transport/road_safety/specialist/observatory/methodology_tools/about_care_en

Directive 2014/45/EU:
DIRECTIVE 2014/45/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 3 April 2014 on periodic roadworthiness tests for motor vehicles and their trailers and repealing Directive 2009/40/EC

DGT: *Dirección General de Tráfico, Spanish database of traffic accidents*

PTI: *Periodic Technical Inspection*

CBA: Cost and benefit analysis

Abstract

In accordance with Article 20 of Directive 2014/45/EU, the purpose of this study is to assess the benefit of including two- and three wheelers and light trailers within the framework of periodic inspection of vehicles and to propose the precise way to do so.

For both categories of vehicles, the following Scenarios are considered:

- Scenario 0: without case. Base case
- Scenario 1: complete inspection: proposed Scenario
- Scenario 2: simplified inspection

The analysis is conducted focusing on the availability of data. For two- and three-wheelers, the study considers the impact of introducing inspection of mopeds in Spain between 2007 and 2010 depending on the region. The report demonstrates that the benefit of this initiative is 4.73 times greater than the cost.

The part on trailers has been difficult because of the lack of data on accidents and the challenge of obtaining a parameter to estimate their use, since trailers are not fitted with odometers. With all these considerations taken into account, the cost and benefit analysis has been undertaken with the data of Croatia resulting in a benefit 6.32 times greater than the cost.

Both proposals avoid the use of additional equipment and do not require amendment of the Annexes of Directive 2014/45/EU.

Résumé

Conformément à l'article 20 de la Directive 2014/45/UE, l'objectif de cette étude est d'évaluer l'intérêt d'inclure les véhicules à deux et trois roues et les remorques légères dans le cadre du contrôle périodique des véhicules et de proposer la manière précise de le faire.

Pour les deux catégories de véhicules, les scénarios suivants sont envisagés :

- Scénario 0 : sans casse. Cas de base
- Scénario I : inspection complète : scénario proposé
- Scénario II : inspection simplifiée

L'analyse est axée sur la disponibilité des données. Pour les véhicules à deux et trois roues, l'étude examine l'impact de l'introduction de l'inspection des cyclomoteurs en Espagne entre 2007 et 2010 selon les régions. Le rapport démontre que les avantages de cette initiative sont 4,73 fois plus importants que les coûts.

La partie sur les remorques a été difficile en raison du manque de données sur les accidents et de la difficulté d'obtenir un paramètre pour estimer leur utilisation, puisque les remorques ne sont pas équipées d'odomètres. Compte tenu de toutes ces considérations, l'analyse coûts-avantages a été effectuée à partir des données de la Croatie, avec un avantage 6,32 fois supérieur au coût.

Les deux propositions évitent l'utilisation d'équipements supplémentaires et ne nécessitent pas la modification des annexes de la Directive 2014/45/UE.

Executive Summary

This report analyses the suitability of including two- and three-wheelers and light trailers in the scope of periodic technical inspection of vehicles, taking into account Article 20 of Directive 2014/45/EU. In the case of motorcycles, paragraph 7 of Article 2.(2) is also to be considered since it mentions possible alternative measures replacing the periodic inspection.

The study requirements identified the following subjects to be developed:

- Data collection
- Collection and analysis of national road safety measures
- Definition of Scenarios
- Cost and benefit analysis
- Formulation of policy recommendation

Data collection has consisted in in-depth research of available data combined with surveys conducted with authorities and other relevant stakeholders in the European Union. During the Roadworthiness Committee meeting hosted by DG MOVE on 20 September 2018, an additional call was made.

A more detailed data analysis has been conducted in the countries of the project partners and subcontractors: Croatia, Germany and Spain.

Additional research has been undertaken to estimate the use of light trailers. Cost and Benefit analysis based on the identification of deficiencies during PTI requires a parameter showing vehicle use. This, being usually the mileage, is not available for light trailers since they are not fitted with odometers. The use of trailers has been estimated based on existing research projects (Germany) and user surveys (Croatia).

Further difficulties related to data retrieval and analysis have been the lack of records of accidents involving light trailers and the sparse availability of reference to deficiencies in the causes of road crashes.

Directive 2014/45/EU permits effective alternative road safety measures by Member States for two- and three-wheelers. It has not been possible to identify any alternative measure during the development of this study.

The Scenarios considered in this report are the following:

- Scenario 0: without case. Base case
- Scenario 1: complete inspection
- Scenario 2: simplified inspection

A complete inspection involves the entire content of Annex I of Directive 2014/45/EU: "Minimum requirements concerning the contents and recommended methods of testing", whereas a simplified inspection only involves those items for which most deficiencies have been found during periodic inspection.

The techniques used for assessment of both categories of vehicles are different. On the one hand, analysis of the impact of vehicle inspections of two- and three-wheelers consists in measuring the impact of introducing the inspection for mopeds in Spain during the period from 2007 to 2010 depending on the region.

Having the opportunity to compare accident data before and after implementation of a PTI scheme is very much unique in Europe and helps to identify the impact in a more accurate way than other techniques.

The study determines with a degree of likelihood of 99% that inspection of these vehicles in Spain accounts for the 18% decrease in fatalities during this period.

The inspection of mopeds in Spain is carried out in accordance with the requirements of Annex I of Directive 2014/45/EU and, in addition, includes a test to measure sound level and maximum speed.

The benefit-cost ratio does not take account of either the positive impact of the inspection for the environment or the fact that only 41.57% of L category vehicles were inspected (2016 data). Therefore, the benefit-cost ratio might reasonably be considered as conservative.

All things considered, the inspection of mopeds in Spain generates a benefit 4.73 times greater than the cost.

On the other hand, for trailers, the cost and benefit analysis approach is different since it was not possible to compare the same area with and without PTI. Consequently, the data for the study is related to accidents, deficiencies found during PTI and an estimation of use of such vehicles.

The benefit/cost ratio obtained for Croatia has reached 6.32. This value is large enough to allay doubts relating to data uncertainty.

The inspection of light trailers in Croatia also includes the items described in Annex I of Directive 2014/45/EU where applicable.

In view of the results of the cost and benefit analysis, for both vehicles Scenario 2 – Complete inspection - is proposed, with the less rigorous periodicities corresponding to the analysed countries:

- Inspection of two- and three-wheelers:

  Mopeds: 1st inspection after 3 years, subsequent inspections every 2 years

  Motorcycles: 1st inspection after 4 years, subsequent inspections every 2 years

- Inspection of light trailers:

  Option 1: 1st inspection after 4 years, subsequent inspections every 2 years

  Option 2:

    O1: inspection every 3 years

    O2: 1st inspection after 2 years, subsequent inspections every year

Inspection of the above-mentioned vehicles according to Annex I of Directive 2014/45/EU does not require equipment additional to that specified for other categories, as listed in Annex III of the same Directive.

Annex I of Directive 2014/45/EU already contains provisions for two- and three-wheelers: stands (6.2.11) and handgrips and footrests (6.2.12). There is also a specific requirement for light trailers: overrun brake (1.1.23).

Résumé analytique

Le présent rapport analyse la pertinence d'inclure les véhicules à deux ou trois roues et les remorques légères dans le régime de contrôle technique périodique des véhicules, en tenant compte de l'article 20 de la Directive 2014/45/EU. Dans le cas des motocyclettes, le paragraphe 7 de l'article 2, paragraphe 2, doit également être pris en considération car il envisage des méthodes alternatives au contrôle périodique.

Les exigences de l'étude identifient les sujets suivants :

- Collecte des données
- Compilation et analyse des mesures nationales de sécurité routière
- Définition de scénarios
- Analyse coûts-avantages
- Formulation de recommandations politiques

La collecte de données a consisté en une recherche approfondie des données disponibles, complétée par la distribution d'une enquête aux autorités et aux autres parties prenantes concernées dans l'Union européenne. Lors du comité de contrôle technique organisé par la DG MOVE le 20 septembre 2018, un appel supplémentaire a été lancé.

Une analyse plus détaillée des données a été effectuée dans les pays des partenaires et des sous-traitants du projet : Croatie, Allemagne et Espagne.

Des recherches supplémentaires ont été entreprises pour estimer l'utilisation des remorques légères. L'analyse coûts-avantages fondée sur l'identification des déficiences au cours de la PTI nécessite un paramètre qui montre l'utilisation du véhicule. Celui-ci, étant habituellement le kilométrage, n'est pas disponible pour les remorques légères puisqu'elles ne sont pas équipées d'odomètres. L'utilisation des remorques a été estimée sur la base des recherches existantes (Allemagne) et des enquêtes auprès des utilisateurs (Croatie).

D'autres difficultés liées à l'extraction et à l'analyse des données ont été l'absence d'enregistrement des accidents impliquant des remorques légères et la faible disponibilité de références aux déficiences dans les causes des accidents.

La Directive 2014/45/UE autorise les États membres à prendre des mesures de sécurité routière alternatives efficaces pour les véhicules à deux ou trois roues. Il n'a pas été possible de trouver d'autre mesure de rechange au cours de l'élaboration de la présente étude.

Les scénarios examinés dans le présent rapport sont les suivants :

- Scénario 0 : sans cas Cas de base
- Scénario I : inspection complète
- Scénario II : inspection simplifiée

Une inspection complète se réfère à l'ensemble du contenu de l'annexe I de la directive 2014/45/EU : « Exigences minimales concernant le contenu et les méthodes d'essai recommandées », alors qu'une inspection simplifiée ne prend en compte que les points présentant le plus de défauts lors d'une inspection périodique.

Les techniques utilisées pour l'évaluation des deux catégories de véhicules sont différentes. L'analyse de l'impact de l'inspection des véhicules à deux et trois roues consiste à mesurer l'effet du contrôle technique des cyclomoteurs en Espagne mis en place entre 2007 et 2010 selon les régions.

La possibilité de comparer les données sur les accidents avant et après la mise en œuvre d'un système d'inspection périodique est tout à fait unique en Europe et permet d'identifier l'impact d'une manière plus précise que d'autres techniques.

L'étude détermine avec un haut degré de certitude, à un seuil de signification de 1 %, que l'inspection de ces véhicules en Espagne explique la diminution de 18 % du nombre de tués pendant cette période.

L'inspection des cyclomoteurs en Espagne est effectuée conformément aux concepts de l'annexe I de la directive 2014/45/EU et comprend, en outre, un test pour mesurer le niveau sonore et la vitesse maximale.

Le rapport avantages-coûts ne tient compte ni de l'impact positif de l'inspection sur l'environnement ni du fait que seuls 41,57 % des véhicules de la catégorie L ont été inspectés (données de 2016). En conclusion, le rapport avantages-coûts peut raisonnablement être considéré comme prudent.

Dans l'ensemble, l'inspection des cyclomoteurs en Espagne a un avantage 4,73 fois plus élevé que le coût.

En ce qui concerne les remorques, l'approche pour l'analyse coûts-avantages est différente puisqu'il n'était pas possible de comparer la même zone avec et sans PTI. Par conséquent, les données de l'étude sont celles relatives aux accidents, aux déficiences constatées lors des contrôles et à l'estimation de l'utilisation de ces véhicules.

Le rapport avantages/coûts obtenu pour la Croatie a atteint 6,32. Cette valeur est suffisamment élevée pour que toute hésitation liée à l'incertitude des données soit exclue.

L'inspection des remorques légères en Croatie suit également les points décrits à l'annexe I de la directive 2014/45/EU, le cas échéant.

Pour autant que les résultats de l'analyse coûts-avantages soient disponibles, le scénario 1 - Inspection complète est proposé pour les deux types de véhicules, les périodicités les moins rigoureuses correspondant aux pays analysés :

- Inspection des véhicules à deux et trois roues :

  Cyclomoteurs : 1re inspection après 3 ans, à la suite d'inspections tous les 2 ans

  Motocyclettes : 1re inspection après 4 ans, à la suite d'inspections tous les 2 ans

- Inspection des remorques légères :

  Option 1 : 1re inspection après 4 ans, à la suite d'inspections tous les 2 ans

  Option 2 :

    O1 : inspection tous les 3 ans

    O2 : 1re inspection après 2 ans, à la suite d'inspections tous les ans

L'inspection des véhicules susmentionnés conformément à l'annexe I de la Directive 2014/45/EU ne nécessite pas d'équipement supplémentaire par rapport à celui défini pour les autres catégories énumérées à l'Annexe III de cette même Directive.

L'Annexe I de la Directive 2014/45/UE contient déjà des dispositions pour les véhicules à deux et trois roues : béquilles (6.2.11), poignées et repose-pieds (6.2.12). Il existe également une prescription spécifique pour les remorques légères : le frein à inertie (1.1.23).

The project consortium and subcontractors

CITA, The International Motor Vehicle Inspection Committee, is the non-profit worldwide association of public and private organizations dealing with road vehicles' continuous compliance. It has more than 130 members from 55 countries in Africa, America, Asia, Europe and Oceania. Detailed information is available on the website: www.citainsp.org

CVH, Center for Vehicles of Croatia, is a company with public authorisation for managing the organization and uniform performance of PTIs and procedures for the first registration of vehicles, renewal of registration certificate validity and related affairs. It also provides training for inspectors and administrative personnel, maintenance and development of PTI equipment and procedures. Detailed information is available on http://www.cvh.hr/en/home/

DEKRA was founded in 1925 as a vehicle inspection company and has since developed its services to cover many safety areas. With more than 44,000 employees, this expert organization operates in more than 50 countries on all five continents. Its service portfolio comprises three main business units: Automotive, Industrial and Personnel.

The Institute for Economic Research and Consulting, **IERC** GmbH, was founded in 2003 as a private research institute by Prof. Dr Wolfgang H. Schulz. Since then, its research activities have covered the fields of transport, economics, traffic planning and consulting with a special focus on electric mobility and intelligent transport systems.

ISVA-UC3M is the Institute of Motor Vehicle Safety belonging to the Carlos III University of Madrid. It is active in various areas within the automotive and transport sector. Among its key activities are R&D projects related to the automotive field (especially regarding road safety), a major modifications laboratory, a traffic accident reconstruction laboratory, technical assistance for industry and postgraduate training courses.

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Disclaimer

1. Scope and background

This document is the final report corresponding to the project "Study on the inclusion of light trailers and two- and three wheel vehicles in the scope of periodic roadworthiness testing" with identification no. MOVE/C2/SER/2017-295 – SI2.772857, contracted by the European Commission, Directorate General for Mobility and Transport to the consortium formed by CITA, CVH and DEKRA, with the involvement of IERC and the Carlos III University of Madrid – UC3M.

The purpose of this study is to gather factual information, conduct a detailed technical analysis and make a policy recommendation based on quantified arguments of the possible Scenarios for the periodic technical inspection of light trailers in categories O1 and O2[2] and two- and three-wheel vehicles in each subcategory of L vehicles.

This report is structured according to the requested tasks:

- Task 1: Data collection
- Task 2: Collection and analysis of national road safety measures
- Task 3: Definition of Scenarios
- Task 4: Cost and benefit analysis
- Task 5: Formulation of policy recommendations

Where appropriate, each of the tasks is split into light trailers and two- and three-wheelers.

Traditionally, the European framework for vehicle inspection included the requirement to inspect trailers over 3,500 kg. Lighter trailers and two- and three-wheelers may be inspected by decision of each Member State.

Directive 2014/45/EU already includes in its scope two- and three-wheelers and mentions the possible inclusion of light trailers as part of a harmonized European approach. The decision was postponed and in the meantime the requirement of finding the appropriate evidence was established.

This report analyses the impact on road safety in two countries with periodic inspection schemes: Croatia for light trailers and Spain for two- and three-wheelers. The choice of countries is very much associated with data availability. Croatia has inspected O1 and O2 trailers since 1972 and the availability of data from periodic inspections helps compensate for the general lack of accident data for these vehicles.

The case of Spain is very much unique, due to the introduction of inspection of mopeds between 2007 and 2010 depending on the region. This allows us to compare road safety ratios before and after and verify the appropriateness of the results relative to time because of the differing dates of application in each region.

Studying road safety indicators before and after provides a precise view of the impact of the measure since it avoids the limitations of other approaches such as accident analysis.

[2] O1: trailers with maximum mass up to 750 kg. O2: trailers with maximum mass between 750 kg and 3500 kg.

Directive 2014/45/EU does not include light trailers in its scope and Member States shall determine the precise inspection procedures for two- and three-wheelers. The countries used for this study, Croatia for trailers and Spain for two- and three-wheelers, have nevertheless inspected these vehicles in a way very much comparable to Annex I of the said Directive for many years.

The above may seem a paradox, but has a reasonable explanation. The main concepts introduced in Annex I of Directive 2014/45/EU are "method" and "assessment of deficiencies", whereas "items to be inspected" and "reason for failure" were already in Directive 2009/40/EC.

Indeed, "items to be inspected" and "reasons for failure" have been in many cases updated by Directive 2014/45/EU, but, with the exception of some items with limited impact on the vehicles in this study, there are no new ground-breaking concepts.

Furthermore, the CITA Recommendation 1 "Inspection of vehicles in categories M, N and O" dated 24 May 2005, already contained indications for method and the review of that Recommendation dated 17 October 2006 included the defect categorisation with definition of defects equivalent to those contained in Directive 2014/45/EU.

In conclusion, whereas Directive 2014/45/EU clearly excludes light trailers and leaves some degrees of freedom to Member States for the inspection of two- and three-wheelers, the concepts in its Annex I were already taken into consideration in some Member States. This was the case for Croatia and Spain and consequently this report makes reference to the above-mentioned Annex to refer to inspection procedures.

2. Introduction

This report takes advantage of the experience of those EU countries already submitting light trailers and two- and three-wheelers for periodic inspection. It seeks to identify the impact of the inspections on road safety and environmental protection.

Where possible, i.e. in the case of inspection of mopeds in Spain, the study compares accident data before and after setting up the inspection framework. In other cases, the research is carried out based on accident analysis and impact of the defects identified during PTIs in those countries inspecting light trailers and motorcycles.

It is also important to note that some of the vehicles included in this study may not have a registration plate in every Member State. This applies in particular to O1 trailers and mopeds. Establishment of a vehicle registration system is not included in the scope of this study and in fact some EU countries already inspect certain categories of vehicles, i.e. O3 and O4, even if they do not have registration plates.

This study does not take into consideration presumed behaviours of vehicle owners regarding their willingness or not to keep their vehicles in good shape. In some cases this willingness is attributed to owners of high-end motorcycles, but there is no evidence in this regard.

The study on trailers has encountered two major difficulties: the lack of accident data and the non-availability of mileage logs. Further details on these two subjects are given in the following sections.

3. Data collection

Data collection has focused, on the one hand, on the countries of origin of the project consortium members in charge of this part: CVH in Croatia, DEKRA in Germany and UC3M in Spain, but has also included a Europe-wide approach.

In general, data availability looks to be sufficient to undertake the cost and benefit analysis in section 6.

Vehicle use is statistically related to the chances of being involved in a crash. Normally, this data is very well represented by mileage, but trailers, with some exceptions, are not equipped with odometers.

To fill this gap, it has been necessary to launch a survey among users of light trailers to retrieve data about their use. This survey was carried out in Croatia and Spain, since data for Germany was already available.

Precise data has been forwarded to the IERC, since responsible for section 6, in order to undertake the cost and benefit analysis.

3.1. PTI in Croatia

PTI of trailers with GVW up to 3,500 kg has been performed in Croatia from 1972. Since then, the number of trailers has increased and the current numbers are:

- trailers up to 750 kg: 63,386[3]: category O1
- trailers over 750 kg and up to 3,500 kg: 5,891[4]: category O2

As explained in Section 1, vehicle inspection of light trailers in Croatia is already specified according to the recommended methods listed in Annex I of Directive 2014/45/EU. The assessment of deficiencies has been adapted to comply with this Directive since 20 May 2018. Therefore, the PTI data provided for this study contains only one level of deficiencies (major deficiencies) which always fail the vehicle.

If the vehicle is failed, the owner has the possibility of bringing it for re-inspection at no extra charge within a period of 10 days.

The PTI frequency for O1 trailers is: 0/3/3/3…[5]

The PTI frequency for O2 trailers is: 0/2/1/1…[6]

Data collection for O1 and O2 trailers

Fleet sizes of O1 and O2 trailers are continuously increasing, as shown in the illustration below. (CVH PTI Database extract available in Annex 1)

[3] Based on the number of trailers with valid PTI on 01.01.2017.
[4] Based on the number of trailers with valid PTI on 01.01.2017.
[5] First inspection: inspection before registration. Subsequent inspections every 3 years
[6] First inspection: inspection before registration, then 2 years after registration. Subsequent inspections every year

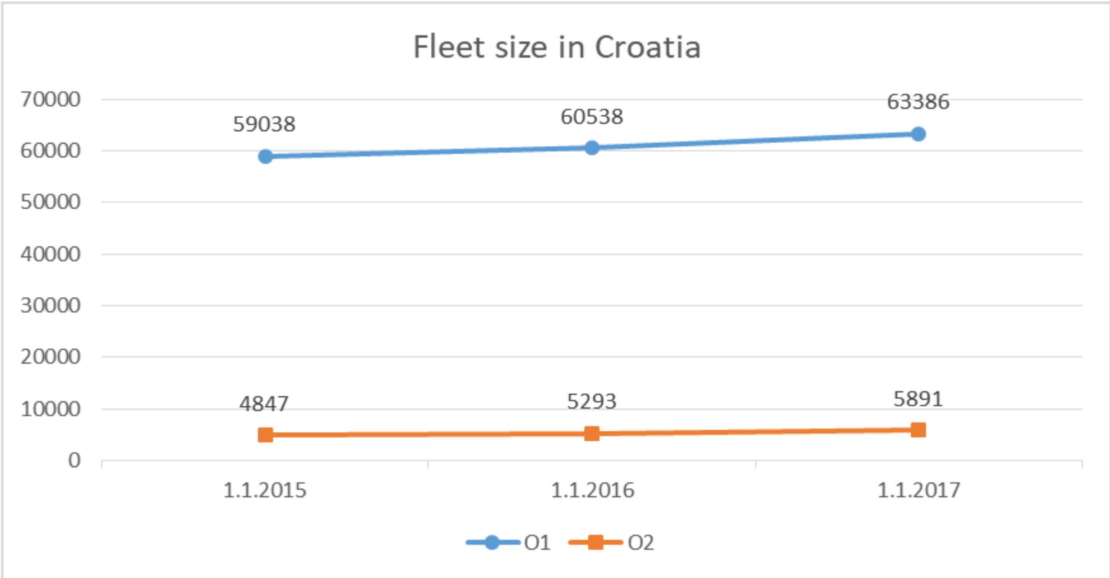

Figure 1: Fleet size in Croatia. Source: CVH PTI database on 01.01.2017 – Annex 1

The data shown corresponds to valid inspections on 1st January each year. In the case of vehicles tested more than once during a given year, only one of the inspections is taken into account.

Deficiency analysis

Deficiencies per inspected O1 or O2 trailer in relation to the age of these vehicles show correlation between these two values. This correlation shows a natural tendency for the number of deficiencies to increase with the age of the vehicle.

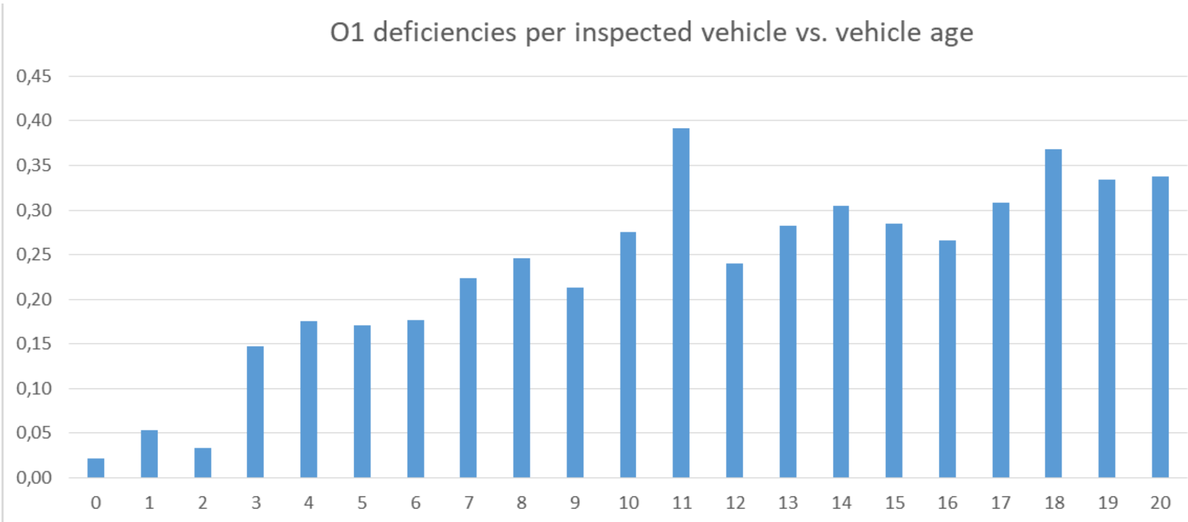

Figure 2: O1 deficiencies vs age. Source: CVH PTI Database – Annex 1

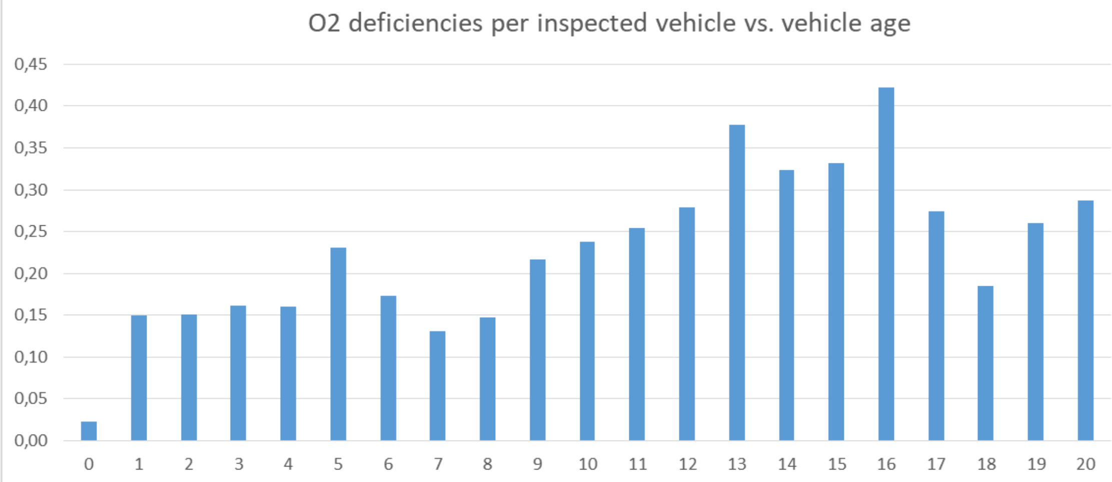

Figure 3: O1 deficiencies vs age. Source: CVH PTI Database – Annex 1

Divergences from a gradual increase in the number of deficiencies per vehicle vs. vehicle age are a matter of sample size. Since O1 trailers are submitted for PTI in 0/3/3/3... periods, sample sizes for each year of production tend to differ (please see Annex I to this report). Thus, for vehicles aged 2, 5, 8, 11 years, etc. small sample sizes bring a certain "noise" into the statistics, but the overall tendency is visible.

