Study on the Roadworthiness Package

Strategy & Consulting

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Final Report

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Executive Summary

Transportation is facing unprecedented challenges not only regarding the development of new and innovative technologies, but also regarding social and environmental aspects. Maintaining safety throughout this transition to new mobility must be the main focus. ***By minimising the probability of technical errors, certain traffic accidents and fatalities can be mitigated.*** One established method of facilitating this is the periodic technical inspection (PTI).

Large gains to safety can be achieved via the introduction of periodic technical inspections (PTI) measures for the first time. Member states were to adopt and publish laws, regulations and administrative measures necessary to comply with Directives 2014/45/EU, 2014/46/EU and 2014/47/EU, collectively known as the Roadworthiness Package (RWP), by 20 May 2017 and apply those measures from 20 May 2018. Conversely, Commission Implementing Regulation (EU) 2019/621 adopted in accordance with Article 19(1) of Directives 2014/45/EU concerning data requirements is binding at EU level. As a result, the RWP consists of a mixture of Directives and a Regulation. ***The data required to be made available by Implementing Regulation (EU) 2019/621 are in many instances not used.*** The impact on Member States was assessed using the countries Sweden, Germany, Italy and France as a basis in Sections 2 and 5. By minimising the probability of technical errors, certain traffic accidents can partially be mitigated. ***Although the introduction of some minimum level of PTI requirements has a measurable effect, multiple factors can be observed to play an important role in road safety***.

The goal of roadworthiness and by extension PTI is to reduce or eliminate road accidents and fatalities. The EU aims to halve traffic deaths by 2030, starting from a baseline in 2020. This target was created after missing a previous goal of halving road deaths between 2010 and 2020 (European Parliament issues wake-up call on road safety, 2021). As demonstrated in Section 3 of this report, exogenous factors such as road quality, age of driver and time of day also play an outsized role. ***Accidents attributable to component failure represent a fraction of the overall figures*** (Figure 1).

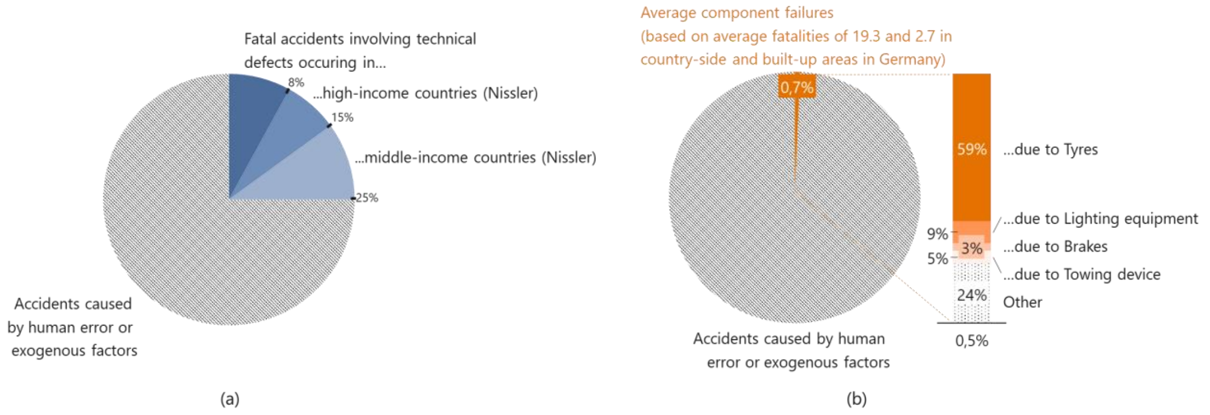


Figure 1: Overview of estimates for fatal accidents pertaining to technical defects with respect to total accident figures based on (a) historical data cited with reference to the 1997 agreement (Nissler, 2017), (b) Destatis data from period 2017-2019 (Destatis Statistische Bibliothek, 2023)

For example, data collected by the European Commission indicate that there were 3167 average fatalities per year in Germany for the period 2017-2019 (Section 3.1). From in-depth analysis in Section 4, average fatalities in Germany due to component failures in this same period total 2.7 in built-up areas and 19.3 in country-side areas. This indicates that fatalities due to component failure of passenger cars and goods vehicles (HGV) represent 0.7% of 3167 road fatalities in total during this period. Passenger cars were responsible for 2 out of 2.7 fatalities in built-up areas and 13.7 out of 19.3 fatalities in country-side areas on average in this period (0.5% of 3167 total fatalities). Of the accidents due to component failures, some proportion of accidents relate to tyres (59% of fatal passenger car and HGV accidents with component failure), lighting equipment (9% of fatal passenger car and HGV accidents with component failure, ~25% of failed PTI for passenger cars) and brakes (3% of fatal passenger car and HGV accidents with component failure, ~16% of failed PTI for passenger cars), with the remainder of the data set attributed to towing devices and “other”. Over the period 2015-2021, these figures were 64% (tyre issues), 9% (lighting issues), 8% (brake issues), 2% (steering issues), 2% (towing device issues) and 15% (other). Defects in axles, including wheels and tyres accounted for 14% of failed PTI for passenger cars. Aspects specific to commercial vehicles during road-side inspection (RSI) included equipment manipulation (disabling), steering/towing device, cargo securing and overloading as well as labelling and documentation. ***In certain cases (e.g. tyres), a data or digital solution is unlikely to help. In most cases, more accurate accident data is required in order to assist understanding of specific root causes and decision-making regarding vehicle improvement.***

Against this backdrop, the Commission sought to revise the directives mentioned above in order to improve the process by which the roadworthiness of a vehicle is assessed. Newer vehicles exhibit high levels of auditability and functionality compared to the level required by the RWP. As discussed in Section 6, an increase in RWP requirements could necessitate more examiners, due to the increase in time needed to check a vehicle. As a result, impacts to the vehicle will be largely administrative. These may have implications on Diagnostic Trouble Codes (DTCs) and data management, however other components won't necessarily be suitable to a data-driven or digital solution. Costs are generated by administrative and/or IT back-end processes, which are needed to make data available, especially for individual or specific users. Whereas requirements relating to the traditional RWP requirements can have large impacts on costs and bureaucratic processes, the introduction of the General Safety Regulation (EU) 2019/2144 aspects typically associated with type-approval are driving larger design implications. Design requirements for vehicles are typically defined in type approval regulations, including aspects relating to the testability of functions. For example, the on-board diagnostics (OBD) port is conclusively standardised in the emissions regulations, although it can also be used for PTI purposes. This approach could be applied to further test requirements.

Throughout the course of the study, numerous stakeholders including representatives from selected Member States (Germany, Sweden and France) as well as OEMs were contacted and interviewed. Unfortunately, PTI inspection centres were not able to be contacted within the scope of this work.

It is clear that the amount of data being generated by vehicles is increasing rapidly. Currently, individual approaches are being adopted by Member States, vehicle manufacturers and OEMs. As a result, options regarding a best way forwards for the exchange and management of PTI data must be considered. In doing so, critical test requirements must also be assessed (Section 7). ***This must be feasible and enable fast and effective technical inspection, whilst reducing as many accidents in the field as possible.*** Options regarding a best way forwards derived from key findings can be presented as two options:

1. ***Harmonised Status Quo***: utilisation of an existing data set with proven usage and functional safety characteristics.

2. ***Harmonised format*** with reduced data baseline: look for other existing methods of making information available, including training, before standardising a reduced data set.

Advanced methods such as electronic PTI (ePTI, based on ISO 20730) are emerging ***represent forward thinking methodologies which can provide a standardised solution via collaborative means***. Furthermore, harmonisation of multiple aspects ought to occur in an initial step/phase, subject to conditions relating to data collection, linkage of data sets and training of inspectors.

Aspects where harmonisation could be improved include testing of suspension systems. Such tests can currently be influenced by a range of factors. Standardisation of this procedure and these variables will be necessary before it can be adopted at scale.

Furthermore, harmonisation could seek to define the tool or inspection device which is used to conduct PTI, the data format and data boundary. Although currently prevented by competition laws, OEM cooperation could enable efficient and feasible identification of an existing or improved data set with a reasonable and effective level of granularity. These are discussed in Section 8, along with potential measures to fully enable these aspects in Section 9. The key findings can be summarised as follows:

Table 1: Summary of Key Findings and corresponding sections of the report

Baseline	The goal of roadworthiness and by extension PTI is to reduce or eliminate road accidents and fatalities. • The introduction of some minimum level of PTI requirements has a measurable effect. • By minimising the probability of technical errors, certain traffic accidents and fatalities can be mitigated.	➢ Section 1
Low Comp. Failures	Accidents attributable to component failure represent a fraction of the overall figures (0.7% in for years 2017-2019 in Germany). • In multiple instances an accident is influenced by several factors and more than one factor may contribute.	➢ Section 1 ➢ Section 3 ➢ Section 4
Digital Solution N/A	In certain cases (e.g. tyres), a digital solution is unlikely to help. • Accidents are largely cause by human error or exogenous factors.	➢ Section 3 ➢ Section 4 ➢ Section 7
Better Data	More accurate **accident data** is required in order to assist understanding of specific root causes and decision-making regarding vehicle improvement. • There is a broad range of estimates regarding the causality of technical defects in road accidents. • Accident data indicate that tyres cause the most accidents. • The data are generally not granular enough to establish a specific failure mode.	➢ Section 1 ➢ Section 2 ➢ Section 3 ➢ Section 4
Data Unused	Data from **Implementing Regulation (EU) 2019/621** are in many instances not used. • Data needs to be standardised (Key Finding "Reg v Dir"). • Cooperation between OEMs or at least further analysis of OEM data sets would be required in order to reach an appropriate solution. • Other categories (e.g. PDX as opposed to ODX) may be more amenable to other methods (general/text descriptions, training).	➢ Section 6

	ePTI, based on ISO 20730, represents forward thinking methodologies which can provide a standardised solution via collaborative means. These would be particularly well suited to modern (e.g. autonomous) vehicle functions.	➢ Section 7
	RSI processes could be further improved via sharing of information. Use of an EU-wide system could enable sharing of PTI pass/fail information to improve operational efficiency and cost of operations.	➢ Section 6
	Whereas Directives are required to be carried over into national law, Regulations are not. • A harmonised solution (e.g. regulation) is required to enable feasible, fast effective technical inspection. • Potentially enable use of mutual recognition schemes. • Leverage and improve on the single market.	➢ Section 2 ➢ Section 5

Based on these key findings, potential measures identified in Section 9 are listed as follows:

- Potential Measure 1: Improve Data Practices (administrative). This relates to more granular accident data, usable (EU) 2019/621 data and an EU-centralised system could be used to track RSI status.
- Potential Measure 2: Improve Tyre Testing. This relates to more precise definition of the equipment to be used and/or more frequent checks.
- Potential Measure 3: make PTI a regulation. This would enable harmonised PTI.

1 Introduction and Background

Transportation is facing unprecedented challenges not only regarding the development of new and innovative technologies, but also regarding social and environmental aspects. Maintaining safety throughout this transition to new mobility must be the main focus. One established method of facilitating this is the periodic technical inspection (PTI). Within the scope of this research, PTI measures and publicly available data will be discussed and analysed with a focus on M and N category vehicles.

A minimum level of PTI requirements can provide a benefit

Large gains to safety can be measured following the introduction of PTI for the first time (Rechnitzer, 2000). In multiple instances the number of fatalities is influenced by several factors and more than one factor may contribute to an accident (Elvik, 2009). The majority of causes may be attributed to other factors, as discussed in Section 3 of this report.

Nevertheless, there is a broad range of estimates regarding the causality of technical defects in road accidents, as shown in Table 2.

Table 2: Percentage of vehicles with technical defects that contributed to a traffic accident

Accident Type	Region	Year	Proportion of Accidents	Source
Fatal	Middle income countries (EU)	-	15% - 25%	(Nissler, 2017)
Fatal	High income countries (EU)	-	8% - 15%	
Damage to Property/ Injury	Europe	1985	1.3% - 11.4% (official) 1.5% - 24.4% (in-depth)	(Rompe & Seul., 1985), as cited by (Elvik, 2009) (p 743)
Damage to Property/ Injury	Denmark	1992	7% - 9%	(Asander, 1992)
	Finland		23%	
Damage to	Developed countries	1997	3% - 19%	(Martín-delosReyes, et al., 2021)

Property/ Injury				
Damage to Property/ Injury	Developing countries	2005	0% - 27%	(Taneerananon, et al., 2005)

Previous work conducted on improving road safety demonstrates that accidents due to component failure represent a small piece of a larger picture

By minimising the probability of technical errors, certain traffic accidents can be mitigated. The Handbook of Road Safety Measures shown in Figure 2 catalogues a total of 29 vehicle design and protective measures (Elvik, 2009). In this analysis, objective measures such as the benefit-cost ratio (BCR) and accident rate, defined in equation (1), are used. The benefit is the present value (PV) of the reduction in the accident rate. The accident rate is defined as the number of injured persons per million person kilometres. The BCR requires an estimate of costs, which are mostly one-time costs incurred when buying a piece of equipment. A BCR greater than one indicates that the option is financially beneficial.

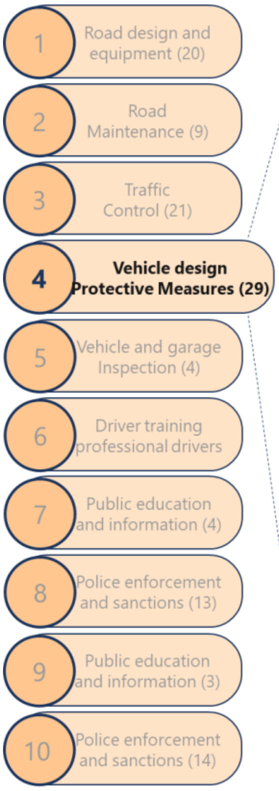
$$BCR = \frac{PV(reduction\ in\ injured\ persons/million\ person\ km)}{PV(costs)} \qquad (1)$$

Tyre tread depth ensures that friction is maintained when driving on wet road, the lack of which can be associated with an accident rate of 1.2 in daytime and 1.4 at nighttime. Elvik estimates a BCR of 0.3 when increasing the tyre tread depth requirement from 1.6mm to 3mm, implying that the costs exceeded the benefits at the time of publishing (2009). Studded tyres can also increase friction and thus reduce the accident rate on snow or ice-covered roads when compared to non-studded tyres, however usage on bare road surfaces may cause the spread of very fine dust particles which can be inhaled (BCR – ban: 2.6). Daytime running lamps on a motorcycle are expected to have roughly double the BCR (7.5) when compared to mopeds due to the higher expected number of accidents. Improving vehicle headlamps can be seen to have a BCR of 1.0 when applied to headlamps washers and 9.3 for halogen lamps. Seat belts were calculated to have a BCR of 1.3 for rear seat passengers, 13.3 for front seat passengers and 31.7 for the driver, indicating that the benefits outweigh the costs in each instance. The reduced BCR of 1.13 for child restraints was due to the relatively low number of children under the age of 15. The low impact of seat belts in buses and trucks is partially due to the fact that relatively few injuries occur to the occupants and in the case of buses, typical injuries occur to the passenger who are standing.

Intelligent cruise control is intended to prevent rear-end collisions due to lapses in driver attention by increasing the average distance to the vehicle in front. Lapses in driver attention were reportedly responsible for 63% of rear-end collisions. Lapses in attention whilst driving too close to the vehicle in front accounted for 14% of rear-end collisions and lapses in attention whilst speeding totalled 2% of the data set. Consumption of alcohol (15%), poor judgement (2%) and poor visibility (3%) also played a role. At the time of publishing, the costs were deemed to be greater than the benefits (BCR: 0.6).

The relationship between vehicle type, mass and injured drivers is summarised in detail in Table 4.19.1 of (Elvik, 2009). When engine performance increases, the accident rate was seen to increase for smaller cars but not be effected in larger vehicles. Regulating automobile top speed within the scope of an Intelligent Speed Adaption (ISA) was calculated to have a BCR in the range of 3.7 to 16.7 due to the range of infrastructure installation and maintenance costs.

Aspects with relatively high BCR (benefits clearly outweigh the costs) represent the low hanging fruit. The remaining items increasingly relate to the long tail of the distribution and may not necessarily relate to a BCR greater than one. For example, ABS has a BCR of 0.7 but was mandated by Annex 6 of UNECE R13 and Annex X of Commission Directive 85/647/EEC of 23 December 1985 (adapting to technical progress Council Directive 71/320/EEC), the latter of which has been repealed by the GSR Regulation (EU) 2019/2144. According to Elvik, increasing the tyre tread depth from 1.6mm to 3mm would have cost around NOK 240 million for a reduction in accidents worth an estimated NOK 80 million (BCR: 0.3).



Measure	BCR	% Accidents (injury)
4.1 Tyre tread depth	0.3	22% on wet roads (Norway)
4.2 Studded tyres	2.6 (ban)	21% on snow/ice (Norway)
4.3 ABS and disc brakes	0.7	14% due to locked wheel (Great Britain)
4.4 High-mounted stop lamps	4.1	13% due to rearend collisions (Norway)
4.5 Daytime running lights for cars	2.5	6% (multi-vehicle accidents)
4.6 Daytime running lights for mopeds/motorcycles	3.8-7.5	32% (multi-vehicle accidents*)
4.7 Improving vehicle headlights	1.0-9.3	30% occur in the dark (Norway)
4.8 Reflective materials and protective clothing	5.3	30% occur in the dark (Norway)
4.9 Steering, suspension and vehicle stability	-	3.8% (11% for fatal accidents)
4.10 Bicycle helmets	1.0-2.5	40%-44% (cyclists)
4.11 Motorcycle helmets	17.2	44% reduction in injuries
4.12 Seat belts in cars	1.3 - 31.7	64% (killed or injured due to impact w/ interior)
4.13 Child restraints	1.13	70% reduction for a child between 1 and 7 years
4.14 Airbags in cars	-	-
4.15 Seat belts in buses and trucks	0.0	High proportion of uninjured drivers (Norway)
4.16 Vehicle crashworthiness	0.9-30	59% (Norway)
4.17 Driving controls and instruments	0.0	-
4.18 Intelligent cruise control (ICC)	0.6	10% - 20% (Norway)
4.19 Regulating vehicle mass (weight)	-	Varies by vehicle mass
4.20 Regulating automobile engine capacity (power), top speed	0.3, 3.7-16.7	40-50% increase when not regulated (small cars)
4.21 Regulating engine capacity (power) of mopeds/motorcycles	-	-
4.22 Under-run guards on heavy vehicles	3.9	35% fatal accident involving lorries/front impacts
4.23 Safety equipment on heavy vehicles	-	-
4.24 Moped and motorcycle equipment	-	-
4.25 Bicycle safety equipment	0.1 - 2.2	-
4.26 Safety standards for trailers and caravans	-	-
4.27 Fire safety standards	-	-
4.28 Hazardous goods regulations	-	-
4.29 Electronic stability control (ESC)	4.8	40-50% (single vehicle), 10% (multi-vehicle)

Figure 2: Overview of Road Safety Measures Handbook (number of measures) along with a summary of the Vehicle Design and Protective Measures (Elvik et al., 2009), Benefit to Cost Ratio and % relevance for accidents (* not statistically significant)

Although improving the static stability (see Figure 2, 4.9 Steering, Suspension and Vehicle Stability) by one-tenth could reduce the number of fatal accidents by around 9/100,000 accidents, no costs were known to the authors (Elvik et al). Similarly, no cost estimates were available for the installation of airbags, for regulating engine capacity of mopeds and motorcycles, equipment for heavy duty vehicles, motorcycles, trailers and caravans and fire safety standards. The implications of malfunctioning driving controls or instruments is presumed to have an impact on the probability of the driver committing an error, however no costs were available. Separate studies provided details on costs (NOK 3.2 mil) and social benefits (NOK 80-110 mil) regarding safety measures of hazardous goods.

Other studies conclude that PTI related failures may play a less causal role

A study based on 80,000 reported accidents in Connecticut found that vehicle related factors contribute approximately 1% of accidents reported (Fazzalaro, 2007). Little concluded that certain states in the USA who introduced periodic motor vehicle inspections (PMVI) experience a 5% increase in fatal accidents, thus other factors may play an outsized role (Little, 1971).

However, the introduction of some minimum level of PTI requirements has a measurable effect

A reasonable minimum level of PTI requirements has been shown to have a measurable effect on traffic safety (Wolfgang H. Schulz, 2020). Table 3 summarises the percentage reduction identified by further authors.

Table 3: Percentage reduction in accident rates following the introduction of periodic motor vehicle inspection (PMVI), or between jurisdictions with PMVI and those without (Rechnitzer, 2000)

Percentage reduction	**Study**
10% (in accident rate) 0% (in fatal crash rate)	(NHTSA, 1989) USA
16% (in accidents with personal injury)	(Asander, 1992) Sweden
14% (in police reported accidents) 15% (in injury accidents)	Berg et al. (1984) Sweden (cited in (Fosser, 1992))
50% (in accident rate)	Romp & Seul (1985) USA
9.1% (in accident rate, after one inspection, compared to uninspected vehicles) 21% (in accident rate, after periodic inspections, compared to uninspected vehicles) 5.3% (in accident rate for inspected vehicles compared to their accident rates before inspection)	(Schroer & Peyton, 1979) USA
10%-15% (in accident rate)	(White, 1986) NZ
General reduction in accident rate	(Crain, 1981) USA
Fatality and accident rates found to decrease, but no proportion figures given	(Loeb & Gilad, 1984) USA

Multiple factors can be observed to play an important role in road safety

Legislative factors are first examined in section 2, where the impact of Directives 2014/45/EU, 2014/46/EU and 2014/47/EU as well as Implementing Regulation (EU) 2019/621 is analysed. Factors related to road safety are then examined in detail in section 3, where total accident figures at EU level and for selected Member States are presented. Factors related to PTI and RSI are reviewed in section 4, where it is determined that the proportion of accidents attributable to technical deficiencies and by extension PTI is quite low when compared to the figures in the previous section. Perspectives from various Member States and vehicle manufacturers (OEMs) are collected and evaluated in sections 5 and 6 respectively. This analysis demonstrates that a structured and unified data set across Member States and OEMs is required and that the introduction of type-approval measures is a major driver of cost. A comprehensive review of existing and incoming test procedures is then presented in section 7. A discussion of key findings and ensuing political options are then summarised in sections 8 and 9.

Table 4: Summary of Key Findings in Section 1 (introduction and background)

Key Finding	Summary of introduction and background
	A minimum level of PTI requirements can provide a benefit. However, the introduction of some minimum level of PTI requirements has a measurable effect.
	Vehicles with technical defects that contributed to a traffic accident exhibit wide estimate ranges and limited granularity.
	Previous work conducted on improving road safety demonstrates that accidents due to component or technical failure represent a small piece of a larger picture.
	Component failures represent a low proportion. Multiple factors can be observed to play an important role in road safety.

2 Legislative Factors in PTI

Point to be addressed	Summary of Results
Transposition and mandate of the provisions of EU PTI / RSI directives nationally and what it means for vehicle manufacturers from design and cost perspective.	**Member states were to adopt and publish laws, regulations and administrative measures at a national level necessary to comply with Directives** 2014/45/EU, 2014/46/EU and 2014/47/EU by 20 May 2017 and apply those measures from 20 May 2018. Conversely, Commission **Implementing Regulation (EU) 2019/621** concerning data requirements is **binding at EU level**. Variations are evident in topics such as **scope** (vehicle category), **minimum interval**, **categorisation of deficiencies**, structure of **required tests** (2014/45/EU Annex I), **training of inspectors**. These variations could be reduced by increasing the level of harmonisation by making PTI a regulation. Slight variations are evident in topics such as quality assessment, cargo securing, exchange of information. Directive 2014/46/EU exhibits a high degree of standardised adoption. Details are listed in Appendix 2.
Literature review of existing studies and outcomes / conclusions. (key words: PTI, RSI, Accidents due to poor maintenance, PTI effectiveness for reducing road accidents, etc.).	Review of non-technical documents and studies has been conducted. Roadworthiness legislation and type-approval legislation are **typically clearly and separately defined**. Design requirements for vehicles should be laid down exclusively in type-

	approval regulations, including aspects relating to the testability of functions.

2.1 Roadworthiness Package

Directive 2009/40/EC was introduced in order to recast Council Directive 96/96/EC on the approximation of the laws of the Member States relating to roadworthiness tests for motor vehicles and trailers.

The European Roadworthiness Package consists of three directives which pertain to periodic roadworthiness tests for motor vehicles and their trailers (Directive 2014/45/EU, repealing Directive 2009/40/EC), registration documents for vehicles (Directive 2014/46/EU) and the technical roadside inspection of the roadworthiness of commercial vehicles (Directive 2014/47/EU). Implementing Regulation (EU) 2019/621 provides measures which were adopted in accordance with Article 19 of Directive 2014/45/EU regarding vehicle technical information to be made available to testing centres and relevant competent authorities. An overview of these is provided in Figure 3.

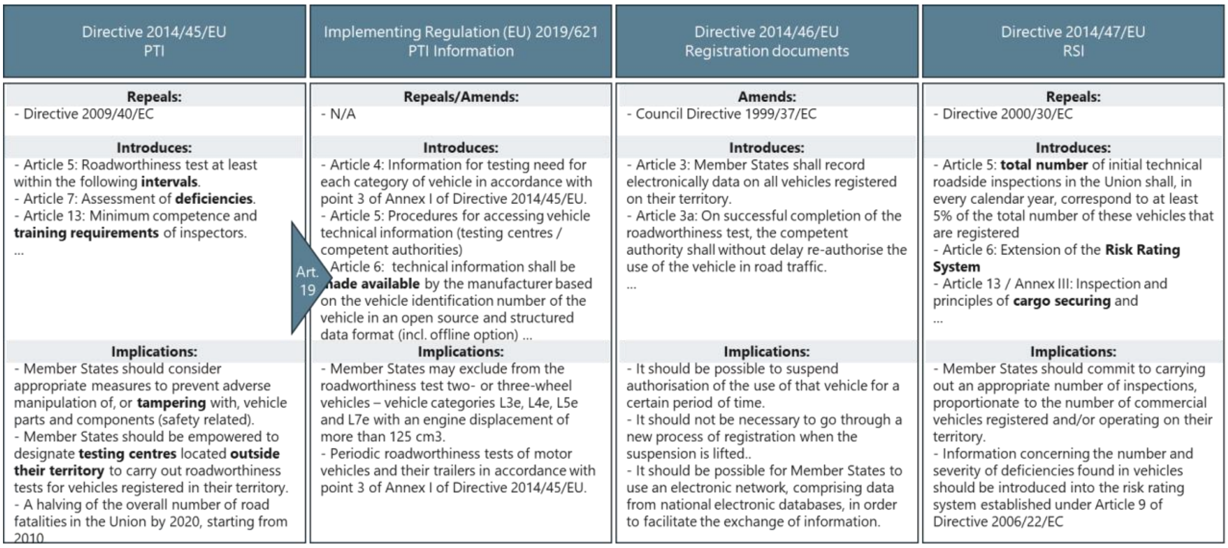


Figure 3: Overview of the European Roadworthiness Package (Directive 2014/45/EU, Directive 2014/46/EU, Directive 2014/47/EU) and Implementing Regulation (EU) 2019/621

Directive 2014/45/EU enlarges the scope of Directive 2009/40/EC to include provisions relating to testing centres and facilities as well as the designation of inspectors. It defines in Annex I minimum requirements concerning the content and recommended methods of testing. These include reasons for failure as well as assessment of deficiencies and apply to:

- 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 of categories M_2 and M_3.

The scope of the technical roadside inspection in Annex II of Directive 2014/47/EU leverages Annex I of Directive 2014/45/EU, however with minor adjustments. For example, Directive 2014/47/EU generally has a one-to-one correlation between the reason for failure and the assessment of deficiencies and requires slightly lower braking efficiencies for M_1 (50% instead of 58%), N_1 (45% instead of 50%), N_2, and N_3 (43% instead of 45%) vehicles.

Article 23 of Directive 2014/45/EU, Article 2 of Directive 2014/46/EU and Article 26 of Directive 2014/47/EU state that:

> *"Member Staes shall adopt and publish, by 20 May 2017, the laws, regulations and administrative measures necessary to comply with this Directive… They shall apply those measures from 20 May 2018."*

As a result, it could be deduced that the transposition of the European Roadworthiness Package at national level can lead to discrepancies between Member States. These discrepancies include scope of application, minimum inspection interval and handling of deficiencies and are detailed for Sweden, Germany and Italy in Section 11.2.

Whereas Directives are to be transposed into national law, Implementing Regulation (EU) 2019/621 is binding in its entirety and applicable in all Member States (Article 7). It builds on points 1. through 9. described in Annex I of Directive 2014/45/EU listed above, replacing reasons for failure and assessment of deficiencies with the information needed for each category of vehicle. An overview of the points for which information currently needs to be provided by OEMs in provided in Section 11.3.

These points are summarised below in Section 2.4.

2.2 National Adoption of Directives

Figure 4, Figure 5 and Figure 6 show the transposition of the European Roadworthiness Package at a national level for Sweden, Germany and Italy. Sweden and Germany had a larger pool of existing regulations, which were either used directly or modified. Italy carries over the

European regulation almost in its entirety. There are some minor adjustments made and these have been highlighted in Section 11.2. The sources highlighted in orange were used more intensely for the research conducted as part of this study. Table 5 below lists the names and sources of these documents.