The influence of sample size is even more evident with O2 trailers because there are only 5,819 vehicles in the observed population, but here still, the overall tendency is very visible. The "decrease" in the number of deficiencies per vehicle vs. vehicle age after 16 years of age is also a consequence of the small sample sizes (please see also Annex I to this report).

The current trailer failure rate in Croatia is as follows:

- O1 trailers: 12.74%
- O2 trailers: 11.35%

Types of deficiencies do not differ much over the years for O1 vehicles. Data from 2017 shows that over half of the deficiencies are related to lights and signalling devices, 25% to chassis, 12% to wheels, axles and tyres, etc.

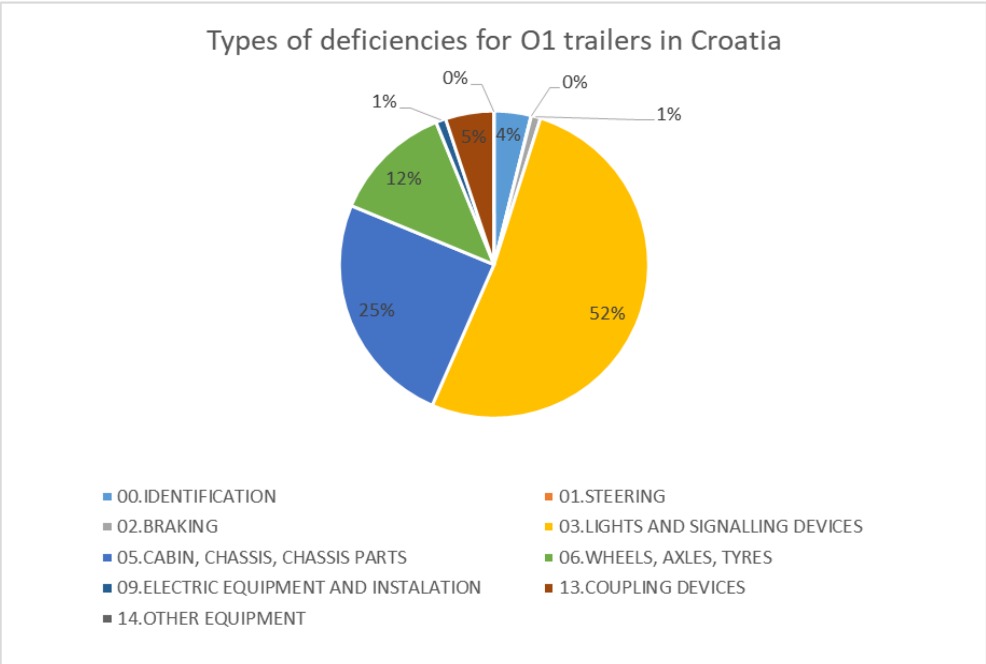

Figure 4: O1 type of deficiencies. Source: CVH PTI Database – Annex1

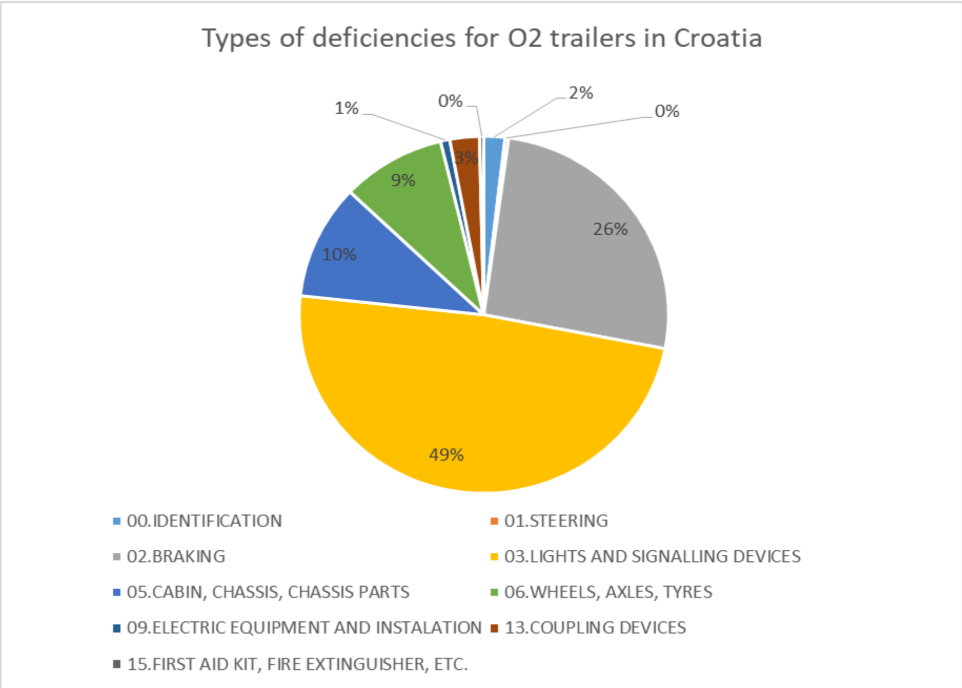

Figure 5: O2 type of deficiencies. Source: CVH PTI Database – Annex1

O2 trailers show different kinds of deficiencies, mainly because of brakes, which are mandatory for O2 but not for O1. Still, half of the deficiencies involve lighting and signalling equipment, 26% concern brakes, 10% chassis, 9% wheels, axles and tyres, etc.

Road traffic accidents

Data on O1 and O2 road traffic accidents is scarce. Statistics show a slight increase in fleet size over the years whereas the trend in terms of accidents is different for O1 and O2.

Between 2015 and 2017, the number of O1s increased by 7.36% and accidents by 20.99%. At the same time, the number of O2s rose by 21.54% and accidents fell by 12.05%. It is noteworthy that the number of accidents is relatively similar for O1 and O2 even though the number of O1s is more than 10 times greater than the number of O2s.

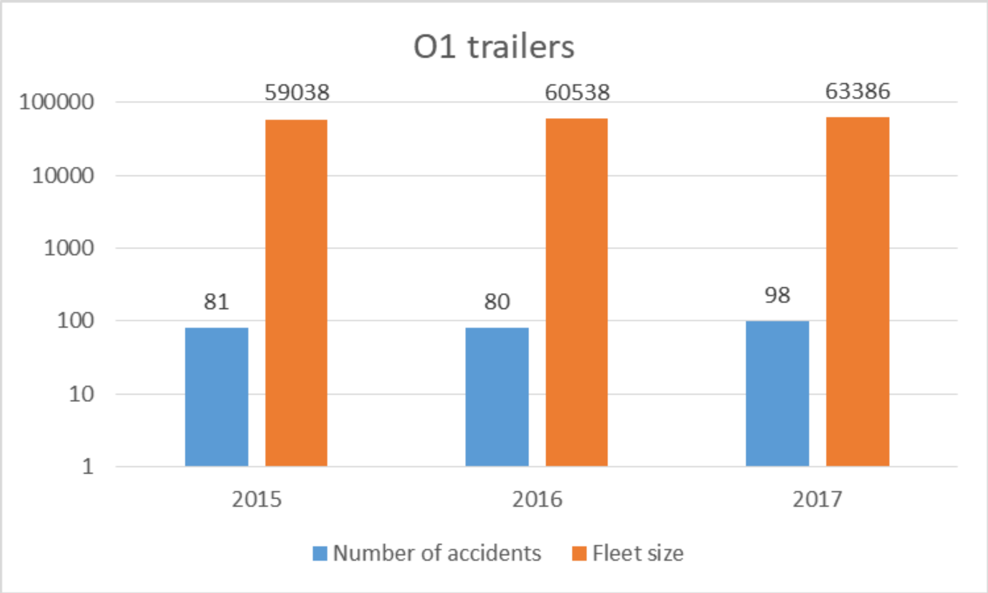

Figure 6: O1 accidents. Source: Croatian Ministry of the Interior traffic accidents database

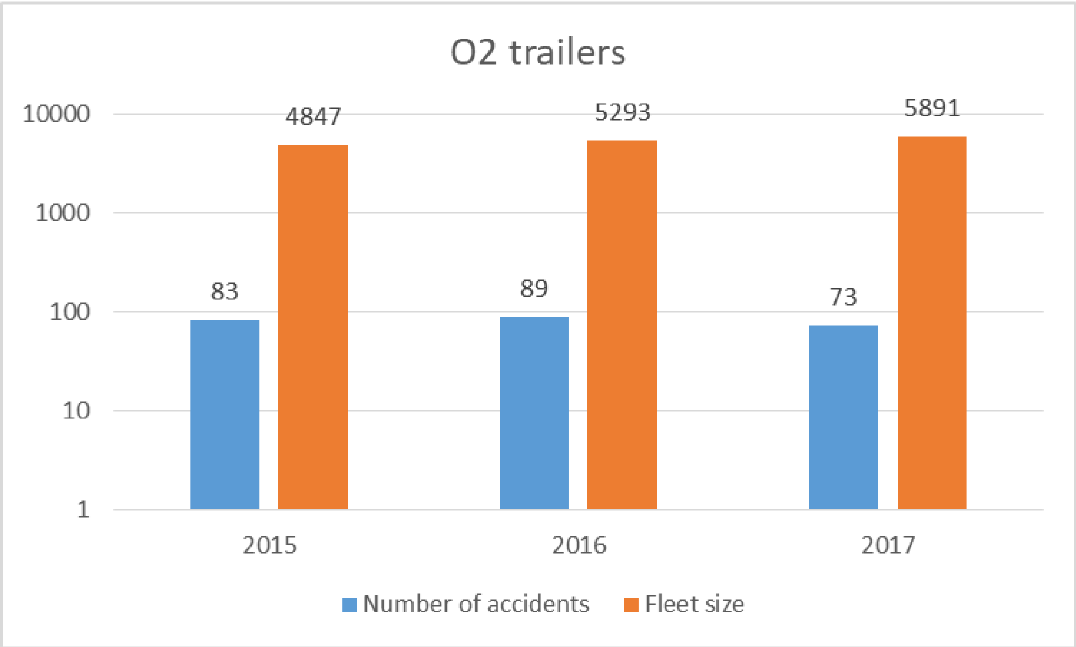

Figure 7: O2 accidents. Source: Croatian Ministry of the Interior traffic accidents database

The CBA for light trailers described in section 6 requires an input that shows how much vehicles are used. In the case of motor vehicles, the parameter showing the amount of use is the mileage as recorded in odometers. Trailers are not fitted with such devices and to compensate for this lack of data it has been necessary to conduct a survey among trailer users to estimate mileages.

3.2. PTI in Germany

In Germany, there is a wide range of data available, concerning powered two- and three-wheelers as well as light trailers. With regard to registration of the respective vehicle types, both O1 and O2 trailers and most L-category vehicles must be registered. L1e and L2e vehicles in Germany require an insurance indicator (Versicherungskennzeichen) but they are not registered.

The fleet sizes of light trailers and powered two- and three-wheelers have continuously increased in recent years. While the fleet size of powered two- and three-wheelers exceeded 4.3 million on 01.01.2017, light trailers combined account for more than 6.3 million, with O1 trailers being the larger category. It must be noted however, that data provided by the German Federal Motor Vehicle Transport Authority (KBA) specifies trailers from 0 kg to 800 kg* and from 800 kg to 3,500 kg**, while O1 and O2 definitions specify trailer weights from 0 kg to 750 kg and 750 kg to 3,500 kg respectively.

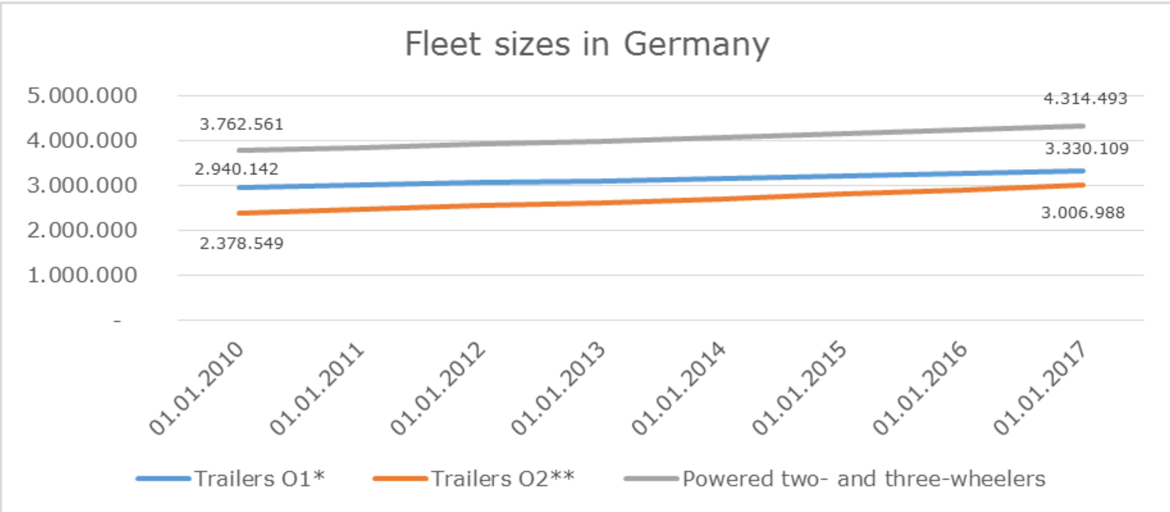

Figure 8: Fleet sizes in Germany. Source: Kraftfahrt-Bundesamt 2010, 2011, 2012, 2013, 2014b, 2015b, 2017a, 2017c – see Bibliography

The results of a mileage survey in 2014 revealed an estimated 14.8 billion kilometres per year for passenger cars with trailers and 17.5 billion kilometres for two-wheeled motor vehicles (Bundesanstalt für Straßenwesen 2017).

Mopeds and motorcycles

Because L3e, L4e, L5e and L7e vehicles must be submitted for a PTI every 24 months in Germany, detailed data on technical deficiencies is available. However, a PTI reform took place in Germany in 2012, making it impossible to compare current statistics with those before 2013.

Data analysis of all inspection organisations in Germany shows a level of deficiencies of about 13.4% found in PTIs in 2016. Comparing this PTI rate with deficiencies from previous years shows a slight decrease in deficiencies. In 2013, the level of deficiencies was 14.3%. Although there has already been a differentiation of deficiency categories in the years presented in Germany, the deficiency categories have been merged to prevent misconceptions about minor and major deficiencies according to Directive 2014/45/EU.

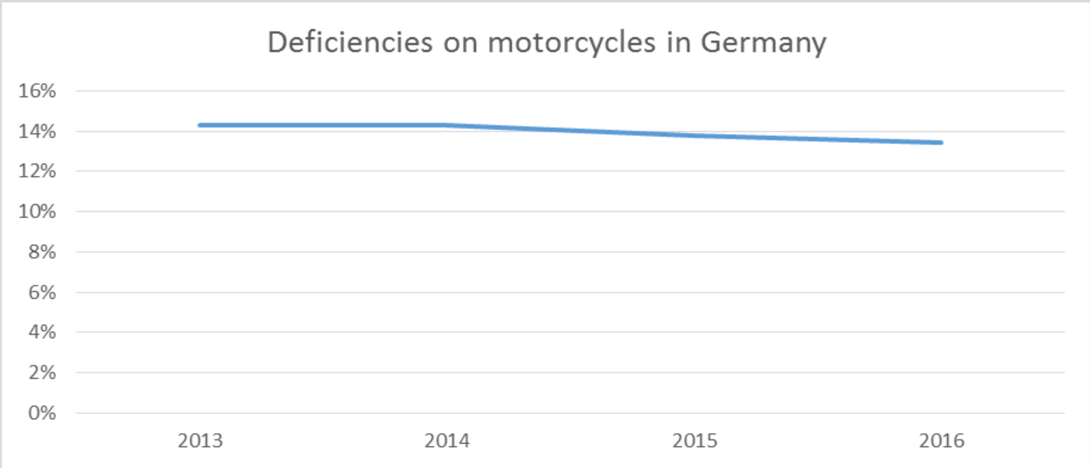

Figure 9: Deficiencies on motorcycles in Germany. Source: Kraftfahrt-Bundesamt 2014a, 2015a, 2016, 2017b - see Bibliography

The types of deficiencies do not differ much over the years. Data from 2016 indicates that over one third of all deficiencies arise from motorcycle lighting in Germany. Axles, wheels, tyres and suspension account for over 16%, while brake deficiencies appear on more than 11% of all inspected motorcycles. Nuisance and chassis represent categories of about 10% of all deficiencies, while deficiencies of the remaining types represent smaller proportions.

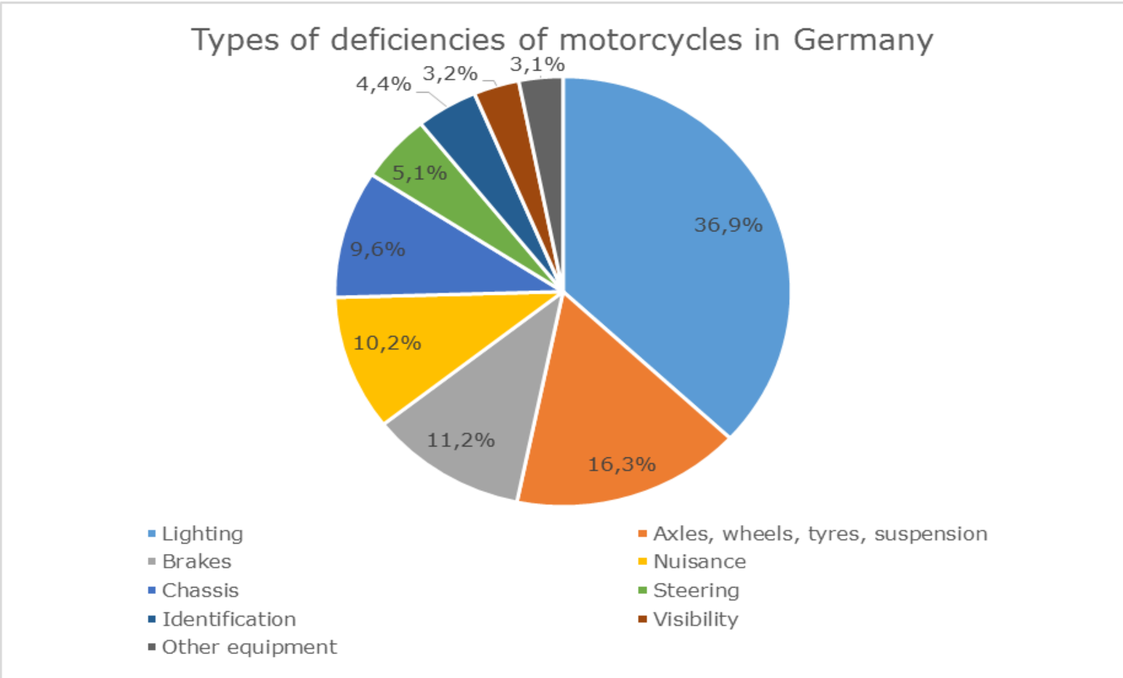

Figure 10: Types of deficiencies of motorcycles in Germany. Source: Kraftfahrt-Bundesamt 2017b - see Bibliography

Looking at the consequences of accidents involving motorcycles and mopeds in Germany, a trend is visible. Since 2001, fatalities have decreased considerably from 964 to 536 (-44%) for motorcycle drivers and from 138 to 68 (-51%) for moped drivers.

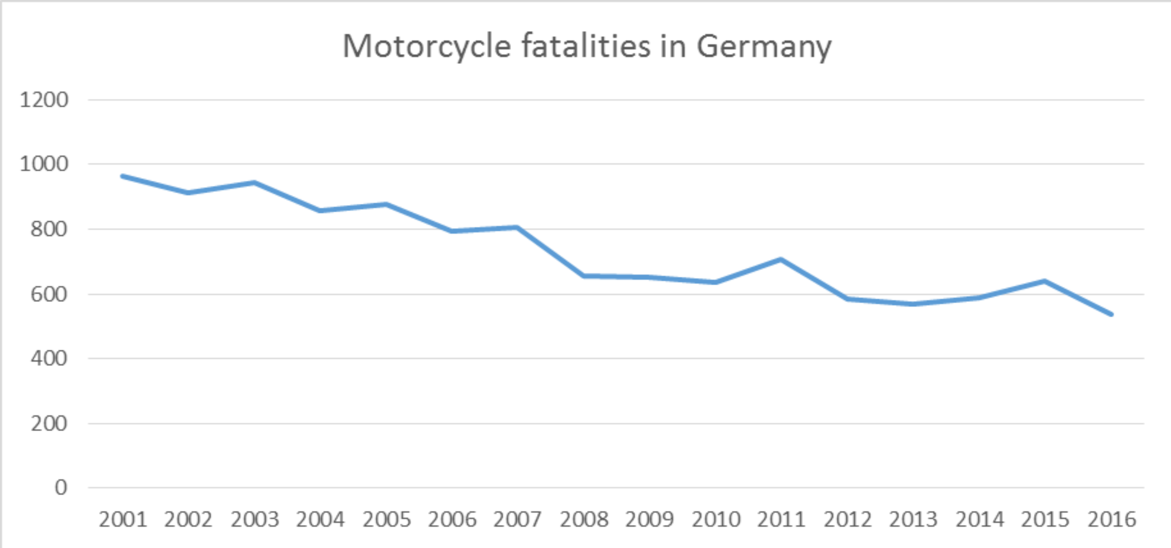

Figure 11: Motorcycle fatalities in Germany. Source: Statistisches Bundesamt 2017 https://www-genesis.destatis.de/genesis/online/data;jsessionid=5CDEA9A6A28DBF50E6A52AA607A7AE22.tomcat_GO_1_3?operation=previous&levelindex=2&levelid=1519313285114&levelid=1519313240450&step=1

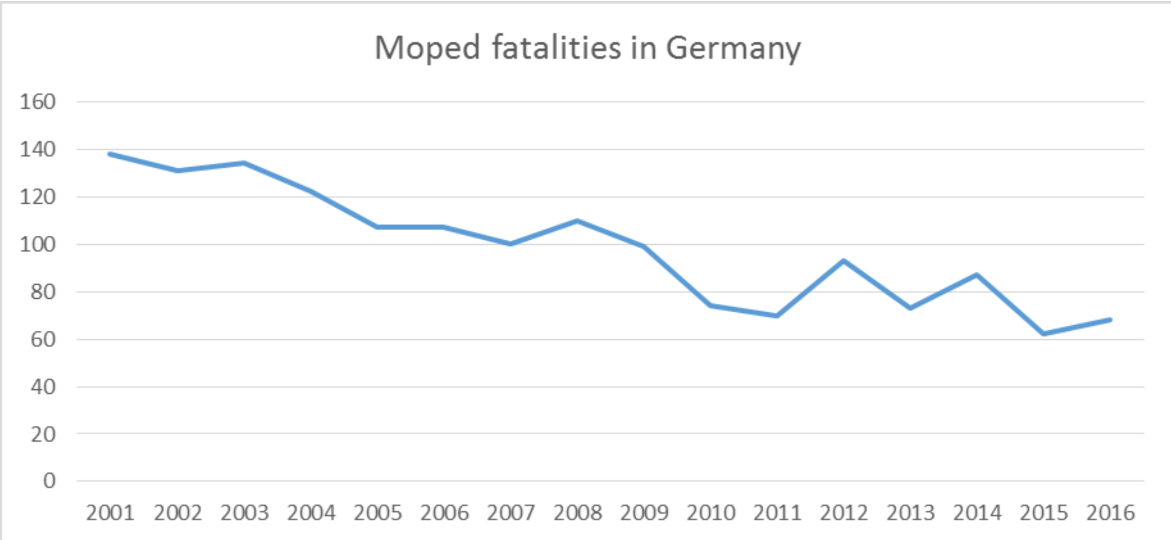

Figure 12: Moped fatalities in Germany. Source: Statistisches Bundesamt 2017 https://www-genesis.destatis.de/genesis/online/data;jsessionid=5CDEA9A6A28DBF50E6A52AA607A7AE22.tomcat_GO_1_3?operation=previous&levelindex=2&levelid=1519313285114&levelid=1519313240450&step=1

However, this decrease in fatalities is less than the overall decrease in all road accident fatalities in Germany since 2001. While 6,842 people were killed in road accidents in 2001, this number decreased to 3,206 in 2016. The proportion of motorcyclists in these fatalities increased from 13.8% in 2001 to 16.7% in 2016, whereas the proportion of moped drivers remained relatively stable at 2% in 2001 and 2.1% in 2016.

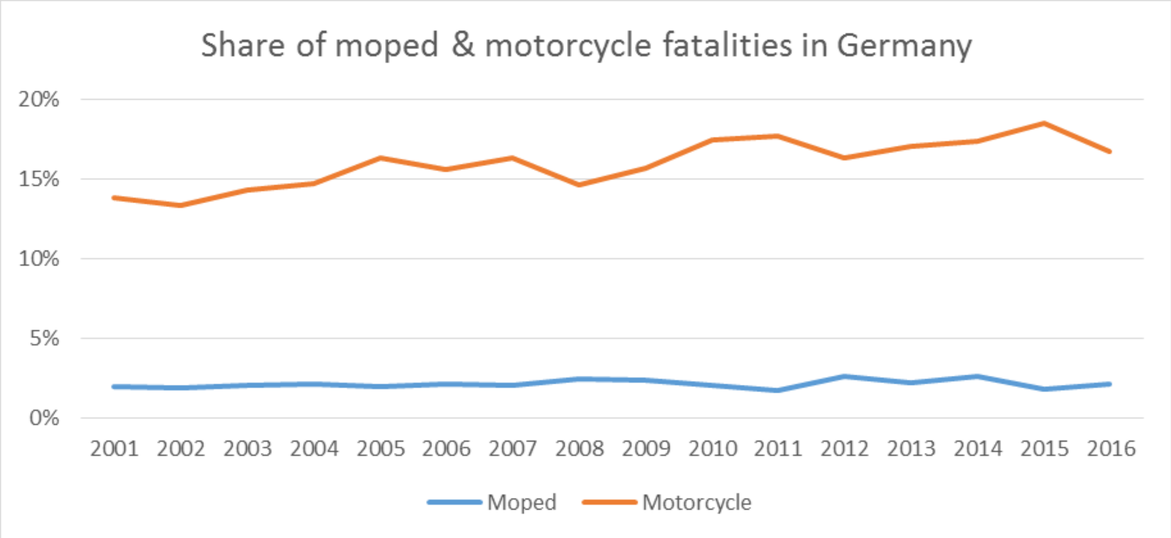

Figure 13: Share of moped and motorcycle fatalities in Germany. Source: Eurostat http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tran_sf_roadve&lang=en

Looking at the consequences of accidents, the number of fatalities is quite low compared with the number of injuries. In 2016, 14,413 moped drivers and 28,901 motorcycle drivers were injured in road accidents in Germany. Of the injured moped drivers, 2,936 were seriously injured and 11,477 were slightly injured. The figures for motorcyclists are 9,614 serious injuries and 19,287 slight injuries.

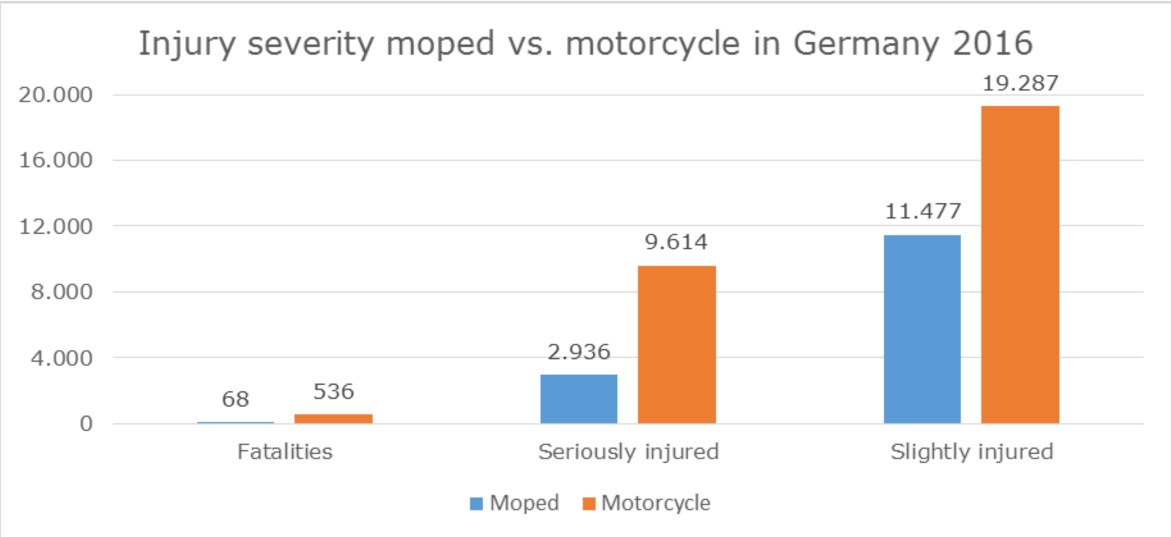

Figure 14: Injury severity moped vs. motorcycle. Source: Statistisches Bundesamt2017 https://www-genesis.destatis.de/genesis/online/data;jsessionid=5CDEA9A6A28DBF50E6A52AA607A7AE22.tomcat_GO_1_3?operation=previous&levelindex=2&levelid=1519313285114&levelid=1519313240450&step=1

As regards accidents involving mopeds and motorcycles in Germany, there is also detailed information on the causes of accidents. The following table shows causes of accidents noted in accident reports in 2016. The main causes of accidents for both motorcycles and mopeds were inappropriate speed at 33.5% and 19.9%, followed by not keeping an adequate distance at 13% and 10.3%. For motorcycles in particular, overtaking errors are also a major cause of accidents at 10.6%. Many causes of accidents for both vehicle types have been summarized in the category of other driver errors. Technical deficiencies account for only 1.3% of motorcyclist collisions and 1.5% of moped collisions. It should however be mentioned that accident analysts are rarely sent to accident scenes and most accident reports are completed by regular police officers who have less expertise in identifying technical deficiencies at an accident scene.

Causes of accidents in 2016	Motorcycles		Mopeds	
Alcohol	410	2.1%	725	7.6%
Influence of intoxicants	71	0.4%	129	1.4%
Fatigue or other mental/physical deficiencies	71	0.4%	79	0.8%
Wrong use of road	997	5.2%	632	6.6%
Inappropriate speed	6,446	33.5%	1,897	19.9%
Mistake in keeping adequate distance	2,504	13.0%	988	10.3%
Mistake in overtaking / being overtaken	2,033	10.6%	360	3.8%
Mistake in driving past	34	0.2%	40	0.4%
Mistake in driving side by side	140	0.7%	109	1.1%
Right of way violation	560	2.9%	662	6.9%
Mistake turn, turn around, driving backwards...	477	2.5%	670	7.0%
Wrong behaviour to pedestrians	95	0.5%	101	1.1%
Illegal parking/stopping, insufficient road safety	9	0.0%	2	0.0%
Ignoring lighting regulations	9	0.0%	14	0.1%
Overload, insufficient load securing	9	0.0%	13	0.1%
Other mistakes by the driver	5,141	26.7%	2,990	31.3%
Technical deficiencies	246	1.3%	142	1.5%

Table 1: Causes of accidents in 2016. Source: Statistisches Bundesamt 2018
https://www-genesis.destatis.de/genesis/online/data;jsessionid=5CDEA9A6A28DBF50E6A52AA607A7AE22.tomcat_GO_1_3?operation=previous&levelindex=2&levelid=1519313285114&levelid=1519313240450&step=1

It has to be assumed that undiscovered technical defects are not necessarily causes of accidents, but they can be reinforcing factors and/or alter the presented statistics. The assumption that the true value of technical deficiencies for crashed motorcycles is in fact higher is supported by a study conducted by DEKRA from 2002 to 2009. Following accidents, 700 motorcycles were inspected, of which 165 (23.6%) were defective. 56 of those motorcycles exhibited defects that were of relevance to the accident (DEKRA Automobil GmbH 2010, 23).

Light trailers

Contrary to the data for powered two- and three-wheelers, the data basis for light trailers is considerably inferior. For example, the KBA publishes the types of deficiencies discovered at periodic technical inspections only for trailers in general, but not for O1 and O2 trailers separately. However by falling back on DEKRA internal data on PTI results, deficiency types for O1 and O2 trailers in Germany can be presented in detail in the scope of this study. With regard to accident numbers, causes and consequences in terms of injuries and/or fatalities, unfortunately no data is available for Germany.

Similar to the procedure for motorcycles, the different deficiency categories in Germany have been merged in the scope of the analysis for this study. Comparing the deficiency rates of O1 and O2 trailers shows a higher rate of O2 trailer deficiencies. In detail, the level of deficiencies discovered at PTIs in 2016 was about 19.8% for O1 trailers and 27.6% for O2 trailers. While the rate of PTI with deficiencies increased slightly from 19.4% in 2014 to 19.8% in 2016 for O1 trailers, the deficiency rate for O2 trailers increased from 2014 to 2015 but returned to the level of 2014 in 2016.

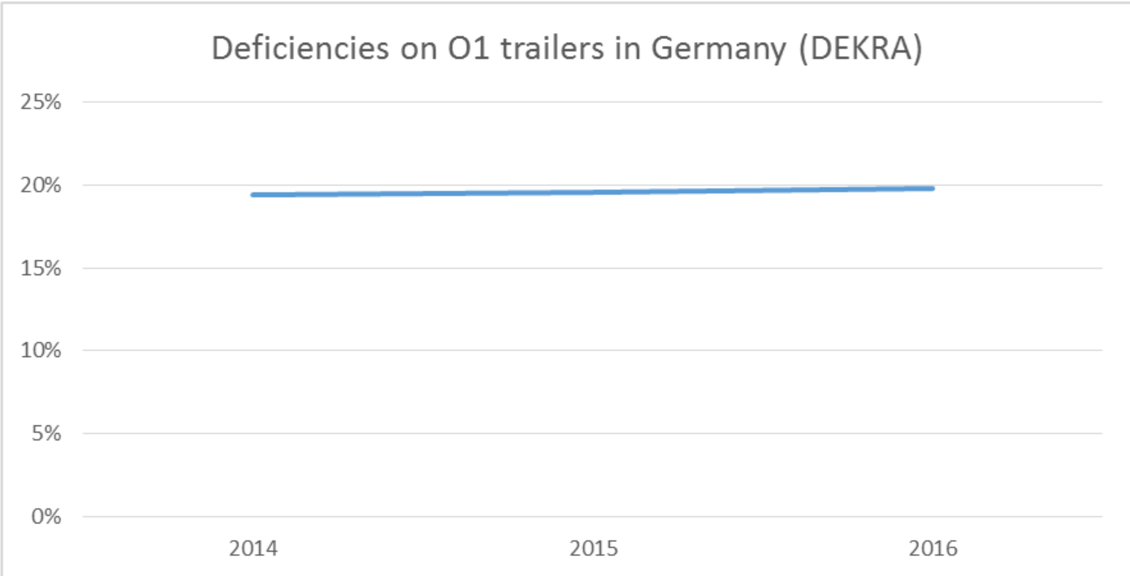

Figure 15: Deficiencies on O1 trailers in Germany. Source: DEKRA PTI results

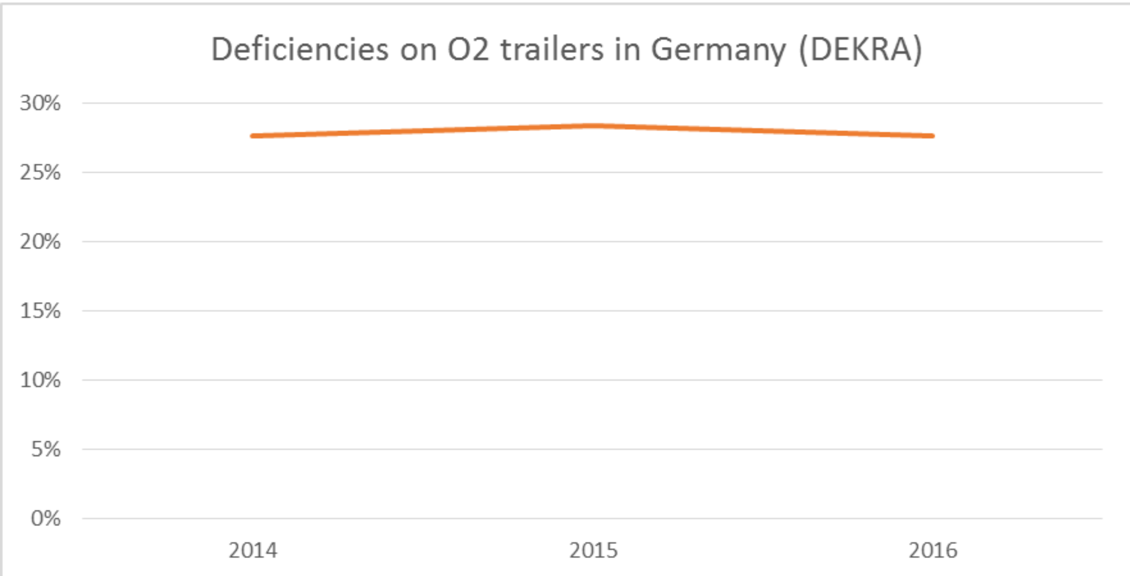

Figure 16: Deficiencies on O2 trailers in Germany (DEKRA). Source: DEKRA PTI results

As in the case of motorcycles, the types of deficiencies did not differ much over recent years. With regards to O1 trailers, lighting deficiencies are by far the most common defects with 64.6%. Axles, wheels, tyres and suspension as well as chassis defects follow at about 14% each.

Deficiencies on O2 trailers differ from O1 deficiencies especially on one aspect, namely brakes. Since O1 trailers are not equipped with brakes and O2 trailers are, this part of O2 trailers represents the second most common defect at 35%, following lighting defects at about 41%. Chassis and axles, wheels, tyres and suspension follow at about 8% each.

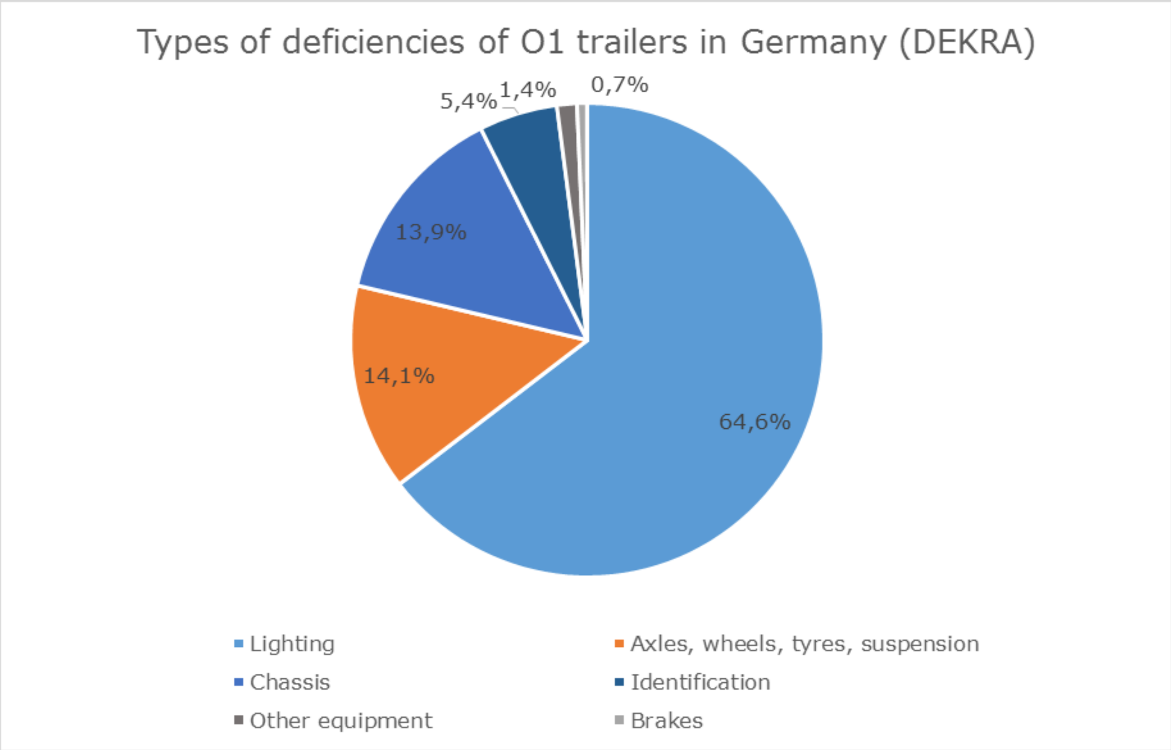

Figure 17: Types of deficiencies of O1 trailers in Germany (DEKRA). Source: DEKRA PTI results

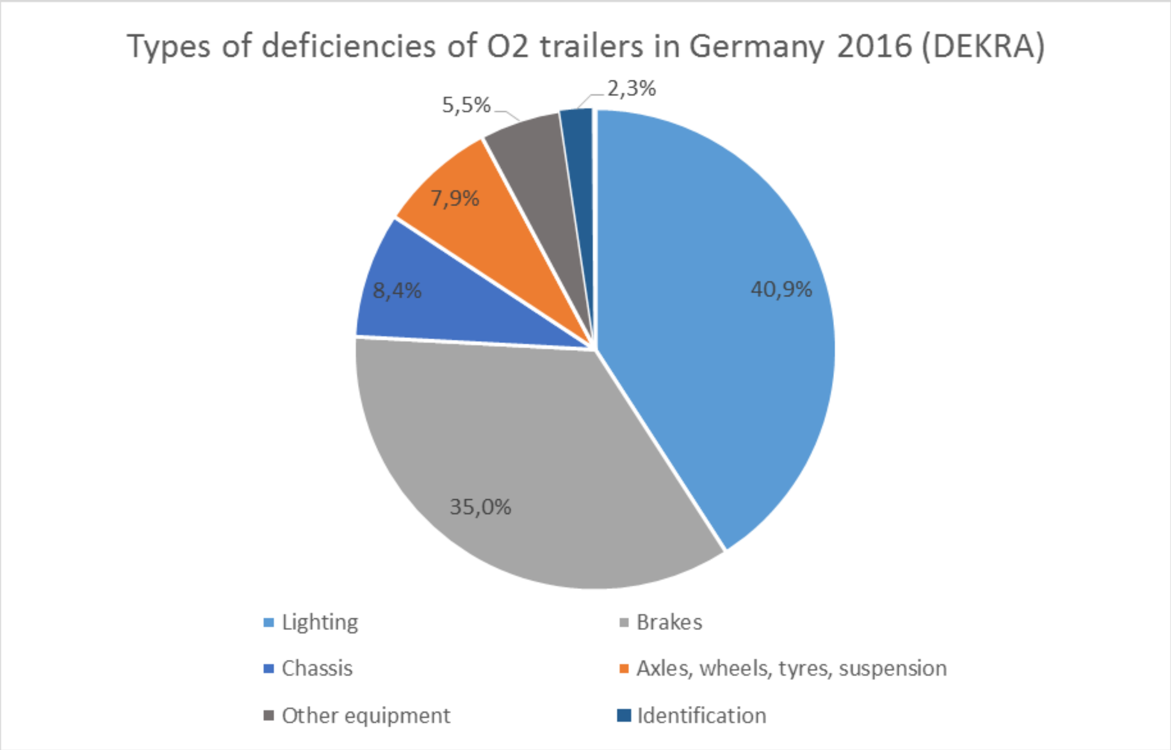

Figure 18: Types of deficiencies of O2 trailers in Germany (DEKRA). Source: DEKRA PTI results

3.3. PTI in Spain

In Spain, a significant proportion of the information collected comes from the national database of road traffic accidents, Dirección General de Tráfico (DGT).

In this Member State, L vehicles including mopeds and O2 must be registered, but not O1.

Available statistical data on accidents of trailers and semi-trailers is classified according to their maximum mass. The DGT database sorts the data according to different mass ranges than those defining the O category. Classification of data is as follows:

- Under 999 kg (therefore, in this range we can find data on O1 and O2 together).
- Over 1,000 kg and not exceeding 1,499 kg (in this range, we can find data only on O2).
- Over 1,500 kg and not exceeding 2,999 kg (in this range, we can find data only on O2).
- Over 3,000 kg and not exceeding 4,999 kg (in this range, we can find fixed data on O2 and O3).

Since it is not possible to distinguish the data for O1 and O2, or for O2 and O3, in certain ranges, this has to be taken into consideration when assessing the findings.

The fleet size of light trailers has continuously increased in recent years. In 2016, the fleet size for all trailers[7] reached the value of 443,598. Among these, there are

[7] The term trailer includes trailer and semi-trailer when necessary.

106,799 trailers with maximum mass under 999 kg (O1 and O2), 45,598 trailers with mass between 1,000 and 2,999 kg (O2) and 2,310 trailers with mass between 3,000 and 4,999 kg (O2 and O3). The rest of this fleet size corresponds to O3 and O4.

However, for powered two- and three-wheelers the Scenario is slightly different. Whereas the fleet size of motorcycles is continually growing, the fleet size of mopeds has decreased in recent years. The most recent data is from 31.12.2016, with more than 3.2 million motorcycles and nearly 2 million mopeds.

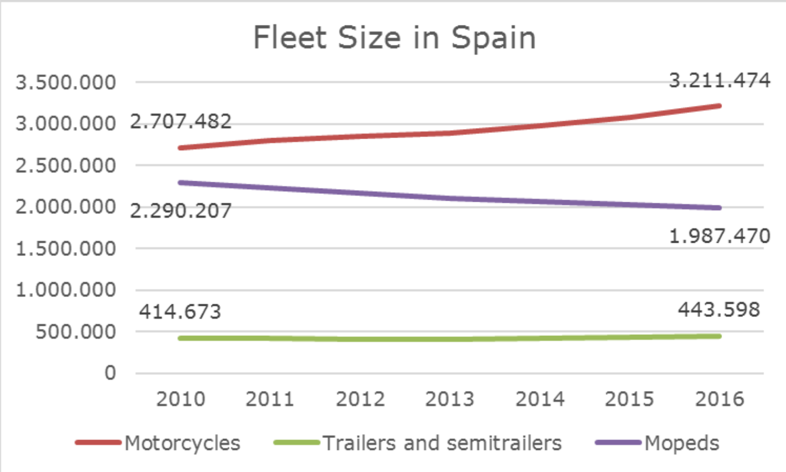

Figure 19: Fleet size in Spain. Source: National database of traffic accidents and vehicle registration in Spain DGT (Dirección General de Tráfico), Fleet size, 2010-2016

Mopeds and motorcycles

PTI for all L vehicle categories is mandatory in Spain. The introduction date for moped inspections depends on the region; the first inspections started in 2007 and were country-wide by 2010.

Data on technical deficiencies has been provided by Spain's Ministry of Industry, Trade and Tourism.

According to the data shown in figure 20, the deficiencies discovered at PTIs in 2016 for motorcycles and mopeds represent about 2.15% in relation to the total of detected defects for all kinds of vehicle. While the level of minor deficiencies remained practically constant at about 1.2% in recent years, the level of major deficiencies decreased from 5.1% in 2014 to 4.5% in 2016[8].

[8] Spanish Royal Decree 711/2006. The definition of deficiencies in the Spanish legal framework for vehicle inspection is equivalent to what was approved in Directive 2014/45/EU at the time when PTI for mopeds, categories L1e, L2e and L6e, became mandatory in that country.

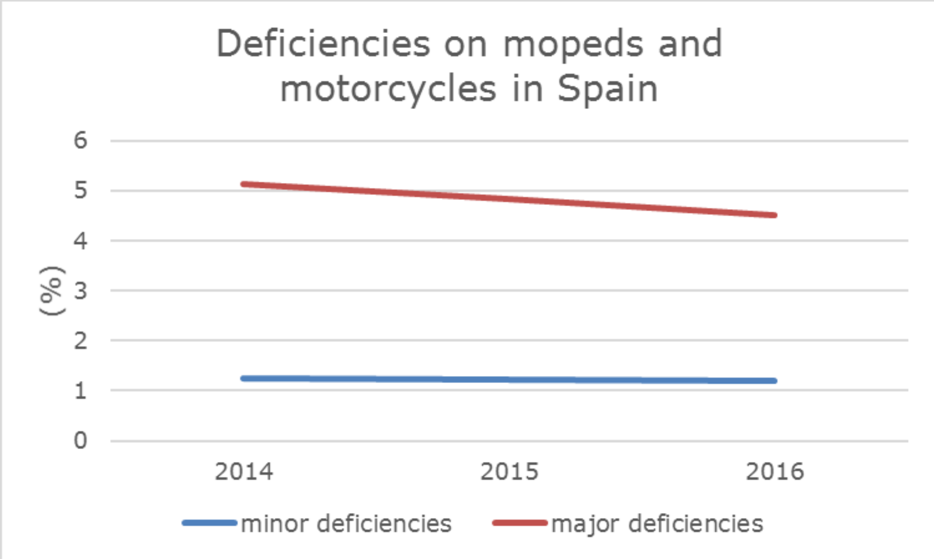

Figure 20: Deficiencies on mopeds and motorcycles in Spain. Source: Ministry of Industry and Energy, Periodic Technical Inspection Results in Spain, 2014, 2015, 2016

Nevertheless, looking at the absolute values, we can observe that both minor and major deficiencies have risen in recent years. There may be various reasons for this, such as the growth of the motorcycle fleet and the ageing of this kind of vehicle.

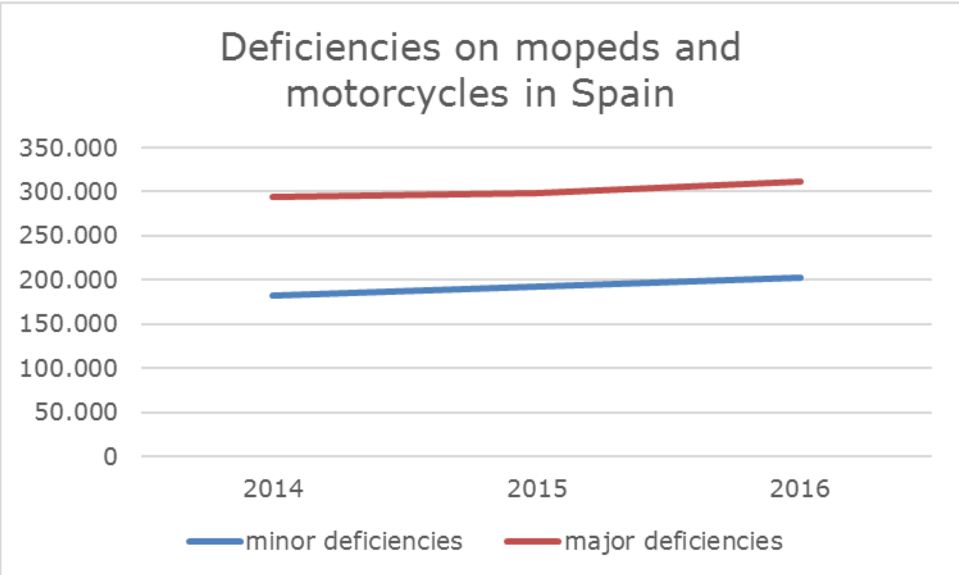

Figure 21: Deficiencies on mopeds and motorcycles in Spain. Source: Ministry of Industry and Energy, Periodic Technical Inspection Results in Spain, 2014, 2015, 2016

The types of deficiencies do not differ much through the years. Data from 2016 indicates that over one third are related to lighting and signalling devices. Outer fittings, bodywork and chassis account for 13% of deficiencies. Vehicle identification deficiencies represent 11%. While axles, wheels, tyres and suspension account for 10%. Brake deficiencies appear on 6% of all inspected motorcycles and mopeds. Polluting emissions, such as noise, appear in 8% of detected deficiencies. Engine and transmission account for smaller proportions (5%).

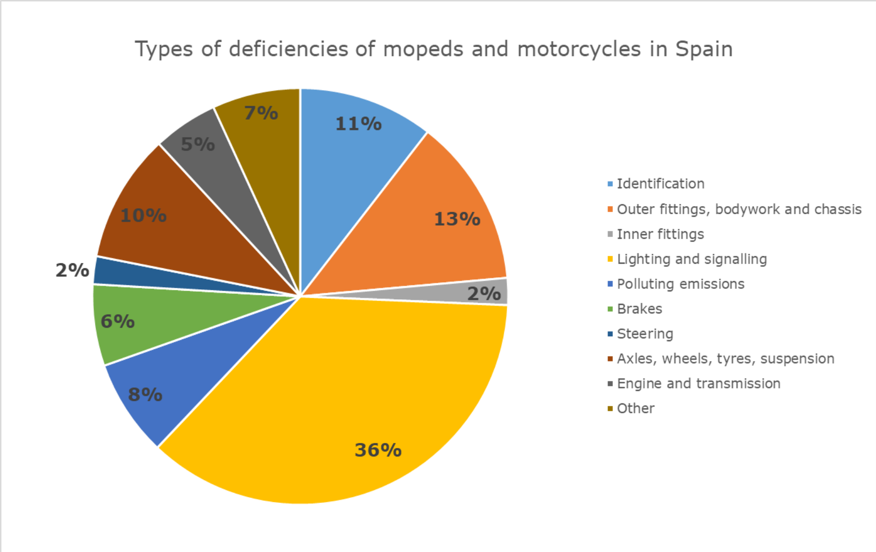

Figure 22: Types of deficiencies (including minor and major deficiencies) in mopeds and motorcycles in Spain. Source: Ministry of Industry and Energy, Periodic Technical Inspection Results in Spain, 2016

Looking at only the major deficiencies detected in mopeds and motorcycles, lighting and signalling also show the highest values (31%). The next most affected aspects are polluting emissions (13%), outer fittings, bodywork and chassis (12%) and axles, wheels, tyres and suspension (12%).