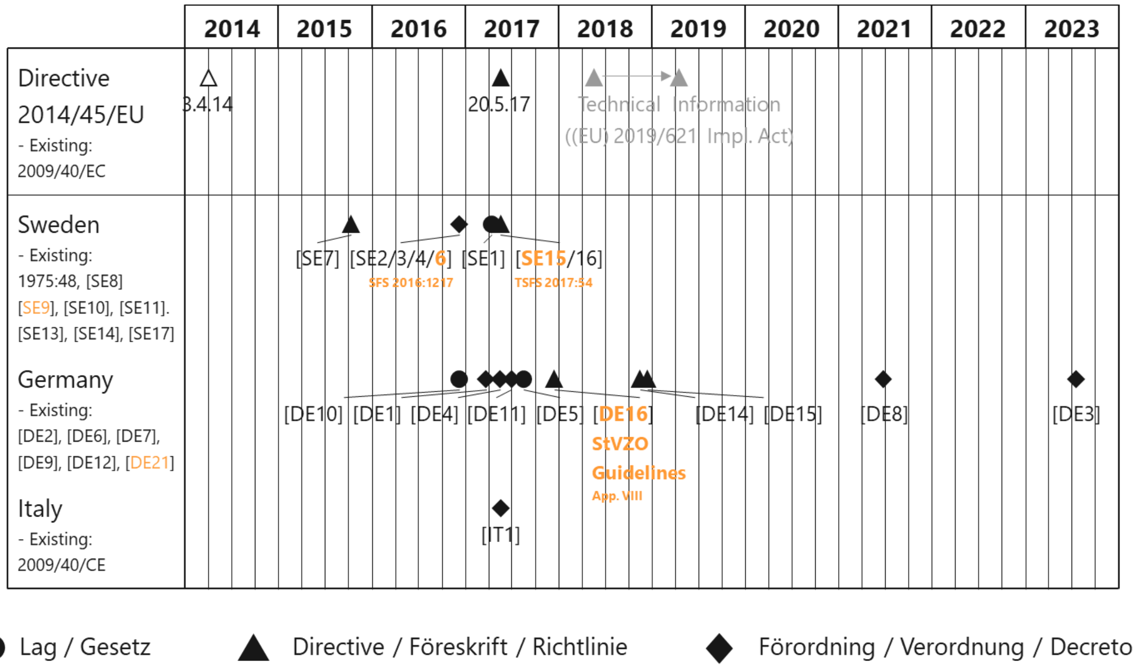


Figure 4: Timeline of Directive 2014/45/EU adoption (△) and transposition deadline (▲) along with existing legislation and transposition at a National level

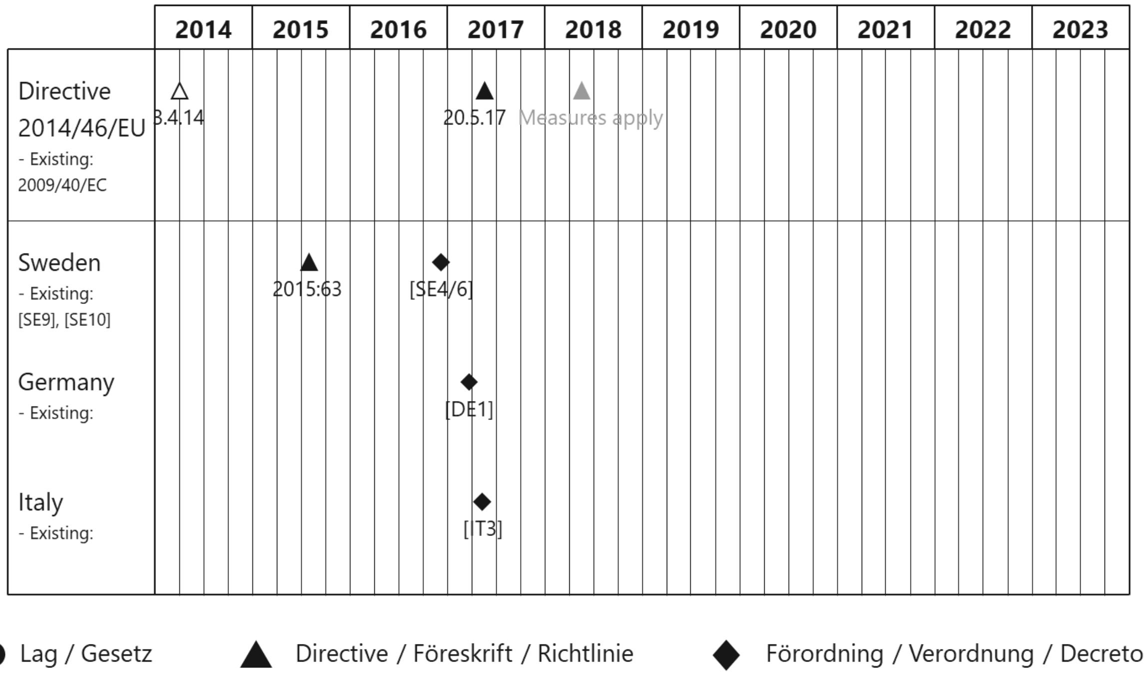


Figure 5: Timeline of Directive 2014/46/EU adoption (△) and transposition deadline (▲) along with existing legislation and transposition at a National level

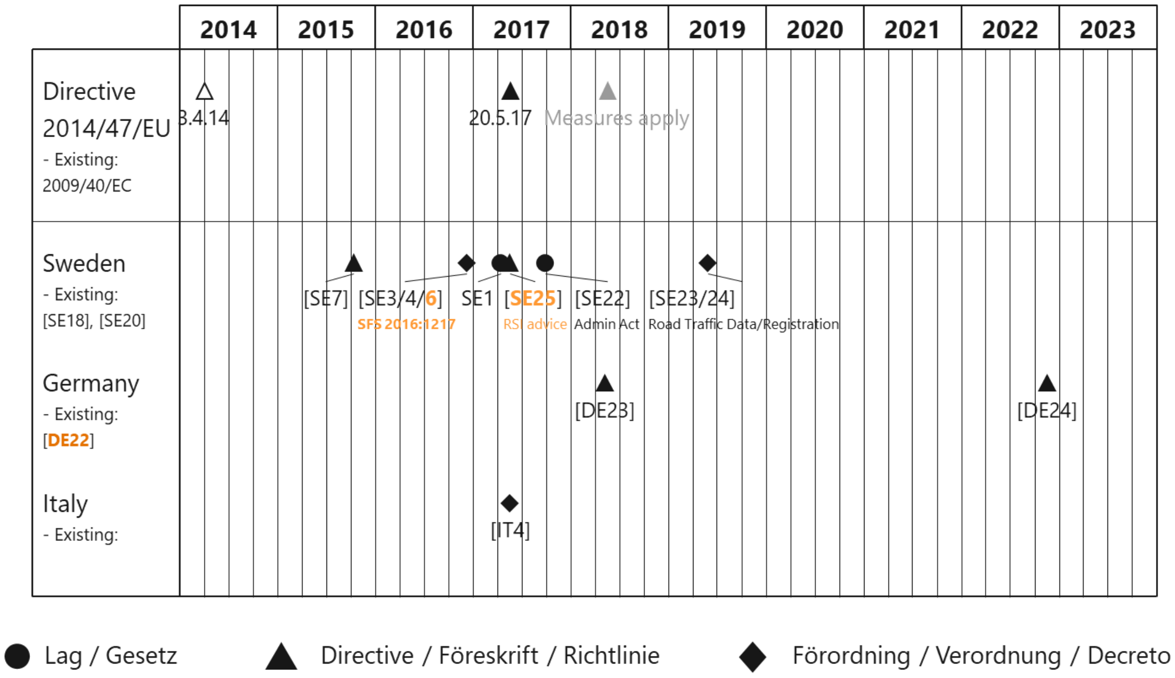


Figure 6: Timeline of Directive 2014/47/EU adoption (△) and transposition deadline (▲) along with existing legislation and transposition at a National level

Table 5: List of regulatory documents shown in the above timelines

Sweden [SE]		Germany [DE]		Italy [IT]	
1	Lag (2017:274) om ändring i fordonslagen (2002:574) (13 april 2017)	1	Dritte Verordnung zur Änderung der Fahrzeug-Zulassungsverordnung und anderer straßenverkehrsrechtlicher Vorschriften (23. März 2017)	1	Recepimento della direttiva 2014/45/UE del Parlamento europeo e del Consiglio del 3 aprile 2014 relativa ai controlli tecnici periodici dei veicoli a motore e dei loro rimorchi e recante abrogazione della direttiva 2009/40/CE.
2	Förordning (2016:1214) om ändring i förordningen (1975:48) om upphävande av kungörelsen (1940:440) om hänförande av vissa automobiler till fordonstypen motorredskap (8 december 2016)	2	Verordnung zur Durchführung des Kraftfahrsachverständigengesetzes (24. Mai 1972)	2	Razionalizzazione dei processi di gestione dei dati di circolazione e di proprieta' di autoveicoli, motoveicoli e rimorchi, finalizzata al rilascio di un documento unico, ai sensi dell'articolo 8, comma 1, lettera d), della legge 7 agosto 2015, n. 124.

3	Förordning (2016:1215) om ändring i trafikförordningen (8 december 2016)	3	Verordnung über die Zulassung von Fahrzeugen zum Straßenverkehr (20.07.2023)	3	Recepimento della direttiva 2014/46/UE del Parlamento europeo e del Consiglio del 3 aprile 2014 che modifica la direttiva 1999/37/CE del Consiglio, relativa ai documenti di immatricolazione dei veicoli
4	Förordning (2016:1216) om ändring i förordningen (2001:650) om vägtrafikregister (8 december 2016)	4	52. Verordnung zur Änderung straßenverkehrsrechtlicher Vorschriften (18. Mai 2017)	4	Recepimento della direttiva 2014/47/UE del Parlamento europeo e del Consiglio del 3 aprile 2014, relativa ai controlli tecnici su strada dei veicoli commerciali circolanti nell'Unione e che abroga la direttiva 2000/30/CE
5	Gesetz zur effektiveren und praxistauglicheren Ausgestaltung des Strafverfahrens (17. August 2017)	5	Gesetz zur effektiveren und praxistauglicheren Ausgestaltung des Strafverfahrens (17. August 2017)		
6	Förordning (2016:1217) om ändring i fordonsförordningen (2009:211) (8 december 2016)	6	Straßenverkehrsgesetz (5. März 2003)		
7	Transportstyrelsens föreskrifter (2015:56) om ändring i Transportstyrelsens föreskrifter och allmänna råd (TSFS 2010:84) om kontrollbesiktning (12 oktober 2015)	7	Bußgeldkatalog-Verordnung (14.03.2013)		
8	Fordonslag (2002:574) (Vehicle Act)	8	2. Verordnung zur Änderung der Fahrzeugzulassungsverordnung und der Gebührenordnung für Maßnahmen im Straßenverkehr (25.06.2021)		
9	Fordonsförordning (2009:211)	9	Gesetz über amtlich anerkannte Sachverständige und amtlich anerkannte Prüfer für den Kraftfahrzeugverkehr (22.12.1971)		
10	Förordning (2001:650) om vägtrafikregister	10	6. Gesetz zur Änderung des Straßenverkehrsgesetzes und anderer Gesetze (7.12.2016)		
11	Kungörelse (1940:440) om hänförande av vissa automobiler till fordonstypen motorredskap	11	10.Zuständigkeits-anpassungsverordnung (30.06.2017)		

13	Trafikförordning (1998:1276)	12	Verordnung zum Neuerlass der Straßenverkehrs-Zulassungs-Ordnung (26.04.2012)		
14	Transportstyrelsens föreskrifter och allmänna råd (2010:84) om kontrollbesiktning	14	Richtlinie für die Prüfung von Einrich- tungen, die bei der Systemdatenprü- fung und/oder der Prüfung über die elektronische Fahrzeugschnittstelle nach § 29 i. V. m. Anlage VIIIa StVZO…		
15	Transportstyrelsens föreskrifter och allmänna råd (TSFS 2017:54) om kontrollbesiktning (konsoliderad version) (19 maj 2017)	15	HU-Scheinwerfer-Prüfrichtlinie		
16	Transportstyrelsens föreskrifter och allmänna råd (TSFS 2017:53) om krav på utbildning och kompetens för besiktningstekniker samt polisman och bilinspektör (konsoliderad version) (19 maj 2017)	16	HU-Richtlinie		
17	Transportstyrelsens föreskrifter och allmänna råd (TSFS 2010:78) om teknisk kontrollutrustning hos besiktningsorgan och provningsorgan	21	Straßenverkehrszulassungsordnung		
18	Väglag (1971:948)	22	Verordnung über technische Kontrollen von Nutzfahrzeugen auf der Straße (TechKontrollV) (21. Mai 2003)		
20	Förordning (2001:651) om vägtrafikdefinitioner	23	Verordnung zur Änderung der Verordnung über technische Kontrollen von Nutzfahrzeugen auf der Straße (8. Mai 2018)		
22	Förvaltningslag (2017:900)	24	Zweite Verordnung zur Änderung der Verordnung über technische Kontrollen von Nutzfahrzeugen auf der Straße (17. Nov 2022)		
23	Vägtrafikdataförordning (2019:382)				
24	Förordning (2019:383) om fordons registrering och användning				

25	Transportstyrelsens föreskrifter och allmänna råd (TSFS 2017:55) om flygande inspektion				

These points are summarised below in Section 2.4.

2.3 Link to Type-Approval Legislation

The following regulations relate directly to type-approval. Regulation (EU) 2018/858 relates to the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units. Regulation (EU) 2019/2144 also relates to the type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their **general safety** and the protection of vehicle occupants and vulnerable road users. In particular, Annex III of Regulation (EU) 2019/2144 on general safety amends Annex II of Regulation (EU) 2018/858. These are depicted in Figure 7. Although type-approval legislation is not the focus of this study, aspects with a potential impact on safety were considered and discussed with OEMs in detail in Section 6.6.

Design requirements for vehicles are typically defined in type-approval regulations, including aspects relating to the testability of functions. A good example of this is the OBD port. Its design is conclusively standardised in the emissions regulations, although it can also be used for PTI purposes. This approach could be applied to further test requirements.

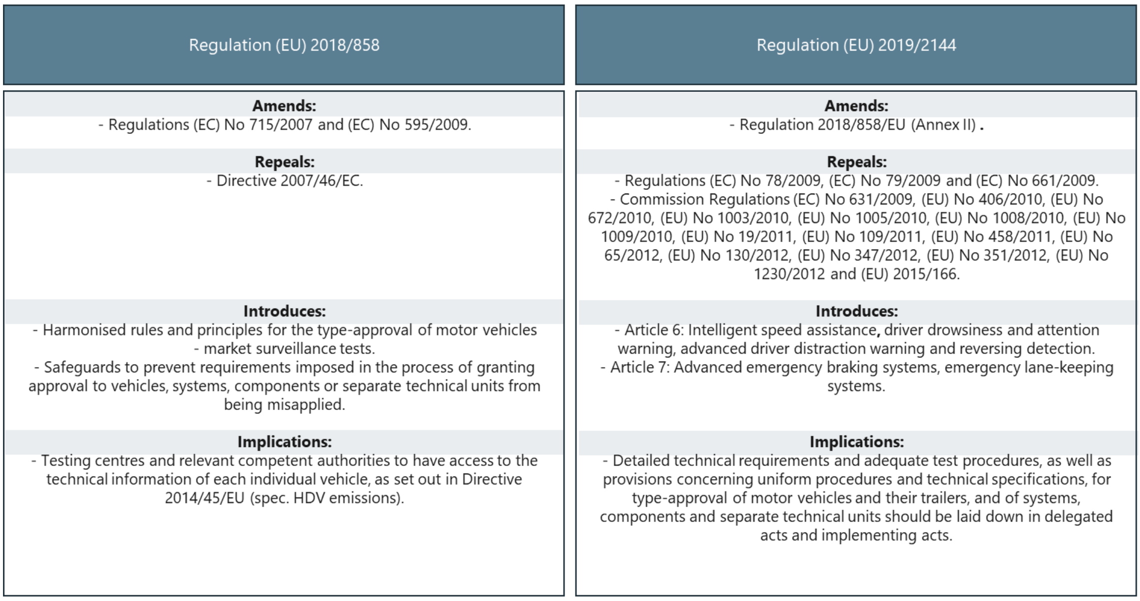


Figure 7: Overview of type-approval regulation for vehicles of categories M, N and O

Article 8 of Regulation (EU) 2019/2144 on general safety states that:

> *„The Commission shall by means of implementing acts adopt provisions concerning uniform procedures and technical specifications for the type-approval of frontal protection systems, including technical specifications concerning their construction and installation.“*

Frontal protection systems for M_1 and N_1 vehicles are included in Annex III of Commission Implementing Regulation (EU) 2021/535.

Paragraph three of Article 7 of Regulation (EU) 2019/2144 states that:

> *"Vehicles of categories M_1 and N_1 shall also be equipped with an emergency lane-keeping system."*

Commission Implementing Regulation (EU) 2021/646 relates to the uniform procedures and technical specifications for the type-approval of motor vehicles with regard to their emergency lane-keeping systems (ELKS).

Article 6 of Regulation (EU) 2019/2144 lists further advanced systems in paragraph 1. Commission Delegated Regulation (EU) 2021/1958 concerns specific test procedures and technical requirements with regard to intelligent speed assistance. Commission Delegated Regulation (EU) 2021/1243 details rules concerning alcohol interlock installation facilitation. Commission Delegated Regulation (EU) 2021/1341 contains detailed rules concerning specific test procedures and technical requirements driver drowsiness and attention warning. emergency stop signal, reversing detection and event data recorder.

Recitals, although not directly legally binding to the extent that the operative provisions are, can be important regarding interpretation. Recital (4) of Regulation (EU) 2019/2144 states

> *"Moreover, current technology creates a reasonable expectation that advanced systems will also react to other vulnerable road users under normal driving conditions, despite not being specifically tested. The technical requirements in this Regulation should be further adapted to technical progress following an assessment and review process in order to cover all road users who use personal mobility solutions without protective bodywork, such as scooters, self-balancing vehicles and wheelchairs."*

As demonstrated in Sections 6.6 and 11.7, the inclusion of certain type-approval checks during periodic technical inspections (PTI) is generating considerable overheads for both the vehicle manufacturers and inspections agencies. Type-approval regulation should seek to define these aspects as well as the testability thereof sufficiently.

2.4 Summary of legislative factors in PTI

A summary of the key findings in this section are presented below in Table 6.

Table 6: Summary of legislative factors in PTI

Key Finding	Summary of Results
	**Member states were to adopt and publish laws, regulations and administrative measures at a national level necessary to comply with Directives** 2014/45/EU, 2014/46/EU and 2014/47/EU by 20 May 2017 and apply those measures from 20 May 2018. Conversely, Commission **Implementing Regulation (EU) 2019/621** concerning data requirements is **binding at EU level**. Variations are evident in topics such as **scope** (vehicle category), **minimum interval**, **categorisation of deficiencies**, structure of **required tests** (2014/45/EU Annex I), **training of inspectors**. These variations could be reduced by increasing the level of harmonisation by making PTI a regulation. Slight variations are evident in topics such as quality assessment, cargo securing, exchange of information. Directive 2014/46/EU exhibits a high degree of standardised adoption. Roadworthiness legislation and type-approval legislation are **typically clearly and separately defined**. Design requirements for vehicles should be laid down exclusively in type-approval regulations, including aspects relating to the testability of functions.

3 Factors related to road safety – the full picture

Point to be addressed	Summary of Results
Literature review of existing studies and outcomes / conclusions. (key words: PTI, RSI, Accidents due to poor maintenance, PTI effectiveness for reducing road accidents, etc.).	Review of non-technical documents and studies has been conducted. Current goals of the RWP are not being met with respect to achieving the reduction targets specified. Accidents are largely caused by **human error** or exogenous factors, subject to enforcement procedures. Of many identified issues, **a vehicle data solution is unlikely to help**. Accident **data** are generally **not granular enough**.
	Case studies reviewed typically involve **multiple failure modes and/or driver distraction** and relate to: - 1 x Speedometer (Sweden) - 1 x Shock absorbers/driver not wearing seatbelt, (Germany) - 1 x tachograph manipulation (Germany) - 1 x driver distraction/no lane keeping system (Germany) - 2 x Commercial Vehicle/inadequate VRU sensor field of vision (Germany) Whereas PTI may catch issues with inaccurate speedometers, PTI cannot improve situations where occupants are not wearing seatbelts. PTI is also unlikely to help catch type-approved sensors with an inadequate field of view. **Design requirements** for vehicles including aspects relating to the testability of functions should

	be **adequately defined in type-approval regulations**.

The goal of roadworthiness and by extension PTI is to reduce or eliminate road accidents and fatalities. The EU aims to halve traffic deaths by 2030, starting from a baseline in 2020. This target was created after missing a previous goal of halving road deaths between 2010 and 2020 (European Parliament issues wake-up call on road safety, 2021). Figure 8 shows accident figures for all European as a whole as well as for selected countries France, Italy, Sweden and Germany. It is also noted that Spain and Romania also feature high accident figures in this data set. The adoption and transposition deadline is also shown. As noted in Section 5.4, there is inherent difficulty in trying to compare PTI effectiveness with accident data in countries where PTI is well established. However, a downward trend is generally observed.

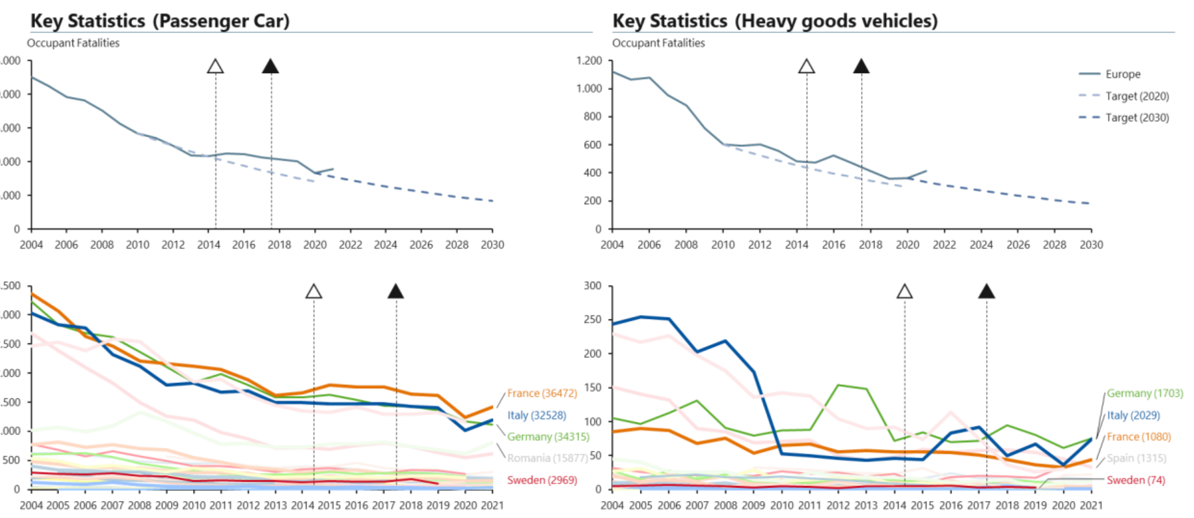


Figure 8: Overview of European and national legislation with adoption (△) and transposition deadline (▲)

3.1 Accidentology

Accident data has been collected for the Member States in focus of this study from various national road safety profiles (National Road Safety Profile - Germany, 2021), (National Road Safety Profile - Italy, 2021), (National Road Safety Profile - France, 2021), (National Road Safety Profile - Sweden, 2021). Out of 27 EU countries, Sweden has the lowest number of fatalities per million inhabitants. On a per million inhabitant basis, Germany ranks 7th, France 14th and Italy 15th. These figures do vary, depending on period examined as shown in Table 8.

These studies quantify the average number of road fatalities by transport mode (Figure 9) and road type (Figure 10) per year for the period 2017-2019. Sweden averaged a total of 266 fatalities per year for this period, which represents an 8% decrease when compared to the period 2010-2012. Germany, Italy and France experienced average yearly fatalities of 3167, 3295 and 3311 respectively for the period 2017-2019. Germany and Italy experienced reductions of 16% each, whereas France saw a decrease of 14% when compared with 2010-2012. The European Union as a whole had a larger reduction in yearly fatalities (18%), which is partly explained by countries like Spain (8613 fatalities, -28%), Latvia (139 fatalities, -27%) and Greece (656 fatalities, -62%), for example (National Road Safety Profile - Spain, 2021) (National Road Safety Profile - Latvia, 2021) (National Road Safety Profile - Greece, 2021). The Slovak Republic saw a decline of 14% (1030 fatalities) (National Road Safety Profile - Slovakia, 2021). These values are shown in brackets for the respective countries in Figure 9 and Figure 10.

Figure 9 represents the number of road fatalities by transport mode. On average in Europe, occupants of cars and lorries/HGVs represented 45% and 6% of fatalities for the period 2017 through 2019. These proportions were slightly higher on Swedish roads, totalling 52% and 7% respectively. In Italy, these figures were slightly lower at 44% and 5% respectively. These figures in Germany were lower for car occupants (44%) and on the average for lorries/HGV. The proportion of fatalities attributed to car occupants was above average in France (51%) whereas the proportion attributed to lorries/HGV was below average (4%).

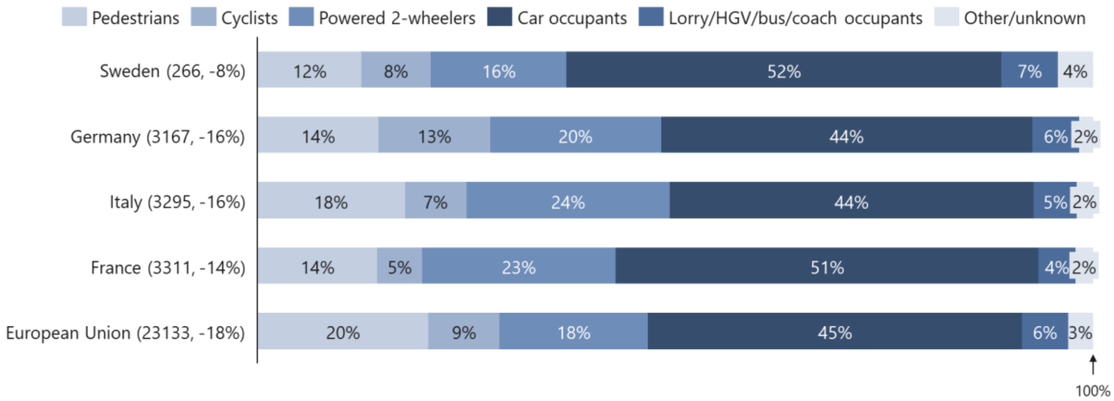


Figure 9: Proportions of road fatalities by transport mode (2017 – 2019) (average annual fatalities for period, with percentage decrease since period 2010-2012)

Figure 10 shows the number of road fatalities by road type. The majority of accidents occur on rural roads, representing the type of road on which 52% of European fatalities occurred. Of the countries analysed in detail, Germany (57%), France (62%) and Sweden (66%) recorded proportionately more fatal accidents on rural roads. This figure in Italy is slightly lower than the European average at 48%. Urban roads and motorways respectively accounted for 38% and 8% of road fatalities on average in Europe.

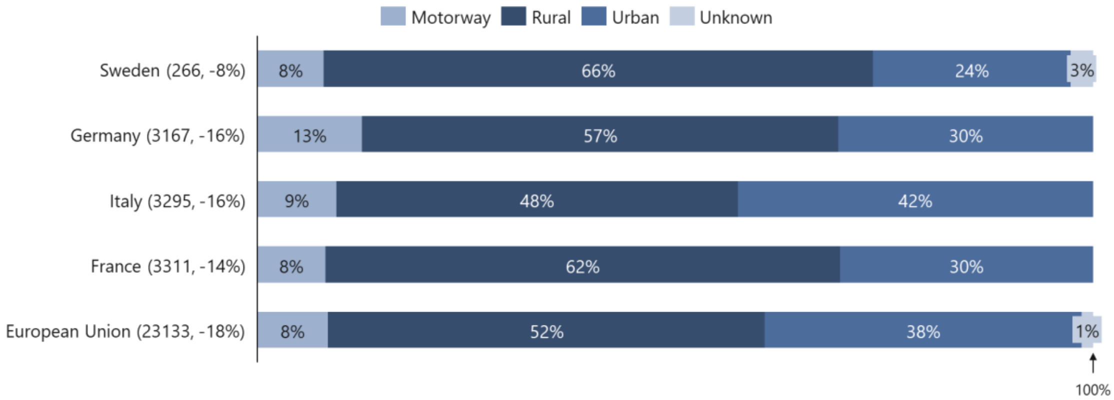


Figure 10: Proportions of road fatalities by road type (2017 – 2019) (average annual fatalities for period, with percentage decrease since period 2010-2012)

Various road types may also have different speed limits, as summarised in Table 7. Although rural roads account for the highest proportion of fatal accidents, motorways have the highest speed limit. Although higher speeds are permitted on German motorways, the recommended limit is 130 km/h, equivalent to that of Italy and France. Germany has a relatively high proportion of fatalities on motorways (13%).

Table 7: Speed limits for passenger cars (* - recommended limit)

	Sweden	**Germany**	**Italy**	**France**	**EU**
Urban Roads	50 km/h	50 km/h	50 km/h	50 km/h	50 km/h: 26; 65 km/h: 1
Rural Roads	110 km/h	100 km/h	90 km/h or 110 km/h	90 km/h	110 km/h: 2; 100 km/h: 3; 90 km/h: 17; 80 km/h: 4
Motorways	120 km/h	130 km/h (*)	130 km/h	130 km/h	No limit: 1; 140 km/h: 2; 130 km/h: 14; 120 km/h: 6;

					100 km/h: 1

However, it is difficult to establish a link between incremental PTI measures and accident data in countries with well-established PTI frameworks. The introduction of PTI requirements where accurate data can be compared both before and after the introduction is generally seen as an appropriate method, for example in the Slovak Republic and Turkey (Schulz & Scheler, 2020).