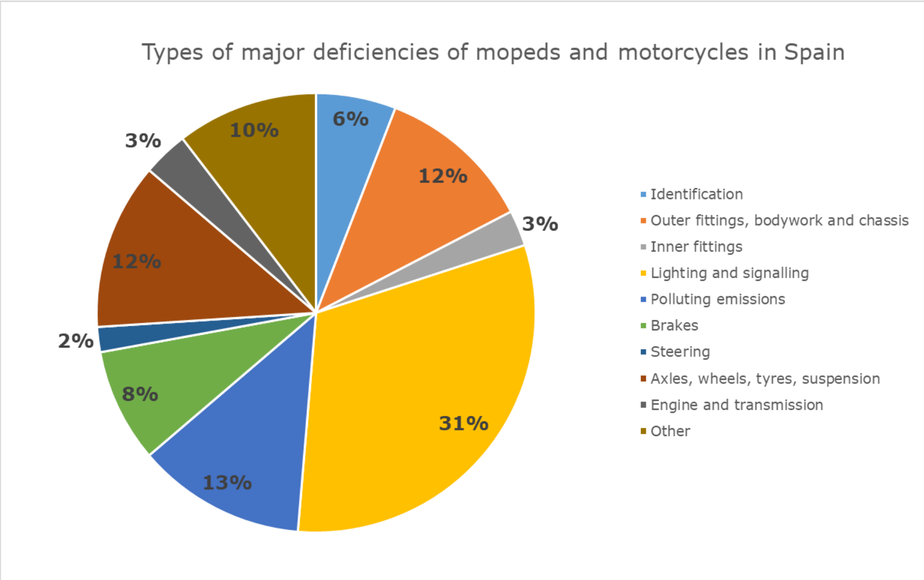

Figure 23: Types of major deficiencies in mopeds and motorcycles in Spain. Source: Ministry of Industry and Energy, Periodic Technical Inspection Results in Spain, 2016

The following graphs show the major deficiencies detected in 2016 differentiating between mopeds and motorcycles in one of the most representative regions in Spain, Andalusia. In mopeds, special attention should be given to lighting and signalling (23%), other deficiencies (such as speed restriction and unauthorised modifications) (18%) as well as axles, wheels, tyres and suspension (13%).

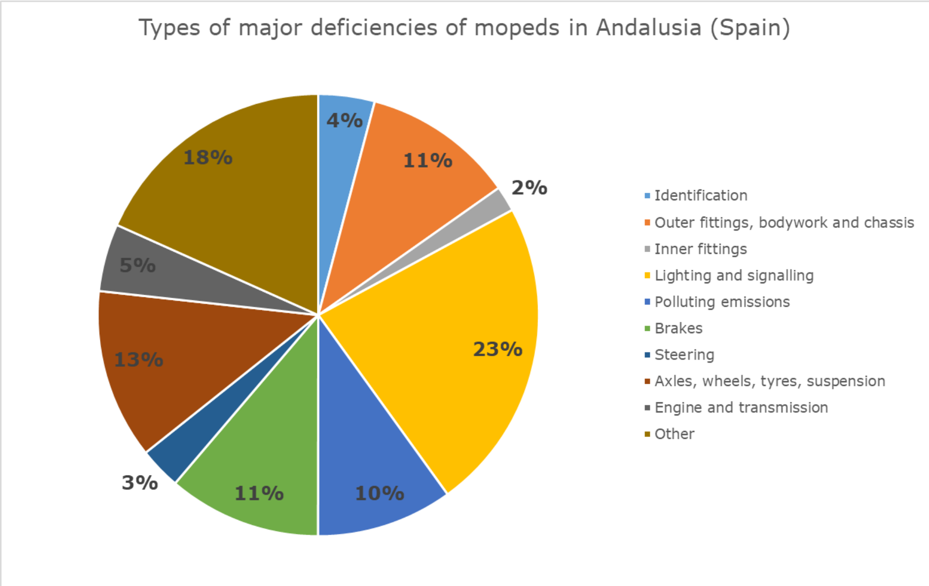

Figure 24: Types of major deficiencies of mopeds in Andalusia. Source: Ministry of Industry and Energy, Periodic Technical Inspection Results in Spain, 2016

In motorcycles, emphasis must be given to lighting and signalling (33%), polluting emissions (15%) as well as outer fittings, bodywork and chassis (14%) and axles, wheels, tyres and suspension (12%).

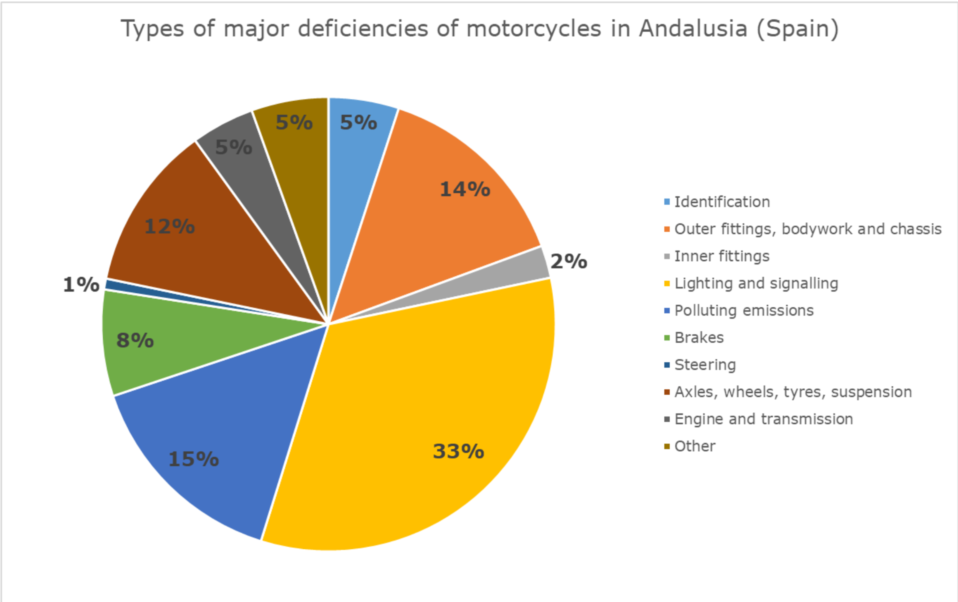

Figure 25: Types of major deficiencies of motorcycles in Andalusia. Source: Ministry of Industry and Energy, Periodic Technical Inspection Results in Spain, 2016

The impact of accidents involving mopeds significantly decreases in the initial period of figure 27, starting with 463 fatalities in 2001 and dropping to 54 in 2013 (84% reduction). The figure remains stable from 2013 to 2016 ranging from 53 to 56 fatalities. The Scenario for motorcycles is completely different. Motorcycle driver and occupant fatalities were 370 in 2001 and rose to a peak of 632 in 2007. Then, fatalities decreased to 287 in 2014, and afterwards the number went up again reaching 343 fatalities in 2016.

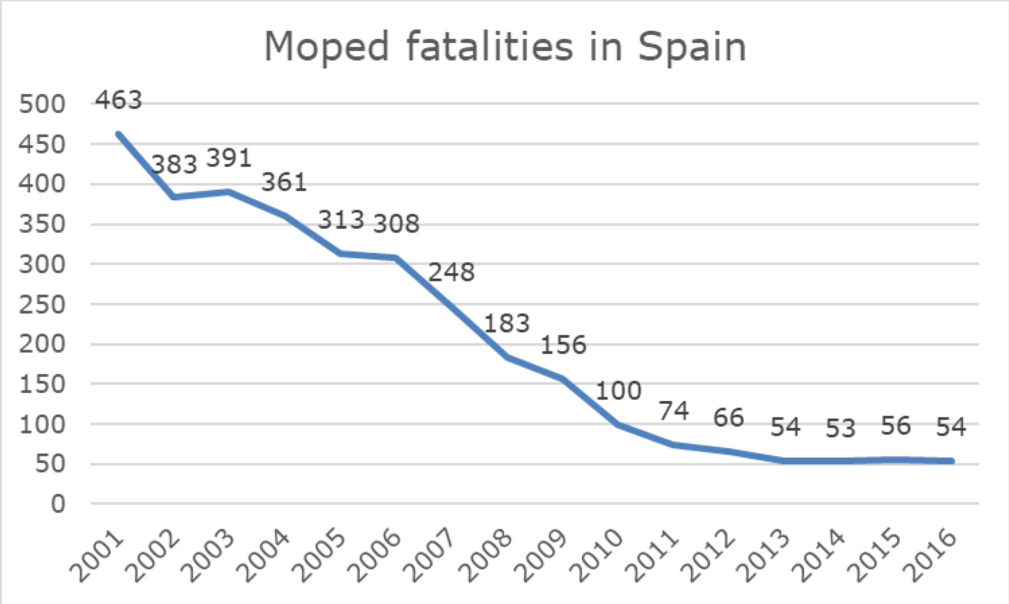

Figure 26: Motorcycle fatalities in Spain. Source: National database of traffic accidents in Spain DGT (Dirección General de Tráfico), Driver and occupant fatalities in motorcycles, 2001-2016

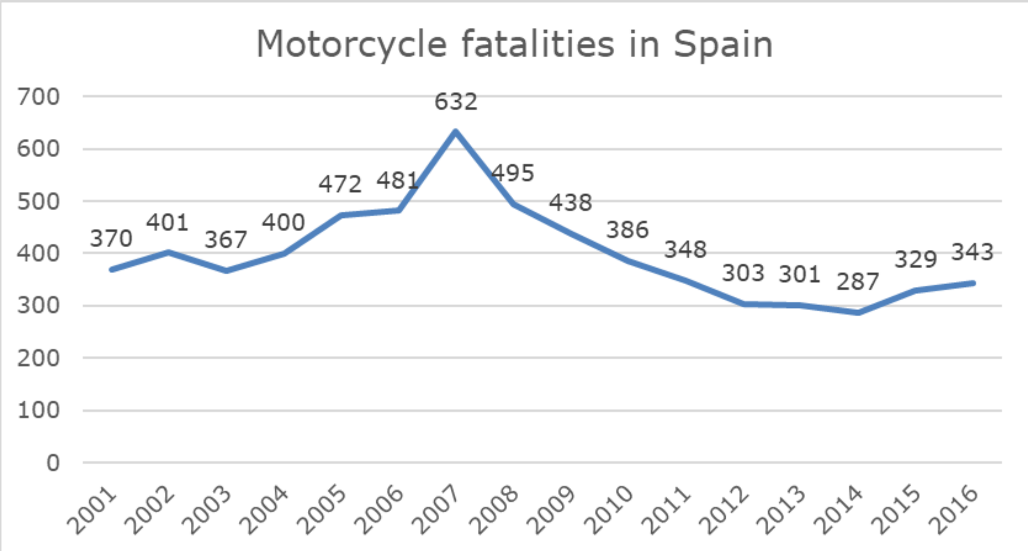

Figure 27: Moped fatalities in Spain. Source: National database of traffic accidents in Spain DGT (Dirección General de Tráfico), Driver and occupant fatalities in mopeds, 2001-2016)

Previous trends are maintained when focusing on the seriously injured. Seriously injured users of mopeds have notably decreased since 2001 from 4,604 to 625, which means a reduction of 86%. Whereas the number of seriously injured motorcycle users increased in the period 2001 - 2007 from 2,031 to 3,478. Since 2007, the seriously injured figure decreased to 2,459 in 2012, and afterwards increased again to 2,681 in 2016.

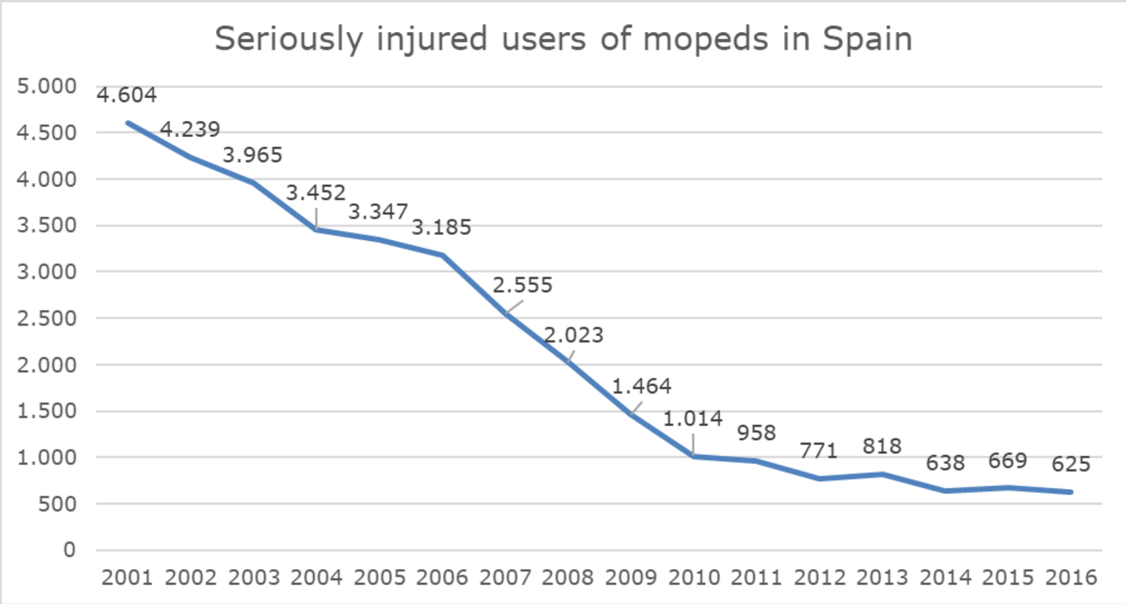

Figure 28: Moped injured. Source: National database of traffic accidents in Spain DGT (Dirección General de Tráfico), Drivers and occupants seriously injured in mopeds, 2001-2016

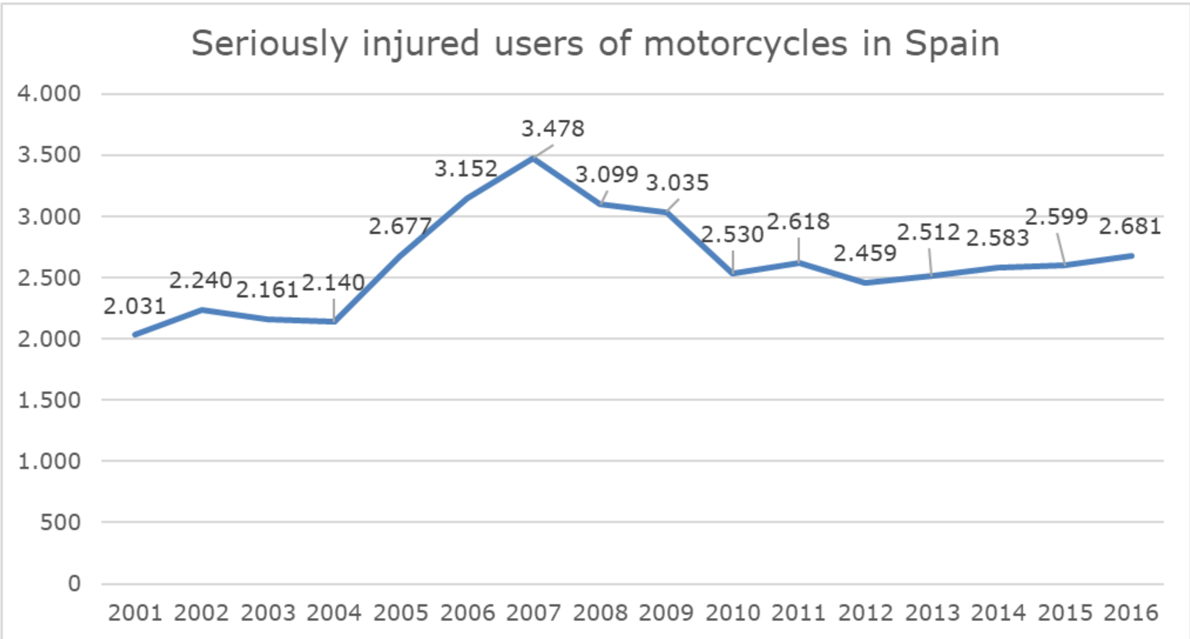

Figure 29: Motorcycle injured. Source: National database of traffic accidents in Spain DGT (Dirección General de Tráfico), Drivers and occupants seriously injured in motorcycles, 2001-2016

The situation as regards comparing the impact of road accidents in the period 2007 – 2016 is the following.

- Entire fleet:
  - 2007: 3,823 fatalities and 19,295 seriously injured
  - 2016: 1,810 fatalities (-53%) and 9,755 seriously injured (-50%)
- Motorcycles:
  - 2007: 632 fatalities and 3,478 seriously injured
  - 2016: 343 fatalities (-45%) and 2,681 (-23%) seriously injured
- Mopeds:
  - 2007: 248 fatalities and 2,555 seriously injured
  - 2016: 54 (-78%) fatalities and 625 (-76%) seriously injured

Furthermore, the proportion of motorcyclists in the total number of fatalities increased from 17% in 2007 to 19% in 2016, whereas the proportion for moped drivers decreased from 6% in 2007 to 3% in 2016.

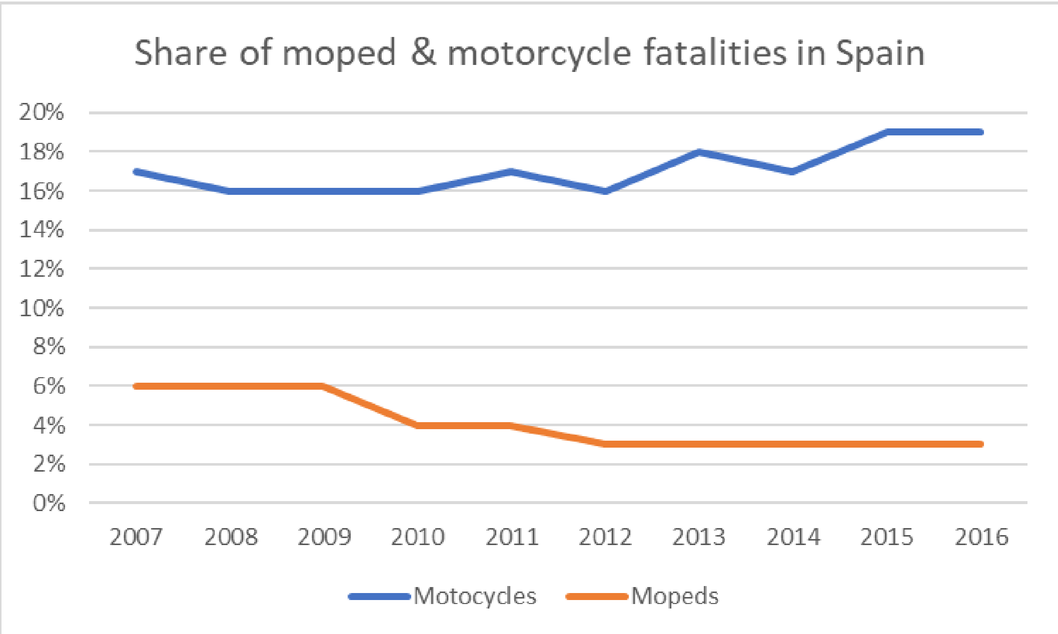

Figure 30: Share of moped and motorcycle fatalities. Source: National database of traffic accidents in Spain DGT (Dirección General de Tráfico), Main figures of road accidents of motorcycles, 2016

The number of fatalities is small compared with the number of injured people. In 2016, 8,385 moped drivers and 27,045 motorcycle drivers were injured in road accidents. Among the injured moped drivers, 625 were seriously injured and 7,760 were slightly injured. The figures for motorcycle users are 2,681 seriously injured and 24,364 slightly injured.

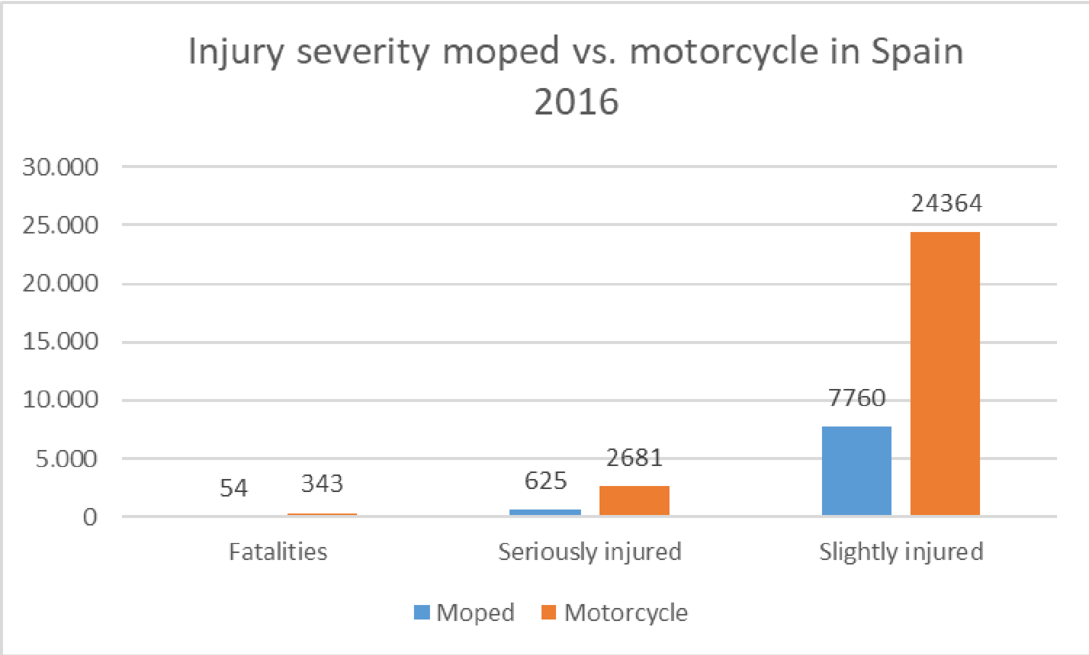

Figure 31: Comparison of level of injury of moped and motorcycle users. Source: National database of traffic accidents in Spain DGT (Dirección General de Tráfico), Main figures for motorcycle road accidents, 2016

The following table shows causes of accidents recorded in accident reports in 2016 for motorcycles. The main causes were inappropriate speed in the case of 22.72% and distracted driving in the case of 19.75%, followed by right of way violation and not keeping an adequate distance at 16.92% and 10.64% and 10.3%, respectively.

Causes of accidents in 2016	**Motorcycles**	
Distracted driving	774	19.75%
Inappropriate speed	890	22.72%
Right of way violation	66	16.92%
Mistake in keeping adequate distance	417	10.64%
Mistake in overtaking / being overtaken	120	3.06%
Mistake in turning, turning around, driving backwards, ...	164	4.19%
Careless driving	29	0.74%
Dangerous driving	7	0.18%
Alcohol*	124 (of 1,820)	6.81%
Fatigue or sleep	61	1.56%
Inexperience	106	2.71%
Disease or mental/physical deficiencies	23	0.59%
Wrong behaviour to pedestrians	9	0.23%
Other mistakes	184	4.7%
*In the case of alcohol cause, sample data on 1,820 accidents was taken into account, where the drivers involved were tested with the breath alcohol test.		

Table 2: Causes of accidents in 2016. Source: National database of traffic accidents in Spain DGT (Dirección General de Tráfico), Main figures of road accidents of motorcycles, 2016

In 2016, 7% of motorcycles involved in accidents with fatalities or seriously injured persons were ridden without a valid PTI at the time of the crash. This figure is 9% when only considering fatalities.

There is a relationship between the age of the motorcycle and inspection status. 8% of vehicles between 5 and 9 years old were involved in crashes without valid PTI. This figure rises to 13% for vehicles older than 15 years.

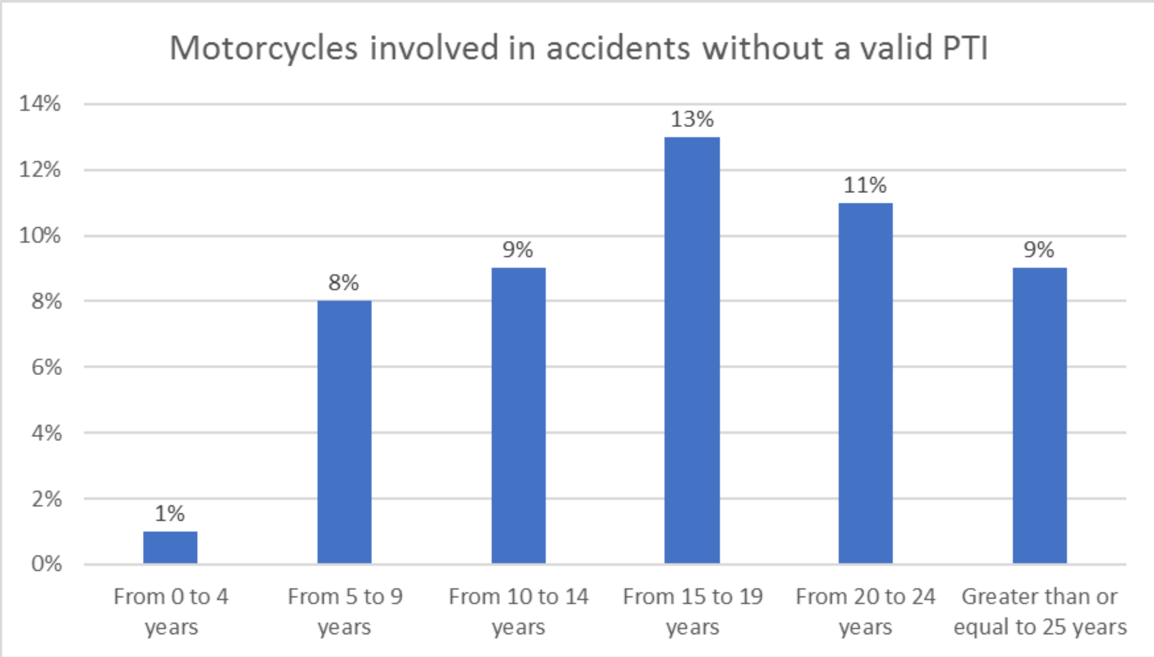

Figure 32: Motorcycles involved in accidents without a valid PTI. Source: National database of traffic accidents in Spain DGT (Dirección General de Tráfico), Main figures of road accidents of motorcycles, 2016

Spain introduced certain changes in the driving licence scheme for motorcycles in 2004. Before that year, it was necessary to hold an A1 driving licence to ride motorcycles with up to 125 cm^3 engine displacement, 11 kW of power and 0.1 kW/kg of power-weight ratio.

Royal Legislative Decree 1598/2004[9] permitted driving of the vehicles described above with any of the following licences: A1, A or B with at least three years' driving experience.

As a result of this legislative change, there was a significant increase in the registration of motorcycles up to 125 cm^3. Before this regulation came into force, in 2003, motorcycles represented 22% of vehicle registrations, whereas in 2013 this figure was 61%. This was reflected in the accident rate. In the period between 2003 and 2013, the number of motorcycles over 125 cc involved in an accident increased by 51%, whereas the number of motorcycles up to 125 cc involved in an accident rose by 296%.

Trailers

In contrast to the data for two- and three-wheelers, the database for light trailers is considerably smaller. Furthermore, it is not possible to obtain precise data for O1 and O2 separately and no data is available on traffic accident numbers, causes and consequences in terms of injuries and/or deaths.

Figure 33 below contains aggregated data on deficiencies detected for trailers and semi-trailers. Considering the minor and major deficiencies detected in trailers as a proportion of the deficiencies for all vehicle categories, the rate of minor deficiencies increased in recent years from 1.8% in 2014 to 2.1% in 2016. The level of major deficiencies also increased from 3% in 2014 to 3.5% in 2016.

[9] https://www.boe.es/buscar/doc.php?id=BOE-A-2004-13415

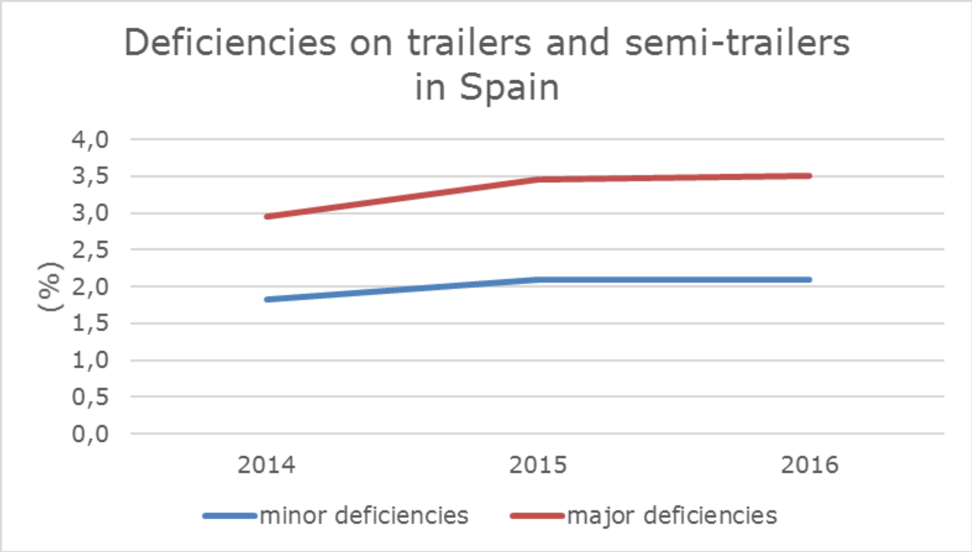

Figure 33: Deficiencies of trailers and semi-trailers. Source: Ministry of Industry and Energy, Periodic Technical Inspection Results in Spain, 2014, 2015, 2016

The results of PTI for trailers show more minor deficiencies than major.

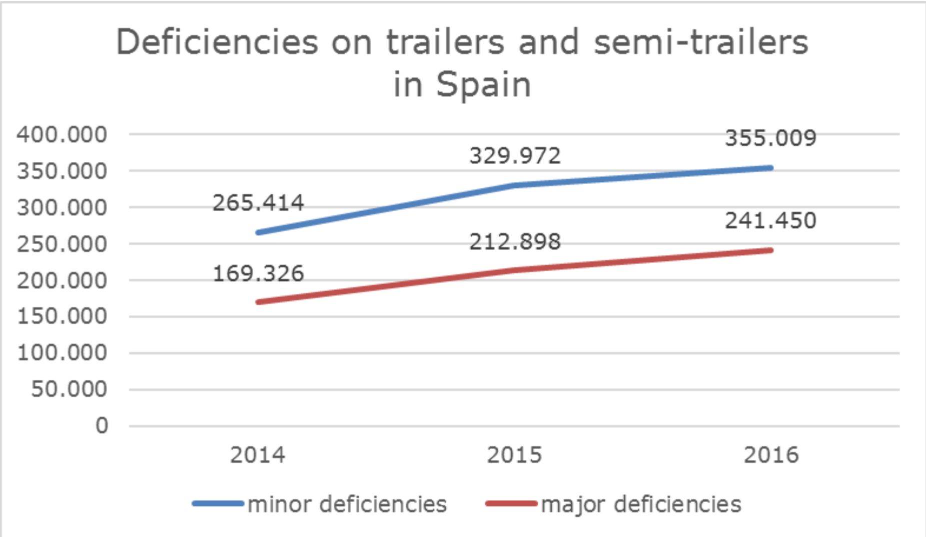

Figure 34: Deficiencies of trailers and semi-trailers. Source: Ministry of Industry and Energy, Periodic Technical Inspection Results in Spain, 2014, 2015, 2016

As in the case of motorcycles, there has been no significant difference in types of deficiencies in recent years. In 2016 brakes accounted for 44% of deficiencies and lighting and signalling deficiencies were 31% of the total. The remaining defects were related to outer fittings, bodywork and chassis, 12%. Axles, wheels, tyres and suspension follow with 8%.

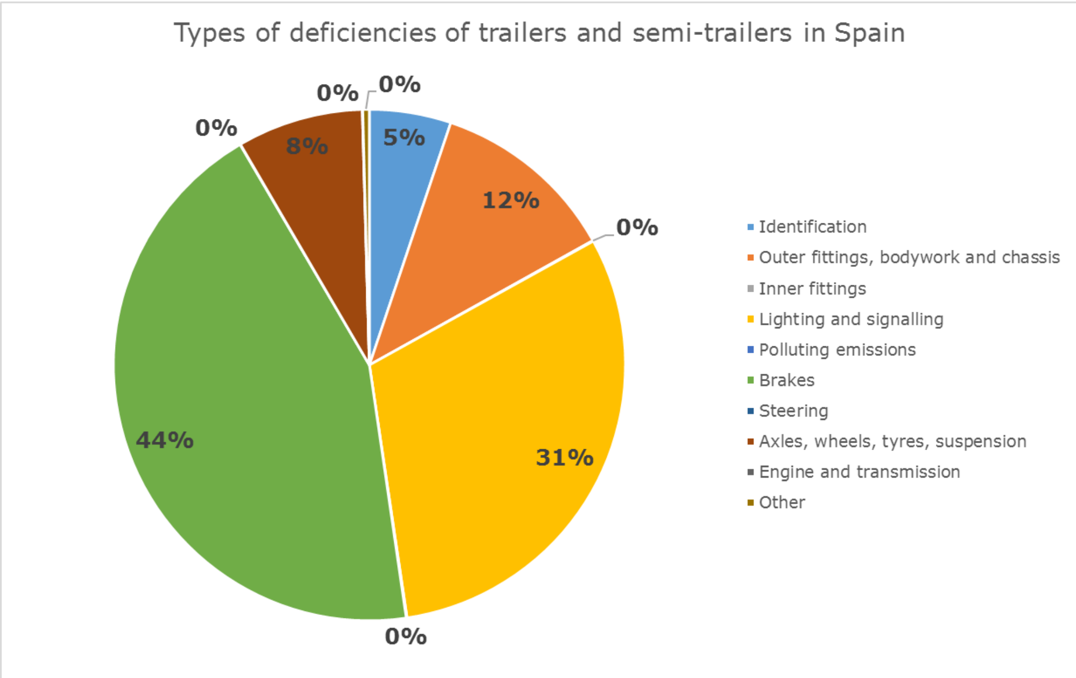

Figure 35: Type of deficiencies of trailers and semi-trailers. Source: Ministry of Industry and Energy, Periodic Technical Inspection Results in Spain, 2016

When analysing major defects, brake deficiencies are by far the most common defects at 53%. Lighting and signalling deficiencies represent 18%. Axles, wheels, tyres and suspension follow with 16%. Outer fittings, bodywork and chassis are the cause of 9% of major deficiencies.

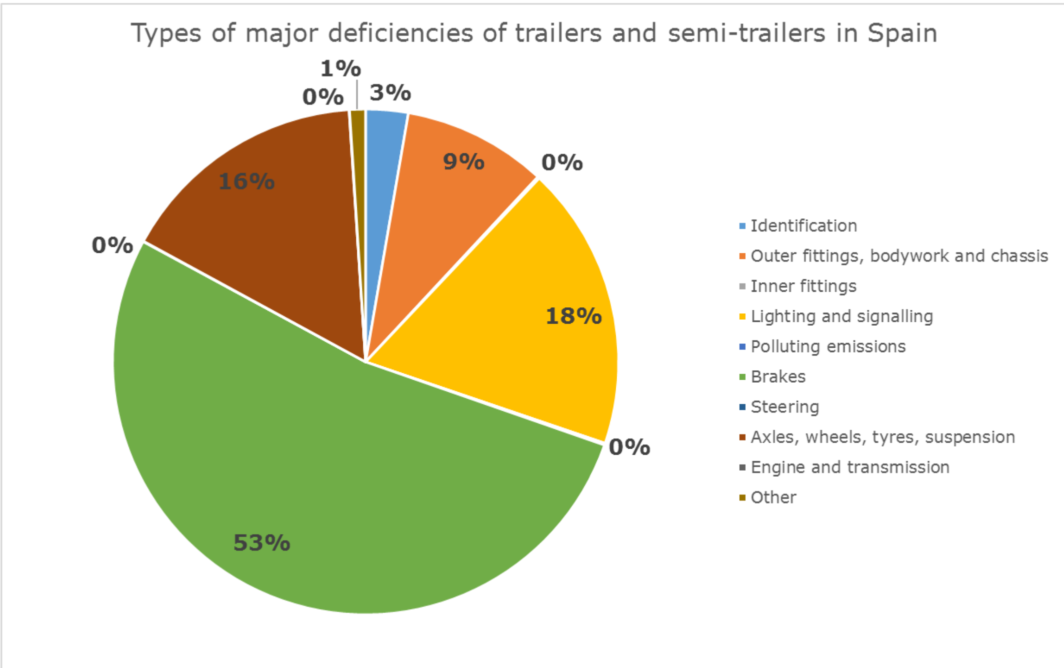

Figure 36: Type of major deficiencies of trailers and semi-trailers. Source: Ministry of Industry and Energy, Periodic Technical Inspection Results in Spain, 2016

3.4. Approach at European level

The following table displays which Member States have compulsory PTI for motorcycles in place. Note that Belgium, Cyprus, Denmark, Finland, France, Ireland, Malta, the Netherlands and Portugal do not have that requirement.

Country	Motorcycle PTI	PTI frequency in months
Austria	✓	12
Belgium	✗	-
Bulgaria	✓	24
Croatia	✓	24 / 12
Cyprus	✗	-
Czech Republic	✓	48 / 24
Denmark	✗	-
Estonia	✓	36 / 24 / 24 / 24 / 12 / 12 / 12
Finland	✗	-
France	✗	-
Germany	✓	24
Greece	✓	24
Hungary	✓	48 / 24
Ireland	✗	-
Italy	✓	48 / 24
Latvia	✓	24
Lithuania	✓	36 / 24
Luxembourg	✓	48 / 24 / 12
Malta	✗	-
Netherlands	✗	-
Poland	✓	36 / 24 / 12
Portugal	✗	-
Romania	✓	24
Slovakia	✓	48 / 24
Slovenia	✓	48 / 24 / 24 /12
Spain	✓	48 / 24
Sweden	✓	24
United Kingdom	✓	12

Table 3: PTI schemes for motorcycles in Europe. Source: Road Safety Country Overview, European Commission, Directorate General for Transport. See Bibliography references 2016a, 2016b, 2016c, 2016d, 2016e, 2016f, 2016g, 2016h, 2016i, 2016j, 2016k, 2016l, 2016m, 2016n, 2016o, 2016p, 2016q, 2016r, 2016s, 2016t, 2016u, 2016v, 2016w, 2016x, 2016y, 2016z, 2016aa, 2016ab

Inspection frequencies are another difference between Member States. Inspection requirements vary from 12 to 48 months depending on the first registration date of the vehicle.

There were 24.7 million motorcycles on European roads in 2015, most of them in Italy, Germany and Spain. In 2005, the fleet size represented about 19.7 million, which implies an increase of about 25% within the last ten years.

Fleet data for light trailers seems less reliable in some countries.

Country	Motorcycles	O1 Trailers	O2 Trailers
Austria	482,765	342,290	265,629
Belgium	465,786	n/a	n/a
Bulgaria	165,754	No response	No response
Croatia	62,998	59,038	4,847
Cyprus	25,802	3,848 *(2016)*	3,136 *(2016)*
Czech Republic	558,941	No response	No response
Denmark	153,411	No response	No response
Estonia	29,053	61,451	11,544
Finland	261,800	806,373	120,854
France	2,694,166	298,536	781,666
Germany	4,145,392	3,210,827	2,793,324
Greece	1,619,621	No response	No response
Hungary	162,828	244,687	43,523
Ireland	34,960	n/a	n/a
Italy	6,540,697	n/a	n/a
Latvia	21,241	38,537	10,190
Lithuania	26,651	84,536	11,196
Luxembourg	18,569	n/a	n/a
Malta	19,918	No response	No response
Netherlands	652,544	n/a	994,243 *(2016)*
Poland	1,272,333	n/a	474,287
Portugal	501,500	No response	No response
Romania	106,187	No response	No response
Slovakia	88,652	No response	No response
Slovenia	58,083	99,798	20,653
Spain	3,079,463	154,707 *(2016: 0 kg – 4,999 kg)*	
Sweden	290,314	414,497	433,956
United Kingdom	1,140,169	No response	No response

Table 4: Fleet sizes 2015. Source: Survey to the Member States, Eurostat 2018, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road_eqs_trail&lang=en

While the number of accidents with motorcycles and injuries remained stable from 2010 to 2015, fatalities decreased in the same period by 14%. In 2010, 156,972 accidents with motorcycles across Member States caused 4,560 fatalities, whereas in 2015, 157,347 accidents caused 3,913 fatalities.

No conclusion can be made in terms of potential shifts between serious and slight injuries, since some countries don't distinguish between severity levels. Injuries in general increased slightly from 158,810 to 159,349. (European Commission 2018 - http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tran_r_vehst&lang=en).

Comparing accident numbers with fleet sizes reveals that most accidents per motorcycle occur in Croatia (1.8%), United Kingdom (1.6%) and Malta (1.4%). Fewest accidents per motorcycle occur in Estonia (0%), Denmark (0.1%) and Poland

(0.2%). With regard to fatalities per accident, more motorcycle drivers died when involved in an accident in Poland (9.7%), Cyprus (9.1%) and Bulgaria (8.5%), whereas the fatality rate per motorcycle accident in 2015 was the lowest in Estonia (0%), Malta (0.7%) and Spain (1.3%).

<table>
<tr><th>Country</th><th>Accidents</th><th>Fatalities</th><th>Seriously Injured</th><th>Slightly Injured</th></tr>
<tr><td>Austria</td><td>4,127</td><td>83</td><td>1,468</td><td>2,751</td></tr>
<tr><td>Belgium</td><td>3,093</td><td>100</td><td>515</td><td>2,584</td></tr>
<tr><td>Bulgaria</td><td>585</td><td>50</td><td>225</td><td>348</td></tr>
<tr><td>Croatia</td><td>1,127</td><td>58</td><td>452</td><td>730</td></tr>
<tr><td>Cyprus</td><td>143</td><td>13</td><td>92</td><td>48</td></tr>
<tr><td>Czech Republic</td><td>2,319</td><td>91</td><td>436</td><td>1,964</td></tr>
<tr><td>Denmark</td><td>224</td><td>19</td><td>124</td><td>92</td></tr>
<tr><td>Estonia</td><td>8</td><td>0</td><td colspan="2">9</td></tr>
<tr><td>Finland</td><td>490</td><td>20</td><td colspan="2">491</td></tr>
<tr><td>France</td><td>13,500</td><td>614</td><td>5,514</td><td>7,622</td></tr>
<tr><td>Germany</td><td>29,295</td><td>639</td><td>9,986</td><td>19,809</td></tr>
<tr><td>Greece</td><td>5,929</td><td>237</td><td>433</td><td>5,603</td></tr>
<tr><td>Hungary</td><td>1,326</td><td>50</td><td>604</td><td>705</td></tr>
<tr><td>Ireland</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Italy</td><td>41,411</td><td>773</td><td colspan="2">43,078</td></tr>
<tr><td>Latvia</td><td>226</td><td>7</td><td>48</td><td>179</td></tr>
<tr><td>Lithuania</td><td>186</td><td>13</td><td>41</td><td>144</td></tr>
<tr><td>Luxembourg</td><td>149</td><td>6</td><td>76</td><td>78</td></tr>
<tr><td>Malta</td><td>283</td><td>2</td><td>85</td><td>209</td></tr>
<tr><td>Netherlands</td><td>1,150</td><td>43</td><td>699</td><td>235</td></tr>
<tr><td>Poland</td><td>2,139</td><td>208</td><td>867</td><td>1,084</td></tr>
<tr><td>Portugal</td><td>4,398</td><td>73</td><td>326</td><td>4,210</td></tr>
<tr><td>Romania</td><td>911</td><td>55</td><td>385</td><td>520</td></tr>
<tr><td>Slovakia</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Slovenia</td><td>570</td><td>25</td><td>161</td><td>369</td></tr>
<tr><td>Spain</td><td>24,228</td><td>329</td><td>2,599</td><td>22,679</td></tr>
<tr><td>Sweden</td><td>921</td><td>44</td><td>248</td><td>663</td></tr>
<tr><td>United Kingdom</td><td>18,609</td><td>361</td><td>4,784</td><td>12,977</td></tr>
</table>

Table 5: Accidents with casualties on motorcycles 2015. Source: European Commission
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tran_sf_roadve&lang=en

Both accident and fatality figures significantly decreased from 2010 to 2015 in the case of mopeds. While 89,073 accidents caused 1,107 fatalities in 2010, 68,511 accidents (-23%) led to 717 deaths (-35%) in 2015. Furthermore, injuries decreased in the same period by about 25%, from 90,672 to 68,043.
Three countries, namely Estonia, Luxembourg and Malta, did not record any moped driver fatalities in 2015, whereas Greece (6.5%), Bulgaria (6%) and Denmark (4.9%) hold the highest fatality per accident rate.

<table>
<tr><th>Country</th><th>Accidents</th><th>Fatalities</th><th>Seriously Injured</th><th>Slightly Injured</th></tr>
<tr><td>Austria</td><td>4,007</td><td>8</td><td>709</td><td>3,632</td></tr>
<tr><td>Belgium</td><td>3,822</td><td>19</td><td>304</td><td>3,456</td></tr>
<tr><td>Bulgaria</td><td>184</td><td>11</td><td>37</td><td>127</td></tr>
<tr><td>Croatia</td><td>841</td><td>14</td><td>223</td><td>641</td></tr>
<tr><td>Cyprus</td><td>58</td><td>2</td><td>44</td><td>16</td></tr>
<tr><td>Czech Republic</td><td>338</td><td>6</td><td>41</td><td>282</td></tr>
<tr><td>Denmark</td><td>391</td><td>19</td><td>173</td><td>173</td></tr>
<tr><td>Estonia</td><td>2</td><td>0</td><td colspan="2">2</td></tr>
<tr><td>Finland</td><td>609</td><td>2</td><td colspan="2">636</td></tr>
<tr><td>France</td><td>7,107</td><td>155</td><td>2,683</td><td>4,403</td></tr>
<tr><td>Germany</td><td>15,466</td><td>62</td><td>3,058</td><td>12,492</td></tr>
<tr><td>Greece</td><td>487</td><td>32</td><td>74</td><td>409</td></tr>
<tr><td>Hungary</td><td>1,294</td><td>27</td><td>436</td><td>760</td></tr>
<tr><td>Ireland</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Italy</td><td>12,320</td><td>105</td><td colspan="2">12,612</td></tr>
<tr><td>Latvia</td><td>133</td><td>6</td><td>9</td><td>136</td></tr>
<tr><td>Lithuania</td><td>77</td><td>3</td><td>9</td><td>66</td></tr>
<tr><td>Luxembourg</td><td>31</td><td>0</td><td>11</td><td>25</td></tr>
<tr><td>Malta</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Netherlands</td><td>4,356</td><td>35</td><td>2,070</td><td>1,187</td></tr>
<tr><td>Poland</td><td>1,726</td><td>65</td><td>584</td><td>1,072</td></tr>
<tr><td>Portugal</td><td>2,795</td><td>42</td><td>192</td><td>2,709</td></tr>
<tr><td>Romania</td><td>853</td><td>34</td><td>259</td><td>563</td></tr>
<tr><td>Slovakia</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Slovenia</td><td>339</td><td>1</td><td>56</td><td>265</td></tr>
<tr><td>Spain</td><td>8,187</td><td>56</td><td>669</td><td>7,780</td></tr>
<tr><td>Sweden</td><td>838</td><td>5</td><td>110</td><td>756</td></tr>
<tr><td>United Kingdom</td><td>2,249</td><td>8</td><td>348</td><td>1,743</td></tr>
</table>

Table 6: Accidents with casualties on mopeds 2015. Source: European Commission http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tran_sf_roadve&lang=en

Accident data specifically for light trailers is not available in Member States. However, there is data accessible in the CARE database for accidents causing casualties involving passenger cars with trailers. Since passenger cars are not permitted to pull trailers over 3,500 kg, this source can be seen as the closest possible source of the desired accident data on light trailers. Nevertheless, the respective data shows a lot of "trailer unknown" categories and as a result, only a few European countries offer accident data for passenger cars with trailers and casualties. In these countries, passenger cars with trailers were involved in 1,050 registered accidents with casualties, 30 fatalities and 1,574 victims in 2015.

Country	Accidents	Fatalities	Seriously Injured	Slightly Injured
Bulgaria	2	0	1	1
Croatia	164	-	1	5

Country	Accidents	Fatalities	Seriously Injured	Slightly Injured
Denmark	32	2	28	19
Finland	42	4	71	
Italy	114	2	170	
Latvia	12	1	2	18
Portugal	21	0	1	30
Slovenia	10	1	2	12
Spain	44	5	11	77
Sweden	124	0	20	179
United Kingdom	525	11	94	676

Table 7: Accidents with casualties with passenger cars with trailers involved 2015. Source: Survey to the Member States, European Commission 2018
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tran_sf_roadve&lang=en

4. Collection and analysis of national road safety measures

The initial aim of this working package was the retrieval of information regarding the alternative measures that Member States may define and implement instead of the PTI of two- and three-wheelers.

Furthermore, the activity has been extended to obtain additional data on the current roadworthiness regime applicable to this kind of vehicle, crash and fatality data by means of a survey. The survey also included questions about light trailers.

4.1. National road safety measures

From 1 January 2022 two- or three-wheel vehicles – vehicle categories L3e, L4e, L5e and L7e with an engine displacement of more than 125 cm^3 will be included in the periodic roadworthiness testing regime within the European Union. The last paragraph of Article 2 (2) of Directive 2014/45/EU however permits Member States to exclude two- and three-wheel vehicles with an engine displacement of more than 125 cm^3 from the scope of the directive, if they have put in place effective alternative road safety measures for these vehicles. These alternative road safety measures therefore have to take into account relevant road safety statistics covering the last five years.

As displayed in the previous chapter, a few Member States do not have a PTI in place for the respective vehicle categories at present. To retrieve information about PTI itself and effective alternative road safety measures in place or planned, along with relevant road safety statistics supporting these measures, a questionnaire has been sent to the Member States and stakeholders via DG MOVE and CITA. This survey can be found in the appendix to this study.

On the one hand, the surveys' intention was to obtain information regarding the PTI. In this regard, Member States were asked whether light trailers and two- or three-wheel vehicles have to be registered in their country and if there is PTI in place for these vehicle categories. If there is a PTI for the respective vehicle categories in place, Member States were asked to specify the inspection period and, in the case where vehicles of a certain category do not have to be registered, how such vehicles are monitored. It is expected that the latter question will generate significant interest, especially considering the magnitude of the changes required and the potential impact of introducing compulsory PTI regimes. Furthermore, relevant PTI statistics, namely the number of inspections and proportions of deficiency types for the different vehicle categories, were requested.

On the other hand, the survey aimed to collect statistical data that was not available from public sources. These questions covered fleet sizes of light trailers as well as accident, injury and fatality numbers for the same vehicle category.

Of special interest however were the "effective alternative road safety measures". As set out by Directive 2014/45/EU, Member States may exclude L3e, L4e, L5e and L7e vehicles from the PTI regime provided that they have put in place effective alternative road safety measures, which had to be notified by 20 May 2017 as part of the national measures transposing the Directive. Since the Directive requires account to be taken of relevant road safety statistics covering the last five years, Member States were also asked to state those relevant statistics.

Regarding the feedback, there are responses from 16 out of 28 Member States: Croatia, Germany and Spain – representing countries which have already been analysed in detail in the scope of this study – as well as Austria, Belgium, Bulgaria, Cyprus, Finland, France, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands and Slovenia.

Besides data that could be derived from the answers and used to complete missing data as presented in the previous chapters, information about the introduction of PTI for L vehicles or alternative road safety measures has been of special interest. Member States that do not yet inspect L3e, L4e, L5e and L7e vehicles and who responded to the survey are Belgium, Cyprus, Finland, France, Ireland and the Netherlands. According to the country reports of the European Road Safety observatory *(European Commission 2016g, 2016s, 2016v)*, Denmark, Malta and Portugal also do not inspect the mentioned vehicle categories, but unfortunately, did not respond to the survey.

Even though according to Directive 2014/45/EU vehicle categories L3e, L4e, L5e and L7e with an engine displacement of more than 125 cm³ will be included in the PTI regime, some Member States do not plan to start testing these vehicles from 1st January 2022. These countries are France, Ireland and the Netherlands. Belgium and Finland did not state whether they will start testing them or not.

According to the feedback received, Cyprus is the only Member State with no PTI in place that is planning to test the listed L vehicles from 1st January 2022. While Bulgaria is already testing the vehicles in question, it is planning to start further testing of L1e, L2e and L6e vehicles from 1st January 2023.

Specific alternative road safety measures have not been specified in the responses for Finland, Belgium and France. While not specifying concrete road safety measures, Finland, however, is claiming to take "accident data for all accidents and more detailed data from fatal accidents", as relevant road safety statistics, into account.

With regard to effective alternative road safety measures in place or planned, responses have been submitted by the Netherlands and Ireland. These responses will be repeated here as they were given.

According to the feedback from the Netherlands, "there will be an action plan regarding the safety of the L category".

More detailed answers have been given by Ireland. Accordingly, the following measures are in place: "The Road Safety Authority in Ireland are involved in and implement year-on-year safety measures with regards to motorcycles, in the areas of research, education and public awareness campaigns. In terms of research, a Pre-crash behaviour study into fatal collisions was conducted during 2014/2015 (which included data from 2008 – 2012), followed up by a Motorcyclist Rider Behaviour Study, which was conducted during 2017. In the area of education, the Authority administer and manage a graduated driver training programme. As part of that programme, Initial Basic Training (IBT) is a mandatory training course in Ireland that teaches safe riding skills. The duration of the rider course depends on how powerful their motorcycle is. With respect to public awareness campaigns, these have been ongoing in the past 5 years, the most recent of which was launched during 2017. The RSA also proactively track the effectiveness of our safety measures. More information on this is available on request."