In the next section, case studies summarising accident data and information pertaining to PTI for each country. Data was collected from various sources which use independent methods of data labelling. Key case study information can be found in Table 8. For completion of analysis, exogenous factors related to road safety will be considered in Section 3.5.

Table 8: Key case study information (inspection interval, fatalities per 100,000 inhabitants)

Country	**Inspection Interval**	**Fatalities per 100,000 inhabitants per year**[1]
Sweden (Population 10.42 m)	M: 2-2-2 N_1 : 3-2-14m N_2/N_3: 1-1-1	2.24 (based on 3,262 fatalities over 14 years, 2010-2023)
Germany (Population 83.20 m)	M_1: 3-2-2 M_2/M_3/N: 1-1-1	3.19 (based on 31,832 fatalities over 12 years, 2010-2021)
Italy (Population 59.11 m)	M_1 / N_1: 4-2-2 M_2 / M_3 / N_2 / N_3: 1-1-1	0.92 (based on 1,586 fatalities over 2.92 years, 2019-2023)

These points are summarised below in Section 3.6.

[1] Figures calculated for Germany and Italy based on data discussed in the respective case study is lower than the European figures in the national road safety profiles (37 and 53, / million, respectively). The value calculated for Sweden (2.24 / 100,000) is consistent with the national road safety profile (22 / million).

3.2 Case Study: Sweden

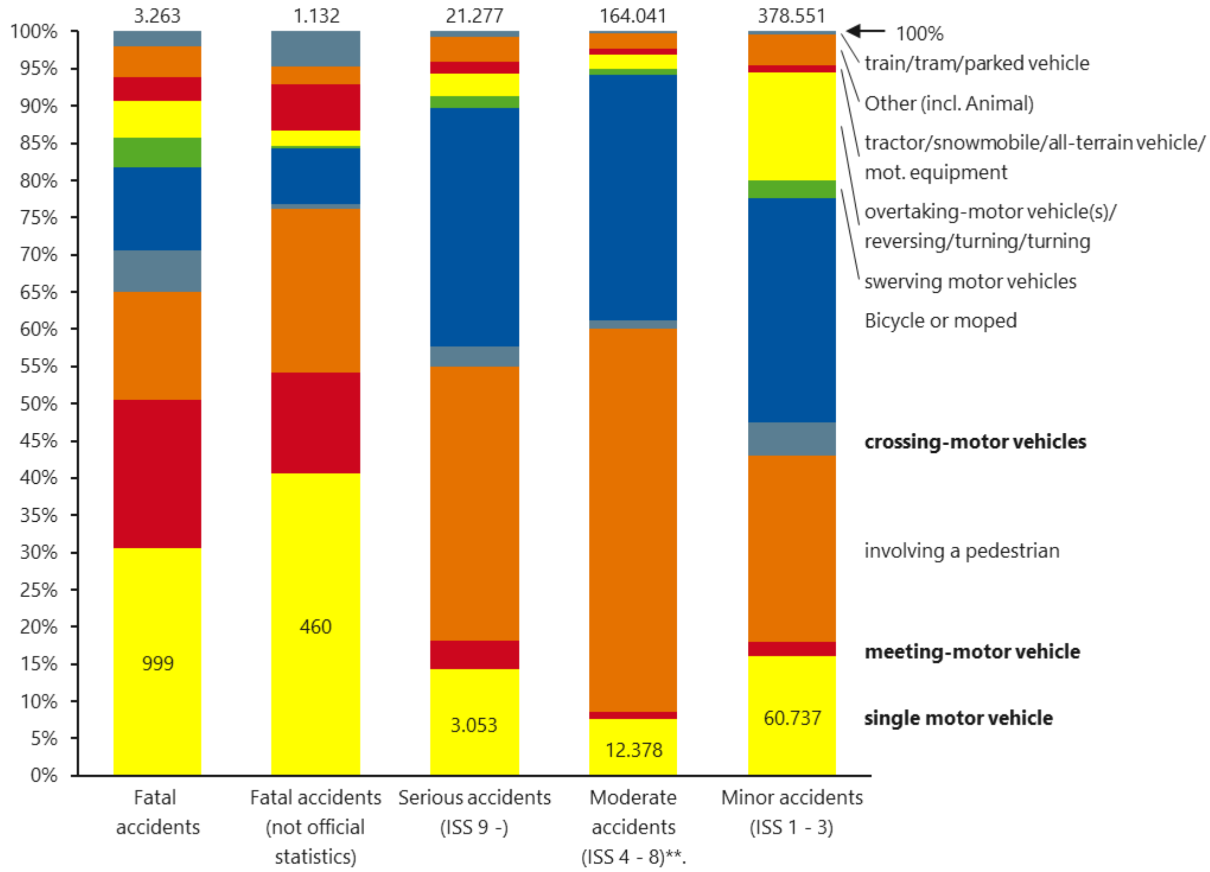


Figure 11: Anonymised data requested from (Trafikverket, 2023) regarding traffic accidents between 2010 and 2023

Accidents involving accidents on Swedish roads between 2010 and 2023 was requested from and provided by Transportstyrelsen in November 2023 (Figure 11). Accidents involving single motor vehicles represent 30% of fatalities and 16% of the data set. Accidents involving more than one vehicle (meeting motor vehicles) constitute 20% of fatalities and 2% of the overall data set. Accidents involving a pedestrian, bicycle or moped also correspond to approximately 20% of fatalities and 11% of the overall data set.

Roadworthiness tests in Sweden are carried out in 2-year intervals (2-2-2) for M-category vehicles. For vehicles of category N_1, the first inspection is carried out 3 years following initial registration, the second 2 years thereafter and then every 14 months (3-2-14m). N_2 and N_3 are required to be checked annually (1-1-1) (Dinu, 2020). During a roadworthiness test, the following checks are carried out (Körkort-Online, 2024):

- Frame: the car’s load-bearing structure has not been damaged by, for example, severe rusting.
- Wheels and control system: no damage to the front or back wheels. The tyres’ condition and tread depth are also checked (at least 1.6 mm).
- Drive system: the engine, and the electrical, exhaust and drive systems.
- Brake system: the function, effectiveness and evenness of the brakes.
- Bodywork: seat belts, windows and doors.
- Communication: lights, indicators, horn, windscreen washer fluid and warning triangle.
- Environment: the exhaust emissions are compared with the threshold values.
- Other: towbar, instrument lights and speedometer.

A case study was taken from The Court of Appeal for Western Sweden (The law.now, 2009) and is summarised in Figure 12. In this instance, a driver was circulating on the road at 57km/hr where the maximum speed limit was 50 km/h. The car's speedometer at the time of the speeding violation showed a lower speed than the actual speed.

Speeding Violation | Fatalities: 0

- Vehicle(s) Involved:
  - One vehicle circulating at 57 km/h in 50 km/h zone
- Attributed Blame:
  - Component failure
- Implication for PTI:
  - Speedometer was found to have a minor defect which resulted in the meter not showing the correct speed
- Implication for policy making:
  - Charges for speeding have been dismissed
  - The driver had no reason to question whether the car’s speedometer was working correctly

Figure 12: Case Study (Speedometer, Sweden)

These points are summarised below in Section 3.6.

3.3 Case Study: Germany

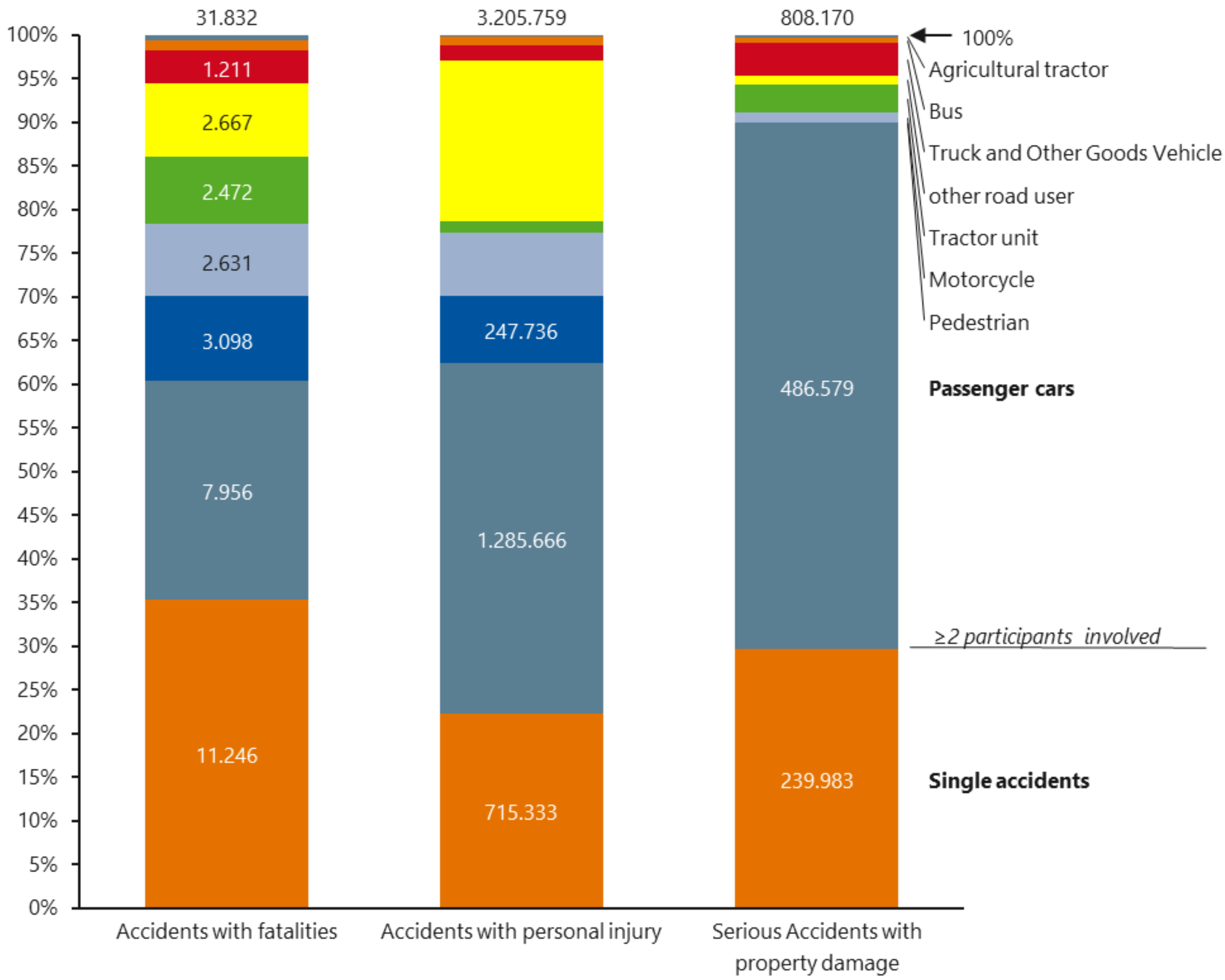


Figure 13: Data from (Destatis Statistische Bibliothek, 2023) regarding traffic accidents between 2010 and 2021

Accidents on German roads was taken from the German Statistical Library (Figure 13). Accidents involving single vehicles ("single accidents") amount to 35% of fatalities and 24% of the data set. Accidents involving passenger cars (more than one) are responsible for 25% of fatalities and 44% of the data set. Accidents involving a pedestrian or motorcycle can be linked to 18% of fatalities and 12% of the data set.

Roadworthiness tests in Germany are carried out for the first time three years following registration and thereafter every two years (3-2-2) for vehicles of category M_1. Vehicles of categories M_2 and M_3 as well as N-category vehicles are inspected annually (1-1-1) (Dinu, 2020). During a roadworthiness test, the following checks are carried out (TÜV-Checkliste, 2024):

- License plates: must be clearly visible and securely attached.
- All lights, lamps and spotlights on the vehicle: must be functional.
- Brakes: must transmit braking force evenly, not show any signs of rust on the surface.
- Seat belts and belt buckles: must not be damaged.
- Tyre tread: minimum tread depth is 1.6 mm (StVZO, Table 5 [DE21])
- Windshield in the area above the steering wheel, windshield wipers and windshield washer system
- Interior and exterior mirrors
- Dashboard warning lights (e.g. airbag, ABS)
- Leaking fluids
- Horn

Case studies were extracted from DEKRA's Road Safet Report 2023 (DEKRA, 2023). A convertible carrying three people became unstable at the end of a long left-hand bend. The road conditions were considered to be good. The driver reacted with an excessively heavy steering movement, which caused the vehicle to start skidding, come off the road and rolled onto a slope. The vehicle overturned and came to a standstill on its roof. The front seat passenger was flung out of the vehicle. Had the front seat passenger been wearing her seat belt properly, she would not have been flung from the car. The TÜV status and age of the convertible were not specified (Figure 14).

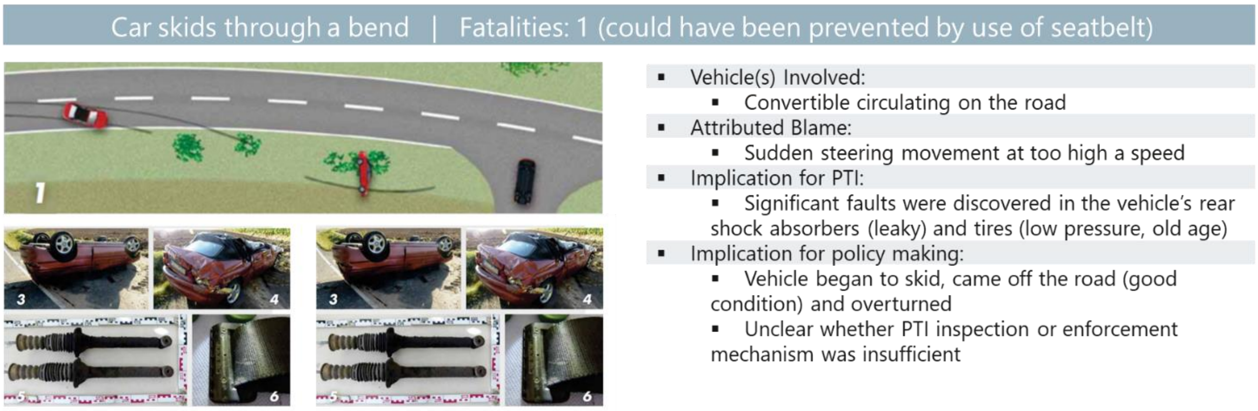


Figure 14: Case Study (Shock absorbers (no seatbelt), Germany)

In a second case, the driver of a car began to decelerate (Figure 15). The driver of an articulated vehicle behind the car detected the deceleration process too late. Despite an intervention from the automated emergency braking system and the articulated vehicle driver reacting with emergency braking and an evasive manoeuvre, the truck collided with the car. The car was hurled to the right and the driver fatally injured. It was determined that there was no security seal on the EC tachograph and that the vehicle had been manipulated in a way that caused a lower speed to be transmitted from the sensors than was actually the case. Since a lower speed was also transmitted to the driver assistance systems, this severely impaired their effectiveness.

Figure 15: Case Study (tachograph manipulation, Germany)

A further case involves a collision between a car and a bus on a federal highway travelling in opposite directions (Figure 16). Snow was falling however the road had been gritted and was safe to drive on, with clearly visible road markings. Without any apparent reason, the car drove into the lane of the oncoming bus. The bus driver braked and performed an evasive manoeuvre but was unable to prevent the collision. The two vehicles collided head on, with 90% of the front of the car coming into contact with 50% of the front of the bus. It was assessed that a lane keeping assistance system would have been able to detect the road markings.

Figure 16: Case study (driver distraction (no lane keeping system), Germany)

The fourth example relates to the visibility of vulnerable road users (VRU) from large commercial vehicles and is supported by two case studies (Figure 17). In the first instance, a truck driver was driving off the freeway during daylight and wanted to turn right onto an inter-urban road (with the turn signal on). A pedelec rider, who had right of way, approached from the left along the right-hand side of the road. The truck had a turning assistant, which was activated when the turn signal was turned on, however the system only scanned the righthand side of the vehicle. The truck driver reduced his speed and turned off onto the inter-urban road. This resulted in a fatal collision between the pedelec rider and the front left corner of the truck.

In a second instance, a transporter was reversing down a narrow road in a residential area at a T-junction. At the same time, a pedelec driver wanted to turn right into this road. There was a hedge and a fence at the junction area, which hampered the view. The pedelec rider did not see the transporter and did not appear on the vehicle backup camera until moments before the collision.

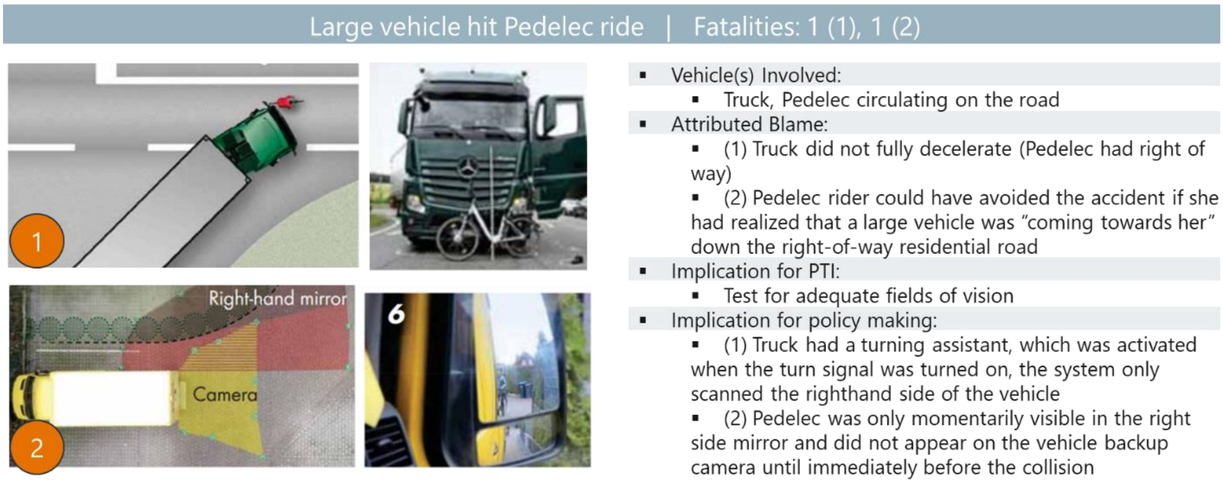


Figure 17: Case study (Commercial Vehicle VRU sensor field of vision, Germany)

These points are summarised below in Section 3.6.

3.4 Case Study: Italy

Data involving accidents on Italian roads is publicly assessable and was manually extracted from Italy's Ministero dell'Interno (Polizia-di-Stato, 2023). Accidents involving fatalities, damage to property and injuries made up 1%, 62% and 37% of the data set. Of the infringements contained in this data set, it is evident that 59% were attributed to not using a seatbelt, 26% to dangerous speed, 11% to alcohol and 4% to not using lights (Figure 18). Multiple months (highlighted orange) were identified in which both an above average number of accidents for at least one accident category and below average number of infringements for at least one infringement category occurred. Data pertaining to PTI issues are not contained in this data set.

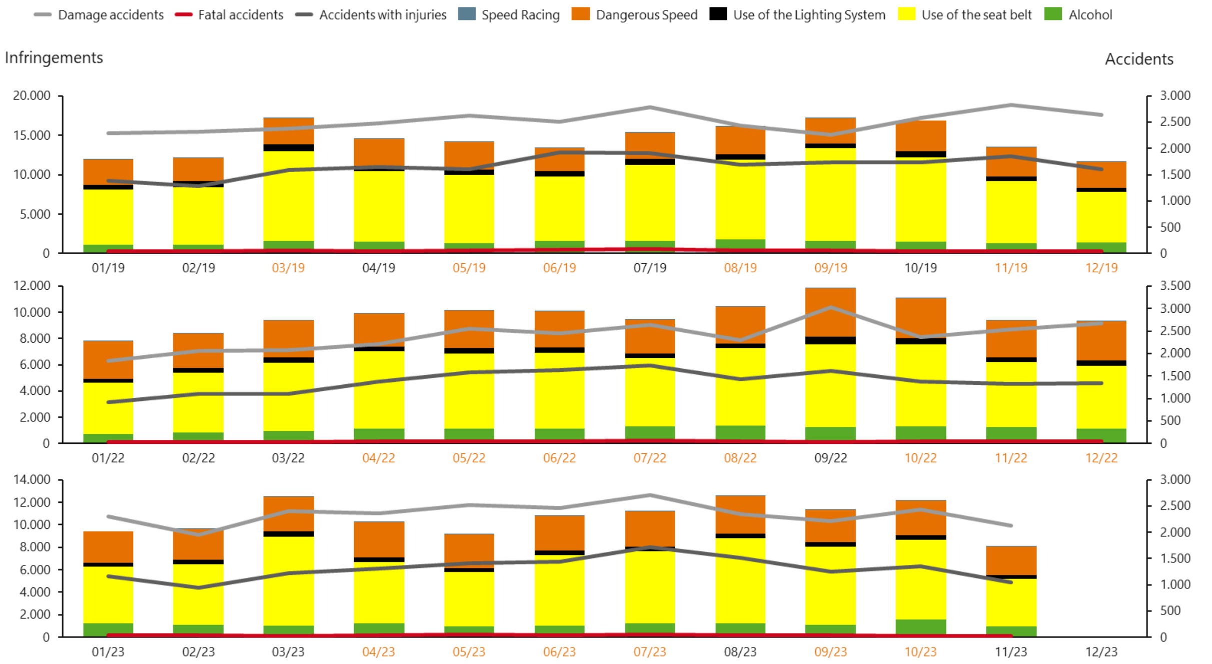


Figure 18: Data from (Ministero dell'Interno, 2023) regarding traffic accidents in 2019, 2022, 2023

Roadworthiness tests in Italy are carried out for the first time four years following registration and thereafter every two years (4-2-2) for vehicles of category M_1 and N_1. Vehicles of categories M_2, M_3, N_2, N_3 are inspected annually (1-1-1) (Dinu, 2020). During a roadworthiness test, the following checks are carried out (Angloinfo, 2023):

- Brakes (freni)
- Tyres (pneumatici)
- Lights (luci)
- Steering of the vehicle (sterzo del veicolo)
- Car suspension (suspensioni)
- Wheel alignment (ruote)
- Car transmission (trasmissione)
- Windscreen (tergicristallo) and wipers (spazzola del tergicristallo)
- Chassis (telaio)
- Seatbelts (cinture di sicurezza)
- Warning device (segnalatore acustico)

These points are summarised below in Section 3.6.

3.5 Exogenous Factors in Road Safety

The national road safety profiles mentioned in Section 3.1 were also used for analysis of exogenous factors. These include road quality, age of vehicles, time of day, age of driver and other behavioural factors (National Road Safety Profile - Germany, 2021), (National Road Safety Profile - Italy, 2021), (National Road Safety Profile - France, 2021) and (European Road Safety Observatory, 2021). These figures were originally soured from EUROSTAT, CARE and WHO, as referenced in the National Road Safety Profiles.

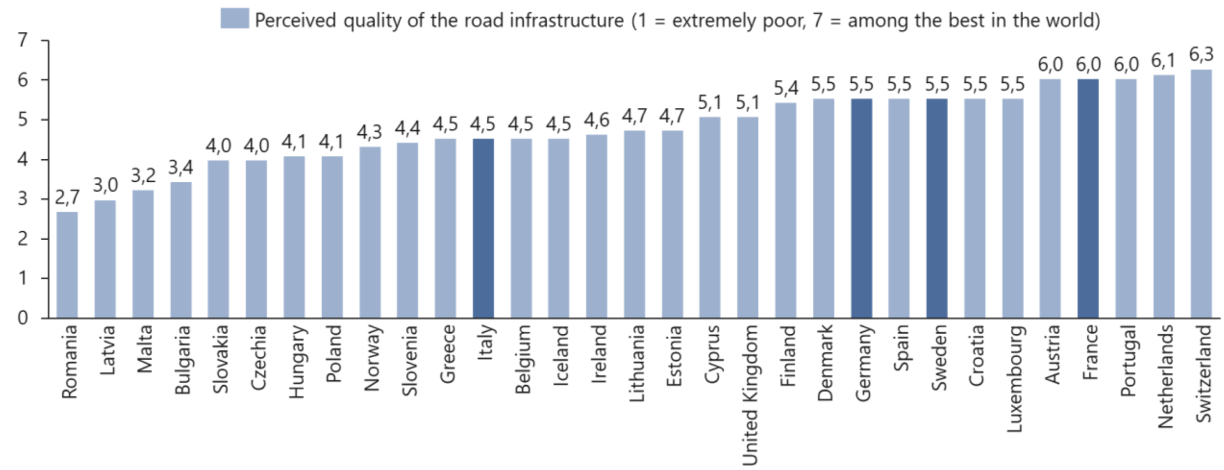


Figure 19: Perceived quality of the road infrastructure (1 = extremely poor, 7 = among the best in the world) (2017-2018)

Figure 19 shows a ranking of perceived road quality in Europe. Other the coutnries selected for detailed study in this report, France has the highest perceived road quality, followed by Sweden and Germany, which lie above the European average of 4.8. Italy's pereived road quality is 4.5.

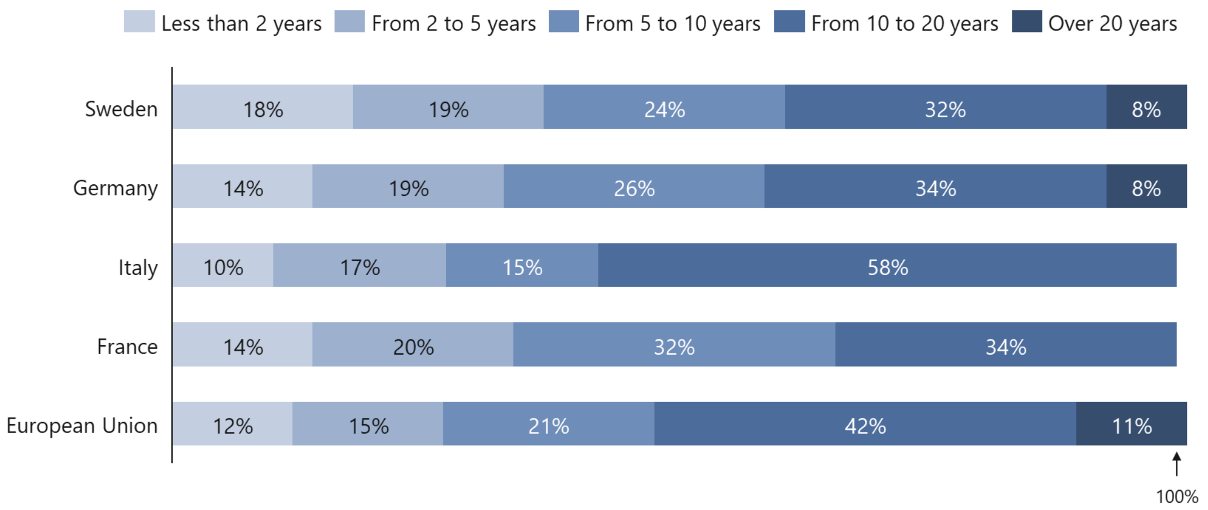


Figure 20: Age of registered passenger cars (2019)

Figure 20 shows the age of registered passenger cars in the EU in 2019. The proportion of passenger cars aged 10 or more is highest in Italy (58%), whereas the proportions in France, Germany and Sweden lie below the European average. According to reports by the National Highway Traffic Safety Administration in the USA, the risk of being fatally injured in a crash is higher when driving an older vehicle (NHTSA, 2013). When compared to a driver of a vehicle that is 3 years old or newer, the driver of a vehicle that is 4 to 7 years old is estimated to be 10% more likely to be fatally injured in a crash. Estimates for drivers of a vehicle that is 8 to 11 years old (19% more likely), a driver of a vehicle that is 12 to 14 years old (32% more likely), a driver of a vehicle that is 15 to 17 years old (50% more likely) and a driver of a vehicle that is at least 18 years old (71% more likely) were also provided.

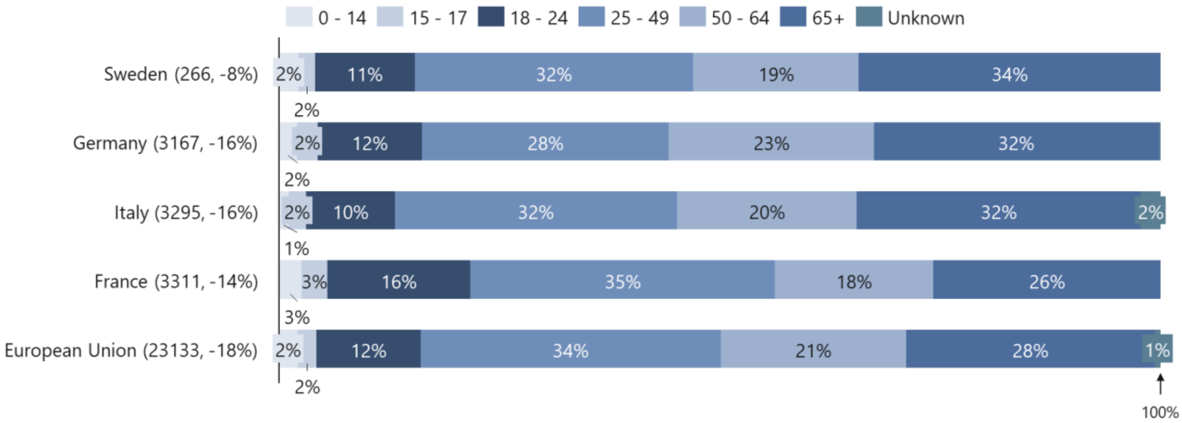


Figure 21: Number of road fatalities by age group (2019)

Figure 21 shows the breakdown of road fatalities by age group. On a per year basis, these figures are higher for the age brackets 18-24 and 65+.