Furthermore, the following measures are planned: "The Road Safety Authority plans to continue the safety measures with respect to motorcycles outlined above for the coming years. With regards to O1 and O2 category vehicles, these are not currently registered in Ireland (as registration is not mandated). Based on the results of its present study, should the Commission decide to include O1 and O2 vehicles in the scope of mandated PTI on an EU wide basis, there would be a number of steps that Ireland would need to undertake prior to its implementation here. These would include the development of technical standards for such vehicles, establishing a compliance regime, developing a mechanism to register such vehicles (including public consultation) and preparatory work to include these vehicles in PTI testing. We envisage that this overall process would encompass at minimum 2.5 to 3 years following the publication of a regulation by the EU (should this occur)."

Finally, these measures in place or planned take into account the following road safety statistics covering the last five years: "The road safety measures employed by the Road Safety Authority are based on specific research into the collision data on fatalities and serious injuries involving motorcycles. The contributory factors to the collisions were also examined and collated into meaningful statistics."

Examining these current road safety measures for L vehicles in place in Ireland, it is noticeable that they do not take into account technical and environmental aspects like PTIs, but rather focus on the driver's behaviour and skills. Road safety measures planned do instead take into account potential PTI for light trailers in Ireland. Precisely how an action plan regarding the safety of L vehicles is being developed in the Netherlands remains to be seen.

As opposed to L3e, L4e, L5e and L7e vehicles, as yet there is no plan to include light trailers in the PTI regime within the EU. As displayed in the previous chapter, statistical information about accidents involving light trailers or even causes of accidents is very scarce to non-existent. As aforementioned, the survey sought to gather further information regarding accidents involving light trailers, but the answers reinforced the deficit of data. However, some of the available accident and injury figures suggest that light trailers are of relevance for road safety. In Finland and the United Kingdom, for example, in 2015 there were fewer accidents involving passenger cars with trailers recorded than accidents involving mopeds, but more people died in the accidents involving passenger cars with trailers.

One could argue that, with the absence of PTI for light trailers, drivers have to take care of the roadworthiness of their trailers themselves in many Member States. One of the few potential measures by authorities to exert influence on trailer owners under these circumstances would be the provision of information about the correct use, maintenance and roadworthiness check of their trailer. For instance, such information could be provided via official websites or digital and/or physical booklets.

The booklet "Road safety advice and driver licensing rules for drawing light trailers"[10] by the Irish Road Safety Authority (RSA) describes several safety checks on relevant trailer parts to ensure that the trailer is "safe and mechanically sound, fit for purpose, and legally compliant with all relevant Road Traffic legislation" (Road Safety Authority 2015, p. 18). Nevertheless, the responsibility of judging roadworthiness remains with the driver.

Stakeholders were invited to submit additional data during the presentation of the mid-term report of this study, at the Roadworthiness Committee meeting held in Brussels on 20th September 2018.

5. Definition of Scenarios

This chapter considers as the "base case", the Scenario of not implementing any kind of roadworthiness activity for ensuring suitability of light trailers and two- and three-wheelers.

5.1. Definition of Scenarios for trailers

The present failure rate for trailers in Croatia is as follows:

- O1 trailers: 12.74%
- O2 trailers: 11.35%

This means that if PTI for this kind of vehicle did not exist, at least 8,300 O1 trailers and 930 O2 trailers in Croatia would travel in traffic with deficiencies which would have led to a failed PTI. Of course, these are the numbers collected from an existing PTI system where deficiencies are kept under control, but if it were possible to obtain such data from a country in which light trailers are not controlled by a PTI system, it is reasonable to assume that these numbers would be much greater.

Although data on light trailer road traffic accidents is scarce, mostly because road traffic accidents are commonly attributed to the driver or to the road conditions, results of PTIs of light trailers show that there are deficiencies found on them and that these could potentially contribute to road traffic accidents. Therefore, three Scenarios are offered which include inspection methods and items as prescribed in Directive 2014/45/EU.

5.1.1. Scenario 0 - No PTI

This is an existing Scenario that offers no improvement in roadworthiness through PTI of O1 and O2 trailers.

5.1.2. Scenario 1 - Full PTI

This Scenario includes all inspection areas set out by Directive 2014/45/EU - although it is clear that to date the Directive does not include O1 and O2 - and which could also be applied to light trailers:

[10] http://www.rsa.ie/Documents/Road%20Safety/Leaflets/Leaf_booklets/Road%20Safety%20Advice%20for%20Drawing%20Light%20Trailers.pdf

(0) Identification of the vehicle;
(1) Braking equipment;
(2) Steering;
(3) Visibility;
(4) Lighting equipment and parts of the electrical system;
(5) Axles, wheels, tyres, suspension;
(6) Chassis and chassis attachments;
(7) Other equipment;
(8) Nuisance;
(9) Supplementary tests for passenger-carrying vehicles.

Identification of the vehicle
The vehicle shall be identified via chassis number which is engraved on the vehicle or inscribed on a non-removable plate. Also, if it is already registered, it shall be identified via the registration plate.

Braking equipment
Including visual and functional inspection.

Functional inspection shall include at least test drive and braking at speed of approx. 30 km/h while observing for brake activation on each wheel and anomalies. Appropriate brake testing on roller brake testers is also recommended. No additional equipment is needed for this inspection.

Steering
For a small number of O1 and O2 trailers equipped with turntables, the same rules should apply as for O3 and O4 trailers set out in Annex I of 2014/45/EU. Wheel play detectors set out under point (8) of Annex III are suitable for this part of the inspection.

Visibility
Not applicable to trailers.

Lighting equipment and parts of the electrical system
This part is relevant because of its impact in road use and because the most common deficiencies found on trailers involve lighting equipment. The proposal is to apply the existing criteria of Directive 2014/45/EU. Visual inspection of simultaneous performance of lights on towing vehicle and trailer would be recommended. No additional equipment is needed for this inspection.

Axles, wheels, tyres, suspension
We propose it to be inspected according to 2014/45/EU. Thread depth of tyres can be measured using a device for measuring tread depth as per item (13) in Annex III of Directive 2014/45/EU.

Chassis and chassis attachments
We propose it to be inspected according to 2014/45/EU, except for those elements not fitted in trailers, such as powertrain.

Other equipment
In most cases this does not apply to O1 and O2.

Nuisance
This item is relevant in relation with potential fluid leaks from the brake system or devices that are permanently mounted on trailer (hydraulic fluid for lift, fuel for power generation, etc.). We recommend inspecting the vehicles for such leaks.

Supplementary tests for passenger-carrying vehicles.
Some O2 trailers could be equipped to carry passengers, which requires that they comply with the requirements set out for M2 and M3 buses. In such cases we recommend the inspection of these additional items for example: operation of entrance and exit doors, existence and accessibility of emergency exits, ventilation, heating, seats, safety belts, gangways, etc.

Scenario 1 does not require the use of any equipment in addition to those listed in Annex III of Directive 2014/45/EU.

5.1.3. Scenario 2 - Tailored PTI of trailers

According to the information from Spain, Germany and Croatia, most deficiencies are found in four of the inspected areas, thus our second recommended Scenarios is a PTI specially tailored for the inspection of items within these areas :

(0) Identification of the vehicle;
(1) Braking equipment;
(4) Lighting equipment and parts of the electrical system;
(5) Axles, wheels, tyres, suspension;
(6) Chassis and chassis attachments.

Identification of the vehicle
Identification of the vehicle is not showing a big incidence in deficiencies, but is essential in order to carry out the inspection of any vehicle. Every vehicle must be properly identified before PTI so the results can be unambiguously attributed precisely to that inspected vehicle.

Braking equipment
It would be essential that the braking equipment will be inspected on trailers equipped with brakes. We propose both visual and functional inspection for which no additional equipment is needed, as already mentioned at Scenario 1.

Lighting equipment and parts of the electrical system
As this is by far the most common deficiency found on most trailers, this inspection area should be included in the inspection. The visual inspection of simultaneous performance of lights on towing vehicle and trailer would be recommended. No additional equipment is needed for the inspection of this area.

Axles, wheels, tyres, suspension
This area comprises parts that are subject to corrosion and wear and tear and is among the most often found deficiencies. Thread depth of tyres can be measured using the same device which is part of the minimum equipment of testing centres according to Annex III point (13) of Directive 2014/45/EU.

Chassis and chassis attachments
We propose the same inspection as set out by Directive 2014/45/EU for O3 and O4 vehicles.

This Scenario implies a shorter inspection but nevertheless includes the areas with the highest number of deficiencies according to the information from Spain, Germany and Croatia.

Scenario 2 does not require use of any equipment in addition to those listed in Annex III of Directive 2014/45/EU.

5.2. Definition of Scenarios for two- and three-wheelers

One of the causes that contribute to crashes is the technical failure of vehicles. PTI of vehicles is the main tool for ensuring that vehicles on the road maintain a reasonable level of fitness for purpose during their life.

The reduction in the number of road fatalities on motorcycles and mopeds has not followed the same pattern as for other types of vehicles. Since in several Member States neither motorcycles nor mopeds have to pass inspection, the PTI becomes especially advantageous in this field of application.

From 1 January 2022, two- or three-wheeled vehicles - vehicle categories L3e, L4e, L5e and L7e, with an engine displacement of more than 125 cm^3 - will be included in the periodic roadworthiness testing regime. It is for the Member States to determine the areas, items and appropriate methods of testing for the PTI in line with Article 6(3) of Directive 2014/45/EU. The last paragraph of Article 2(2) of the Directive however permits Member States to exclude two- and three-wheeled vehicles with an engine displacement of more than 125 cm^3 from the scope of the Directive, if they have put in place effective alternative road safety measures for these vehicles.

In view of the above, and using the same approach as for light trailers, three Scenarios are proposed:

- Scenario 0 – No PTI
- Scenario 1 – Full PTI for two- or three-wheel vehicles
- Scenario 2 – Tailored PTI for two- or three-wheel vehicles

These three options are described below.

5.2.1. Scenario 0 - No PTI

If the PTI were not compulsorily implemented, the number of two- and three-wheelers on the road with deficiencies would be much higher. Consequently, the risk of occurrence of a road traffic accident would be higher given that the fleet of vehicles is constantly increasing. Thus, an increase in the number of accidents, deaths and serious injuries would be reasonably expected.

5.2.2. Scenario 1 - Full PTI

Spain, where inspection of L vehicles is mandatory, has been taken as an example for the definition of the Scenarios. In this country, Royal Legislative Decree 920/2017 rules on the PTI and transposes the content of Directive 2014/45/EU. Spain uses the structure of Annex I of Directive 2014/45/EU for two- and three wheelers.

Previously, and as explained in Section 1, the arrangements for performing the inspection of two wheelers were already defined, bearing in mind the concepts later included in Directive 2014/45/EU, as listed below:

(0) Identification of the vehicle;
(1) Braking equipment;
(2) Steering;

(3) Visibility;
(4) Lighting equipment, reflective devices and parts of the electrical system;
(5) Axles, wheels, tyres and suspension;
(6) Chassis and chassis attachments;
(7) Other equipment;
(8) Nuisance (polluting emissions).

Many of these items are visually inspected. Other items require functional inspection, but in most cases they do not require specific equipment in addition to those already available in the PTI stations for the inspection of the other vehicle categories. Consequently, adding two- and three-wheeled vehicles' inspection could optimize existing resources.

Although Annex I of Directive 2014/45/EU does not apply to L-category vehicles, both the content and the structure of this annex are very much suitable for L-category vehicles, provided that some considerations due to the conception of L vehicles are taken into account. This is the approach of the Spanish inspection procedure and therefore references to Directive 2014/45/EU are made.

Indeed, the Spanish standard for inspecting L-category vehicles is prior to Directive 2014/45/EU, but most of the concepts contained therein are applicable. At the end of the day, the important new feature of this Directive compared with the previous one is the assessment of deficiencies rather than description of new procedures.

Identification of the vehicle
The vehicle shall be identified via the chassis number which is engraved on the vehicle or inscribed on a non-removable plate. Also, if it is already registered, it shall be identified via the registration plate.

Braking equipment
Including the following items, where applicable: service brake, parking brake, anti-lock system, braking system pedal, brake servo and master cylinder (hydraulic systems), rigid pipes, flexible pipes, linings, brake drums and discs, wires, rods, handles and connections, brake cylinders and load sensing valve. This list is based on items inspected in PTI in Spain specifically for motorcycles.

All these items are listed in Directive 2014/45/EU, including efficiency requirements for L vehicles[11]. The majority of these items can be visually inspected. In the case of service brake inspection, a brake tester must be used for the functional testing, in order to verify wheel braking, brake imbalance or efficiency.

Roller brake testers used in single-wheel axles are conceptually the same device used for passenger cars and vans, including the same accuracy of measurement but with a single roller. Inspection sites with a limited flow of two-wheelers may use the same roller brake tester as for passenger cars provided that only one of the rollers is spinning and the other one is covered. Equipment manufacturers offer this option.

As an alternative to the roller brake tester, a decelerometer may be used. Both roller brake testers and decelerometers are defined as minimum equipment for testing facilities in Annex III of Directive 2014/45/EU.

[11] Directive 2014/45/EU, Annex 1, Art. 3, 2.2.1

Figure 37: Brake tester for two- or three-wheeled vehicles.

Steering
Within this area we propose the visual inspection of the steering wheel and steering shaft or handlebar, steering box and linkage of steering and joints. Furthermore, the wheel's deviation should also be measured by means of a sideslip meter (only applicable to those vehicles with two wheels in the steering axle(s)). This equipment is used for the inspection of other vehicle categories, thus it is already available in PTI stations.

Visibility
Within this area the condition of rear-view mirrors and, when applicable, safety glasses and the direct field of view should be checked. Windshield wiper(s) and washer(s) should be checked in those vehicles, which are equipped with a front windshield of such dimensions and shape that the driver, from his driving position, cannot normally see the forward path other than through that glass. All of these items can be visually inspected and by verifying operation, as already defined in Directive 2014/45/EU for windscreen wipers and washers.

Lighting equipment and parts of the electrical system
This section should cover the visual inspection of dipped beam and main beam, reversing lamp, indicator lights, emergency signal, stop lamps, rear registration plate lamp, position lamps, fog lamp, retro-reflectors, specific light-signalling and daytime running lights. Headlamp aim should be checked with the appropriate device, already referred to in Annex III of Directive 2014/45/EU.

Axles, wheels, tyres, suspension
Within this section, axles, wheels, tyres and suspension should undergo a visual inspection. In some cases, depending on the axle configuration, the use of a wheel play detector is required. Depending on the vehicle configuration, the use of a pit or a hoist may be required.

Chassis and chassis attachments
This section describes the visual inspection of the condition of the bodywork and chassis, coupling device, mudguard and spray-suppression devices, steps, seats or saddles and their anchorages as well as interior protruding parts. These are the items of the Spanish motorcycle PTI, moreover, they are also listed in Annex I of Directive 2014/45/EU for the testing of other vehicle categories. The general condition of the engine, power system, exhaust system and transmission must also be assessed.

Other equipment
This area defines the visual inspection of seat belts and their anchorages, anti-theft system, acoustic warning and the speedometer.

Nuisance (polluting emissions)
The proposal for this section is to inspect sound and emissions level as already defined in Directive 2014/45/EU for other vehicle categories. There is no need for additional equipment beyond those already available at the testing centres according those set out by Annex III of the Directive.

Other tests
The Spanish inspection requires a maximum speed test for mopeds. The maximum speed for this vehicle category has a generic limit of 45 km/h. This performance is checked with a non-loaded roller bench with the vehicle in full throttle, in the appropriate gear, by measuring the speed. Limit speed during the test is corrected having in mind that the bench is not loaded.

The features of the device for a free roller bench, according to the description in the Spanish Inspection handbook[12] are:

- - Minimum diameter of the rollers:
  - Double roller bench: 100 mm.
  - Single roller bench: 300 mm.
- Maximum permissible turning resistance: 0.1 N.m.
- Maximum moment of inertia of the set of rollers: 1 kg.m2.

The approximate cost of this equipment is about EUR 5,000, depending on the civil engineering requirements.

This subject is not proposed in this study, since Directive 2014/45/EU does not refer to mopeds.

Further considerations
As already explained, mopeds cannot exceed 45 km/h and thus cannot be used on highways or motorways. Owners of other vehicles such as agricultural vehicles and trailers face similar burdens. Therefore, in order to facilitate compliance with the testing obligation, Spain permits the inspection of these vehicles, at mobile inspection sites which are equipped with the same devices as the traditional testing centres.

[12] Manual de procedimiento de Inspección de las Estaciones ITV. Revisión 7.1.0 June 2016. Section II, 10.5
https://www.mincotur.gob.es/es-ES/servicios/Documentacion/DocumInteres/Manual_ITV_V710-Junio2016.pdf

Figure 38: PTI Mobile Station for two- and three-wheeled vehicles.

Scenario 1 does not require any equipment additional to the items listed in Annex III of Directive 2014/45/EU.

5.2.3. Scenario 2 – Tailored PTI of two- or three-wheeled vehicles

One of the possible Scenarios could be PTI specially tailored for the inspection of only certain selected areas. These areas for inspection would be those where the most common deficiencies are found in mopeds and motorcycles. According to the information collected during this study, the following areas are proposed:

(0) Identification of the vehicle;
(4) Lighting equipment, reflective devices and parts of the electrical system;
(5) Axles, wheels, tyres and suspension;
(6) Chassis and chassis attachments;
(8) Nuisance (polluting emissions);

The details for the inspection of the items within these areas are those already described in Scenario 1.

Scenario 2 does not require the use of equipment additional to the items listed in Annex III of Directive 2014/45/EU.

6. Cost and Benefit Analysis

6.1. Introduction

The objective of this study is to assess whether it is efficient to include light trailers (O1 and O2) and two- or three-wheel vehicles (L) in the scope of PTIs. In comparison, there will also be a Scenario included with no testing of the aforementioned two vehicle groups whatsoever. In the following section, an extensive cost and benefit analysis will be conducted in order to assess the different Scenarios.

The selected approach for economic assessment is the cost-benefit analysis (CBA). The CBA is often used to justify investment decisions, for instance in road traffic projects. In many European countries, for example, it is a legal requirement that a CBA is carried out in the case of large public investments[13]. The potential benefit and the potential costs of technology are estimated with this approach and monetarily

[13] Schulz, W. H. (1994). Rationalisierungspotentiale in der Verkehrs- und Telematikinfrastruktur - Methoden und empirische Ergebnisse von Nutzen-Kosten-Analysen. Köln.

assessed, considering a selection of effects. The benefits of a technology are multiplied by the cost of a unit and compared with the costs of the technology.

If the risk for stakeholders is low and the risk for society is high, there is no general political willingness to introduce testing of the L and O vehicles. Low risk for the stakeholders means that the price/cost difference per unit can always be expected to be positive. A high risk for society means that there is uncertainty as to whether the PTI results in the calculated safety effects (e.g., the avoidance of fatalities and crashes with other outcomes).

Increased efforts are needed in the research and development of PTI test scenarios to overcome these social barriers. The low financial risk to stakeholders shows that the PTI test functions well and that the system functions are stable. If the risk to society is low, but the risk to stakeholders is high, the stakeholders will demonstrate the greatest level of reservation about introduction of a PTI test Scenario for L and O vehicles. A low risk to society means that the social benefits are higher than the social costs. This would mean that testing light trailers and two- and three-wheeled vehicles in a PTI does affect safety.

The goal now of the CBA is to determine all social net benefits or welfare effects that result from operations by decision makers. The CBA is an instrument that is used to compare alternative socio-economic statuses or courses due to a specific operation. Here, all the important effects that are relevant to the area of efficacy are compared regarding their advantages and disadvantages. In so doing, it is essential that all welfare effects of a project are identified. All effects must be monetarily assessed in a standardized unit. This way, aggregated advantages can be compared with aggregated costs.

The result of a CBA is the benefit-cost ratio (BCR). It is necessary for calculation of return on investment that the costs (including capital and maintenance costs) and benefits (including time saving, accident prevention and saving on operating costs) are discounted at an appropriate rate of discount back to the base year value. Alternatively, known market prices for the base year can be used for the forecast period. Benefit-cost ratios, which are determined in this way, have the advantage that they are not manipulated by hidden assumptions regarding projection prices, capital costs, and labour costs. This approach calculates without discounting capital. Uncertainties regarding future economic growth are excluded. In particular, the assessment of benefits has shown that the average annual benefit, assuming the market prices for the study period, is equal to the benefit annuity of discount models (Schulz, 1994). Therefore, on the benefit side, a discount on future benefits is not mathematically necessary.

The starting point for the CBA is comparison of the Scenarios in which PTI tests are implemented with the status quo, Scenario 0, where a PTI is not applied. In the case without a test, the benefit is 0, and economic losses will occur, due to the accidents that could have been prevented. Direct comparison of cost and benefit in conjunction with implementation of a measure can only be realized if both are assessed in the same unit. Since the geographical scope of this study is the European Union, the unit for the monetary assessment is the euro [€].

6.2. Cost-Benefit Analysis methodology

The introduction of testing for O1, O2 and L vehicles maintains the safety potential in operation at a consistently high level over the entire life of the vehicle and can detect signs of ageing at an early stage, aiming to reduce deficiencies to a minimum. The goal of this study is to identify primary and secondary benefits of the testing of safety functions and to demonstrate the effect of the testing and the discrepancy between the zero case with no checks in place and the testing case.

To be able to conduct the CBA, data has been collected as previously described in the work packages. The data was collected in the three different countries, Spain, Croatia and Germany, with each having specific rules. Furthermore, the results of the described survey are also being used in the CBA, compensating for certain other lacks of data held by the countries.

With the unique setup in Spain, having introduced PTI for mopeds in some provinces earlier than in others, the data can be compared, and conclusions drawn, on how far this introduction has led to greater road safety. The proposed hypothesis for Spain is thus that the regions that had already introduced PTI measures would experience fewer (fatal) accidents than those that as yet had no periodic inspections.

This could then be generalized to the whole group of L vehicles.

The following analysis incorporates the steps to assess the usefulness of introduction of PTI for L vehicles.

6.3. Mopeds - L1 (2 wheels) and L2 (3 wheels) vehicles

6.3.1. Methodology and Base Values

Methodological Approach / Empirical Model

For the analysis, a data set is constructed. The data set contains data from the 18 Spanish regions (the 17 regions plus a group comprising Ceuta and Melilla). The time span for the data is ten years, from and including the year 2007 until and including the year 2016. The different regions introduced the PTI measure in different months and years. The following table gives an overview of the different dates when the PTI introduction for mopeds took place

	Mandatory compliance date	**Date range of adaptation to mopeds PTI obligation**
Cantabria	April 2007	21/03/2007
País Vasco	January 2008	01/04/2007-31/12/2007
Andalucía	August 2008	01/10/2007-31/07/2008
La Rioja	July 2008	01/10/2007-01/07/2008
Aragón Murcia Asturias Navarra	October 2008	01/01/2008-01/10/2008
Castilla-La Mancha	(August 2008) (April 2009) May 09	01/01/2008 - 15/08/2008 for registrations before 01/01/2002 16/08/2008-31/03/2009 for registrations between 01/01/2002 and 31/07/2005 01/04/2009 - 30/04/2009 for registrations between 01/08/2005 and 30/04/2006 Expiration according to law RD 2042/1994 for registrations after 30/04/2006
Comunitat Valenciana	February 2009	21/09/2008-21/01/2009
Extremadura	January 2009	01/01/2009
Galicia	November 2009	01/01/2009-31/10/2009
Catalunya	June 2009	01/02/2009-01/06/2009
Castilla y León	November 2009	01/02/2009-01/11/2009
Baleares	May 2010	21/06/2009-21/04/2010

Table 8: Starting of PTI for mopeds per region in Spain. Source: DGT-National Database of Road Traffic Accidents in Spain, http://www.dgt.es/

For the remaining regions, Madrid, Canarias and Ceuta and Melilla, 2008 was assumed as the official date when PTI was in place.

Further data included for evaluation of introduction of PTI for L1 vehicles is the accident rates for mopeds, fatalities due to crashes with mopeds and severe and slight injuries from moped crashes. A dummy variable is included, based on the table above, with the value one for each year and region with PTI in place, and zero otherwise.

The following graph shows the trend in moped accidents in the years 2007 until 2016.

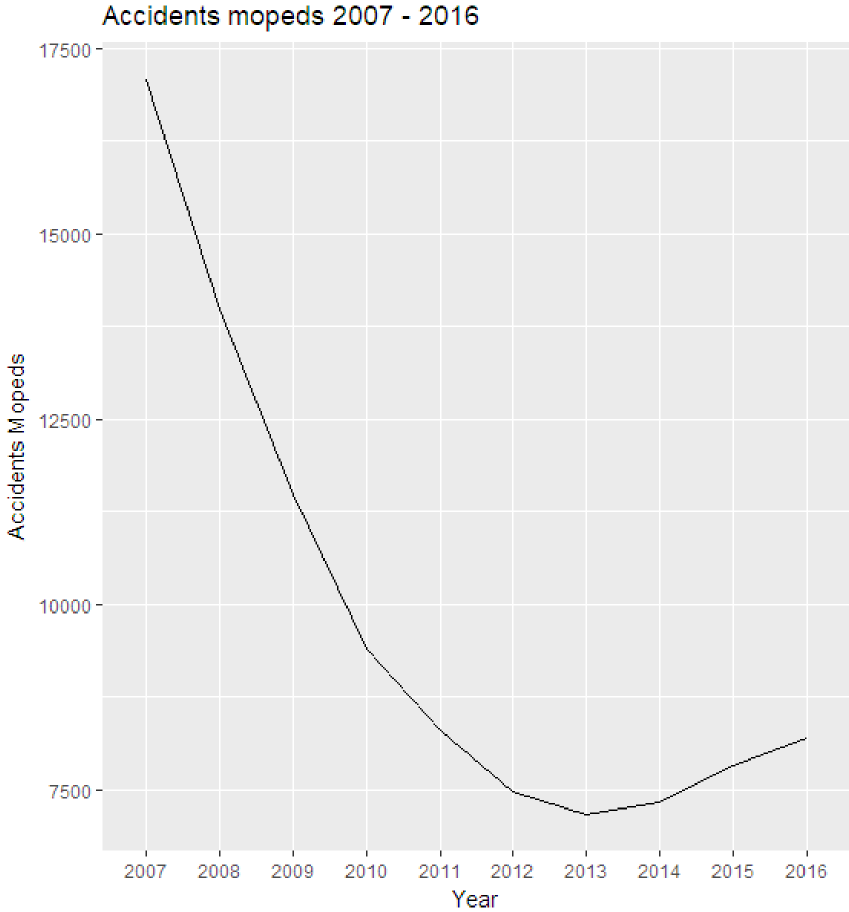

Figure 39: Moped accidents in Spain. Own figure. Source: DGT-National Database of Road Traffic Accidents in Spain, http://www.dgt.es/

There is a visible trend, showing that moped accidents fell sharply between 2007 and 2013 but have been on the rise again since then, although not to the same extent as they fell. The reason why these numbers are rising is not clear and, for this analysis, is only of minor interest, since the scope is to find out to what extent the PTI is benefiting road safety.

We expect that the introduction of PTI has a measurable effect on the number of accidents in so far that there should be fewer accidents. Furthermore, we expect a connection between the total number of mopeds and the total number of accidents, with the former being higher, also the latter being higher. To prove this hypothesis, we start with a simple regression firstly to see whether there is a connection.