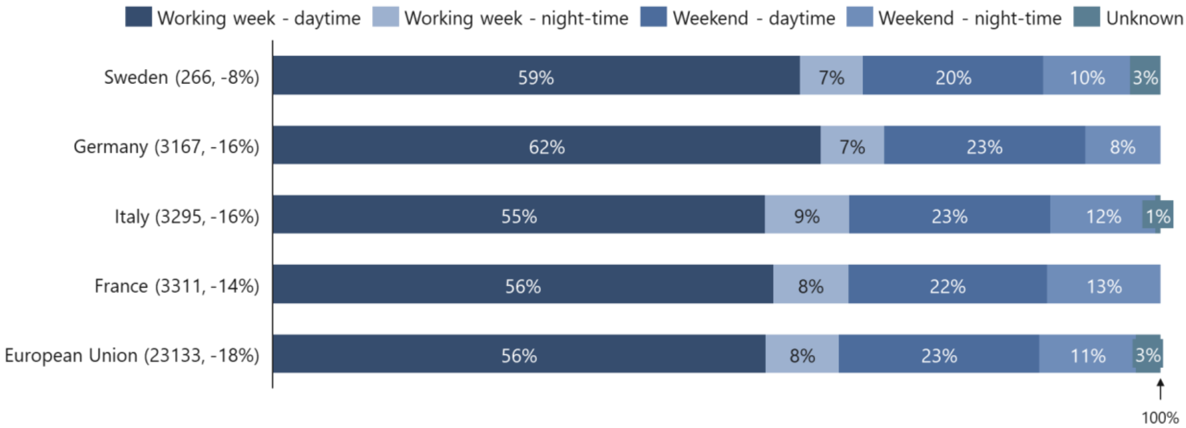


Figure 22: Number of road fatalities by light conditions (2019)

Figure 22 demonstrates the proportion of accidents by time of day. The majority of accidents occur during the daytime.

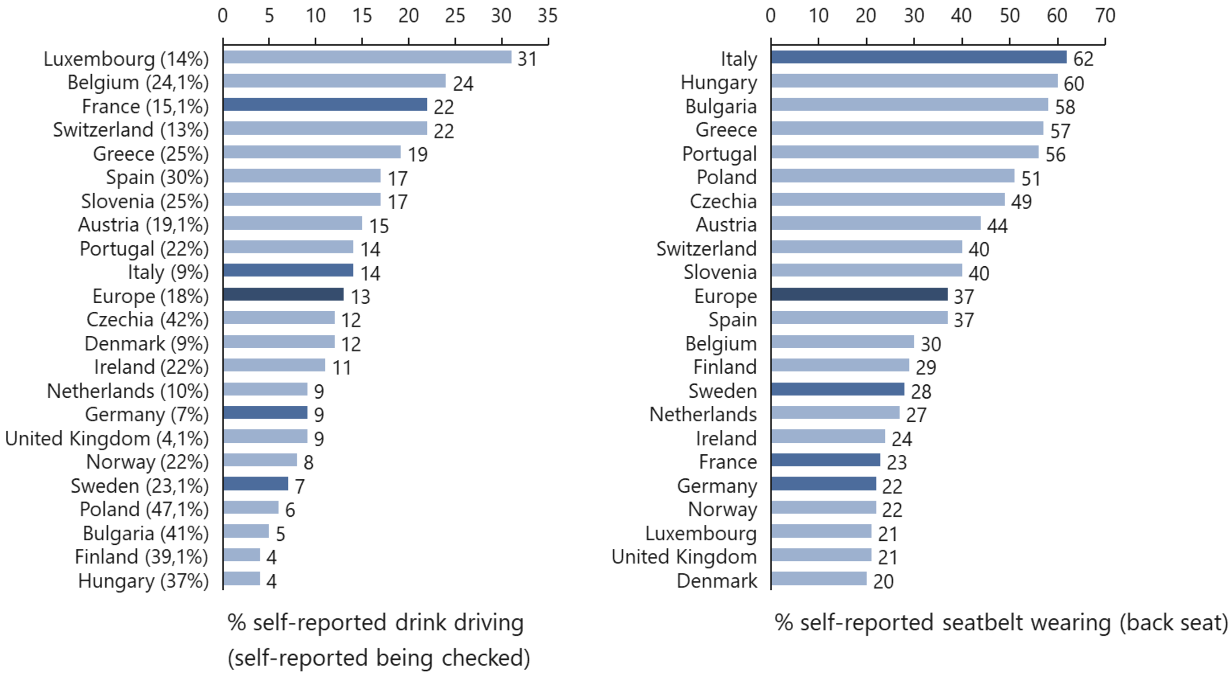


Figure 23: Overview of self-reported behavioural factors (drink driving and seatbelt wearing)

Self-reported statistics are not completely accurate but can give a relative indication of inclination or propensity. Figure 23 shows self-reported statistics for seat-belt wearing and drink driving. Whereas the legal limit for alcohol may vary depending on EU country and according to driving licence, seatbelts are mandatory.

The proportion of people who self-report drink driving in highest in France at 22%, whilst 24.1% report actually being checked. 23% wearing a seatbelt whilst in the back seat. Italians reported drink-driving close to the European average but were among the most likely to say they wear a seatbelt when in the back seat. Germany and Sweden were among the least likely to report drink-driving and also wearing a seatbelt when in the back seat. Of the countries in focus for this study, Swedes self-reported being most likely to be checked for alcohol whilst driving (23.1%), although this proportion is slightly more than half that in the Czech Republic (42%). The allowed blood alcohol concentration (BAC) may vary depending on the driver. In Italy, the general population may drive a vehicle up to a BAC of 0.5 g/l whereas novice and professional drivers may not drink alcohol prior to driving (0 g/l). In Germany, the general population and professional drivers may drive up to a BAC of 0.5 g/l, whereas novice drivers may not drink alcohol before driving. In Sweden, this limit is set at 0.2 g/l for the general population, novice and professional drivers.

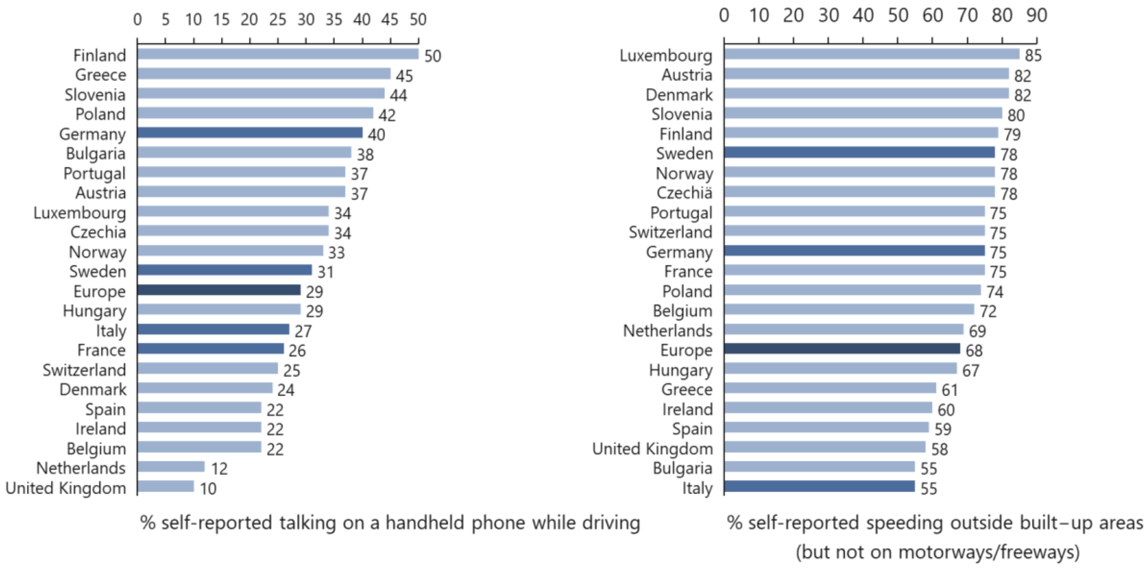


Figure 24: Overview of self-reported behavioural factors (phone usage and speeding)

Figure 24 shows further behavioural factors related to handheld phone use and speeding outside built-up areas. Germans and Swedes were more likely to report using a mobile phone and speeding when compared to the European average.Conversely, Italians were less likely to report doing so. Self-reporting of mobile phone use whilst driving was lower than the european average whilst speeding outside built-up areas was higher, in France.

3.6 Summary of factors related to road safety

A summary of the key findings in this section are presented below in Table 9.

Table 9: Summary of factors related to road safety

Key Finding	Summary of Results
	Current goals of the RWP are not being met with respect to achieving the reduction targets specified. Accident **data** are generally **not granular enough**.
	Case studies reviewed typically involve **multiple failure modes and/or driver distraction** and relate to: - 1 x Speedometer (Sweden) - 1 x Shock absorbers/driver not wearing seatbelt, (Germany) - 1 x tachograph manipulation (Germany) - 1 x driver distraction/no lane keeping system (Germany) - 2 x Commercial Vehicle/inadequate VRU sensor field of vision (Germany) Whereas PTI may catch issues with inaccurate speedometers, PTI cannot improve situations where occupants are not wearing seatbelts. PTI is also unlikely to help catch type-approved sensors with an inadequate field of view. **Design requirements** for vehicles including aspects relating to the testability of functions should be **adequately defined in type-approval regulations**.
	Accidents are largely caused by **human error** or exogenous factors, subject to enforcement procedures. Of many identified issues, **a vehicle data solution is unlikely to help**.

4 Factors related to PTI and RSI

Point to be addressed	Summary of Results
Literature review of existing studies and outcomes / conclusions. (key words: PTI, RSI, Accidents due to poor maintenance, PTI effectiveness for reducing road accidents, etc.).	Review of technical documents and studies has been conducted. Accidents are largely cause by **human error** or exogenous factors. **Technical deficiencies make up a small proportion** of total fatalities, injuries and damage to property. Of vehicles involved in accidents with component failures, **tyres and brakes represent a large proportion** of vehicle defects. The police arriving at the scene must make a judgement call regarding the cause of the accident. The proportion of commercial vehicles inspected which are foreign to the German market was 65% in 2018 and 73% in 2022. Load securing, equipment issues and labelling and marking constitute a reasonable proportion of failed RSI. For certain identified issues (e.g. tyres), **a data solution is unlikely to help**. Although granularity of the Destatis **data** set is above average, there is still an “other” category which provides limited information.

PTI and RSI specifically relate to safety checks and procedures described by points 0 to 9 in Section 2.1. These are defined in Annex I of Directive 2014/45/EU, which is used in Annex II of Directive 2014/47/EU and as the basis for the Annex in Implementing Regulation (EU) 2019/621. Contrary to emissions testing, there is no comparable standard for safety-relevant systems (CITA, 2017). These may include:

- Deceleration of vehicle,

- Longitudinal, lateral and yaw stabilisation of vehicle movements,
- Hold the vehicle stationary,
- Change of heading direction,
- Adjustment of the intensity and/or direction of the road illumination,
- Adjustment of the signal image of the vehicle lighting devices,
- Protecting the survival space of road users,
- Prevention of the accidental deployment of protective devices for road users,
- Adjustment of the behaviour of the suspension and shock absorbers,
- Monitoring and control of tyre air pressure,
- Adjustment of the aerodynamic devices,
- Electric drivetrain concept for vehicle drive,
- Changes in visibility
- Accident- and emergency-related communication,
- V2V and V2I communication

4.1 Accidents involving vehicles with technical deficiencies

Accidents taken from Destatis involving vehicles with technical deficiencies in passenger cars between 2015 and 2021 are displayed in Figure 25. The police arriving at the scene must make a judgement call regarding the cause of the accident and by extension the technical deficiency.

Of accidents involving fatalities, 64% were due to tyres, 9% were due to lighting, 8% were due to brakes and 2% were due each to steering and towing devices.

The remaining 15% was allocated to “other”. Of accidents involving injuries, 54% were due to tyres, 11% to brakes, 7% to steering, and 3% to each lighting and towing devices. The remaining 23% was allocated to “other”. Of accidents involving damage to property, 67% were due to tyres, 6% to brakes, 5% to towing devices, 4% to steering and 2% to lighting. 16% was allocated to “other”.

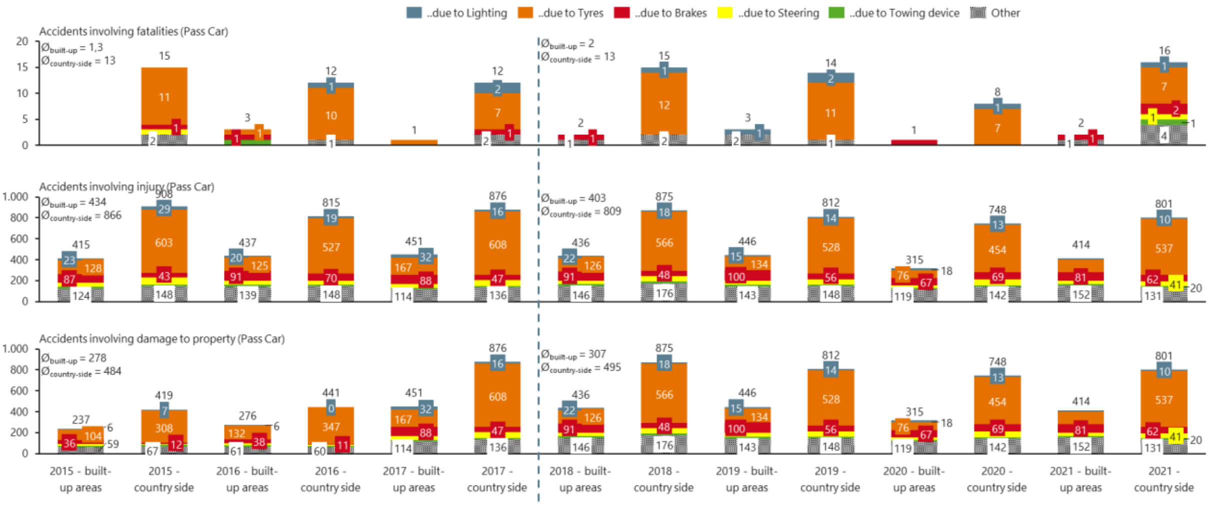


Figure 25: Overview of accidents involving death, injury and damage to property for passenger cars, where fault could be attributed to a technical deficiency (Destatis Statistische Bibliothek, 2023)

Accidents involving vehicles with technical deficiencies in heavy goods vehicles between 2015 and 2021 are displayed in Figure 26. Of accidents involving fatalities, 58% were due to tyres, 9% were due to each brakes and towing devices. The remaining 24% was allocated to "other". Of accidents involving injuries, 50% were due to tyres, 12% to brakes, 5% to towing devices, 4% to steering and 2% to lighting. The remaining 27% was allocated to "other". Of accidents involving damage to property, 57% were due to tyres, 9% to steering, 5% to brakes, 2% to steering and 1% to lighting. 26% was allocated to "other".

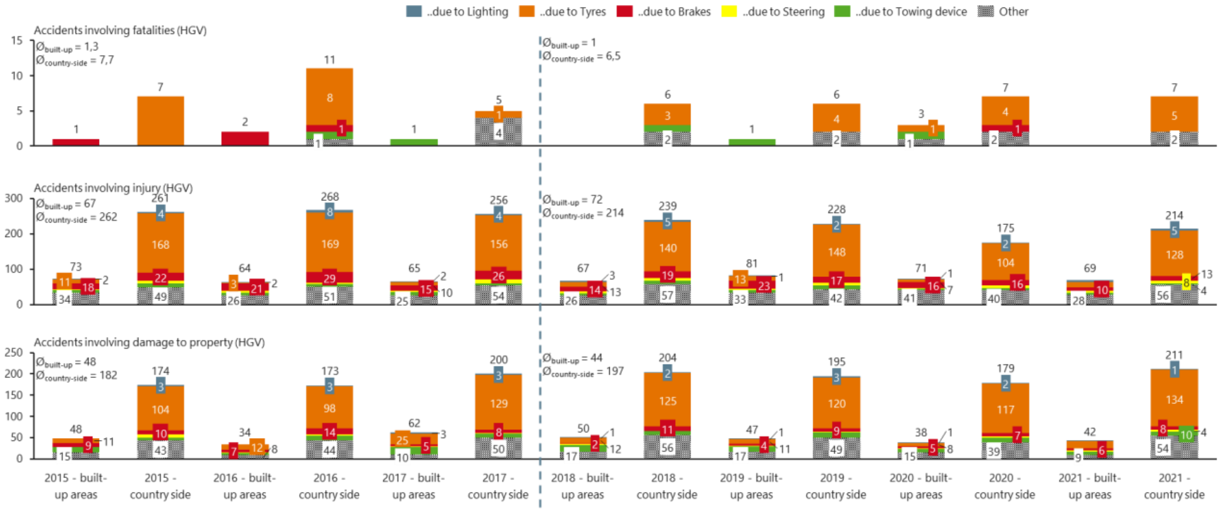


Figure 26: Overview of accidents involving death, injury and damage to property for heavy vehicles, where fault could be attributed to a technical deficiency (Destatis Statistische Bibliothek, 2023)

These points are summarised below in Section 4.4.

4.2 Issues detected during inspections

Issues stemming directly from PTI assessments were examined next. Figure 27 shows a breakdown of the "major" and "minor" faults for vehicles at different age intervals. "Major" faults were most prevalent in vehicles over 9 years of age. In 2020, lighting equipment was responsible for ~25% of defects, brakes represented ~16% of defects and defects in axles, including wheels and tires corresponded to 14% of defects. In 2010 these figures were 35%, 25% and 20% respectively. The overall number of vehicles assessed by DEKRA decreased over this period.

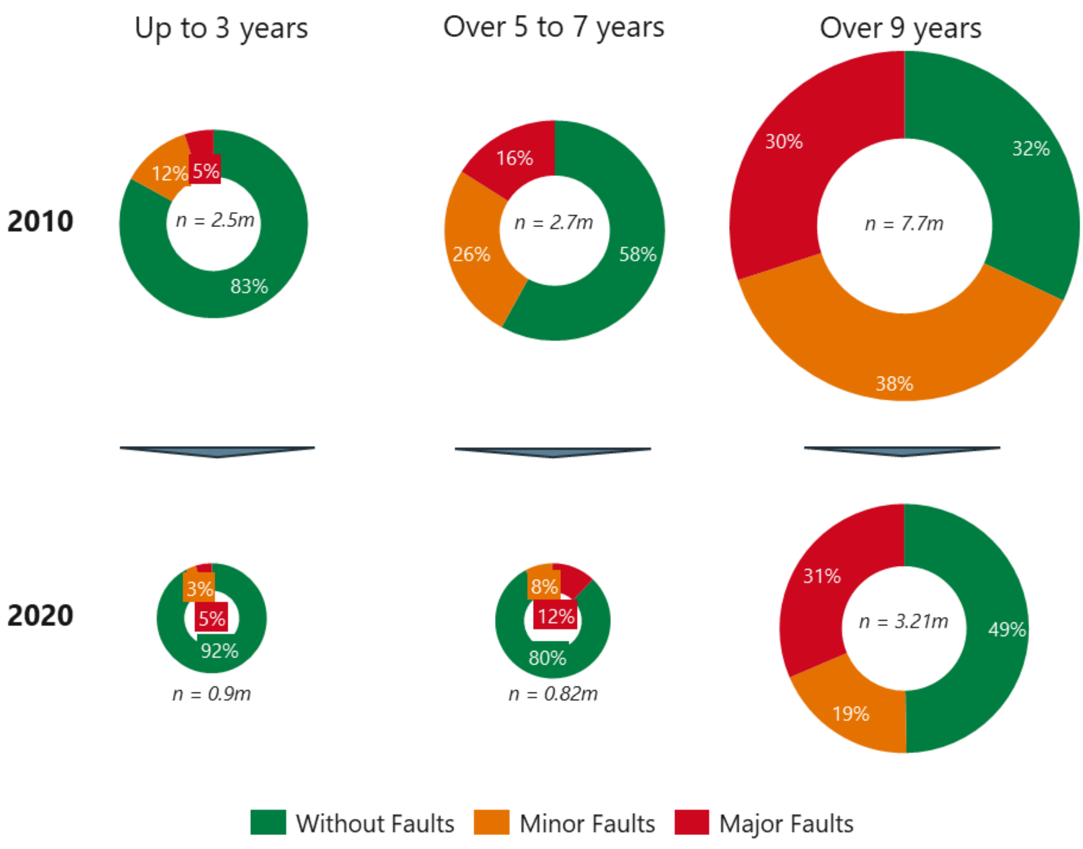


Figure 27: DEKRA PTI Results in Germany, by vehicle age (DEKRA, 2012) (DEKRA, 2022)

Figure 28 shows the corresponding data from heavy duty trucks. In 2009, inadequate braking action of the service braking device or the parking brake, uneven braking action of the service braking device or the parking brake, torn brake linings, leakiness of the braking device are noted as being problematic. This contrasts with 2018, where typical faults relate to wear and tear and include, brakes, tyres, chassis and the results of overloading. The number of vehicles passing through DEKRA assessment locations grew over this period.

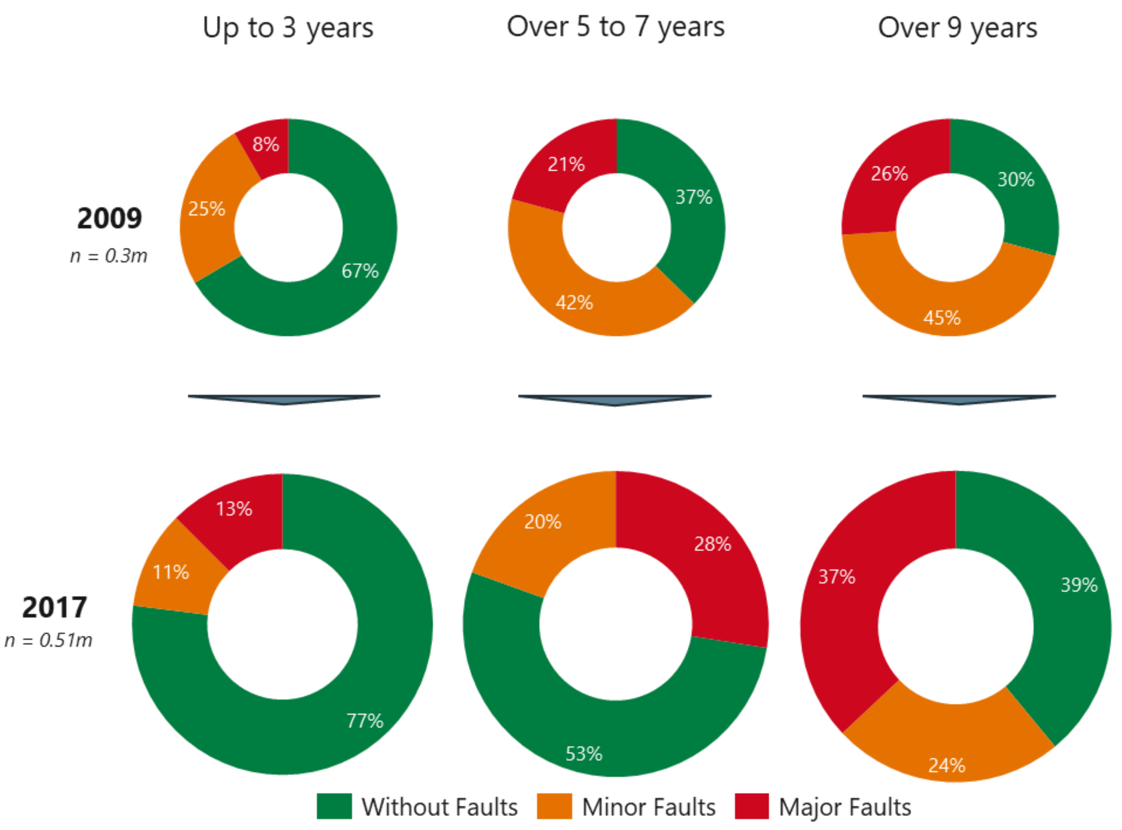


Figure 28: DEKRA Inspection failure rates for heavy-duty trucks (>12 t) in Germany by vehicle age (DEKRA, 2009) (DEKRA, 2018)

These points are summarised below in Section 4.4.

4.3 Issues detected during road-side checks

With regard to roadside inspections (RSI), violations pertaining to transport documentation/written instruction, labelling/marking, equipment and load securing were consistently recorded in larger numbers (Figure 29). These represented 25%, 24%, 18% and 10% in 2018 respectively. In 2022, these figures were 24%, 22%, 22% and 14%. Despite the link to PTI from RSI legislation described in Section 2.1, PTI issues do not seem to feature prominently in the RSI data set. Furthermore, there may be other subjective factors at play which are not directly related to technical items.

In 2018, the proportions of domestic and foreign vehicles inspected on German roads were 35% (142849) and 65% (259225). Of these, the proportions of domestic and foreign vehicles with violations was 31% (16771) and 69% (38061) respectively. The ratio of domestic vehicles with violations (11,74%) was lower than for foreign vehicles (14,68%) (Destatis Statische Bibliothek, 2018).

In 2022, the proportions of domestic and foreign vehicles inspected on German roads were 27% (62367) and 73% (168677). Of these, the proportions of domestic and foreign vehicles with violations was 28% (9203) and 72% (23433) respectively. The ratio of domestic vehicles with violations (14,76%) was slightly higher than for foreign vehicles (13,89%) (Destatis Statische Bibliothek, 2022).

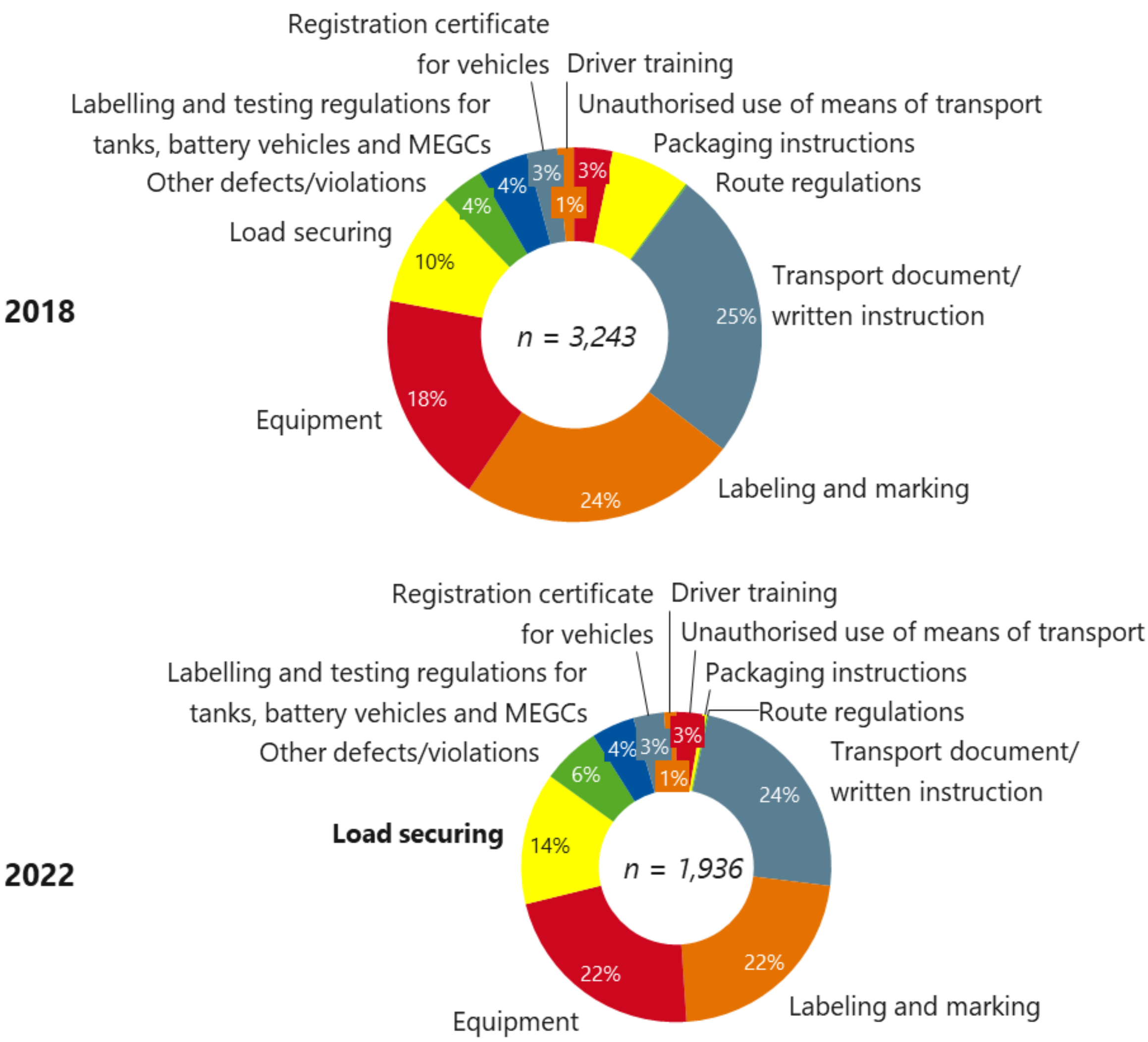


Figure 29: Percentage of violations of dangerous good legislation (Gefahrgutrecht) during roadside checks in Germany (Ergebnisse der Kontolllen im Gefahrgutrecht, 2018 - 2022)

4.4 Summary of factors related to PTI and RSI

A summary of the key findings in this section are presented below in Table 10.

Table 10: Summary of factors related to PTI and RSI

Key Finding	Summary of Results
	Of vehicles involved in accidents with component failures, **tyres and brakes represent a large proportion** of vehicle defects. The police arriving at the scene must make a judgement call regarding the cause of the accident. Although granularity of the Destatis **data** set is above average, there is still an “other” category which provides limited information.
	Accidents are largely cause by **human error** or exogenous factors. **Technical deficiencies make up a small proportion** of total fatalities, injuries and damage to property.
	For certain identified issues (e.g. tyres), **a data solution is unlikely to help**. Load securing, equipment issues and labelling and marking constitute a reasonable proportion of failed RSI. The proportion of commercial vehicles inspected which are foreign to the German market was 65% in 2018 and 73% in 2022.

5 Member State Consultations

Point to be addressed	Summary of Results
Transposition and mandate of the provisions of EU PTI / RSI directives nationally and what it means for vehicle manufacturers from design and cost perspective.	**Member states have adopted various approaches** with respect to transposition. Although providing "flexibility" for the Member States, a unified and harmonised approach to reducing road fatalities is made more complicated. Sweden: national legislation covers all mandatory requirements in EU legislation, but uses a **different structure**. Germany: carried over mandatory requirements **and included additional other points**, which were in repealed national legislation. In rating deficiencies, a fourth column (unfit for traffic) is also used. A tiered rating system is used for simple vs more advanced failure, where more advanced failures are rated in accordance with EU directive. Italy has broadly **carried over the EU legislation** directly into their national documents. Scope is extended to cover a broader range of vehicles to ensure high safety. France has no inspection requirement for L-category vehicles (TBD: 15 April 2024, 5-3-3). Also uses a 2-tiered system for categorising deficiencies ("minor" for simple failure, "major" for advanced failure) in some instances where the European requirement defines a "major" category only. Among the largest differences between Member States are the **inspection**

	intervals, the **rating system** of deficiencies and the **training of inspectors**.
Collect views on effectiveness of current inspection mechanism through conducting interviews what exact information from vehicle manufacturers or business operators are need to fulfil the objectives of PTI.	Improvements to the level of harmonisation would be welcomed. Parkour testing and testing of advanced functions is under consideration for ADAS functions. This currently drives cost at testing centres. The current usage of the Malfunction Indicator Lamp (MIL) currently does not provide significant insight for determining faults in complex systems. This functionality has however been proved out through various design verification testing phases and should be able to determine if a PTI issue is detected and if further investigation should take place. Import vehicles have much lighter data provision requirements. Factors relating to the minimum level of harmonisation, ePTI, relevant OBD and ADAS functionality data are being discussed.

Member States were recently publicly asked to provide feedback on the European Roadworthiness package. An initial evaluation of these results are shown in Section 11.1. In general, the need for harmonisation was reiterated by multiple respondents.

The following general comments were made:

- Contents and methods of testing of high voltage components with respect to electric and hybrid vehicles
- Testing facilities and equipment: ideally need to fit individual needs of Member State
- Testing centres: accreditation according to DIN EN ISO/IEC 17020
- Electronic vehicle information platform: Relevant OBD data must be made easily accessible

    - The exchange of the roadworthiness certificate for commercial vehicles was mooted
- ePTI: revision of (EU) 2019/621 for electronic PTI data items

The following comments were made with respect to Directive 2014/45/EU

- ADAS testing: status of ADAS and safety related systems
- Emissions Testing: methods of testing and suitable equipment for future testing of PN and NO_x
- Inspectors: qualifications and conflicts of interest
- Harmonisation: increase of harmonisation of the minimum level requirements within the EU, with some flexibility at Member State level
- Access to data: importance of a standardised interface

Analysis of the implementation of the European Roadworthiness Package at Member State level by national legislation can be found in Section 11.2. Based on this analysis, interviews were conducted in order to understand certain aspects more deeply.

5.1 Sweden

Contact was attempted via email, but no response was received.

5.2 Germany

The Stakeholder from Germany mentioned that recent incremental developments in PTI as well as safety measures would be difficult to uncover in recent data sets. A noticeable change was evident upon introduction of seatbelt measures. Certain locations are responsible for certain tests, which may be carried out via Parkour testing or using the “HU-adapter”. Parkour testing is particularly difficult when testing functions at high speed. Despite the various testing facilities ("Prüfstelle": ~15%; “Stützpunkt”: ~85%), which can vary by region, there is no discernible variation in inspection effectiveness. A certain level of subjectivity is evident, particularly with regarding lower levels of deficiencies. More clarity would be welcomed.

Some early models of electric vehicles did not consistently label high-voltage cables (orange). Similarly, a certain level of re-engineering is occasionally necessary in order to better understand certain ADAS technologies. Calibration of cameras behind the windscreen occasionally needs to be conducted. Autonomous vehicles require a specific operational approval and may be examined more frequently. ADAS marker lamps are under consideration around the globe. China is considering ADAS marker lamps which are visible from all sides of the vehicle whereas certain bodies in the USA are investigating the feasibility of forward facing ADAS marker lamps.

The current usage of the Malfunction Indicator Lamp (MIL) currently represents a “blunt” method for determining faults in complex systems. This functionality has however been proved out through various design verification testing phases and should be able to determine if a PTI issue is detected and if further investigation should take place. There are certain systems (ABS/ESP) which generate a number of DTCs, but it is not entirely clear which DTCs are relevant. OEMs currently provide this information. In Germany, all the non-relevant DTCs are required to be provided, which represents the majority of the DTCs generated. Japan, on the other hand, only requires the relevant DTCs to be provided. This data set is smaller in comparison.

Finally, the discrepancy between locally produced and imported vehicles was addressed. Import vehicles are required to provide a fraction of the data when compared to locally made vehicles. A link has not yet been established between the reduced data provision and incidents in the field.

5.3 Italy

The Stakeholder from Italy highlighted their adherence to the European directives. It was acknowledged that there are some issues with tyres, however these are not related to pressure or tread (which are additional requirements in the German legislation). No further specific issues were identified.

The increased scope of Directive 2014/47/EU’s application to include fast categories of tractors (T1b, T2b, T3b and T4b) is due to a focus on mobility safety. The stakeholder mentioned that there are restrictions on fast tractors in Italy, however tractors of this nature crossing the Austrian border, for example, may be checked by the Italian authorities.

Italy’s regulation also acknowledges the requirement for data privacy within the transposition of Directive 2014/46/EU. This was due to another legal requirement which was created in 2005.

The stakeholder from Italy reported that the data required by Implementing Regulation (EU) 2019/621 are not used in Italy. He suggested that difficulties relating to accessing data required by Commission Implementing Regulation (EU) 2019/621 could be due to the lack of connectivity at many inspection locations.

5.4 France

The Stakeholder from France highlighted the difficulty in trying to determine PTI effectiveness based on accident data in countries where PTI is well established. A clear link can be established in countries which recently introduced PTI measures, when reliable data prior to and after this introduction are available.

Linkage of data sets was identified as a clear enabler for PTI measures. France has a connected network for UTAC, tyres and type-approval data, which can be used to streamline checks (e.g. after tyre modification). A whole vehicle type-approval extract contain may provide additional information (e.g.) pertaining to masses and dimensions.

The ineffectiveness of Commission Implementing Regulation (EU) 2019/621 was suggested to be due to the lack of data format standardisation. In certain cases in the past, a mixture of JPEG and text files have been uploaded to fulfil the same requirement.

5.5 Key differences in Member State Transposition

	PTI since	Vehicles	Training of inspectors	What works well	What could work better
1	1951	M1: 3-2-2 M2/3: 1-1-1 N: 1-1-1 L: 2-2-2 O: 3-1(2)-1(2)	Bachelor Degree (plus refresher)	4th column of "dangerous defects"	Checking of ADAS functionality (e.g. ADS marker lamps)
2	1992	M1/N1: 4-2-2 M2/3: 1-1-1 N2/3 1-1-1	300 hour + exam (reduced w/ experience)	2-tiered system (Minor/major) defects for defects listed as "major" in EU directive Linkage of data sets (UTAC/tyres/TA)	Data provided per (EU) 2019/621 cannot enable fast/effective PTI (cost/standardization)
3	1997	M1, N1, T5: 4-2-2 M2/3, N2/3, O3/4: 1-1-1 L: 4(1)-2(1)-2(1)	~376 hours	EU Legislation	Many PTI stations cannot (digitally) access (EU) 2019/621 data

Figure 30: Key results from the Member State consultations

Key results from the Member State consultations are summarised in Figure 30. Countries have adopted initial roadworthiness measures in different years prior to the introduction of the European Roadworthiness Package. Article 5 of Directive 2014/45/EU defines intervals, within which roadworthiness tests must be conducted. These vary by vehicle category. France and Italy have carried over the European requirement, that passenger cars with no more than eight seats (M_1) be checked four years after the date of initial registration and thereafter every two years. Germany requires that the initial check following registration take place after three years for such passenger cars (M_1).

Assessment of deficiencies was identified as a distinguishing factor between national legislation. These details are summarised in Section 5.5.1. In Figure 30, it is noted that France utilises a 2-tiered system (minor/major) for the assessment of certain deficiencies categories defined as "major" at EU level. With respect to Item 5.1.1 relating to axles, "major" and "dangerous" ratings must be assigned to insecure fixings. In addition to this minimum requirement, France's legislation also includes "fixing anomaly" as a "minor" defect for vehicles weighing less than 3,5 tonnes (Legifrance, 2024). It was also noted the training of inspectors varies greatly by country. Germany is observed to have one of the highest standards and these are detailed in Section 5.5.2.

5.5.1 Treatment of Deficiencies

One major key difference in various Member States regarding the transposition of the RWP is the characterisation of deficiencies and defects found on vehicles. These are summarised in Table 11. Directive 2014/45/EU describes three groups of deficiencies. Minor deficiencies have no significant effect on the safety of the vehicle or impact on the environment, and result in other minor non-compliance. “Major” deficiencies may prejudice the safety of the vehicle or have an impact on the environment or put other road users at risk or result in other more significant non-compliance. Dangerous deficiencies constitute a direct and immediate risk to road safety or have an impact on the environment. It is at this point that a Member State or its competent authorities may ban or prohibit the use of the vehicle on public roads. Italy has transposed European law on a near identical basis.

Sweden also describes three categories, but instead uses assessment categories of “2x” for simple deficiencies, “2” for other deficiencies and “3” for vehicles that represent an obvious danger to traffic. German law has categories of “minor defects” (GM) and “significant defects” (EM) but divides the dangerous deficiency category into “dangerous defects” (VM) and “unsafe for traffic” (VU). The dangerous defect (VM) category does not entail an immediate ban on the operation of the vehicle in order to facilitate fast and efficient technical inspection.

The requirement that combined effects be assigned the most serious deficiency rating is described similarly across the evaluated Member States. These points are summarised in Table 11.

Table 11: Overview of deficiencies in selected Member States

	Europe ((EU) 2014/45, 2014/45/UE)	Sweden (2017:54, 2009:211)	Germany (HU Guideline)
Minor	Minor deficiencies ▪ No significant effect on the safety of the vehicle or impact on the environment, and other **minor** non-compliances	Assessment two (2x) ▪ Vehicle considered defective, deficiency considered **simple**	GM - Minor defects ▪ **No** traffic **hazard** or unacceptable environmental **impact** is to be **expected** at the time the defect is discovered.
Major	Major deficiencies ▪ 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	Assessment two (2) ▪ Vehicle considered defective, **driving ban is not issued**	EM - Significant defects ▪ This also includes defects that could pose a traffic hazard
Dangerous	Dangerous deficiencies ▪ A direct and immediate risk to road safety or an impact on the environment ▪ **May prohibit** the use of the vehicle on public roads	Assessment three (3) ▪ The vehicle shall be considered as defective that the vehicle **cannot be used** without obvious danger to traffic safety	VM - Dangerous defects ▪ A direct and immediate danger to traffic or an adverse effect on the environment ▪ **No immediate ban** on the operation of the vehicle on public roads
Unsafe for traffic	-	-	VU - Unsafe for traffic ▪ A direct and immediate danger to traffic or impact the environment ▪ An **immediate ban** on the operation of the vehicle on public roads
Combined Effects	A vehicle showing several deficiencies ..., may be classified in the next **most serious deficiency** group if it can be demonstrated that the combined effect results in a higher risk to road safety	Assessment S ▪ Deficiencies that interact in such a way that their combined effect is assigned a **significantly greater negative significance** from a traffic safety point of view	If there are several defects, the vehicle is classified into one of the defect classes depending on the **most serious defect**

5.5.2 Training of inspectors

Minimum requirements concerning the competence, training and certification of inspectors is defined in Annex IV or Directive 2014/45/EU and has been carried over by Italian legislation. Swedish legislation uses this list as a basis, however specifies exact competencies or sub-categories of this depending on competency cluster ("Behörighetsklaser"): control inspection (K1/2/3), Registration and Suitability (R1/2/3) and Roadside ("flying") Inspection (F1/2/3). Germany also outlines specific competency requirements depending on the type of inspection: safety ("Sicherheitsprüfung"), exhaust examination ("Abgasuntersuchung"), exhaust examination for motorcycles ("Abgasuntersuchung an Kraftfahrädern"). These points are summarised in Table 12.

Table 12: Overview of inspector requirements in selected Member States

	Europe / Italy (EU) 2014/45	Sweden (TFSF 2017:53)	Germany (StVZO)
Inspection subcategory	-	Control inspection (K1/2/3), Registration and suitability inspection (R1/2/3), RSI (F1/2/3)	Safety (SP) / Exhaust (AU) / Exhaust - motorcycle (AUK)
Certified Knowledge	- Mechanics - Dynamics - Vehicle dynamics - Combustion engines - Material and material processing - Electronics - Electrics - Electronic vehicle components - IT applications	- Mechanics - Dynamics - Hydraulics and pneumatics - Vehicle technology - Propulsion systems - Materials theory and processing - Electronics and EV components - Electrical technology - Formulas and calculations - Legal knowledge	- Motor vehicle/Automobile mechanic, - Motor vehicle electrician, - Motor vehicle mechatronics technician - Mechanic for bodywork maintenance (SP only) - Body and vehicle builder (SP only) - Body /vehicle construction mechanic (SP only) - Metalworker, specializing in vehicle construction (SP only) - Metal worker, specializing in commercial vehicle construction (SP only) - Agricultural / construction machinery mechanic (SP only) - Two-wheeler mechanic (AUK only)
Qualification	(EU) 765/2008	(EU) 765/2008	Dipl.-Ing., Dipl.-Ing. (FH), Ing. (grad.), Bachelor, Master, state examined technician
Examination	~376 hours (Italy)	Practical and theoretical tests	3 year employment or final exam
Refresher Training	Periodically	12 months	36 months
Repeat Initial Training	-	-	Refresher not completed within 38 months
Certificate	YES		

5.6 Summary of Member State consultations

A summary of the key findings in this section are presented below in Table 13.

Table 13: Summary of Member State consultations

Key Finding	Summary of Results
Reg v. Dir	**Member states have adopted various approaches** with respect to transposition. Although providing “flexibility” for the Member States, a unified and harmonised approach to reducing road fatalities is made more complicated.

Sweden: national legislation covers all mandatory requirements in EU legislation, but uses a different structure.

Germany: carried over mandatory requirements and included additional other points, which were in repealed national legislation. In rating deficiencies, a fourth column (unfit for traffic) is also used. A tiered rating system is used for simple vs more advanced failure, where more advanced failures are rated in accordance with EU directive.

Italy has broadly carried over the EU legislation directly into their national documents. Scope is extended to cover a broader range of vehicles to ensure high safety.

France has no inspection requirement for L-category vehicles (TBD: 15 April 2024, 5-3-3). Also uses a 2-tiered system for categorising deficiencies ("minor" for simple failure, "major" for advanced failure) in some instances where the European requirement defines a "major" category only.

Among the largest differences between Member States are the **inspection intervals**, the **rating system** of deficiencies and the **training of inspectors**.

Improvements to the level of harmonisation would be welcomed.

Parkour testing and testing of advanced functions is under consideration for ADAS functions. This currently drives cost at testing centres.

The current usage of the Malfunction Indicator Lamp (MIL) currently does not provide significant insight for determining faults in complex systems. This functionality has however been proved out through various design verification testing phases and should be able to determine if a PTI issue is detected and if further investigation should take place.

Import vehicles have much lighter data provision requirements.

Factors relating to the minimum level of harmonisation, ePTI, relevant OBD and ADAS functionality data are being discussed.

6 OEM Consultations

Point to be addressed	Summary of Results
Recommend best way forward for exchange of information (online / offline-> up to date), considering cyber security risk and track latest software version.	Data provision within the scope of Commission Implementing Regulation (EU) 2019/621 **does not reliably ensure fast and effective PTI processes**. A lack of harmonisation is evident. Furthermore, there is no requirement to use these data points. An exact analysis of what is actually required should be conducted in order to steer discussion on which data points should be included in new legislation. As a result, **data offered** via the online portal are largely **unused**. Options regarding a best way forward ought to involve a greater level of harmonisation and are considered in section 8. A centralised system could be used to track RSI status, so that vehicles which have been checked recently are not unnecessarily checked multiple times. Any additional cost of maintaining a secure system would be offset by the increase in efficiency.
Review of impact of the PTI cost considering GSR (EU 2019/2144) requirements to be checked in comparison to current PTI scope.	Newer vehicles exhibit high levels of auditability and functionality compared to the level required by RWP. An increase in RWP requirements would necessitate more examiners due to the increase in time needed to check a vehicle. This may also have implications for data management. Costs are generated by administrative / IT back-end processes, which are needed to make data available, especially for individual/specific users. Manipulation of

	data needs to be considered. Costs are not justified if data is not used. When compared to Directives 2014/45/EU and 2014/47/EU, larger design deltas are incurred by additional GSR-related (2019/2144) and UNECE (R155/156) requirements during PTI.

6.1 Overview of Survey Responses

An initial survey was conducted. Based on these responses, five OEMs were selected.

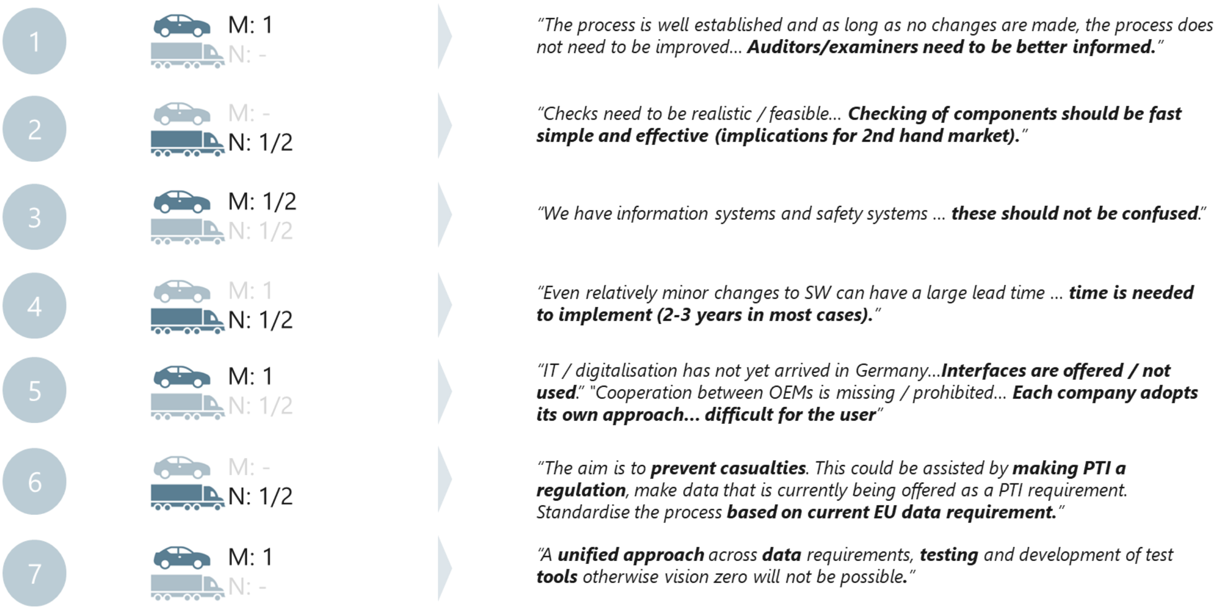


Figure 31: List of OEMs selected for individual discussion, with summarising remarks.

OEM 1 (passenger car) highlighted the importance of training of the inspectors. It was suggested that the process being conducted by the OEMs is well established. Improvements relating to the auditing and examination processes and the personnel conducting these were suggested.

OEM 2 (commercial vehicles) stressed the need for the simplicity of checks, the feasibility of which could greatly improve characteristics of the 2nd hand market. Greater harmonisation or standardisation was highlighted as being a key enabler in this respect.

OEM 3 (passenger car) stated clearly that the goal of PTI is to ensure road safety and that type-approval issues should not be incorporated into PTI processes. The pace of technological development was mentioned as being a significant challenge in years to come. This could have implications for advanced test-bench design. Where the limits of test-bench testing are reached, Parkours testing would have to be used.

OEM 4 (commercial vehicles) reiterated that the design and durability testing of new vehicles exceeds the requirements of the Roadworthiness Package. Thus although the provision of data as a result of the Roadworthiness Package is possible, it still has a large impact on product development timeframes (2-3 years). A lack of regulation or differing requirements was determined to be a main driver of increased effort. Harmonisation via a Regulation would be of assistance in this regard.

OEM 5 (passenger car) noted that the Implementing Regulation (EU) 2019/621 to the Roadworthiness Package requires data to be made available but results in each OEM adopting a fairly unique approach. The variation in the “density” of the data set is evident. Greater harmonisation would be welcomed.

Based on discussion in the presentation of results, further discussions were had. One manufacturer of commercial vehicles (6) suggested that the requirements of the 2014 Directives could be mandated on a European level, for example via the use of an implementing regulation. In addition to this, a centralised system could be used to track RSI status, so that vehicles which have been checked recently are not unnecessarily checked multiple times. Any additional cost of maintaining a secure system would be offset by the increase in efficiency.

A manufacturer of passenger cars (7) highlighted the need for a unified and harmonised approach if vision zero is to be realisable.

The interviews were used to review the impact of the Roadworthiness Package on vehicle manufacturers (OEMs) from a design and cost perspective, summarised in Figure 32. Specific instances of Directives 2014/45/EU, 2014/46/EU and 2014/47 were discussed, whereby the focus was given to PTI (2014/45/EU). In order to assess the additional impact being generated, General Safety Regulation (EU) 2019/2144, UNECE R155 and R156 were reviewed in this context. Directive 2014/45/EU (PTI) was found to have a moderate impact on design and cost, which is largely driven by Implementing Regulation (EU) 2019/621 adopted in accordance with Article 19. Directive 2014/46/EU (Registration) was deemed to be fairly harmonised across the Member States and as a result, little to no addition impact to design and cost is generated. Directive 2014/47/EU was determined to have a minimal impact on OEMs, however greater efficiency could be achieved via a centralised system for sharing RSI status. The General Safety Regulation (EU) 2019/2144 has an outsized impact across the board, which can have a range of implications for design and cost which exceed those of the PTI Directive 2014/45/EU. Finally, UNECE R155 on cyber security and R156 on software versioning were rated as having a range of impacts on design, where the cost or additional effort can potentially be exceedingly high.

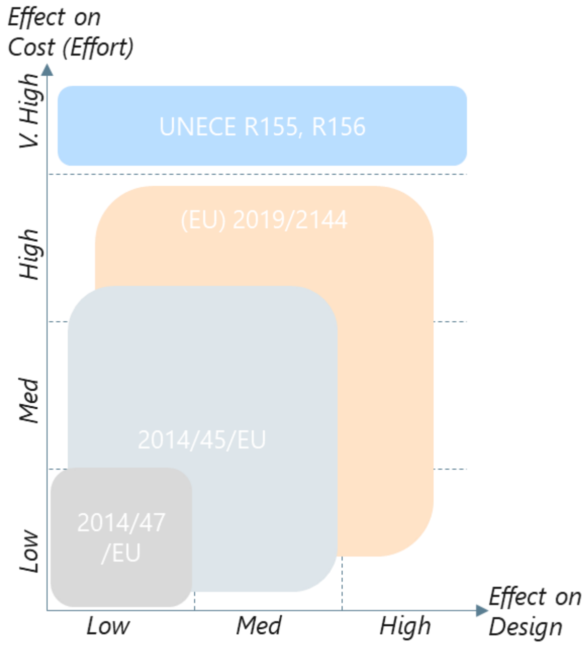


Figure 32: Overview of impact on cost and design for vehicle manufacturers based on requirements of the 2014 RWP and additional aspects which are increasingly being incorporated into PTI

6.2 Review of Impact on Design and Cost with respect to 2014/45/EU

Directive 2014/45/EU pertaining to Periodic Technical Inspection (PTI) applies to vehicles for the carriage of persons and their luggage (categories M_1, M_2, M_3), for the carriage of goods (N_1, N_2, N_3), trailers (O_3, O_4), light vehicles (L3e, L4e, L5e, L7e) and fast tractors (T5). The overall impact of this directive on cost and design currently varies. Cost may vary due to lack of unified regulation across OEMs and Member States. Further potential cost and design drivers are indicated by the arrows in the graphics below. A full analysis can be found in 11.4 Appendix 4: Review of Impact on Design and Cost with respect to 2014/45/EU. A summary of results are shown in Figure 33 and Table 14.

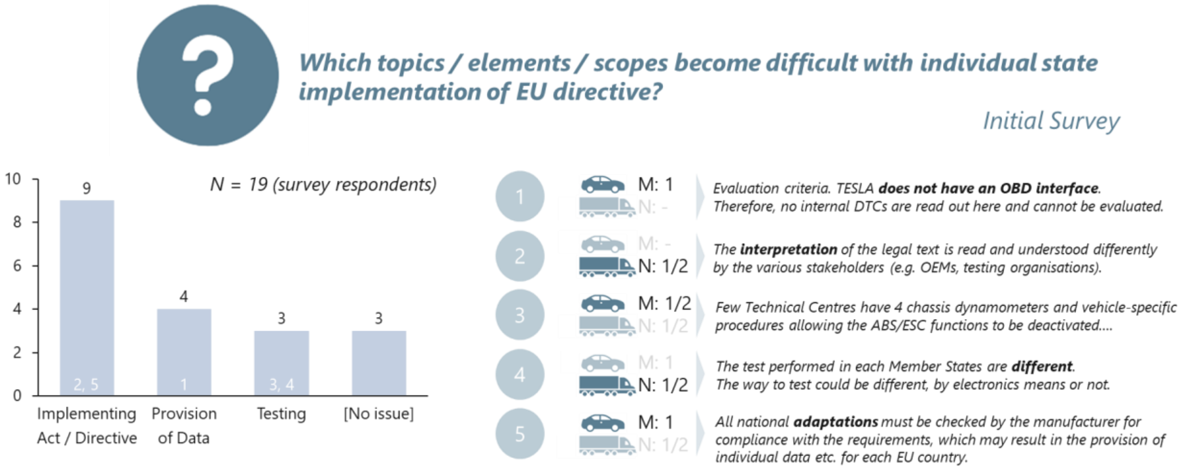


Figure 33: Overview of responses from the five selected OEMs outlined in Figure 31

Table 14: Summary of cost and design drivers results from PTI Directive 2014/45/EU

Topic	Cost drivers:	Design Drivers
Article 7 - Deficiencies	EV battery repl. User profile (Garage visits) Electronic checks (lighting) Body components	Obsolescence Emissions Data from garages Electronic checks (lighting/turning) -
Article 16 – Electronic Platform	Continuous impr. - Lack of regulation Tampering consid. Data mgmt. (IT)	Odometer manipulation Odometer manipulation Emissions (EURO7) - -

6.3 Review of Impact on Design and Cost with respect to 2014/46/EU

It was unanimously indicated that Directive 2014/46/EU cannot easily be discussed in terms of cost and design implications on PTI/RSI since the criteria are already part of integral processes. Little to no additional costs are generated by this regulation in this regard. There is also a high degree of standardisation across the EU.

6.4 Review of Impact on Design and Cost with respect to 2014/47/EU

Directive 2014/47/EU pertaining to Roadside Inspections (RSI) applies to vehicles for the carriage of persons and their luggage (categories M_2, M_3), for the carriage of goods (N_2, N_3), trailers (O_3, O_4) and fast tractors (T5). The overall impact of this directive on design is currently low, as vehicle design requirements including durability testing ensure safe and secure operation. Potential cost and design drivers are indicated by the arrows on the graphics along with a full analysis in Section 11.5 (Appendix 5: Review of Impact on Design and Cost with respect to 2014/47/EU). A summary of results is shown in Table 15.

Table 15: Summary of cost and design drivers results from RSI Directive 2014/47/EU

Topic	Cost drivers:	Design Drivers
Article 10 – RSI Article 11 – Alcohol Interlock (interface)	Alignment of check-points w/ PTI	Accessibility

6.5 Review of Impact on Design and Cost with respect to (EU) 2019/621

Implementing Regulation (EU) 2019/621 applies to vehicles subject to roadworthiness tests pursuant to Directive 2014/45/EU. The overall impact of this directive on design is relatively low, as vehicle design requirements including durability testing ensure safe and secure operation. Potential cost deltas result from the size of the data set made available and the maintenance of the online channel. A full analysis can be found in section 11.6 (Appendix 6: Review of Impact on Design and Cost with respect to (EU) 2019/621). A summary of results are shown in Figure 34 and Table 16.