Plotting the connection between mopeds and accidents in 2007 and 2016 proves our expected relationship, as can be seen in the following two graphs.

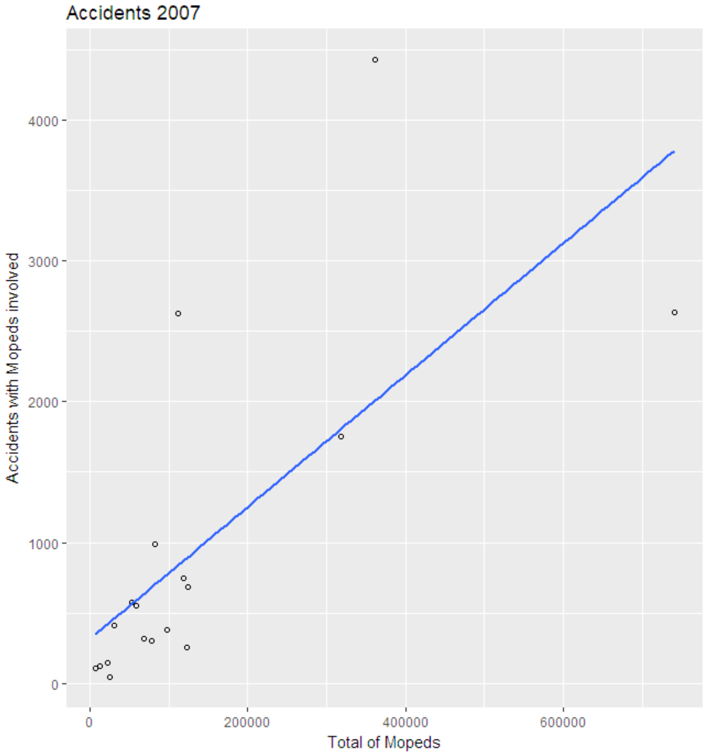

Figure 40: Accidents vs total of mopeds in 2007. Own figure. Source: DGT -National Database of Road Traffic Accidents in Spain, http://www.dgt.es/

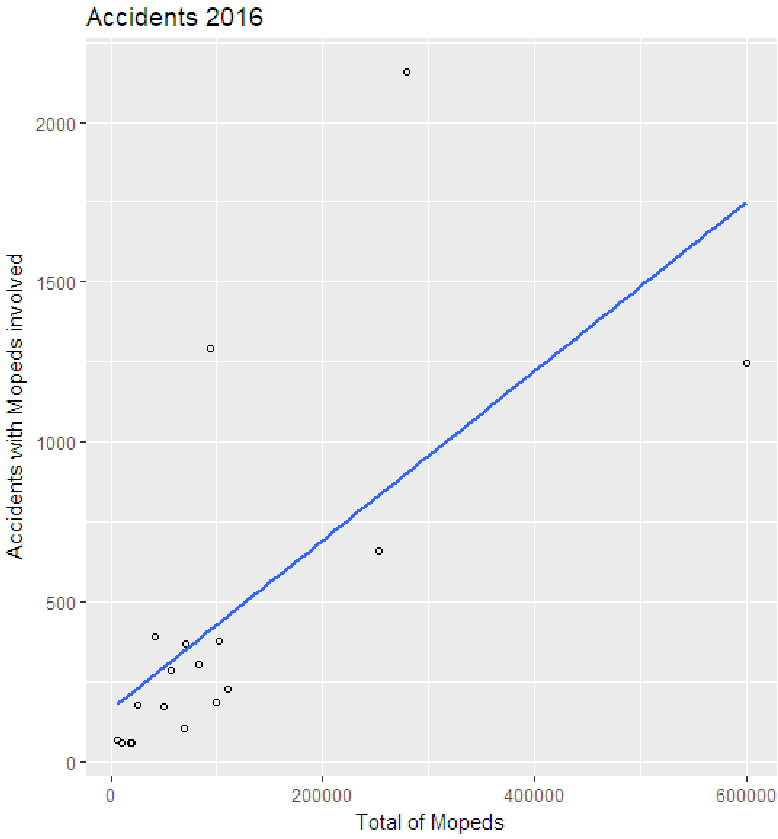

Figure 41: Accidents vs total of mopeds in 2016. Own figure. Source: DGT -National Database of Road Traffic Accidents in Spain, http://www.dgt.es/

It becomes clear that there is a general trend observable that the more mopeds there are in a region, the higher the number of accidents involving mopeds. The dots in the graphs are different regions of Spain. The trend persists over time since it is similar in 2007 and 2016.

This gives an indication that there is a measurable effect of the total number of mopeds on the total number of accidents, but we would like to understand the effect of the PTI on moped accident numbers.

The approach to understanding the relationship between the PTI and accidents is to apply a panel data regression. In this case, a panel data model with fixed effects is used. The state fixed effects are used since we cannot be sure that there might not be other factors that would influence the outcome.

Other factors that would influence the outcome could be the quality of roads, the cultural acceptance of drinking and driving in certain regions, the weather conditions and so on. These factors are hard or impossible to measure. Therefore, these factors are regarded as constant over time in the given regions since we can expect that they will change only very slowly, but we still account for them in the model.

The result of the regression is that in the past the number of moped accidents was reduced due to the application of PTI. On average 284 moped accidents were avoided each year. The question arises of how trustworthy this result is. The results of a regression can be proved by statistical variables, which measure the significance of the whole model and the regression coefficients.

The regression coefficients reflect the causal relationship between PTI and accident reduction. The statistic variable is the significance of the t-value which is presented within the statistic tables by the number of stars (*) for each variable. The variable PTI has three stars. This means that from a statistical point of view it is very likely that there is a causal relation between PTI and moped accident reduction. In our model, there is a 99% probability that the effect of the PTI is exactly on average a reduction of 284 moped accidents per year. Otherwise the likelihood that this is not true is only 1%. This value is usually presented in the statistical table outcomes.

The next question is whether the whole approach is trustworthy. This means that all variables included in the model make sense and that there is no kind of conflict between the independent variables. The statistical variable for this assessment is the adjusted R-square (R^2). The model has an adjusted R^2 of 0.5418. This number indicates how much of the data is falling on the line of the regression. The adjusted R^2 is usually the preferred value since the normal R^2 usually increases with the number of variables added to the model. The adjusted R^2 on the other hand, explains the percentage of variation by only those independent variables that are actually affecting the dependent variable, taking into account that it might increase by chance.

Taken together, the usual significance tests for regressions show the following:

- The whole approach with two independent variables (number of mopeds, PTI) is sufficient to explain the trend in moped accidents.
- The impact of the independent variables, which is reflected by the regression coefficient (e.g. for PTI the regression coefficient is -284) is reliable, because the likelihood is 99%.

Table 9 presents the results.

Fixed Effects Model for moped accidents

Dependent variable: Moped Accidents	
Total of mopeds	0.0109***
	(0.0010)
PTI	-284.1384***
	(44.5816)
Observations	180
R2	0.5904
Adjusted R2	0.5418
F Statistic	115.3253***
Note:	* p < 0.1; ** p < 0.05; *** p < 0.01

Table 9: Fixed Effects Model for moped accidents. Source: own calculation

This result gives a hint that there is a reduction due to the introduction of PTI. To estimate the economic savings and derive the benefit-cost quotient, an estimation of the fatal, severe and slight outcomes of the accidents is also conducted. The model is constructed similarly to the one described above with the dependent variables now being fatalities from the accidents, severe and slight injuries. The results of the modelling are in table 10 below.

Fixed Effects Model for three different accident outcomes

Dependent variable:			
	Fatalities (1)	Severely Injured (2)	Slightly Injured (3)
Total of mopeds	0.0002***	0.0022***	0.0102***
	(0.00001)	(0.0001)	(0.0010)
PTI	-5.0430***	-53.1784***	-262.1746***
	(0.5498)	(6.0283)	(43.3027)
Observations	180	180	180
R2	0.7698	0.7546	0.5726
Adjusted R2	0.7425	0.7254	0.5218
F Statistic	267.5901***	245.9536***	107.1722***
Note:	* p < 0.1; ** p < 0.05; *** p < 0.01		

Table 10: Fixed Effects Model for three different outcomes. Source: Own calculation

The table summarizes the outcome of this second calculation. The total number of mopeds indicates that with a larger fleet there is a slightly larger number of accidents with the different outcomes. This signifies that with each additional moped in the fleet, 0.0002 fatalities, 0.0022 severe injuries and 0.0102 slight injuries respectively are likely to occur. This is represented by the numbers in the "Total of mopeds" row.

Having introduced and applied PTI to mopeds, the model results show that it can be reasoned that it can save around five lives per year, prevent around 53 severe injuries per year and around 262 slight injuries. Considering a reduction of 195 fatalities in total over the years from 2007 until 2013, resulting on average in 27.8 fewer fatalities per year, the introduction of PTI accounts for 18% of the reduction of fatalities in this period.

It has to be considered that, due to consolidation of the inspection of mopeds in Spain, many vehicles still missed the inspection. In 2016, only 41.76%[14] of two- and three-wheelers due to be inspected were actually submitted for the compulsory check.

All of the data is again significant at the 1% level. These results are in the PTI row. The numbers in brackets are the standard errors; the lower this number, the closer the data points are to the mean.

6.3.2. Cost-Unit Rates for consequences of accidents

The economic benefit resulting from improvement in road safety lies in the avoidance of costs that are incurred as the result of accidents. The following table lists the unit costs for fatalities, severe and slight injuries due to road accidents in the European Union that are applied in this study. The values shown are based on the deliverable 6.5.1 of the project SAFESPOT[15] and are updated with inflation rates.

The consequence of the accident	Unit costs
Fatality	€1,370,993
Severe injury	€170,035
Slight injury	€22,288

Table 11: Cost-Unit Rates for Accident Effects adjusted to inflation for the year 2017. Source: SAFESPOT Project Deliverable 6.5.1

With these cost-unit rates, we can then calculate the economic savings and the effectiveness in the form of the benefit-cost ratio in chapter 6.3.5.

[14] Contribución de la Inspección Técnica de Vehículos (ITV) a la seguridad vial y al medioambiente 2017", realizado por el ISVA-UC3M (Instituto de Seguridad de los Vehículos Automóviles "Duque de Santomauro, Universidad Carlos III de Madrid) y AECA-ITV (Asociación Española de Entidades Colaboradoras de la Administración en la Inspección Técnica de Vehículos ITV). In process of Publication

[15] SAFESPOT. Deliverable 6.5.1 (2010). Retrieved from http://www.safespot-eu.org/documents/SF_D6.5.1_Socio-economic_assessment_v12.pdf

6.3.3. Evaluation of Costs

To be able to evaluate the cost-effectiveness of the measure, the costs of a PTI for a moped must be known. The prices seem to differ depending on the region and who offers the PTI.

The website facua.org[16] has the most comprehensive list of prices for the year 2012. The price of a PTI for a motor vehicle with up to three tyres has a cost of 10.66 Euros in the cheapest region, Murcia, and can be as high as 37.04 Euros in Castilla y León. These prices are adjusted for inflation to represent the 2017 prices. The average for the stations is 20.17 Euros. Adjustment to Spain's inflation from 2012 to 2017 yields a value of 20.65 Euros[17].

Comparing this to the prices for some regions in 2018, stated on the webpage of Applus, a PTI provider, with an average of 23.05 Euros[18], an average value of 21 Euros as the average cost for a PTI of L vehicles in Spain seems to be acceptable. This value also includes value-added tax (VAT). It could be reasoned that this value is too high since the VAT is paid but benefits the state. However, we would like to advocate that time cost is something which is never accounted for, comprising the drive to the PTI station and getting the vehicle checked and thus the value of 21 Euro seems appropriate.

6.3.4. Evaluation of Benefits

To estimate the benefits, we need to have further assumptions. From the PTI data for Andalucía in 2016, it becomes clear that around 11% of the fleet in the region were tested per year, a value that seems feasible, given the inspection cycle. For 2016, this would yield around 218,622 mopeds checked in that specific year in all of Spain. Given our analysis from chapter 6.3.1 that around five lives can be saved per year, 53 severe injuries and 262 slightly injuries can be prevented, and multiplying these by the cost-unit rates stated previously, this would yield around 21,706,276 Euros saved for the economy. Dividing this number now by the number of mopeds submitted to the PTI in 2016, economic savings of around 99 Euros (benefit) per moped could be realized.

6.3.5. Results – Benefit-Cost Ratio

Given the benefit of 99 Euros per moped checked and considering the 21 Euros cost for a PTI after taxes, a benefit-cost ratio of around 4.73 is the outcome. Therefore, it can be reasoned that the PTI measure is suitable and cost-effective for an economy, not only to prevent accidents and save lives but also to benefit the economy.

Given that the benefit of PTI in terms of reduction of emissions has not been identified in the analysis and the fact that around 40% of Spanish two-wheelers miss the inspection, it is reasonable to consider the benefit-cost ratio obtained in this study as conservative.

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[16] FACUA. (2018). Tablas estudio ITV 2012. Retrieved from https://www.facua.org/es/tablas/itv2012.htm

[17] Eurostat. (2018). Eurostat - Tables, Graphs and Maps Interface (TGM) table - HICP - inflation rate. Retrieved from https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00118&plugin=1

[18] Applus. (2018). Tarifas ITV | Precios ITV según Comunidad Autónoma | Applus. Retrieved from http://www.applusiteuve.com/en/la-itv/tarifas-itv/

6.4. Trailers – O Vehicles

In order to estimate the effect of PTI for trailers, some assumptions have to be made to be able to assess the effect. The data quality available for trailers is very low and much data that would be needed is practically non-existent.

6.4.1. Estimation of distance travelled with a trailer

The annual mileage is important to assess, so that conclusions about the use of trailers can be drawn. A functional relationship can be derived in order to determine how many kilometres are travelled by a vehicle with and without a trailer. This is deduced from the mileage of passenger cars with trailers in Germany. Germany and Croatia, representing a large and medium-sized country, have had surveys in order to assess the yearly mileage per car with a trailer. Table 12 sums up the values estimated by the BASt for Germany in 2014[19].

	Motorway	Country road	Built-up area	Total
Passenger cars with a trailer	5,200,000,000	4,900,000,000	4,600,000,000	14,700,000,000

Table 12: Mileage for cars with trailers in Germany in 2014 in km. Source: BASt

The fleet size of O1 and O2 trailers in Germany amounted in to 6,004,151 units in 2014.

Assuming that each trailer is used approximately similarly and dividing the total number of kilometres travelled by the number of trailers, a yearly mileage per trailer of around 2,448 kilometres travelled per trailer results.

For this study a survey has been conducted in Croatia, in order to yield further insights into the use and structure of O1 and O2 vehicles. One of the survey's questions asked how many kilometres the respondent travels with a trailer per year. The average of the 406 questionnaires is 2,188 kilometres.

Since these numbers are close to each other and given that Germany is a bigger country with a larger network of motorways, the empirical evidence can be assumed to be representative. The share of driving on motorways, country roads or in built-up areas is rather evenly distributed in Germany with around 35%, 33% and 31% respectively. In Croatia, on the other hand, trailer use is more particularly in a non-urban and rural context, with around 46% and 20% respectively, while use on motorways and in urban areas is relatively low at 12% and 21% respectively.

6.4.2. Estimation of accidents with trailers

In order to estimate the likelihood of an accident happening with a trailer, a relationship is used. This relationship is necessary since there is no reliable data available on how many accidents occurred with a trailer attached and whether the trailer was the cause of the accident.

[19] Bundesanstalt für Straßenwesen. 2017. 'Ergebnisse Fahrleistungserhebung 2014'. BASt - Fachthemen. 2017. Retrieved from https://www.bast.de/DE/Verkehrssicherheit/Fachthemen/u2-fahrleistung-2014/u2-Fahrleistung-2014-ergebnisse.html?nn=605482

The PIN report[20] (Adminaite, Calinescu, Jost, Stipdonk, & Ward, 2018) using the European Union's Road Accidents Database – CARE, contains a comprehensive table stating how many deaths have occurred per vehicle kilometre.

Table 13 below shows a part of the data available. With Croatia and Germany being used as the reference in this study, since it is difficult to obtain Europe-wide data. For comparison, the number for the EU19 is also stated.

	Road deaths three years average	Average distance travelled (in millions)	Deaths per billion vehicle-km	Time period covered
Germany	3,281	768,467	4.3	2015-2017
Croatia	329	24,145	13.6	2015-2017
EU19	19,584	3,314,230	5.9	2015-2017

EU19 average: EU28 excluding BG, CY, ES, EL, HU, LU, LT, SK and RO due to lack of data on vehicle distance travelled.
**National provisional estimates used for 2017, as the final figures for 2017 were not yet available at the time of going to print.*

Table 13: Road deaths and distance travelled. Source: Adminaite, Calinescu, Jost, Stipdonk, & Ward, 2018 - Ranking EU Progress on Road Safety

This implies that per 1 billion vehicle-km, on average 4.3 and 13.6 deaths occur in Germany and Croatia respectively.

It can thus be deducted that the average number of deaths per 1,000 vehicle-km is around $4.269e^{-6}$ or 0.000004269 in Germany and $1.361e^{-5}$ or 0.00001361 in Croatia.

Since the average kilometres per year travelled with a trailer are around 2,448 km per year in Germany as derived before, multiplying it by the average number of deaths per 1,000 vehicle-km yields 0.0000104508 per trailer in Germany.

Calculation of this similar number for Croatia yields 0.0000297835.

This is to be multiplied by the number of trailers in Germany and Croatia of 6,163,382 O1 and O2 trailers in Germany in 2016 and 69,277 O1 and O2 trailers in Croatia in 2017.

The estimated maximum accident numbers that are thus likely to happen with a trailer are 0.94 deaths with a trailer in Croatia and 26.31 deaths with a trailer for Germany.

[20] Adminaite, D., Calinescu, T., Jost, G., Stipdonk, H., & Ward, H. (2018). *Ranking EU Progress on Road Safety - 12th Road Safety Performance Index Report*. Retrieved from https://etsc.eu/wp-content/uploads/PIN_AR_2018_final.pdf and https://ec.europa.eu/transport/road_safety/specialist/statistics_en#

If the number of people killed on European roads is known, then the number of people suffering severe or minor injuries can be deduced from this.

- The ratio of registered fatalities to the number of severely injured persons is 1:8.
- The ratio of registered fatalities to the number of persons suffering minor injuries is 1:50[21].

The ratio for severely injured persons has been derived from the PIN report[22], taking the arithmetical average over the period from 2007 to 2017.

Table 14 summarizes the calculated numbers for deaths, severe injuries and slight injuries.

	Fatalities	Severely Injured	Slightly Injured
Germany	27	211	1,316
Croatia	1	8	50

Table 14: Average of fatalities, severely injured and slightly injured in Germany and Croatia. Source: Adminaite, Calinescu, Jost, Stipdonk, & Ward, 2018 - Ranking EU Progress on Road Safety

It becomes evident that these mathematically derived numbers in the case of Croatia are different to the numbers obtained from the survey to the Member States as presented in Section 3.

Since we are looking at a country which has already successfully introduced PTI for trailers, the numbers in the survey can be seen as the accident numbers with a working PTI for trailers in place. On the other hand, the above calculated numbers were derived from EU averages, also representing countries where no checks of trailers are in place. Therefore, the difference between these two numbers is estimated to be the effect of a PTI in place. Since the survey only yielded data for Croatia and Germany has no data available, the case of Croatia will be calculated further.

The following table represents the difference between the calculated outcome and the survey outcome.

	Fatalities	Severely Injured	Slightly Injured
Croatia	1	7	49

Table 15: Difference in outcomes due to PTI. Source: own calculations

6.4.3. Estimation of the economic benefit of the different outcomes

To estimate the benefits with regard to these crashes with a trailer, the cost-unit estimates for accidents and the respective outcomes from chapter 6.3.1 are used here as well. Table summarizes the numbers. The benefits reported are the hypothetical maximum benefits that could be saved due to strict PTI checks and thus

[21] Gibson, G., Varma, A., Cox, V., Korzhenevych, A., Dehnen, N., Bröcker, J., . . . Meier, H. (2014). *Ricardo-AEA - Update of the Handbook on External Costs of Transport - Final Report* (Ricardo-AEA/R/ ED57769). Retrieved from https://ec.europa.eu/transport/sites/transport/files/themes/sustainable/studies/doc/2014-handbook-external-costs-transport.pdf

[22] Idem, Recital (19)

prevention of crashes with fatal outcome, severe or slight injuries with O1 and O2 trailers.

	Benefit of fatalities prevented	Benefit of severe injuries prevented	Benefit of slight injuries prevented
Croatia	€1,370,993	€1,190,245	€1,092,112

Table 16: Cost of different accident outcomes; the value is the benefit since this economic cost is saved due to PTI

The economic savings for Croatia are thus estimated to be around €3,653,350 per year thanks to a PTI for trailers.

6.4.4. Benefit-cost ratio

The average cost per PTI in Croatia is around 20 Euros for trailers. Given that there have been 28,884 checks, around 577,680 Euros of costs can be estimated. Using the derived benefits from the previous chapter, a maximum benefit-cost ratio of 6.32 can be estimated.

6.4.5. Limitations

Due to a lack of data, many assumptions had to be made in order to get a rough understanding of the effect of PTI for O1 and O2 trailers. The assumptions used are based on empirical data obtained from the authorities and PTI operators in Germany and Croatia. Since there was no data available for Germany on how many accidents occur with and because of a trailer, a benefit-cost ratio for Germany was not obtainable. For Croatia, numbers were on the one hand reported and on the other hand mathematically derived. The benefit-cost ratio for Croatia is around 6.32, which is a feasible but rather high value.

A further study examining the case where a PTI for trailers was introduced and having reliable and good data from before and after the introduction would yield valuable insights and could prove this study right or wrong. Special attention should be given to the reporting of accidents and to the causes of accidents. If more detailed data were available, reporting whether a trailer was towed and whether this trailer had been the cause of the accident, probably even due to a technical defect, then a model could be constructed which would be much more robust. Therefore, it can be recommended that more data on accidents due to O1 and O2 trailers should be collected in countries where there is no PTI for these and in case the measure is introduced, many more valuable insights could be deduced from this.

7. Formulation of policy recommendation

7.1. L - Two- and three-wheelers

The cost and benefit analysis performed in this study shows a very strong relationship between the introduction of PTI for mopeds in Spain and reduction in the number of crashes. It concluded, with a likelihood of 99%, that 284 road accidents per year could be avoided due to the application of PTI for mopeds. This results in an 18% decrease in the total number of crashes during the period, with absolute values of five deaths, 53 severe injuries and 262 minor injuries per year.

The calculation cannot show the full potential of vehicle inspection and is considered as very conservative in terms of assessing the benefits, since close to 40% of L vehicles missed the inspection in Spain, as shown in section 6.3.1. Furthermore, the estimation of the benefit does not take into account the effects on health due to improvement of air quality and reduction of noise.

This translates into a benefit-cost ratio of around 4.73. Therefore, the PTI for mopeds is suitable and cost-effective for an economy, not only to avoid road accidents, save lives and prevent injuries, but also to benefit the economy.

The measurable success of the PTI of mopeds in Spain is grounds for recommending the inspection of all two- and three-wheelers, regardless of their engine and power limitations. Whereas the definition of mopeds sets a limit on speed, power and mass-power ratio of vehicles, other two- and three-wheeler categories do not have such boundaries and are prone to higher speeds and accelerations that are traditionally linked with an increase in the number and severity of accidents.

The European motorcycle fleet consists of 24.7 million motorcycles. Most of them are in Italy with 6,540,697 motorcycles, Germany with 4,145,392 motorcycles and Spain with 3,079,463 motorcycles. Motorcycles must be inspected every 24 months in most countries, as in the case of Germany. Whereas Italy and Spain have a PTI frequency for motorcycles of 48/24 months (see section 3.4, Table 3).

Given that:

- the result of the CBA, even if its calculation has been conservative;
- the concepts contained in Annex I of Directive 2014/45/EU may be applicable as they are to two- and three-wheelers;
- the study has not identified any initiative related to the alternative safety measures mentioned above;
- the proposed Scenarios do not require any equipment in addition to that listed in Annex III of Directive 2014/45/EU; and that
- the equipment already used for other categories of vehicles as listed in Directive 2014/45/EU may be used for two- and three-wheelers;

The recommendation is to inspect vehicles according to Scenario 1 described in section 5.

Scenario 2 does not include braking, steering, visibility and other equipment. These items are removed because their impact on deficiencies is relatively low.

Some countries have experienced social rejection when trying to introduce the PTI of two- and three-wheelers. It is not clear whether a less comprehensive inspection, like the one proposed in scenario 2, may facilitate people's acceptance.

The proposed frequency of inspection (in months) is:

- For mopeds: 36/24[23]
- For motorcycles (rest of L vehicle categories): 48/24[24]

[23] First inspection: three years after registration. Subsequent inspection every two years.
[24] First inspection: four years after registration. Subsequent inspection every two years.

The proposed PTI frequency for mopeds is based on the case of Spain. In this country, mopeds have been inspected according to this time period since 2007; the cost and benefit analysis in section 6 shows the relationship between inspection of these vehicles and reduction of fatalities and injuries.

The proposed PTI frequency for other categories of L vehicles is kept as for M1 vehicles with standard use.

Regarding "items", "methods", "reasons for failure" and "assessment of deficiencies", the complete Annex I of Directive 2014/45/EU may be applied to two- and three-wheelers with the exception of item 9, explicitly devoted to M2 and M3. Though it is recommended to insert a footnote to clarify that each item shall be checked only if applicable for the vehicle submitted to inspection.

The already existing footnote 1 "'Requirements' are laid down by type-approval at the date of approval, first registration or first entry into service as well as by retrofitting obligations or by national legislation in the country of registration. These reasons for failure apply only when compliance with requirements has been checked" is an additional safeguard to avoid any non-suitable application of Annex I.

It is noteworthy that the above-mentioned Annex I includes items very much relevant to two- and three-wheelers such as the item 6.2.11 "Stand" and item 6.2.12 "Handgrips and footrests".

Annex III of Directive 2014/45/EU already defines the necessary equipment for L vehicles and in practice, the inspection of two- and three-wheelers as described in Scenario 1 does not require any equipment that is not already used for other categories. In other words, any inspection site for M1 vehicles equipped according to Annex III already has the necessary equipment to inspect motorcycles.

7.2. O1 and O2 trailers (light trailers)

The CBA for two- and three-wheelers is based on the analysis of trends in road safety in Spain before and after the introduction of PTI in mopeds. Unfortunately, similar study possibilities are rare and, in the case of light trailers, it has been necessary to develop the study based on accident data and estimation of the impact of deficiencies on causes of accidents.

Data on accidents involving light trailers is scarce. Furthermore the CBA requires a parameter that shows how much a vehicle is used. In the case of motor vehicles this parameter is the mileage recorded by the odometer, but trailers do not have this device. Estimation of the use of light trailers has been done by means of an on-purpose survey among users of light trailers submitting them for inspection.

The lack of data has restricted the study possibilities because of the increased result uncertainty, and the analysis has only been carried out in the case of Croatia.