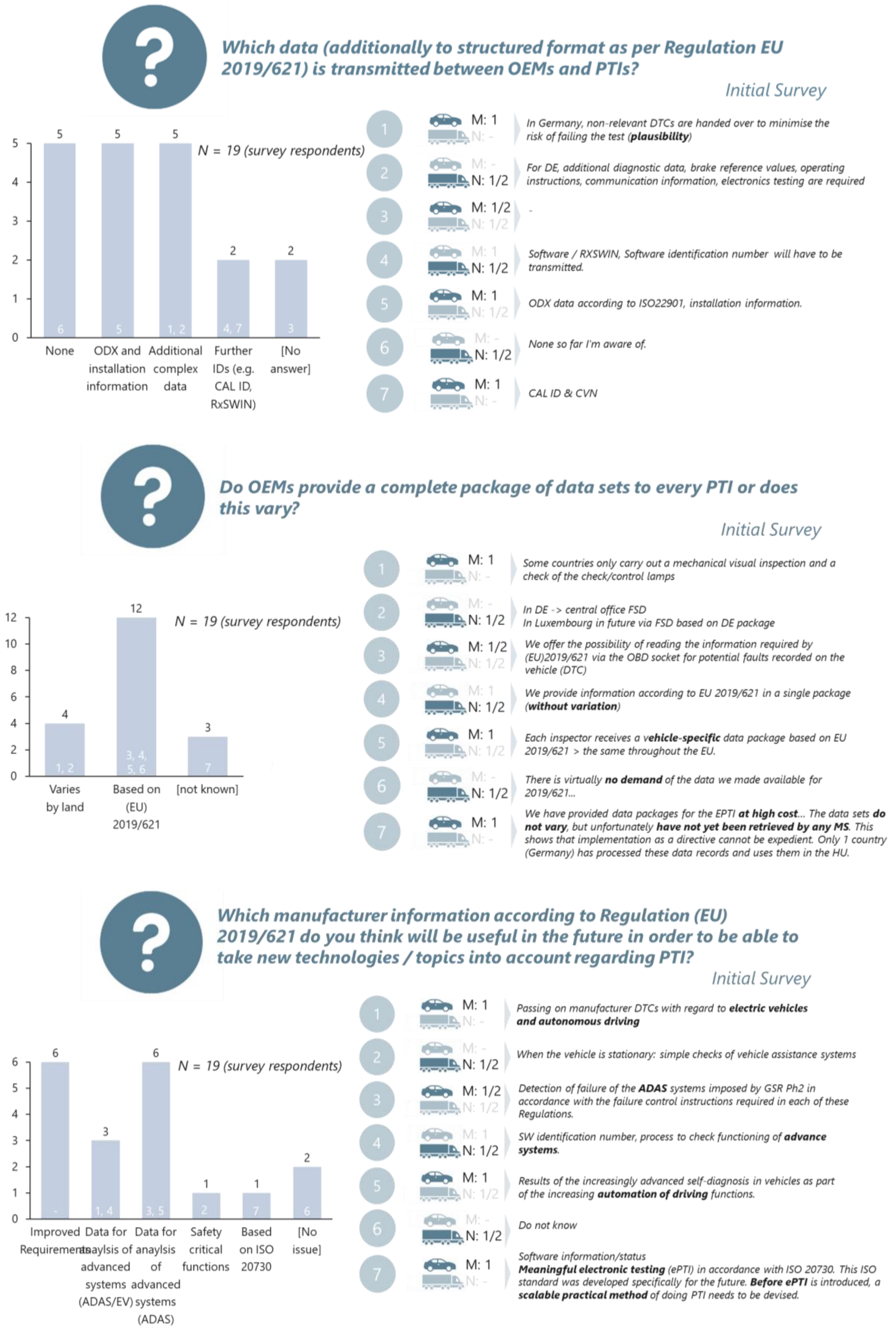


Figure 34: Overview of responses from the five selected OEMs outlined in Figure 31

Table 16: Summary of cost and design drivers results from (EU) 2019/621

Topic	Cost drivers:	Design Drivers
Article 5 – Access to technical Info	DTC management IT-Backend Web-portal - Lack of regulation	N/A

6.6 Review of Impact on Design and Cost with respect to (EU) 2019/2144 (including delegated regulations)

Regulation (EU) 2019/2144 on general safety applies to vehicles of categories M, N and O, as defined in Article 4 of Regulation (EU) 2018/858, as well as systems, components and separate technical units. Regulation (EU) 2018/858 relates to type-approval and as a result ought to be considered separate from roadworthiness regulation. However, specific agencies are increasingly requesting data for roadworthiness purposes.

Cost may vary due to increased testing or validation requirements. It can be seen that the impact to design is generally higher than Directives 2014/45/EU and 2014/47/EU. These are broadly due to the difficulty of inspection that is inherent in these systems. Furthermore, stipulation of specific technologies and/or methods used to achieve set goals, advanced testing and validation requirements of DTCs, the advent of ePTI (ISO 20730) and management of certain interfaces and core components have potential to have an impact both design and cost. In terms of the operation of vehicles with these devices, quality of infrastructure (clarity or speed signs, lane markings) may also play a role. Parkour testing is observed to be an additional driver of cost incurred largely by the inspection centres. A full analysis can be found in Section 11.7 (Appendix 7: Review of Impact on Design and Cost with respect to (EU) 2019/2144 (including delegated regulations)). A summary of results are shown in Table 17.

Table 17: Summary of cost and design drivers results from GSR (EU) 2019/2144

Topic	Cost drivers:	Design Drivers
Article 6 – ADAS Article 7/8 – AEB (R152/131)	More examiners TA aspects introduced Into PTI (FSD / DE) Data mgmt., Parkour testing ECU ID/Addresses -	DTC checking - ISO 20730 Std. Interfaces, SW, HW (e.g. ∆ memory) Windscreen (camera)
Article 11 – Automated Vehicles	Reduction PTI interval TA aspects introduced Introduction of PTI (FSD / DE) - - Examiners	Cyber security* - AV function monitoring - -
Delegated and implementation regulation ((EU) 2021/535, (EU) 2021/646, (EU) 2021/1243, (EU) 2021/1341, (EU) 2021/1958, (EU) 2022/545)	Examiners / Parkour testing/Difficulty of checks Lack of regulation ECU ID/Addresses Examiners	Mandatory use of separate systems Mandatory use of system attached to high cost components (e.g. camera) Interference, damper systems

	Data mgmt.	Integration with electric architecture Interface with electric architecture

6.7 Review of Impact on Design and Cost with respect to selected UNECE Regulations

UNECE R155 on cyber security applies to vehicles of categories M, N and O. UNECE R156 on software versioning applies to vehicles of categories M, N, O, R, S and T that permit software updates. The main drivers of cost and design are the enabling of user-specific (individual) features or data sets and checking of software updates (e.g. via the software part number RXSWIN). In terms of software versioning, cost can be seen to be impacted by management of software part numbers that the vehicle should have by design (SHOULD-BE-value). Design is observed to be impacted by accessibility and visibility over the software part numbers the vehicle currently has (IS-value). In certain cases involving the management of IS and SHOULD-BE-values, this cost was estimated to be very high. A full analysis can be found in Section 11.8 (Appendix 8: Review of Impact on Design and Cost with respect to selected UNECE Regulations).

As noted in Section 7.1.1, increasing potential for accessibility drives numerous risks in the cyber security domain. As a result, locking of access to specific OBD functions is under consideration.

Table 18: Summary of cost and design drivers results from selected UNECE regulations

Topic	**Cost drivers:**	**Design Drivers**
UNECE R155 (cyber security), R156 (versioning)	IT Backend, Individual requirements IT Backend Compliance mgmt. (TA issues only) IT Backend SHOULD-BE-values	OBD locking / restricted access RXSWIN Accessibility (vehicle vs company) (TA issues only) SW validation IS-values

6.8 Summary of OEM consultations

A summary of the key findings in this section are presented below in Table 19.

Table 19: Summary of Member State consultations

Key Finding	Summary of Results
	Data provision within the scope of Commission Implementing Regulation (EU) 2019/621 **does not reliably ensure fast and effective PTI processes**. A lack of harmonisation is evident. Furthermore, there is no requirement to use these data points. An exact analysis of what is actually required should be conducted in order to steer discussion on which data points should be included in new legislation. As a result, **data offered** via the online portal are largely **unused**. Newer vehicles exhibit high levels of auditability and functionality compared to the level required by RWP. An increase in RWP requirements would necessitate more examiners due to the increase in time needed to check a vehicle. This may also have implications for data management. Costs are generated by administrative / IT back-end processes, which are needed to make data available, especially for individual/specific users. Manipulation of data needs to be considered. Costs are not justified if data is not used. When compared to Directives 2014/45/EU and 2014/47/EU, larger design deltas are incurred by additional GSR-related (2019/2144) and UNECE (R155/156) requirements during PTI. Options regarding a best way forward ought to involve a greater level of harmonisation and are considered in section 8.
	A centralised system could be used to track RSI status, so that vehicles which have been checked recently are not unnecessarily checked multiple times. Any additional cost of maintaining a secure system would be offset by the increase in efficiency.

7 Review of critical test requirements and procedures to current state of vehicle technology and the exact information needed to fulfill PTI objectives

Point to be addressed	Summary of Results
Review of existing critical test requirements and procedures to current state of vehicle technology (Suspension tester, Noise, Braking, etc.) and recommend new state of art methodologies for effective and cost efficient PTI (ISO 20730 ePTI, common diagnostic equipment, etc.)	Certain systems can currently be checked electronically (e.g. lighting) other pose more difficulties (e.g. turning). Current electronic methods leverage OBD systems via the read out of diagnostic trouble codes (DTCs). Advanced methods such as electronic PTI (ePTI, based on ISO 20730) are emerging, and represent forward thinking methodologies which can provide a standardised solution via collaborative means. Harmonisation of multiple aspects (e.g. inspection device/tool) ought to occur in an initial step/phase. Minimum requirements regarding roadworthiness facilities and test equipment from Annex III (procedures) can be compared and contrasted with the deficiency ratings from Annex I (requirements). Interestingly, there is little detail in the requirement for the testing equipment of tyres in Annex III of Directive 2014/45/EU. Testing of suspension systems can currently be influenced by a range of factors. Standardisation of this procedure and these variables will be necessary before it can be adopted at scale. Further quality assurance systems, such as ISO 17020 accreditation and qualifications of inspectors must also be considered. …

7.1 Review of current technology relating to inspection mechanisms

A number of standards relevant for vehicle inspections have been selected. Many sections contain use cases which are summarised in Figure 35.

The ePTI series ISO 20730 refers to "inspection modules" (IM), which then have a series of derived use cases (number indicated in brackets) which cover aspects relating to interface and implementation. Conversely, ISO 15031 defines communication between vehicle and external equipment for emissions-related diagnostics of petrol or diesel engines in order to check the environmental compatibility. Whereas ePTI represents a newer and forward thinking approach to PTI, ISO 15031 covers existing methods and external test equipment.

In the following section, OBD technologies and standards are reviewed. At the core of this lies the ISO 15031 and 14229 standards. As discussed in 7.1.3, the CAN and IP based sections if ISO 14229 form the basis for the ePTI methodology within the scope of the application and service layers. The HU-Adapter uses an alternative approach and is discussed in 7.1.2.

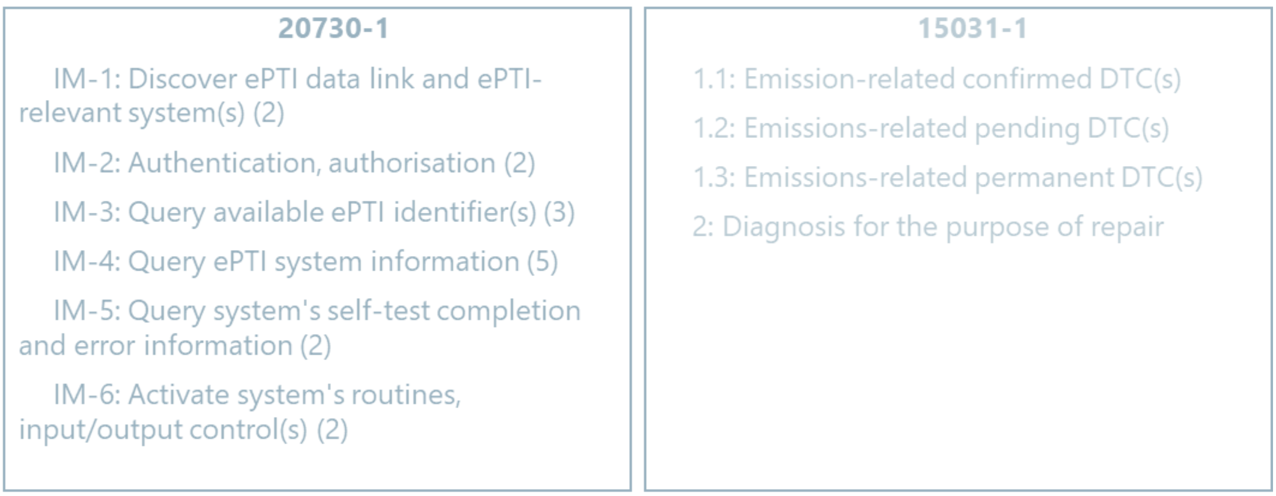


Figure 35: Excerpt of reviewed standards and their described use cases

7.1.1 On-board Diagnostics (OBD) Technologies

Figure 36 provides an overview of standards relating to OBD communication requirements as cited in (Schneider, et al., 2023). First introduced by Volkswagen in 1968, on-board diagnostics (OBD) and a corresponding standardised connector was subsequently formally defined by SAE in 1979. Following the introduction by other OEMs, the California Air Resources Board (CARB) required OBD for emission control purposes from 1991 (OBD-I). The second generation (OBD-II) was then required at a federal level in the USA from 1996 and a European version (EOBD) was mandated in the EU from 2001 (Barreto, 2020). More recently and with the advent of world-wide harmonised OBD (WWH-OBD), there has been a convergence towards UDSonCAN (see Figure 37).

A commonly used conceptual model in this domain is the Open Systems Interconnection (OSI) Model, which can be used to describe the functions of a networking system. These are shown on the left-hand side of Figure 36 for emissions-related OBD and Figure 37 for ePTI.

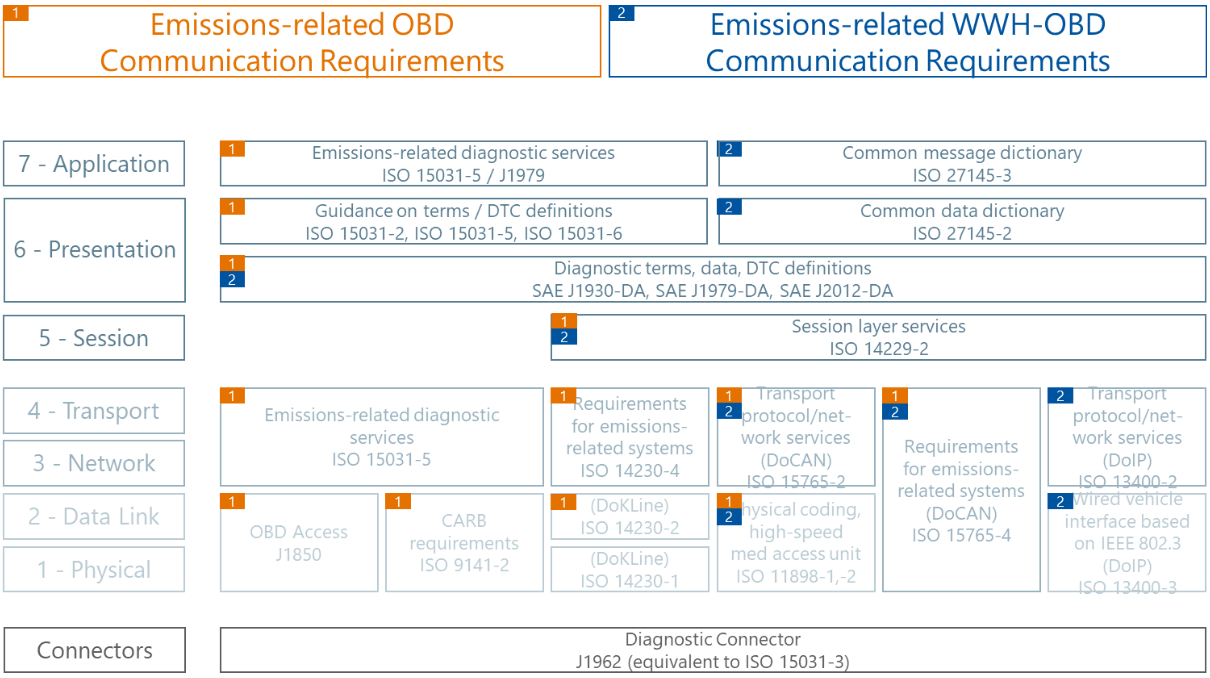


Figure 36: OSI model cited in (Schneider, et al., 2023), based on J1979

Although OBD was initial developed for emission-related diagnosis, for example exhaust after-treatment, the system is more broadly used by OEMs to identify and troubleshoot various in-vehicle systems, such as high-voltage batteries as well as safety functions including chassis and steering. This occurs via the use of diagnostic trouble codes (DTCs). These functions and the supplier of such OBD solutions have been summarised by (Schneider, et al., 2023).

As a result, this functionality could be used for periodic technical inspections. This system enables the owners of such proprietary systems (e.g. OEMs) to have high visibility across in-vehicle DTCs and troubleshooting issues. However, with increasing potential for accessibility, the risk of cyber-attacks or attacks on vehicle safety should not be overlooked, as noted by CITA in a position paper (CITA, Position paper: Standardisation - Electronic periodic technical inspection (ePTI) of electronically controlled safety systems (ISO/WD 20730), 2017). In the following section, the HU-Adapter leverages this system of analysis. Currently, this advanced functionality is covered by the Vehicle Security Operations Centre and is typically covered during type approval.

7.1.2 The HU-Adapter

The HU-Adapter was developed in such a way that HU ("*Hauptuntersuchung"*, PTI) test methods can be applied intuitively and with the least possible time expenditure by the experts using the electronic vehicle interface.

> *"In addition to fulfilling the relevant international standards, such as Ingress Protection, all requirements resulting from the National Directive must also be met. These include, for example, support for all diagnostic protocols and bus systems that were/are used for vehicles first registered in 2006 or later, or internal sensors for acceleration and rotation rate."*
>
> FSD-Zentrale Stelle

The HU-adapter supports the checking of components and systems broadly in accordance with the categories in the StVZO (§ 29, Anlage VIIIa, Table 5 [DE21]). The HU-Adapter communicates with the ECUs via the in-vehicle OBD network. This allows information regarding stored in-vehicle error codes and self-diagnosis to be read out and evaluated. Typically various processes are triggered by the vehicle's self-diagnosis capabilities (FSD Zentrale Stelle, 2023). These can be:

- Initial: identification of simple electrical and/or system faults during activation via "key-on" (e.g. short-circuits, voltage levels, the control lights displayed on the dashboard)
- Sporadic/cyclical: system function checks within specific cycles and/or conditions (e.g. radar sensor is checked once vehicle is moving faster than 20 km/h)
- Permanent: continuous checking (e.g. wheel speed sensor)

Errors that exceed predefined critical values are then stored in the data storage ("*Ereignissspeicher*"). Safety critical functions generally have lower critical values. Certain errors, that are no registered again after a certain amount of time, may be removed from the *Ereignissspeicher*. As opposed to the error codes generated by exhaust and emissions systems, the error codes that are generated by safety related systems are not standardised. As a result, a number of codes may be identified by the tool as errors, which do not relate to an actual error.

In checking the execution (*"Ausführung"*), the installation of certain electronic systems may be checked by querying the safety system ID. These may include the airbags, the braking system (ABS/ESP), damper control, high beam assistant, parking brake and cruise control. The actual values are compared to the offline values. Function (*"Funktion"*) may be tested by ascertaining that a system response lies within a certain acceptable latency. The Effect ("Wirkung") of the braking system, for example, may be checked by ensuring the minimum braking force values are reached. Finally, the state (*"Zustand"*) can be validated by measurements. In future, more detailed analysis of the in-vehicle self-diagnosis capability, described above, is expected to become available. These are defined the StVZO as either a required investigation (R, *"Plichtuntersuchung"*) or additional investigation (A, *"Ergänzungsuntersuchung"*), as shown in Table 20.

Table 20: Overview of Execution (*"Ausführung"*), State (*"Zustand"*), Function (*"Funktion"*) and Effect (*"Wirkung"*) checks (required/additional) according to Annex VIIIa (§ 29) of the StVZO (Table 5 [DE21])

	Section	Execution		State		Function		Effect	
		R	A	R	A	R	A	R	A
6.1	Brake system	0	4	6	6	10	4	2	1
6.2	Steering system	1	0	3	3	2	0	0	0
6.3	Visibility	1	1	3	3	2	0	0	0
6.4	Lighting equipment and other parts of the electrical system	3	0	6	6	2	1	0	0
6.5	Axles, wheels, tires, suspensions	4	1	7	7	0	1	0	0
6.6	Chassis, frame, body; attached parts	5	2	10	10	0	4	0	0
6.7	Other equipment	7	1	3	7	4	3	0	0
6.8	Environmental impact	6	0	7	6	0	0	0	0
6.9	Additional tests on motor vehicles used for commercial passenger transportation	15	1	7	16	7	4	0	0
6.10	Identification and classification of the vehicle	4	0	3	1	0	0	0	0

Once a safety critical error has been detected, the respective cause may be categorised as suspicious (*"Auffällig"*). Safety critical error codes (DTC) are then evaluated with respect to their status (internal check conducted/sporadic error detected/permanent error detected). As long as all internal checks have been conducted for the relevant error codes (DTCs), the vehicle can be deemed to be "sufficiently conditioned" for the evaluation of any detected deficiencies.

The FSD Zentrale Stelle has bilateral agreements with the various manufacturers on the delivery of data that can be used offline, in particular diagnostic data in accordance with Regulation 2018/858 ("RMI"). The transmission paths differ depending on the manufacturer or type of data.

As with all offline approaches, there is an element of latency associated with this data delivery. As mentioned above, safety relevant DTCs, unlike emission-related DTCs, do not exhibit a high level of standardisation.

7.1.3 Electronic PTI (ePTI, based on ISO 20730)

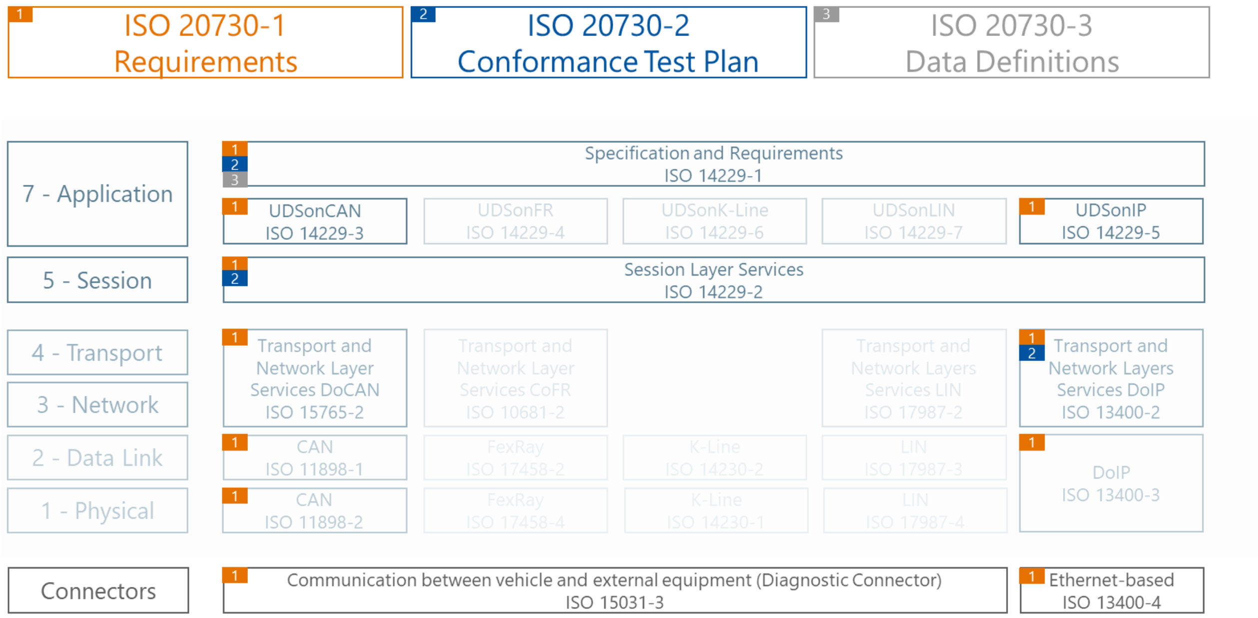


Figure 37: Overview of ISO 20730 (ePTI) and referenced standards

The ISO 20730 series relate to the vehicle interface for electronic Periodic Technical Inspection (ePTI) and consists of Part 1 (Application and Communication Requirements), Part 2 (Conformance test place for part 1) and Part 3 (Data definitions and ePTI-relevant system list): These standards refer to a subset of existing unified diagnostic services shown in Figure 37. Whereas ISO 2730 refers largely to the proceed step, the steps of PTI can be categorically summarised according to ISO 20730 as shown in Figure 38:

- Prepare: off-board pre-conditional information required for performing ePTI via a unique identifier (e.g. VIN).
- Proceed: refers to the standardised interface, data definition and external test equipment.
- Compare: comparison of read-out (IS) data from the vehicle and the reference (SHOULD BE) data provided by an external source.
- Decide: decision to approve or reject the vehicle.

ePTI external test equipment shall be able to read on-board DTC information and/or error DID information as well as current and/or stored value upon sending valid ePTI or RMI credentials (e.g. certificate). The standardised OBD interface can be used for ISO 20730-related access to the vehicle, as referenced by ISO 15031-3. It should be noted that a standardised format (i.e. not a proprietary of OEM-specific interface) is needed to enable equal and fair access to vehicle information, data and services. ISO 20730-3 uses normative references from ISO 3779

(VIN, Content and structure), ISO 14229-1 (Unified diagnostic services) and SAE J1979DA (Digital Annex of E/E Diagnostic Test Modes).

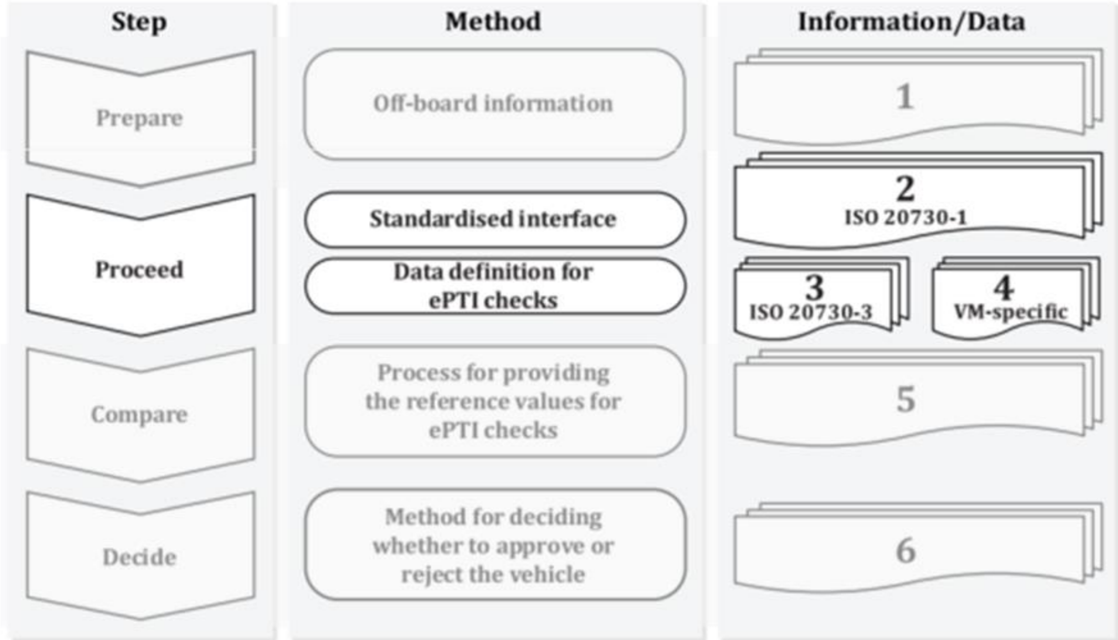


Figure 38: PTI application according to ISO 20730-1 (1, 5, 6 not within scope of ISO 20730)

Inspection modules cover various use cases, from discovery of ePTI data link and systems, queries relating to data (DID), routine (RID) and input/output control identifiers. Odometer value, software number, self-test completion status and error information.

The vehicle identification number (VIN) or other unequivocal identification method is suggested for use during the “prepare“ stage. The VIN can be queried via the generic ePTI information identifier during the “proceed“ stage. Various DID or RID are used to conduct the queries. ISO 20730-3 also includes a list of ePTI-relevant systems (Annex A), DID definitions (Annex B), routine definitions (Annex C) and templates for proposed identifiers and names (Annex D).

7.2 Review of Quality Assurance Mechanisms

ISO 17020 aims to ensure conformity of inspection locations, including aspects regarding quantity, quality, safety, suitability and continued compliance with safety of equipment or systems in operation. Topics such as general, structural, resource, process and management system requirements are covered.

Resource management relates to the qualifications of the inspectors, which ensures that suitable technical knowledge has been acquired by employees.

The management system requirement must either ensure that the described points relating to documentation, auditing and preventative measures are in line with the standard, or that a separate management system has been implemented in accordance with ISO 9001.

7.3 Review of critical test requirements

A review of critical test requirements is now conducted. Using Directive 2014/45/EU as the baseline, the minimum requirement concerning the contents and recommended methods of testing as per Annex I as well as the minimum requirements concerning facilities and equipment as per Annex III are tabulated. The variance, or delta, identified in the Swedish and German national legislation is summarised below.

Regarding the testing of suspension systems, it should be noted that various aspects of the process need to be improved and re-engineered before this process can be reliably implemented at scale. The measurement results can be rather easily influenced by vehicle-related factors such as tyre inflation pressure or vehicle load. Low-profile tyres could also lead to a distorted assessment of the shock absorber, for example in the EUSAMA test procedure. This can lead to the damping of new vehicles with a low weight being incorrectly categorised as insufficient. Innovative chassis technologies such as Flying Carpet may also lead to a similar distortion.

7.3.1 Tyres

Baseline (EU) 2014/45

Test	Assessment	Minor	Major	Danger.
Visual Inspection	(a) Tyre size, load capacity, approval mark or speed category not in accordance with the requirements1 and affecting road safety. Insufficient load capacity or speed category for actual use, tyre touches other fixed vehicle parts impairing safe driving.		X	X
	(b) Tyres on same axle or on twin wheels of different sizes.		X	
	(c) Tyres on same axle of different construction (radial/cross-ply).		X	
	(d) Any serious damage or cut to tyre. Cord visible or damaged.		X	X
	(e) Tyre tread wear indicator becomes exposed. Tyre tread depth not in accordance with the requirements		X	X
	(f) Tyre rubbing against other components (flexible anti spray devices). Tyre rubbing against other components (safe driving not impaired)	X	X	
	(g) Re-grooved tyres not in accordance with requirements1. Cord protection layer affected.		X	X
	(h) Tyre pressure monitoring system malfunctioning or tyre obviously underinflated. Obviously inoperative.	X	X	

Delta

2017:54k 2x 2 3

- Test for damage / pattern depth
- Pattern depth < **1.6 mm** (2x/2)
- **Studded / unstudded** tyres mixed (2x)
- Risk of parts coming loose (3)

HU Guidelines GM EM VM VU

- Test for condition / execution
- **D** 5.2.3 Tyre tread worn on one side (GM)
- **D** 5.2.3 Tyre valve dust cap (Krad) is missing (GM)
- **D** 5.2.3 M+S tyre speed sign is missing or incorrectly attached or there is no visual or acoustic warning (EM)

Figure 39: Overview of tyre test requirements (baseline: Annex I)

Requirements for tyres from Annex I of Directive 2014/45/EU are examined in Figure 39. Section 5.2.3 of the Directive outlines size and load capacity requirements, symmetry aspects, factors relating to damage and wear. Finally regrooved tyres and tyre pressure monitoring system operation is listed. Half of these categories could potentially be attributed to a

Dangerous deficiency. Asymmetric characteristics regarding tyres on the same axle are classified as “major”.

Variations in Swedish law include the pattern depth limit of 1.6 mm. This may result in a deficiency rating of 2x (simple) when occurring in isolation. When multiple instances are evident, a rating of 2 (defective – no ban) is awarded. When studded/unstudded tyres have been mixed resulting in asymmetrical axle characteristics, a rating of 2x (simple) is applied. Of the additional requirements included in Swedish law not state in EU law, the risk of parts of coming loose is awarded a deficiency category of 3 (defective – danger to traffic safety).

Variations in German law include a lower deficiency rating GM (minor defect) for tyre tread that is worn on one side. A similar rating is provided for a missing dust cap on motorcycles. A rating of EM (significant defect) may be applied in instances where M+S tyre speed sign is missing or incorrectly attached. It should be noted that §36 of the Straßenverkerszulassungsordnung (StVZO) also requires the main profile to have a profile depth of at least 1.6 mm (Table 5 [DE21]).

Device for measuring the tread depth of tyres applicable to all vehicles is simply stated in Annex III of Directive 2014/45/EU. No further requirements are mentioned in this context.

7.3.2 Braking

Baseline — (EU) 2014/45

Test	Assessment	Minor	Major	Danger.
Brake tester – maximum effort	(a) Inadequate braking effort on one or more wheels. No braking effort on one or more wheels.		X	X
	(b) Braking effort from any wheel is less than 70 % of the maximum effort recorded from the other wheel on the same axle. Or, in the case of testing on the road, the vehicle deviates excessively from a straight line. Braking effort from any wheel is less than 50 % of the maximum effort recorded from the other wheel on the same axle in the case of steered axles.		X	X
	(c) No gradual variation in brake effort (grabbing).		X	
	(d) Abnormal lag in brake operation of any wheel.		X	
	(e) Excessive fluctuation of brake force during each complete wheel revolution.		X	

Delta

2017:54k — 2x 2 3

- Test for function
- Control of **braking force distribution** between the wheels on the same axle is done by applying the brakes until the most braked wheel has reached a braking force close to blocking or a maximum of 15 (20) kN on a single (double)-mounted wheel
- Noticeable skew when braking on the road very large (2)
- A brake circuit out of order, deceleration < 3.5 m/s² (3)
- Pulsating braking action > 2.8 kN (for cars with a gross weight over 12 tonnes and trailers with a gross weight over 10 tonnes) (1974) (2)

HU Brake Guidelines — GM EM VM VU

- Test for effect, uniformity, release behaviour, behaviour over time
  - a) one-sided without effect (**VM/VU**)
  - b) uneven, limit value (**25%**) exceeded (EM)

Figure 40: Overview of braking test requirements (performance) (baseline: Annex I)

Requirements for the service brake performance are examined in Figure 40. Sections 1.2.1 and 1.2.2 of Annex I of Directive 2014/45/EU detail requirements for performance and efficiency respectively. Performance requirements pertain to the use of a brake tester to identify inadequate braking (“major” defect) or no braking (“dangerous” defect). Remaining issues such as gradual variation in brake effort (grabbing), abnormal lag in operation or excessive fluctuations are assigned to the category of “major”.

Variations in Swedish law include the method of measuring the braking force distribution, by which the brakes are applied until the most braked wheel has reached a braking force close to blocking or 15 or 20 kN for single-mounted and double-mounted wheels respectively. A rating of 3 is applied in cases where the deceleration is less than 3.5 m/s^2.

Variations in German law include the rating assignment of VU (unsafe for traffic – immediate ban) for insufficient braking effect. Furthermore, a limit of 25% is defined for braking unevenness.

Baseline

(EU) 2014/45

Test	Assessment	Minor	Major	Danger.
Brake tester, or road test with deceleration recording instrument	Does not give at least the minimum values as follows (Vehicles registered for the first time after 1/1/2012): - Category M1: 58 % (pre-2012: 50%) - Categories M2 and M3: 50 % (pre-2012: 50%) - Category N1: 50 % (pre-2012: 45%) - Categories N2 and N3: 50 % (pre-2012: 43%) - Categories O2, O3 and O4: (pre-2012: 40%) -- for semi-trailers: 45 % -- for draw-bar trailers: 50 %		X	

Delta

2017:54k

2x 2 3

- Test for function
- Lower permissible values for older vehicles (pre 1974/88/91)
- All vehicles: efficiency < 35% (**3**)
- Alternative method (deceleration)
    - Passenger car 2012 (1974): < 5.8 m/s^2 (< 5.0 m/s^2)
    - Truck 2012 (1974) ≤ 3,500 kg: < 5.0 m/s^2 (< 4.5 m/s^2) (2)
    - Truck 2012 (1974) > 3,500 kg: < 5.0 m/s^2 (< 4.3 m/s^2)* (2)
    - Bus 1991 (1974): < 5.0 m/s^2 (< 4.8 m/s^2) (2)
    - Trailer 2012 (1974): < 5.0 m/s^2 (< 4.0 m/s^2) ** (2)
    - All vehicles: < 3.5 m/s^2 (**3**)

** Additional 1988 category: < 4.5 m/s^2 / ** Additional 1988 category: < 4.3 m/s^2*

HU Brake Guidelines

GM EM VM VU

- Test for function
- Lower permissible values for older vehicles (pre 1991/2010)
    - M1: Passenger cars (pre-2010: 50% instead of 58%) (EM)
    - M2: Bus (pre-1991: 48% instead of 50%) (EM)
    - N1: Truck (pre-1991: 45% instead of 50%) (EM)
    - O: Trailer (pre-2010: 43% instead of 45%, pre-1991: 40%) (EM)

Sweden uses equivalent efficiency limits, applied to different time horizons

Figure 41: Overview of braking test requirements (efficiency) (baseline: Annex I)

Requirements for the service brake efficiency are examined in Figure 41. The minimum values are required by the national legislation for newer vehicles, however the treatment of older vehicles varies.

Swedish law requires passenger cars (M category, 2012) to meeting the efficiency requirement of at least 58%, however passenger car (1974) must demonstrate an efficiency of at least 50%. Similarly trucks (N category, 2012) must attain an efficiency of 50%, however an efficiency requirement of 45% may be demonstrated by trucks (1974, GVW ≤ 3,5 t) and trucks (1988, GVW > 3,5 t). Trucks (1974, GWV > 3,5 t) should achieve a value of 43%. Requirements for Buses (1991) and (1974) stipulate efficiencies of 50% and 48% respectively (Appendix 1, Section 4.1.1, TSFS 2017:54k). Swedish legislation also provides an alternative method which provides a deceleration limit for each vehicle class. Older vehicles are similarly required to adhere to lower deceleration limits. An absolute minimum of 3.5 m/s^2 for all vehicles results in a rating of 3 (defective – danger to traffic safety).

The HU Brake Guidelines also state the European minimum value of 58% for passenger cars first registered after 2010. This value is lowered to 50% for earlier models. Buses and trucks are required to exhibit braking efficiencies of 50% if first registered after 1991. These values may be lowered to 48% and 45% respectively if registered before 1991.

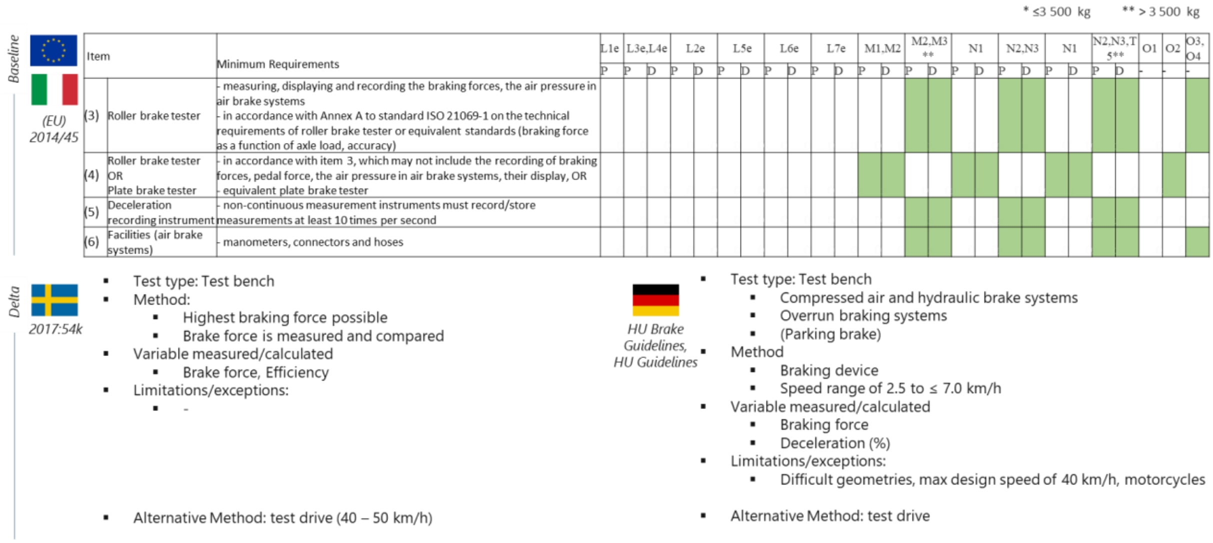


Figure 42: Overview of braking test procedures (baseline: Annex III)

Roller brake testers including equivalent plate brake testers, deceleration recording instruments and facilities for the testing of air brake systems are described in Annex III of Direction 2014/45/EU (Figure 42).

German and Swedish regulation both detail requirements for test bench procedures as well as a test drive method. Swedish law dictates, that the check must be carried out at the highest braking forces possible, but must not exceed 15 kN and 20 kN for single and double mounted wheels respectively. Average braking force during one wheel revolution is used as the basis for the assessment. For fully or partially hydraulic transmission, the total brake force is assessed with regard to the required pedal force. For brake systems with pneumatic brake cylinders, the relationship between braking force and cylinder pressure is established, during which cylinder pressure must reach at least 0.20 MPa, or 0.15 MPa if conditions prevent this. The efficiency is the sum of the extrapolated braking forces divided by the vehicle's mass in newtons that is transferred to the ground via the axles. Deceleration tests may be carried out at an initial speed of 40 – 50 km/hr (Appendix 1, Section 4.1.1, TSFS 2017:54k).

The HU Brake Guidelines require the effectiveness of the braking system to be proven using reference braking forces. At least one reference braking force must be checked for each axle with continuously increasing braking force until the blocking limit is almost reached. If a standardised interface according to Appendix 3 of the Guidelines for Brake Test Benches is available, it must be used. If a test using reference braking forces is not possible due to the technical design of the brake system, vehicle or test bench or if reference braking forces are not available, at least the braking forces must be demonstrated during the brake test that are necessary to achieve the minimum braking according to Appendix 1 is required. For vehicles with a compressed air or compressed air hydraulic brake system, the blocking pressure must not be less than 1.7 bar. Otherwise, the vehicle must be checked with loading or loading simulation.

German and Swedish regulation both detail an additional requirement for a test drive method. Whereas the test procedure in the Swedish regulation is conducted up to speeds of 40 to 50 km/h, German regulation simply specifies that the measurement must take place on a flat, non-slip road surface.

Additional requirements for compressed air systems are contained in Swedish and German law. Swedish law states that the compressor's capacity is measured by checking the time required to reach 0.7 MPa from the output pressure of 0.6 MPa in the compressed air tanks, with the engine at half maximum speed when suspected of being too low (Section 4.6.1, TSFS 2017:54k). Such a deficiency is assigned a deficiency rating of 2 (defective – no ban). German law however requires a rating of VU (unsafe for traffic – immediate ban) when the compressor is identified as not working (section D 1.1.3, HU Guidelines).

7.3.3 Suspension

Baseline

(EU) 2014/45

Test	Assessment	Minor	Major	Danger.
Visual inspection – Shock Absorbers	(a) Insecure attachment of shock absorbers to chassis or axle. Shock absorber loose.	X	X	
	(b) Damaged shock absorber showing signs of severe leakage or malfunction.		X	
Visual inspection – Torque tubes, suspension arms	(a) Insecure attachment of component to chassis or axle. Likelihood of loosening; directional stability impaired.		X	X
	(b) A damaged or excessively corroded component. Stability of component affected or component fractured.		X	X
	(c) Unsafe modification. Insufficient clearance to other vehicle parts; system inoperative.		X	X

Delta

2017:54k — 2x | 2 | 3

- Shock absorbers
  - Test for Function, attachment, binding, slack. (2/3)
  - Function check takes place when driving down in a brake tester and simple test drive (2/3)
- Torque tubes, suspension arms
  - Test for Fastening, damage, play (2/3)
  - **Backlash** testing with help of front carriage plate (Cross-brace)
  - **Play control**, **rust damage** (link arm) (2/3)

HU Guidelines — GM | EM | VM | VU

- Test for condition, execution
- Shock absorbers
  - **D** 5.3.2 Execution inadmissible, admissibility not proven, inadmissible modified (EM)
- Torque tubes, suspension arms
  - **D** 5.3.3a Air spring damaged (GM)
  - **D** 5.3.3b Air spring damaged with moisture ingress, missing (EM)

Figure 43: Overview of suspension test requirements (baseline: Annex I)

Requirements for the suspension are examined in Figure 43. Sections 5.3.2 and 5.3.3 of Annex I of Directive 2014/45/EU detail requirements for shock absorbers and torque tubes/suspension arms respectively. Both aspects are to be checked at least via visual inspection for insecure attachment. Shock absorbers are to be checked for damage or signs of leakage or malfunction. Torque tubes and suspension arms are to be checked for damage, excessive corrosion and unsafe modifications.

The Swedish regulation defines additional checks for shock absorbers and tests for backlash and play control as well as rust damage of the link arm (Section 5.2.1, TSFS 2017:54k). Germany describes an additional requirement pertaining to inadequate or modified shock absorbers as well as damage to the air spring (Section D 5.3.2, D 5.3.3a/b, HU Guidelines).

* ≤3 500 kg ** > 3 500 kg

Baseline (EU) 2014/45

Item		Minimum Requirements	L1e	L3e,L4e		L2e		L5e		L6e		L7e		M1,M2		M2,M3 **		N1		N2,N3		N1		N2,N3,T5**		O1	O2	O3, O4
			P	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	-	-	-
(8)	Device for testing the wheel-axle suspension	- must be equipped with at least two power-operated plates that can be moved in opposite sense in both longitudinal and the transversal directions - must be controllable by the operator from the testing position -- Longitudinal and transversal movement of at least 95 mm -- Longitudinal and transversal movement speed 5 cm/s to 15 cm/s																										

Delta

2017:54k

- Test type: Visual inspection, rust damage, functional check, backlash
- Method:
  - Assess spring travel,
  - Uniformity on right/left sides
  - Spring bearing is checked with tools
- Variable measured/calculated
  - Must be suspension travel both up- and downwards
  - When vehicle is lifted, springs must remain "in place"
- Limitations/exceptions:
  - -

HU Guidelines

- Test type: Condition, execution
- Method:
  - Components, connections/fasteners checked for damage
  - Uniformity
- Variable measured/calculated:
  - Minimum values evaluated
- Limitations/exceptions:
  - -

Figure 44: Overview of suspension test procedures (baseline: Annex III)

Test requirements are detailed in Figure 44. Minimum requirements include the ability of the device to exhibit power-operated plates which can be adjusted in the longitudinal and transversal directions from the testing position of at least 95 mm at speeds ranging from 5 cm/s to 15 cm/s.

Variations in Swedish law include the visual assessment of spring travel and bearing as well as a check for uniformity during a test drive on both sides of the vehicle. Backlash control on the spring bearings is carried out via the use of tools (2.2.1, TSFS 2017:54k).

The HU Guidelines have additional requirements pertaining to condition and execution, whereby components and connections are checked for damage, as well as uniformity (Section 5.3, HU Guidelines).

7.3.4 Nuisance

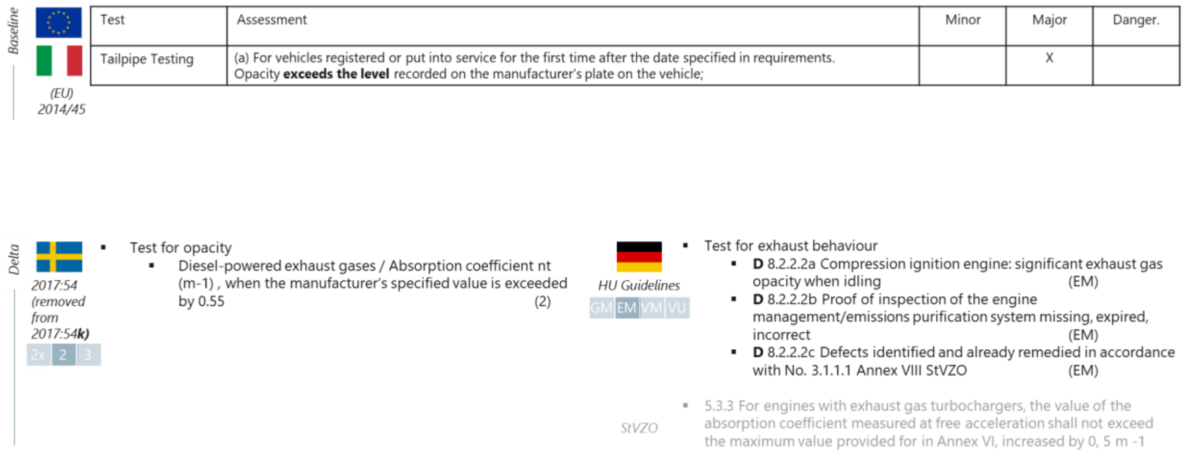


Figure 45: Overview of test requirements for nuisance (baseline: Annex I)

Requirements for nuisance are examined in Figure 45. Section 8.2 of Annex I of Directive 2014/45/EU details requirements for exhaust emissions. Sections 8.2.1 and 8.2.2 of the Directive relate to positive ignition engine emissions and compression ignition engines respectively.

Additional German requirements relate to exhaust opacity when idling for compression ignition engines, non-valid proof of engine inspection as well as defects identified and remedied in line with Section 3.1.1.1 of Annex VIII of the Strassenverkehrszulassungsordnung (official inspection within the meaning of DIN EN ISO/IEC 17020:2012).

Both documents contained a similar requirement relating to the absorption coefficient. Sweden allowed diesel-powered exhaust to exceed the manufacturer's specification by 0.55 m^{-1}. However, this requirement was removed from the consolidated version of the document. German law states that the absorption coefficient shall not exceed the maximum value increased by 0.5 m^{-1}, when measured at free acceleration.

* ≤3 500 kg ** > 3 500 kg

Baseline

(EU) 2014/45

Item		Minimum Requirements	L1e	L3e,L4e		L2e		L5e		L6e		L7e		M1,M2		M2,M3 **		N1		N2,N3		N1		N2,N3,T5**		O1	O2	O3, O4
			P	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	-	-	-
(9)	Class II sound level meter	-																										
(10)	4-gas analyser	- in accordance with Directive 2004/22/EC																										
(11)	Device for measuring the absorption coef.	- sufficient accuracy																										

Delta

2017:54k

- Test type: Visual inspection, sound check, measurement, End-pipe direction
- Method:
  - Components checked for damage
  - Measurement is carried out on vehicles, for which exhaust noise is **perceived** to be too high
  - Simplified sound level control in suitable location
  - End pipe must not open under any part of vehicle body
- Variable measured/calculated
  - Microphone placement:
    - At the same height as the mouth of the exhaust pipe (≥ 0.2 m from ground)
    - Distance of 0.5 m, angle of 45° ± 5° from side
- Limitations/exceptions:
  - -

HU Noise Measurement Guidelines (TBD)

- Test type: Condition, execution, Noise development
- Method:
  - Components, connections checked for damage
- Variable measured/calculated:
  - -
- Limitations/exceptions:
  - -

Figure 46: Overview of test procedures for sound level (baseline: Annex III)

Requirements for nuisance are examined in Figure 46. Section 8.1 of Annex I of Directive 2014/45/EU detail requirements for noise. Both Swedish and German regulation allow for a subjective evaluation of noise generation, in line with the European Directive (8.1.1). Swedish law then dictates that measurement is to be carried out where the noise is perceived to be too high. German regulation requires the publication of noise measurement guidelines before any measurement is to take place.

Delta

2017:54k

- Test type (gas): Measurement, adjustment of CO content (<1975)
- Method:
  - System checked for leaks
  - Probe hose for the exhaust gas meter must be inserted at least 30 cm into the exhaust pipe
  - Meter must be read when a stable value is obtained, but no later than after 30 sec
  - Engine must be operating at stable speed (2000-3000rpm)
- Variable measured/calculated
  - CO and HC
- Limitations/exceptions:
  - -
- Test type: OBD: test for codes P0001-P0499, P0650 (>2,500 kg)

AU Guidelines

- Test type: OBD, Exhaust Examination (AU)
  - Positive ignition
  - Compression ignition
- Method:
  - Visual inspection of the engine MIL and, if applicable, the NO_x warning system
  - Establish communication and functional OBD test
  - Enter the target vehicle data
  - Exhaust function test
  - Generate proof of test
- Variable measured/calculated:
  - "Should be" values listed in 2.2
- Limitations/exceptions:
  - -

Figure 47: Overview of test procedures for 4-gas analyser

Section 8.2 of Annex I of Directive 2014/45/EU detail requirements for gaseous emissions. The 4-gas analyser gas components are defined as carbon monoxide (CO), carbon dioxide (CO_2), oxygen (O_2) and hydrocarbons (HC) in accordance with Directive 2004/22/EC. As shown in Figure 46, such tests are conducted on vehicles with petrol or positive ignition engines. National requirements are detailed in Figure 47.

Swedish requirements detail carbon monoxide (CO) and hydrocarbon (HC) content (Section 30.2.1, TSFS 2017:54k). Measurement is carried out on a vehicle driven by petrol, ethanol or a mixture thereof by inserting a probe hose at least 30 cm into the exhaust pipe, after having checked for leaks. A value is obtained when a stable value is achieved, but no later than 30 seconds. Notably, only two gases are required by this regulation. This is presumably due to the fact that oxygen and carbon dioxide are regulated in other documents, for example TSFS 2010:2 (O_2) and TSFS 2017:37 (CO_2).

German requirements can be found in section 3 of the AU Guidelines relating to examination of a motor vehicle with a spark (positive) ignition engine, with or without a catalytic converter and lambda-controlled mixture preparation and with an OBD system[2]. This entails connecting the reading device to the vehicle's diagnostic interface, if applicable, visual inspection of the engine diagnosis indicator light and, if applicable, the NO_x warning system is checked for presence and function. Following this, communication between the reading device and the control device is established, a functional test of OBD system is conducted and the target vehicle data, such as motor temperature, idle speed and exhaust relevant system data, are entered. A functional test is then conducted to determine the lambda value, following which a proof of test is generated (AU Guidelines). If a catalytic converter is being tested, it must first be brough to operating temperature.

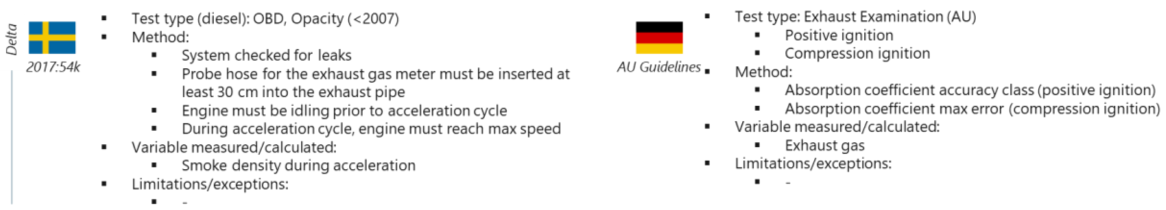


Figure 48: Overview of test procedures for absorption coefficient

Section 8.2.2.2 of Annex I of Directive 2014/45/EU detail requirements for opacity. As shown in Figure 46, such tests are conducted on vehicles with diesel or compression ignition engines with a device capable of sufficient accuracy. National requirements are detailed in Figure 48.

Swedish documentation stipulates that the exhaust system and any exhaust control system is checked for completeness and that no leaks are found. If noticeable leaks are detected, measurement results may be impaired due to dilution of the exhaust gases and the measurement should not be performed. Measurement is then conducted on vehicles where the engine has reached working temperature and is in satisfactory mechanical condition. Suitable insertion depth of the probe is defined as at least 300 mm. If sufficient insertion depth cannot be achieved, an extension line with a tight connection to the exhaust pipe must be arranged. If a vehicle has several exhaust pipes, the various exhaust pipe must be joined with

[2] Sections 3.2, 3.3, 3.4, 3.8, 3.9 refer to spark-ignition, sections 3.5, 3.6, 3.7 refer to compression-ignition

a common line such that the measurement result consists of the “worst” value. The engine must be idling before each free acceleration (warm-up) cycle begins, which may be up to 10 seconds after the gas pedal is released for heavy duty diesel vehicles. To start each free acceleration cycle, the accelerator pedal must be pressed quickly and in one movement to the full throttle position to achieve maximum injection from the injection pump, such that the engine reaches at least two-thirds of the maximum speed or the corresponding speed specified by the manufacturer. The first acceleration cycle should be done slowly to assess whether the deregulation of the engine speed is taking place correctly. The number of acceleration cycles may be limited to one, if the measured value is well below the stated limit value.

German requirements can also be found in section 3 of the AU Guidelines, described above, whereby the peak value of smoke opacity is determined from the “exhaust function test”.

7.3.5 Lighting

Baseline

(EU) 2014/45

Test	Assessment	Minor	Major	Danger.
Visual inspection - Condition and operation	(a) Defective or missing light/light source.(multiple light/light sources; in the case of LED, up to 1/3 not functioning). Single light/light sources; in the case of LED, seriously affected visibility.	X	X	
	(b) Slightly defective projection system (reflector and lens). Heavily defective or missing projection system (reflector and lens).	X	X	
	(c) Lamp not securely attached.		X	
Headlamp aiming device - Alignment	(a) Aim of a headlamp not within limits laid down in the requirements		X	
	(b) System indicates failure via the electronic vehicle interface		X	

Delta

2017:54k

2x 2 3

- Test for function
- Rating: **dazzling** (2)
  - For cars with a headlight height of up to 1 m
    The dipped beam must be considered dazzling if the downward angle is < 5 cm/10 m
  - For cars with a headlight height higher than 1 m
    The dipped beam must be considered dazzling if the downward angle is < 10 cm/10 m
  - For cars with a headlight height from 0.8 m and up to 1 m, the low beam is also considered dazzling if the down angle is < 10 cm/10 m

HU Guidelines

GM EM VM VU

- Test for condition, function

Figure 49: Overview of test requirements for lighting (headlamps) (baseline: Annex I)

Requirements for the lighting are examined in Figure 49. Sections 4.1.1 (condition and operation) and 4.1.2 (alignment) of Annex I of Directive 2014/45/EU detail requirements for headlamps. The former covers defective components and attachments whilst the latter covers aim of the light beam.

The Swedish legislation includes an additional rating for dazzling headlights. This is determined by calculating the downward angle subject to the height of the headlamp.

The German regulation is closely aligned to the European requirements.