This study has focused on Croatia, Germany and Spain. The cost and benefit analysis was performed only on Croatia due to the better data availability. Differences between the calculated outcome and trailer road accident data were used to calculate economic cost saved due to PTI, which resulted in €3,653,350 per year. Since PTI for trailers costs around €20, for 28,884 checks per year, the estimated cost would be around €577,680. Using these two values, a maximum benefit-cost ratio of 6.32 can be estimated. Therefore, we recommend introducing PTI for trailers because, apart from technical and ethical reasons, there are also economic benefits for a society.

The high value of the obtained benefit-cost ratio overcomes doubts related to data accuracy. In other words, if the incidence of deficiencies found in the PTI of light trailers in Croatia were only half those used for the CBR calculation, the result would still be greater than 3.

The recorded deficiency level (major deficiencies) for O1 trailers (Croatia: 12.74%. Germany: 9%) and O2 trailers (Croatia: 11.35%, Germany: 14.5%) reasonably shows that there are vehicles with serious deficiencies on European roads. It is judicious to assume that countries without PTI for these vehicles have a higher deficiency level and, therefore, these vehicles represent an even more relevant threat.

The deficiency structure of O1 and O2 trailers reflects their technical simplicity, and so most deficiencies, according to information from Spain, Germany and Croatia, are found on the following items:

Deficiency structure for O1 trailers:

- Lighting
- Chassis
- Axles, wheels, suspension

Deficiency structure for O2 trailers:

- Lighting
- Brakes
- Chassis
- Axles, wheels, suspension

This deficiencies split enables us to recommend the Scenarios described in section 5.1.

Scenario 1 is the recommended Scenario. It proposes inspection of light trailers according to Annex I of Directive 2014/45/EU. As in the previous section, it is recommended to include a provision to clarify that each item shall be checked only if applicable for the vehicle submitted for inspection.

In particular, the items to inspect are:
(0) Identification of the vehicle;
(1) Braking equipment;
(2) Steering;
(3) Visibility;
(4) Lighting equipment and parts of the electrical system;
(5) Axles, wheels, tyres, suspension;
(6) Chassis and chassis attachments;
(7) Other equipment;
(8) Nuisance;
(9) Supplementary tests for passenger-carrying vehicles.

The above items are to be applied with the particularities described in the definition of Scenarios.

The usual technology of braking systems used in light trailers is the so called "inertia brakes" or "overrun brakes", that slow down the trailer due to the force produced in the coupling device when the towing vehicle reduces its speed. Annex I of Directive 2014/45/EU already contains a provision (item 1.1.23) and specifies a visual inspection.

An on-purpose method to measure the braking efficiency in roller brake testers may be specified for those trailers in which the force in the braking system may be created by reversing the towing vehicles. The description of the method must include the threshold value for the efficiency bearing in mind that approval of inertia brakes is done by calculation and does not require any physical test.

The proposed inspection method does not require equipment additional to that indicated in Annex III of Directive 2014/45/EU for the inspection of M1 vehicles.

Scenario 2 is a simplified version of Scenario 1. The items that are removed are steering, visibility, other equipment, nuisance and supplementary tests for passenger-carrying vehicles, which have a relatively low impact on deficiencies.

From a technical, legal and empirical standpoint, two recommendations on inspection frequency are presented.

Recommendation No. 1: Proposed frequency for both O1 and O2 trailers is (in years) 4/2/2...

The main reason for proposing this frequency is to make introduction of such measures in Member States that do not perform PTI on O1 and O2 trailers, as smooth as possible using familiar legal background from Directive 2014/45/EU.

Recommendation No. 2: From an empirical and technical perspective, the proposed minimum frequency for O1 and O2 trailers would be:
O1 trailers: 3/3/3...
O2 trailers: 2/1/1...

The proposed frequency for O1 trailers is based solely on the experience from results of PTIs in Croatia.

The reason for such a stringent frequency for O2 trailers is their being equipped with brakes. Usually, O2 trailers such as those for transporting horses, boats, construction compressors, etc., are, on the one hand, exposed to harsh environment conditions (manure, salt water, sand and cement, etc.) and, on the other hand, are not used as frequently as motorized vehicles; these are both factors that strongly influence the correct function of their brakes. Therefore, more frequent inspections would help in the regular maintenance of this very important item on O2 trailers.

8. Appendix

Survey

In the context of the DG Move project "Study on the inclusion of light trailers and two- or three-wheel vehicles in the scope of the periodic roadworthiness testing", we would like to ask for your support by answering the following questions with regards to your country.

Thank you very much!

A) Please state the country, you are answering for: ___________________

B) Do the following vehicle categories[25] need to be registered[26] in your country?

Category	yes	no
01) O1	O	O
02) O2	O	O
03) L1e	O	O
04) L2e	O	O
05) L3e	O	O
06) L4e	O	O
07) L5e	O	O
08) L6e	O	O
09) L7e	O	O

C) If possible, please state the size of the fleet of O1 and O2 trailers in your country for the following years:

Category	2010	2011	2012	2013	2014	2015	2016
01) O1							
02) O2							

[25] Vehicle categories: As defined in Regulation (EU) No 168/2013 (for L1e to L7e) and Directive 2007/46/EC (for O1 & O2)

[26] Registration: According to Directive 1999/37/EC, registration "shall mean the administrative authorisation for the entry into service in road traffic of a vehicle, involving the identification of the latter and the issuing to it of a serial number, to be known as the registration number"

D) If accidents involving O1 and O2 trailers are being registered in your country, please complete the following table regarding accidents and its consequences with light trailers involved (if no injury severity is known, please summarise the injury numbers):

	2010	2011	2012	2013	2014	2015	2016
01) Accidents							
02) Slightly injured[27]							
03) Seriously injured[28]							
04) Fatalities[29]							

E) Is periodic technical inspection (PTI) for the following vehicle categories in place in your country?

Category	yes	no
01) O1	O	O
02) O2	O	O
03) L1e	O	O
04) L2e	O	O
05) L3e	O	O
06) L4e	O	O
07) L5e	O	O
08) L6e	O	O
09) L7e	O	O

[27] Slightly injured: Any person injured excluding persons seriously injured. (Economic Commission for Europe, 'Statistics of Road Traffic Accidents in Europe and North America', 136.)
[28] Seriously injured: Any person injured who was hospitalized for a period of more than 24 hours. ((Economic Commission for Europe 2011, 136))
[29] Fatalities: Any person killed immediately or dying within 30 days as a result of an injury accident. ((Economic Commission for Europe 2011, 136))

F) If PTI exist for the respective vehicle categories, please specify the inspection period *(months between inspections: first inspection / second inspection / third inspection etc.)*

E.g. category L3e in Poland: 36 / 24 / 12

Category	Inspection period
01) O1	
02) O2	
03) L1e	
04) L2e	
05) L3e	
06) L4e	
07) L5e	
08) L6e	
09) L7e	

G) If PTI exist but no registration for certain vehicle categories, please describe how track is being kept of those vehicles

Category	Track of the vehicles is being kept by…
01) O1	
02) O2	
03) L1e	
04) L2e	
05) L3e	
06) L4e	
07) L5e	
08) L6e	
09) L7e	

H) If PTI exist for the respective vehicle categories, please specify the number of inspections per category of the latest year available (if statistics are not available for every category separately, please summarise the respective vehicle categories)

Category	Number of inspections	Year
01) O1		
02) O2		
03) L1e		
04) L2e		
05) L3e		
06) L4e		
07) L5e		
08) L6e		
09) L7e		

I) If PTI exist for the respective vehicle categories, please give a summary of the failure rates of the latest year available in percent (if statistics are not available for every category separately, please summarise the respective vehicle categories)

Year: ________

	01) O1	**02) O2**	**03) L1e**	**04) L2e**	**05) L3e**	**06) L4e**	**07) L5e**	**08) L6e**	**09) L7e**
Minor deficiencies									
Major deficiencies									
Dangerous deficiencies[30]									
Brakes									
Steering									
Visibility									
Lighting									
Axles, wheels, tyres, suspension									
Chassis									
Other equipment									
Nuisance									

[30] Minor, major or dangerous deficiencies: If this classification is already in use and relevant statistics are available in your country.

Identification									

From 01 January 2022 two- or three-wheel vehicles - vehicle categories L3e, L4e, L5e and L7e, with an engine displacement of more than 125 cm³ will be included in the periodic roadworthiness testing regime. The last paragraph of Article 2 (2) of Directive 2014/45/EU however allows Member States to exclude two- and three-wheel vehicles with an engine displacement of more than 125 cm³ from the scope of the Directive, if they have put in place effective alternative road safety measures for those vehicles.

J) If you have not yet tested vehicles of those categories, will you start testing them?

□ yes, from 01.01.2022 on

□ yes, earlier – please specify: ____________

□ no

K) If not, please indicate the "effective alternative road safety measures" in place or required by the Directive

□ the following measures are in place:

____

____

____

□ the following measures are planned:

____

____

____

L) If there are alternative road safety measures in place or planned, what relevant road safety statistics covering the last five years are taken into account?

____

____

____

The questionnaire was sent by e-mail to 553 recipients and was open from 14.05.2018 until 26.10.2018. In the mentioned period, 19 responses were received. Due to its complexity, the list of responses is delivered as excel file and is also available at request. Please address your requests to secretariat@citainsp.org.

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9. Bibliography

Bundesanstalt für Straßenwesen. 2017. 'Ergebnisse Fahrleistungserhebung 2014'. BASt - Fachthemen. 2017.
https://www.bast.de/DE/Verkehrssicherheit/Fachthemen/u2-fahrleistung-2014/u2-Fahrleistung-2014-ergebnisse.html?nn=605482

DEKRA Automobil GmbH. 2010. 'Motorcycle Road Safety Report 2010. Strategies for Preventing Accidents on the Roads of Europe.' Stuttgart.

Economic Commission for Europe. 2011. 'Statistics of Road Traffic Accidents in Europe and North America'. Geneva: United Nations.
https://www.unece.org/fileadmin/DAM/trans/main/wp6/publications/RAS-2017.pdf

European Commission.

———. 2016a. 'Road Safety Country Overview - Austria'. European Commission, Directorate General for Transport.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-austria_en.pdf

———. 2016b. 'Road Safety Country Overview - Belgium'. European Commission, Directorate General for Transport.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-belgium_en.pdf

———. 2016c. 'Road Safety Country Overview - Bulgaria'. European Commission, Directorate General for Transport.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-bulgaria_en.pdf

———. 2016d. 'Road Safety Country Overview - Croatia'. European Commission, Directorate General for Transport.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/specialist/erso/pdf/country_overviews/dacota-country-overview-hr_en.pdf

———. 2016e. 'Road Safety Country Overview - Cyprus'. European Commission, Directorate General for Transport.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-cyprus_en.pdf

———. 2016f. 'Road Safety Country Overview - Czech Republic'. European Commission, Directorate General for Transport.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-czech_en.pdf

———. 2016g. 'Road Safety Country Overview - Denmark'. European Commission, Directorate General for Transport.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-denmark_en.pdf

———. 2016h. 'Road Safety Country Overview - Estonia'. European Commission, Directorate General for Transport.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-estonia_en.pdf

———. 2016i. 'Road Safety Country Overview - Finland'. European Commission, Directorate General for Transport.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-finland_en.pdf

———. 2016j. 'Road Safety Country Overview - France'. European Commission, Directorate General for Transport.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-france_en.pdf

———. 2016k. 'Road Safety Country Overview - Germany'. European Commission, Directorate General for Transport.

https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-germany_en.pdf

———. 2016l. 'Road Safety Country Overview - Greece'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/specialist/erso/pdf/country_overviews/dacota-country-overview-el_en.pdf

———. 2016m. 'Road Safety Country Overview - Hungary'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-hungary_en.pdf

———. 2016n. 'Road Safety Country Overview - Ireland'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-uk_en.pdf

———. 2016o. 'Road Safety Country Overview - Italy'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-italy_en.pdf

———. 2016p. 'Road Safety Country Overview - Latvia'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-latvia_en.pdf

———. 2016q. 'Road Safety Country Overview - Lithuania'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-lithuania_en.pdf

———. 2016r. 'Road Safety Country Overview - Luxembourg'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-luxembourg_en.pdf

———. 2016s. 'Road Safety Country Overview - Malta'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-malta_en.pdf

———. 2016t. 'Road Safety Country Overview - Netherlands'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-netherlands_en.pdf

———. 2016u. 'Road Safety Country Overview - Poland'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-poland_en.pdf

———. 2016v. 'Road Safety Country Overview - Portugal'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-portugal_en.pdf

———. 2016w. 'Road Safety Country Overview - Romania'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-romania_en.pdf

———. 2016x. 'Road Safety Country Overview - Slovakia'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-slovakia_en.pdf

———. 2016y. 'Road Safety Country Overview - Slovenia'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-slovenia_en.pdf
———. 2016z. 'Road Safety Country Overview - Spain'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2016-spain_en.pdf
———. 2016aa. 'Road Safety Country Overview - Sweden'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-sweden_en.pdf
———. 2016ab. 'Road Safety Country Overview - United Kingdom'. European Commission, Directorate General for Transport. https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/erso-country-overview-2017-uk_en.pdf
———. 2018. 'CARE Database - Motorcycle, Mopeds and Car with/without Trailer Involved'.
Eurostat.
———. 2017a. 'Persons Killed in Road Accidents by Type of Vehicle'. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tran_sf_roadve&lang=en
———. 2017b. 'Trailers, by Permissible Maximum Gross Weight'. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road_eqs_trail&lang=en
———. 2018. 'Stock Vehicles by Category and NUTS 2 Regions'. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tran_r_vehst&lang=en
Kraftfahrt-Bundesamt.
———. 2010. 'Fahrzeugzulassungen (FZ). Bestand an Nutzfahrzeugen, Kraftfahrzeugen Insgesamt Und Kraftfahrzeuganhängern Nach Technischen Daten (Größenklassen, Motorisierung, Fahrzeugklassen Und Aufbauarten). 1. Januar 2010'. FZ 25. Flensburg.
———. 2011. 'Fahrzeugzulassungen (FZ). Bestand an Nutzfahrzeugen, Kraftfahrzeugen Insgesamt Und Kraftfahrzeuganhängern Nach Technischen Daten (Größenklassen, Motorisierung, Fahrzeugklassen Und Aufbauarten). 1. Januar 2011'. FZ 25. Flensburg.
———. 2012. 'Fahrzeugzulassungen (FZ). Bestand an Nutzfahrzeugen, Kraftfahrzeugen Insgesamt Und Kraftfahrzeuganhängern Nach Technischen Daten (Größenklassen, Motorisierung, Fahrzeugklassen Und Aufbauarten). 1. Januar 2012'. FZ 25. Flensburg: Kraftfahrt-Bundesamt.
———. 2013. 'Fahrzeugzulassungen (FZ). Bestand an Nutzfahrzeugen, Kraftfahrzeugen Insgesamt Und Kraftfahrzeuganhängern Nach Technischen Daten (Größenklassen, Motorisierung, Fahrzeugklassen Und Aufbauarten). 1. Januar 2013'. FZ 25. Flensburg.
———. 2014a. 'Fahrzeuguntersuchungen (FU). Hauptuntersuchungen Und Einzelabnahmen Nach Überwachungsinstitutionen Jahr 2013'. FU 1. Flensburg.
———. 2014b. 'Fahrzeugzulassungen (FZ). Bestand an Nutzfahrzeugen, Kraftfahrzeugen Insgesamt Und Kraftfahrzeuganhängern Nach Technischen Daten (Größenklassen, Motorisierung, Fahrzeugklassen Und Aufbauarten). 1. Januar 2014'. FZ 25. Flensburg.
———. 2015a. 'Fahrzeuguntersuchungen (FU). Hauptuntersuchungen Und Einzelabnahmen Nach Überwachungsinstitutionen Jahr 2014'. FU 1. Flensburg.
———. 2015b. 'Fahrzeugzulassungen (FZ). Bestand an Nutzfahrzeugen, Kraftfahrzeugen Insgesamt Und Kraftfahrzeuganhängern Nach Technischen

Daten (Größenklassen, Motorisierung, Fahrzeugklassen Und Aufbauarten). 1. Januar 2015'. FZ 25. Flensburg.
———. 2016. 'Fahrzeuguntersuchungen (FU). Hauptuntersuchungen Und Einzelabnahmen Nach Überwachungsinstitutionen Jahr 2015'. FU 1. Flensburg.
———. 2017a. 'Fahrzeugzulassungen (FZ). Bestand an Nutzfahrzeugen, Kraftfahrzeugen Insgesamt Und Kraftfahrzeuganhängern Nach Technischen Daten (Größenklassen, Motorisierung, Fahrzeugklassen Und Aufbauarten). 1. Januar 2016'. FZ 25. Flensburg.
———. 2017b. 'Fahrzeuguntersuchungen (FU). Hauptuntersuchungen Und Einzelabnahmen Nach Überwachungsinstitutionen Jahr 2016'. FU 1. Flensburg.
———. 2017c. 'Fahrzeugzulassungen (FZ). Bestand an Nutzfahrzeugen, Kraftfahrzeugen Insgesamt Und Kraftfahrzeuganhängern Nach Technischen Daten (Größenklassen, Motorisierung, Fahrzeugklassen Und Aufbauarten). 1. Januar 2017'. FZ 25. Flensburg.
Road Safety Authority. 2015. Road Safety Advice and Driver Licensing Rules for Drawing Light Trailers. Ballina. http://www.rsa.ie/Documents/Vehicle%20Std%20Leg/Road%20Safety%20Advice%20for%20Drawing%20Light%20Trailers%20A5%20booklet%20Amends%209-12-15%20%20%20%20.pdf
Statistisches Bundesamt. 2017. 'Verkehrsunfälle'. Zeitreihen 2016. Wiesbaden.
———. 2018. 'Unfallbeteiligte: Deutschland, Jahre, Art Der Verkehrsbeteiligung, Fehlverhalten Der Fahrzeugführer Und Fußgänger'. https://www-genesis.destatis.de/genesis/online/data;jsessionid=5CDEA9A6A28DBF50E6A52AA607A7AE22.tomcat_GO_1_3?operation=previous&levelindex=2&levelid=1519313285114&levelid=1519313240450&step=1

Cost and Benefit Analysis bibliography

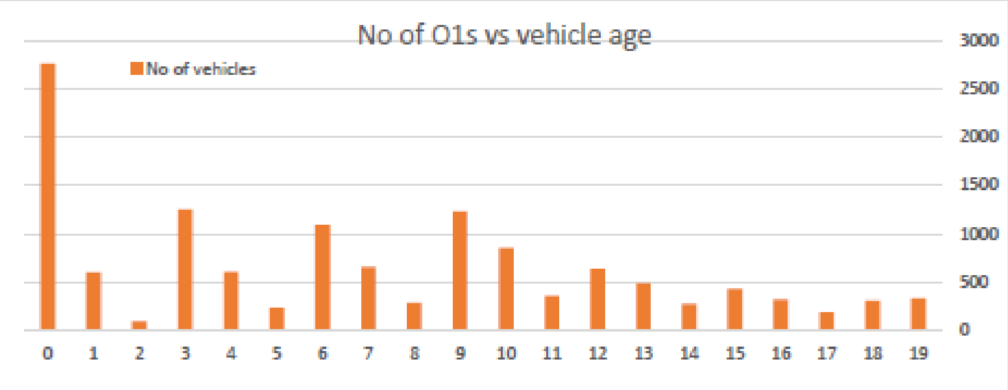
Adminaite, D., Calinescu, T., Jost, G., Stipdonk, H., & Ward, H. (2018). *Ranking EU Progress on Road Safety - 12th Road Safety Performance Index Report*. Retrieved from https://etsc.eu/wp-content/uploads/PIN_AR_2018_final.pdf
Applus. (2018). Tarifas ITV | Precios ITV según Comunidad Autónoma | Applus. Retrieved from http://www.applusiteuve.com/en/la-itv/tarifas-itv/
European Commission. (2003). Proposal for a Directive of the European Parliament and of the Council amending Directive 1999/62/EC on the charging of Heavy Goods Vehicles for the use of certain infrastructure, Brussels.
Eurostat. (2018). Eurostat - Tables, Graphs and Maps Interface (TGM) table - HICP - inflation rate. Retrieved from https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00118&plugin=1
FACUA. (2018). Tablas estudio ITV 2012. Retrieved from https://www.facua.org/es/tablas/itv2012.htm
Gibson, G., Varma, A., Cox, V., Korzhenevych, A., Dehnen, N., Bröcker, J., . . . Meier, H. (2014). *Ricardo-AEA - Update of the Handbook on External Costs of Transport - Final Report* (Ricardo-AEA/R/ ED57769). Retrieved from https://ec.europa.eu/transport/sites/transport/files/themes/sustainable/studies/doc/2014-handbook-external-costs-transport.pdf
Schulz, W. H. (1994). *Rationalisierungspotentiale in der Verkehrs- und Telematikinfrastruktur - Methoden und empirische Ergebnisse von Nutzen-Kosten-Analysen*. Köln.
TÜV Süd. (2018). Gebühren für Fahrzeugprüfungen. Retrieved from https://www.tuev-sued.de/hanse/fahrzeugpruefungen/gebuehren-hauptuntersuchung-fahrzeugpruefungen

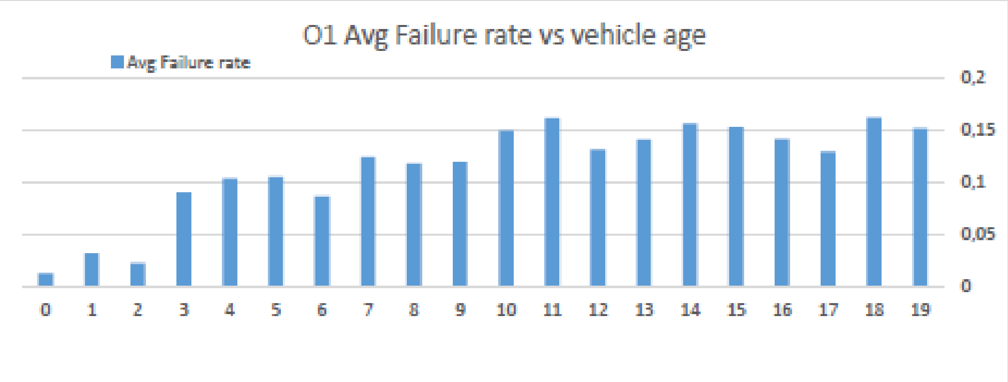
10. Annex 1 – CVH PTI database

Annex 1

CVH PTI - Database part 1

Avg Pass rate	No of vehicles	Year of production	Age	Avg Failure rate
0,847826087	323	1998	19	0,152173913
0,837209302	301	1999	18	0,162790698
0,87027027	185	2000	17	0,12972973
0,8585209	312	2001	16	0,1414791
0,846698113	425	2002	15	0,153301887
0,843283582	269	2003	14	0,156716418
0,858921162	482	2004	13	0,141078838
0,868131868	637	2005	12	0,131868132
0,838068182	352	2006	11	0,161931818
0,850059032	849	2007	10	0,149940968
0,880487805	1230	2008	9	0,119512195
0,882142857	280	2009	8	0,117857143
0,875957121	654	2010	7	0,124042879
0,913523459	1087	2011	6	0,086476541
0,894736842	228	2012	5	0,105263158
0,895867769	605	2013	4	0,104132231
0,909672262	1252	2014	3	0,090327738
0,97752809	89	2015	2	0,02247191
0,968280467	599	2016	1	0,031719533
0,987694535	2764	2017	0	0,012305465

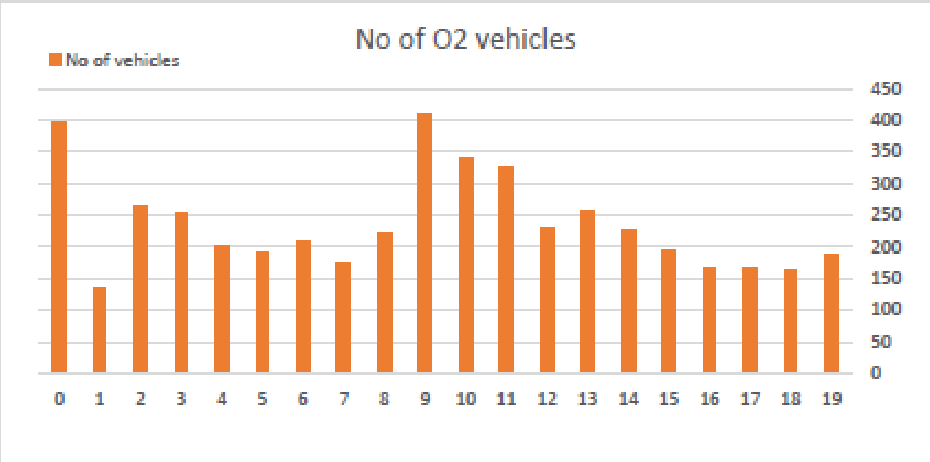


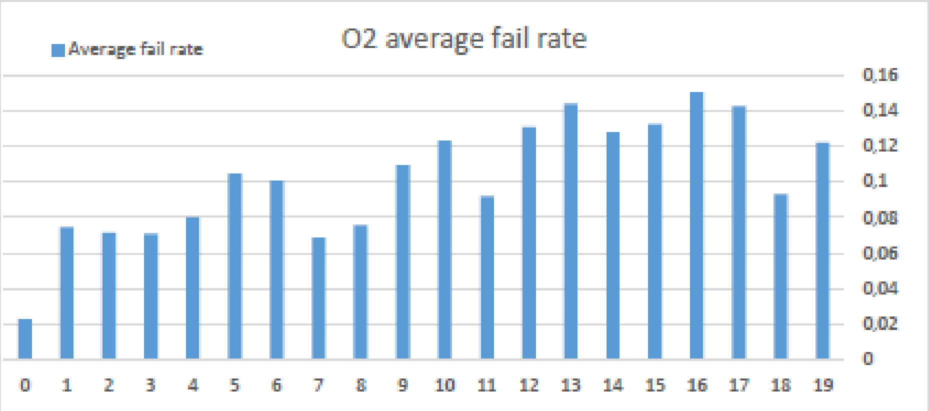


Annex 1

CVH PTI - Database part 2

AvgOfRezultat	No of vehicles	GodinaProizvodnje	Age of vehicle	Average fail rate
0,877659574	188	1998	19	0,122340426
0,906832298	162	1999	18	0,093167702
0,857142857	168	2000	17	0,142857143
0,84939759	166	2001	16	0,15060241
0,867346939	196	2002	15	0,132653061
0,871681416	226	2003	14	0,128318584
0,856031128	257	2004	13	0,143968872
0,868995633	229	2005	12	0,131004367
0,90797546	326	2006	11	0,09202454
0,876832845	341	2007	10	0,123167155
0,890510949	411	2008	9	0,109489051
0,924107143	224	2009	8	0,075892857
0,931428571	175	2010	7	0,068571429
0,899038462	208	2011	6	0,100961538
0,895287958	191	2012	5	0,104712042
0,92	200	2013	4	0,08
0,929133858	254	2014	3	0,070866142
0,928571429	266	2015	2	0,071428571
0,925373134	134	2016	1	0,074626866
0,977329975	398	2017	0	0,022670025





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