* ≤3 500 kg ** > 3 500 kg

Baseline — (EU) 2014/45

Item		Minimum Requirements	L1e	L3e,L4e		L2e		L5e		L6e		L7e		M1,M2		M2,M3 **		N1		N2,N3		N1		N2,N3,T5**		O1	O2	O3, O4
			P	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	-	-	-
(12)	Headlamp aiming device	- setting of the headlight to be tested in accordance with the provisions for the setting of headlights of motor vehicles (Directive 76/756/EEC) (colour, switching, electrical connections...) - the light/dark boundary must be recognisable (daylight w/out direct sun)																										

Delta — 2017:54k

- Test type: Visual inspection, functional check, measurement
- Method:
  - Fastening of headlamp is checked
  - Instrument is placed in front of the headlight according to the instrument manufacturer's instructions
- Variable measured/calculated
  - Colour, brightness and shape of beam
- Limitations/exceptions:
  - -

HU Headlight Guidelines

- Test type: Condition, function
- Method:
  - A projector with a lens intensity of at least 1: 2.5 must be used for the test
  - The front lens of the lens must be fully illuminated and have a focal length of 200 mm ± 4 mm
  - The "line network" at a distance of 10 m
    - Must be imaged sharply
    - Must be 1800 mm x 600 mm
  - The line width must be 10 mm.
  - The distance between the horizontal and vertical must be 100 mm ± 1 mm. Line spacing measured from the center of the line.
  - The image must also contain the markings of test area to scale.
- Variable measured/calculated:
- Limitations/exceptions:
  - -

Figure 50: Overview of lighting test procedures (baseline: Annex III)

Minimum light equipment requirements are shown in Figure 50. This requires the headlight to be tested in accordance with Directive 76/756/EC and that the light/dark boundary be recognisable during daylight but without direct sun.

Swedish legislation requires the fastening to be checked by feeling the headlight (visual inspection). Function control is carried out by assessing the colour, brightness and shape of the light image on the measuring screen of a light measuring instrument. Measurement with a light measuring instrument is carried out to check the headlight setting, once again subject to headlamp height.

German requirements are taken from the HU Headlight Guidelines. Here, a projector with a lens intensity of at least 1: 2.5 must be used for the test and the front of the lens must be fully illuminated and have a focal length of 200 mm ± 4 mm. According to Sections 8.1.2 and 8.1.3, the projector must be set up such that:

- The central mark of the line network shown is 10 m away at the same height above an absolutely flat surface as the centre of the projector lens,
  - The line network at a distance of 10 m (measured from the main plane of the projector lens on the image side) must be imaged sharply.
  - The dimensions of the line network must be 1800 mm x 600 mm at a distance of 10 m.
  - The line width must be 10 mm.
  - The distance between the horizontal and vertical lines (= normal distance N) must be 100 mm ± 1 mm. The line spacing is measured from the centre of the line.

- The image must also contain the markings of test area 5 to scale (according to the current HU headlight test guidelines). If the marking lines and network lines lie on top of each other, they must be shown in dashed lines.

▪ The horizontal lines of the line network run parallel to the stand area,

▪ The image is perpendicular to the direction of light emission. This can be checked by setting the projector to infinity. The position of the centre of the central mark may not change by more than 5 mm.

7.4 Review of exact information required by Regulation (EU) 2019/621

Table 21 shows a breakdown of inspection types across the information requirements contained in the Annex of Regulation (EU) 2019/621. "Functional checks" and "other inspections" may also be accompanied by visual inspections, thus the 48 points of information required refers to the right hand column and not the bottom row (*).

Table 21: Overview of information required by Implementing Regulation (EU) 2019/621

	Visual inspection			Other inspection (subjective)			Functional check			Points of Info. Req.
	Min.	Maj.	Dang.	Min.	Maj.	Dang.	Min.	Maj.	Dang.	
0. IDENTIFICATION OF THE VEHICLE	1	5	0	0	0	0	0	0	0	0
1. BRAKING EQUIPMENT	19	84	35	0	0	0	1	15	8	15
2. STEERING	4	41	26	0	0	0	0	0	0	2
3. VISIBILITY	7	11	1	0	0	0	0	0	0	0
4. LAMPS, REFLECTORS AND ELECTRICAL EQUIPMENT	44	66	6	0	0	0	0	0	0	9
5. AXLES, WHEELS, TYRES AND SUSPENSION	4	35	28	0	0	0	0	0	0	3
6. CHASSIS AND CHASSIS ATTACHMENTS	13	58	34	0	0	0	0	0	0	4
7. OTHER EQUIPMENT	12	41	6	0	0	0	0	0	0	10
8. NUISANCE	0	6	1	0	2	1	1	5	0	5
9. SUPPLEMENTARY TESTS FOR PASSENGER-CARRYING VEHICLES CATEGORIES M2, M3	28	40	4	0	0	0	0	0	0	0
Points of Info. Required		41			2*			6*		**48**

In certain cases, many of the vehicle manufacturers indicated that the information which is required by Article 6 of Implementing Regulation (EU) 2019/621 to be made available online is not used. In other cases, usage was not currently able to be tracked by the software system. These results are shown in Table 22. The fact that certain data sets have never been accessed suggests that no inspection body is systematically using these databases to exact vehicle data. In place of this, bespoke solutions are created on-demand by certain industry bodies, such as SilverDAT (Deutsche Automobil Treuhand GmbH, 2024). Although this works in isolated instances, this represents a large source of overhead for vehicle manufacturers, based on the aspects discussed in Sections 6.7 and 11.8.

Table 22: Overview of usage of data provided due to Implementing Regulation 2019/621

OEM Response	Number of Extracts
#1	0
#2	0
#3	0
#4	Unable to track usage with current tool version
#5	Usage unknown, # active users < 5/year 7 EU technical inspection centers and 3 European authorities registered
#6	Usage unknown Swiss / German Police registered
#7	Usage unknown
#8	2 users registered, usage unknown

7.5 Review of potential options regarding information exchange according to Implementing Regulation (EU) 2019/621

As demonstrated by Table 22, information being provided on the basis of Implementing Regulation (EU) 2019/621 is not being consistently used across the board. For PTI locations to be able to leverage this system, there need to be a unified and consistent approach which is scalable. A more harmonised and consistent approach may also facilitate mutual recognition of results. These are depicted in Figure 51 and discussed in the following sections. Within the scope of either option, cooperation between vehicle manufacturers and key industry players to achieve a solution which is feasible and sensible would be beneficial. This is currently prohibited by competition law.

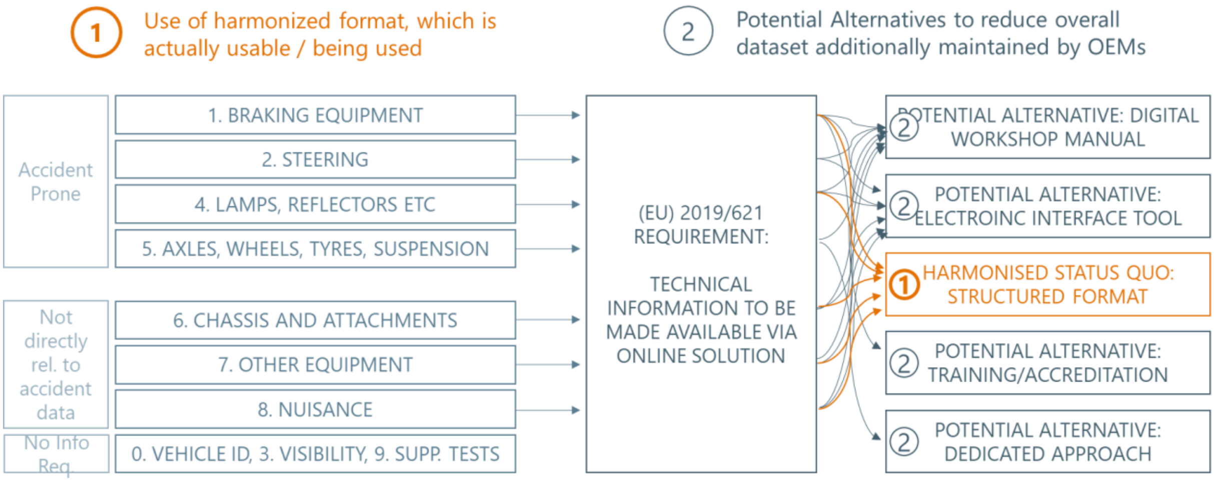


Figure 51: Overview of options pertaining to data based on (EU) 2019/621 requirement

Based on the Key Findings of this report, notably Key Finding “Regulation vs Directive” involving improved harmonisation, the following options can be defined.

7.5.1 Option 1: Harmonised status quo

Option 1 seeks to leverage an existing data set which can practically be implemented in the field and used by both vehicle manufacturers (OEMs) and Member States. The goal is to harmonise and standardise the requirement across OEMs, vehicle manufacturers and EU countries. By default, this data set would also have to fulfill security and safety requirements. Cooperation between vehicle manufacturers (OEMs) and key industry bodies would enable efficient identification of such an existing system. This is currently prevented by competition law.

7.5.2 Option 2: Harmonised format with reduced data scope

Option 2 seeks to reduce the level of data being provided in digital format. Certain information to ensure some minimum level of safety during PTI ought to be provided in some structured format, with a view to achieve a standardised, harmonised offering across vehicle manufacturers (OEMs) and EU countries and avoid individual requests for bespoke solutions.

In order to reduce the total amount of data required to be offered within the scope of a PTI legal framework, certain information may be more amenable to other channels, as shown in Table 23. These could take the form of:

- Digital Workshop Manual (vehicle specific): “general descriptions”, location, size/dimensions to supplement ODX data.
- Electronic Interface Tool: (vehicle specific data) to enable efficient and effective checking of the electronic vehicle interface.

- Training: could apply generally, but also specifically to processes referring to UNECE Regulations and EU law references.
- Potential dedicated alternative approach, for example UTAC's approach in France (tyres data base, see Section 5.4).

Table 23: Overview of potential methods for reduction of information

Category		Workshop manual (vehicle specific)	Electronic Interface Tool Information	Structured format	Training (UN/EU rqmt)	Dedicated Approach
Accident Prone	1. BRAKING EQUIPMENT	2	2	3	8	0
	2. STEERING	1	1	0	0	0
	4. LAMPS, REFLECTORS AND ELECTRICAL EQUIPMENT	4	3	2	0	0
	5. AXLES, WHEELS, TYRES AND SUSPENSION	2	0	0	0	1
	Subtotal	9	6	5	8	1
Not directly related to accident data	6. CHASSIS AND CHASSIS ATTACHMENTS	3	0	1	0	0
	7. OTHER EQUIPMENT	3	6	1	0	0
	8. NUISANCE	2	0	3	0	0
	Subtotal	8	6	5	0	0
Total (48)		17	12	10	8	1

Modified information requirements could be dealt with by dividing the data set into a category with topics directly related to the accident data set (accident prone) and a category with topics not directly related to the accident data set.

This information needs to be review by vehicle manufacturers with respect to the information currently required by (EU) 2019/621 in light of the severity detailed in 2014/45/EU. Certain categories, such as 3. Visibility and 9. Supplementary tests for passenger carrying vehicles have no information requirement.

Based on the accidentology data, information requirements for categories in order of severity relating to tyres (annex section 5), brakes (annex section 1), steering (2) and lighting (4) are listed in Section 11.3.1. Remaining categories not identified as causing accidents (3. Visibility, 6. Chassis and Chassis attachment, 7. Other equipment) are thus dealt with separately in Section 11.3.2. Since this information from the (EU) 2019/621 data set is not being actively used, cooperation between vehicle manufacturers is needed in order to determine which information can most effectively be used to reduce these types of accidents. In light of climate issues, point 8 relating to Nuisance (emissions) ought to be considered going forwards with respect to the remaining emitting vehicle fleet.

7.6 Summary of critical test requirements

A summary of the key findings in this section are presented below in Table 24.

Table 24: Summary of critical test requirements

Key Findings	Summary of Results
	Certain systems can currently be checked electronically (e.g. lighting) other pose more difficulties (e.g. turning). Minimum requirements regarding roadworthiness facilities and test equipment from Annex III (procedures) can be compared and contrasted with the deficiency ratings from Annex I (requirements). Interestingly, there is little detail in the requirement for the testing equipment of tyres in Annex III of Directive 2014/45/EU. Testing of suspension systems can currently be influenced by a range of factors. Standardisation of this procedure and these variables will be necessary before it can be adopted at scale. Further quality assurance systems, such as ISO 17020 accreditation and qualifications of inspectors must also be considered.
	Current electronic methods leverage OBD systems via the read out of diagnostic trouble codes (DTCs). Advanced methods such as electronic PTI (ePTI, based on ISO 20730) are emerging, and represent forward thinking methodologies which can provide a standardised solution via collaborative means. Harmonisation of multiple aspects (e.g. inspection device/tool) ought to occur in an initial step/phase.

8 Discussion of Results

Point to be addressed	Summary of Results
Top 10 major defects as a reason for a failed PTI (major defects) in last 5 years across EU member states	Aspects appearing Destatis data set (passenger car): 1) Lighting equipment, (~25% of failed PTI), 2) Brakes (~16% of failed PTI), 3) Defects in axles, including wheels (14% of failed PTI), 4) Tyres (64% of fatalities), Aspects appearing in a case study (passenger car): 5) Speedometer (1 x case study, no fatality), 6) Shock absorber (1 x case study, 1 x fatality – driver not wearing seatbelt), Aspects appearing in Section 4.3 data (commercial vehicles): 7) Equipment manipulation (disabling), 8) Steering/ towing device, 9) Cargo securing and overloading, 10) Labelling and Documentation
Recommend best way forward for exchange of information (online / offline-> up to date), considering cyber security risk and track latest software version.	Options regarding a best way forwards derived from key findings can be presented as two options: 1. Harmonised Status Quo: utilisation of an existing data set with proven usage and functional safety characteristics. 2. Harmonised format with reduced data scope: look for other existing

	methods of making information available before standardising a reduced data set. Although currently prevented by competition laws, OEM cooperation could enable efficient and feasible identification of an existing and improved data set with a reasonable and effective level of granularity.

Key factors regarding failed PTI were collated from DEKRA reports containing the “main contributors towards failed PTI” for passenger cars (Section 4.2) and heavy goods vehicles (Section 4.3). Brakes and tyres feature prominently in both of these categories. Lighting was a further reason attributed to passenger cars failing PTI whereas issues relating to the chassis, overloading, disabling of equipment and cargo securing were named for commercial vehicles in this category. These represent reasons for a failed PTI in a more administrative sense.

Following this, case studies were analysed (Section 3.2, 3.3, 3.4). An issue was identified with the speedometer of a passenger car showing an incorrect speed, however no fatality or injury was registered in this instance. An issue with the shock absorber was also discovered following a crash involving a convertible, however it was suggested that the resulting fatality could have been prevent had the driver been wearing a seatbelt. An incident involving a manipulated tachograph of a heavy goods vehicle (HGV) was noted an additional reason why in the distracted driver did not brake in time before fatally injuring the driver of the preceding car. Two further instances involved fatal collisions between a HGV and a Pedelec rider due to insufficient field of vision. Here, the link to PTI is tenuous. Design requirements for vehicles including sensors including aspects relating to the testability of functions, should be adequately defined in type-approval regulations.

Accident data from Destatis was also evaluated (Section 3.1). As demonstrated in Figure 1, accidents due to technical failure represent a fraction of the total number of accidents. This demonstrates that tyres (64% of fatalities) are heavily underrepresented in the list of PTI failures for passenger cars (≤14%) and HGV. Lighting is slightly overrepresented in the list of PTI failures (25%) when compared to the accidentology figures (11%). Braking represents 16% of PTI failures and 8% of fatalities. Issues with steering of HGV were also discovered in the accidentology but not listed as a main source PTI failure. These points are summarised in Figure 52.

Source: Main PTI Failures	Source: Case Studies	Source: Accidentology
▪ Passenger Cars: ▪ Lighting equipment, (~25%), ▪ Brakes (~16%), ▪ Defects in axles, including wheels and tyres (14%)	▪ Passenger Cars: ▪ Speedometer ▪ Shock absorber	▪ Passenger Cars: ▪ Tyres (64% of fatalities) ▪ Lighting (11% of fatalities) ▪ Brakes (8% of fatalities)
▪ HGV: ▪ Brakes, ▪ Tyres, ▪ Chassis ▪ Overloading ▪ Equipment (disabling thereof, RSI) ▪ Cargo securing (RSI)	▪ HGV: ▪ Tacho manipulation (driver distraction) ▪ VRU visibility (?) ▪ Caveat: enforcement vs PTI	▪ HGV: ▪ Tyres (50% of fatalities) ▪ Steering/towing device (9% of fatalities) ▪ Brakes (8% of fatalities) ▪ Caveat: Only Germany data available

Figure 52: Overview of top issues relating to PTI taken from respective sources.

These results show that, although the occurrence of technical failures in accidents in quite low, there are specific areas where improvements could be made. Based on the data which is currently available, it can be deduced that fatalities could be effectively reduced via improvements to tyres and the checking thereof. Going forwards, more accurate and consistent data collection of these attributes across Member States will be required.

8.1 Discussion of Key Findings with regard to Suitable Measures

With a view to increasing safety and further reducing fatalities, key findings will now be discussed with respect to potential remedies. This will form the basis of the Potential Measures in Section 9.

Analysis of legislative factors in PTI (Section 2) and Member States (Section 5) identified multiple instances where harmonisation could be improved, for example scope (vehicle category), minimum interval, categorisation of deficiencies, structure of required tests and training of inspectors. In the face advanced vehicle and ADAS functionality, harmonisation of these factors ought to be considered. This could be rectified via **making PTI a Regulation**, which is binding at EU level.

As touched upon in the Introduction (Section 1), factors relating to road safety (Section 3) as well as PTI/RSI (Section 4) demonstrate that accident data is not granular enough and that **more precise accident data practices** ought to be developed.

Based on the data currently being collected, it can be concluded that the **frequency of technical failures is quite low** and represent roughly 0.5% of the data set in Germany. Of these, tyres are identified as the most common failure mode, however **more granularity in the data is required**. Furthermore, this analysis of road safety (Section 3) and PTI/RSI (Section 4) also shows that there are aspects for which a data or digital solution is unlikely to be suitable, however **greater harmonisation** would be beneficial.

Discussion with various OEMs in Section 6 shed light on the issue, that the **data** which are being provided in line with Implementing Regulation (EU) 2019/621 **are not being used**.

Improvements to these data practices could be enabled OEM cooperation, which is currently not permitted under competition law. Detailed discussion with the manufacturers of Commercial Vehicles also highlighted that operational efficiency could be increased by establishing a European system for checking RSI status, in order to prevent multiple checks being performed on the same vehicle.

Advanced methods of testing via electronic PTI (ePTI, based on ISO 20730, Section 7) are emerging are represent a **standardised solution** via collaborative means which can facilitate **efficient data handling** and processing. These results are shown in Table 25, along with key reoccurring themes identified “harmonised PTI”, “improved data practices” and “tyre checking”.

Table 25: Overview of Key Findings and Suitable Measures

Key Finding	Section	Summary of Results	Improved Data Practices	Tyre Check-ing	Harm-onised PTI
	1	A minimum level of PTI requirements can provide a benefit. The introduction of some minimum level of PTI requirements has a measurable effect.	-	-	-
	**2**	**Member states were to adopt and publish laws, regulations and administrative measures at a national level necessary to comply with Directives** 2014/45/EU, 2014/46/EU and 2014/47/EU by 20 May 2017 and apply those measures from 20 May 2018. Conversely, Commission **Implementing Regulation (EU) 2019/621** concerning data requirements is **binding at EU level**. Variations are evident in topics such as **scope** (vehicle category), **minimum interval**, **categorisation of deficiencies**, structure of **required tests** (2014/45/EU Annex I), **training of inspectors**. These variations could be	**-**	**-**	**MED**

	reduced by increasing the level of harmonisation by making PTI a regulation. Slight variations are evident in topics such as quality assessment, cargo securing, exchange of information. Roadworthiness legislation and type-approval legislation are typically clearly and separately defined. Design requirements for vehicles derive be laid down exclusively in type-approval regulations, including aspects relating to the testability of functions.			
5	**Member states have adopted various approaches** with respect to transposition. Although providing "flexibility" for the Member States, a unified and harmonised approach to reducing road fatalities is made more complicated. Sweden: national legislation covers all mandatory requirements in EU legislation, but uses a different structure. Germany: carried over mandatory requirements and included additional other points, which were in repealed national legislation. In rating deficiencies, a fourth column (unfit for traffic) is also used. A tiered rating system is used for simple vs more advanced failure, where more advanced failures are rated in accordance with EU directive. Italy has broadly carried over the EU legislation directly into their national	-	-	**HIGH**

documents. Scope is extended to cover a broader range of vehicles to ensure high safety.

France has no inspection requirement for L-category vehicles (TBD: 15 April 2024, 5-3-3). Also uses a 2-tiered system for categorising deficiencies ("minor" for simple failure, "major" for advanced failure) in some instances where the European requirement defines a "major" category only.

Among the largest differences between Member States are the **inspection intervals**, the **rating system** of deficiencies and the **training of inspectors**.

Improvements to the level of harmonisation would be welcomed.

Parkour testing and testing of advanced functions is under consideration for ADAS functions. This currently drives cost at testing centres.

The current usage of the Malfunction Indicator Lamp (MIL) currently does not provide significant insight for determining faults in complex systems. This functionality has however been proved out through various design verification testing phases and should be able to determine if a PTI issue is detected and if further investigation should take place.

Import vehicles have much lighter data provision requirements.

Factors relating to the minimum level of harmonisation, ePTI, relevant OBD and

		ADAS functionality data are being discussed.			
Better Data	1	Vehicles with technical defects that contributed to a traffic accident exhibit wide estimate ranges and limited granularity.	**MED**	**MED**	-
	3	Current goals of the RWP are not being met with respect to achieving the reduction targets specified. Accident **data** are generally **not granular enough**.			
	4	Of vehicles involved in accidents with component failures, **tyres and brakes represent a large proportion** of vehicle defects. The police arriving at the scene must make a judgement call regarding the cause of the accident. Although granularity of the Destatis **data** set is above average, there is still an “other” category which provides limited information.			
Low Comp. Failures	1	Multiple factors can be observed to play an important role in road safety.	-	**MED**	**MED**
	3	Case studies reviewed typically involve **multiple failure modes and/or driver distraction** and relate to: - 1 x Speedometer (Sweden) - 1 x Shock absorbers/driver not wearing seatbelt, (Germany) - 1 x tachograph manipulation (Germany)			

		- 1 x driver distraction/no lane keeping system (Germany) - 2 x Commercial Vehicle/inadequate VRU sensor field of vision (Germany) Whereas PTI may catch issues with inaccurate speedometers, PTI cannot improve situations where occupants are not wearing seatbelts. PTI is also unlikely to help catch type-approved sensors with an inadequate field of view. **Design requirements** for vehicles including aspects relating to the testability of functions should be **adequately defined in type-approval regulations**.			
	4	Accidents are largely cause by **human error** or exogenous factors. **Technical deficiencies make up a small proportion** of total fatalities, injuries and damage to property.			
	1	Previous work conducted on improving road safety demonstrates that accidents due to component failure represent a small piece of a larger picture.	-	-	**MED**
	3	Accidents are largely caused by **human error** or exogenous factors, subject to enforcement procedures. Of many identified issues, **a vehicle data solution is unlikely to help**.			
	4	For certain identified issues (e.g. tyres), **a data solution is unlikely to help**. Load securing, equipment issues and labelling and marking constitute a reasonable proportion of failed RSI.			

		The proportion of commercial vehicles inspected which are foreign to the German market was 65% in 2018 and 73% in 2022.			
	6	Data provision within the scope of Commission Implementing Regulation (EU) 2019/621 **does not reliably ensure fast and effective PTI processes**. A lack of harmonisation is evident. Furthermore, there is no requirement to use these data points. An exact analysis of what is actually required should be conducted in order to steer discussion on which data points should be included in new legislation. As a result, **data offered** via the online portal are largely **unused**. Newer vehicles exhibit high levels of auditability and functionality compared to the level required by RWP. An increase in RWP requirements would necessitate more examiners due to the increase in time needed to check a vehicle. This may also have implications for data management. Costs are generated by administrative / IT back-end processes, which are needed to make data available, especially for individual/specific users. Manipulation of data needs to be considered. Costs are not justified if data is not used. When compared to Directives 2014/45/EU and 2014/47/EU, larger design deltas are incurred by additional	**HIGH**	-	-

		GSR-related (2019/2144) and UNECE (R155/156) requirements during PTI. Options regarding a best way forward ought to involve a greater level of harmonisation and are considered in section 8.			
	7	Current electronic methods leverage OBD systems via the read out of diagnostic trouble codes (DTCs). Advanced methods such as electronic PTI (ePTI, based on ISO 20730) are emerging, and represent forward thinking methodologies which can provide a standardised solution via collaborative means. Harmonisation of multiple aspects (e.g. inspection device/tool) ought to occur in an initial step/phase.	**HIGH**	-	**HIGH**
	6	A centralised system could be used to track RSI status, so that vehicles which have been checked recently are not unnecessarily checked multiple times.	**HIGH**	-	-

8.2 Discussion of Specific Data Handling Options within the scope of Implementing Regulation (EU) 2019/621

Due to the amount of data that vehicles are and will be capable of producing, along with the high costs incurred for specific or individual requests, a unified approach is needed. As discussed in Section 7.5, OEM cooperation could enable efficient and feasible identification of an existing and improved data set with a reasonable and effective level of granularity (currently prevented by competition laws).

Figure 53 summarises the options presented in section 7.5. Cooperation between key industry players will be necessary in order to achieve a feasible level of harmonisation. Improved data collection across a greater number of Member States would assist decision-making. A harmonised approach will be crucial in attaining Vision Zero.

1	HARMONISED STATUS QUO: STRUCTURED FORMAT	▪ Unified EU approach, common across all OEMs (incl. imports, **efficient use**)	✓ Safety related functions ✓ Can leverage existing data × Tyres (slide 24)
2	POTENTIAL ALTERNATIVE: TRAINING/ACCREDITATION	▪ Unified and improved training (e.g. Bachelor Degree or equivalent) ▪ Mandatory accreditation of PTI under ISO 17020 (**qualifications**) ▪ Definition of requirements "device for measuring the tread depth of tyres"	✓ Tyres (slide 24) × Current lack of workers
2	POTENTIAL ALTERNATIVE: DIGITAL WORKSHOP MANUAL	▪ Low cost option for important (unstructured) information (**availability**) ▪ "Gradual transition" of information instead of "sudden switch" ▪ Offered as option for all vehicle data	✓ "General descriptions" ✓ Supplement ODX data ✓ Machine readable
2	POTENTIAL ALTERNATIVE: ELECTROINC INTERFACE TOOL	▪ Selectively make safety related functions available for PTI purposes (**spec. functional access**)	✓ Lighting × Turning × Security
2	POTENTIAL ALTERNATIVE: DEDICATED APPROACH	▪ Approach in France: Dedicated organisations ▪ UTAC / tyre association (**guidelines** / **linkage of data sets**)	✓ Tyres (slide 5/6)
	Outcome	▪ Vision zero (0 accidents) requires a unified and feasible approach across OEMs and MS ▪ Harmonisation to occur across HU-Tool (online), data format (.PDX), PTI data boundary ▪ OEM cooperation could enable identification of standardised/efficient/feasible solution ▪ More accurate data collection to help decision making	

Figure 53: Overview of advantages and disadvantages of suggested options regarding exchange of information

9 Potential Measures

Provided that a suitable option for provision of data is selected, further measures could be taken to holistically leverage all efforts and increasing the level of harmonisation, in line with option 1 of Figure 53. These measures are shown in Figure 55. Advanced methods such as electronic PTI (ePTI, based on ISO 20730) are emerging and represent forward thinking methodologies which can provide a standardised solution via collaborative means. Harmonisation of multiple aspects (e.g. inspection device/tool) ought to occur in an initial step/phase.

Potential Measure 1: Improve Data Practices (administrative)

Currently vehicle manufacturers submit documents to national authorities, where higher test standards than those required by Directive 2014/45/EU may be set, according to recital (4). A reduced number of data delivery points could enable greater harmonisation across Member States (*Data Receivers*) as well as a simplification of administrative process for vehicle manufacturers whilst maintaining a reasonable level of flexibility at consolidated Member State level. This could effectively be achieved by mutual recognition schemes, which would in turn be facilitated by greater harmonisation (Potential Measure 3).

Accident data could also be collected more consistently across Member States and at a more granular level. This would facilitate more accurate analyses of root causes as well as targeted development of future vehicles.

A European system for checking RSI status could streamline inspections of commercial vehicles.

Potential Measure 2: Improve Tyre Checking

Tyres are currently visually inspected as described in section 5.2.3 of Annex I in Directive 2014/45/EU. In Annex III, a device for measuring the tread depth of tyres appliable to all vehicles is described under point (13) with no further requirements. Given the high number of accidents being caused by tyres, minimum requirements for test equipment for testing bodies (*Testers*) could be improved. Alternatively, the frequency or interval at which tyres are checked could be shortened, thus ensuring a reasonable minimum inspection standard, as shown in Figure 54. As shown in Table 8, inspection intervals currently vary by country.

Potential Measure 3: make PTI a regulation (harmonised PTI)

Directive 2014/45/EU regarding PTI is required to be adopted on a national level in line with Article 23. Furthermore, Member States can include additional scope of testing in their national law, which exceed the European level provisions. Certain requirements could be set at a European level in order to guarantee unified and safe processes. This would streamline the process for the *Data Providers* (vehicle manufacturers). Definition of a standardised PTI tool would assist this.

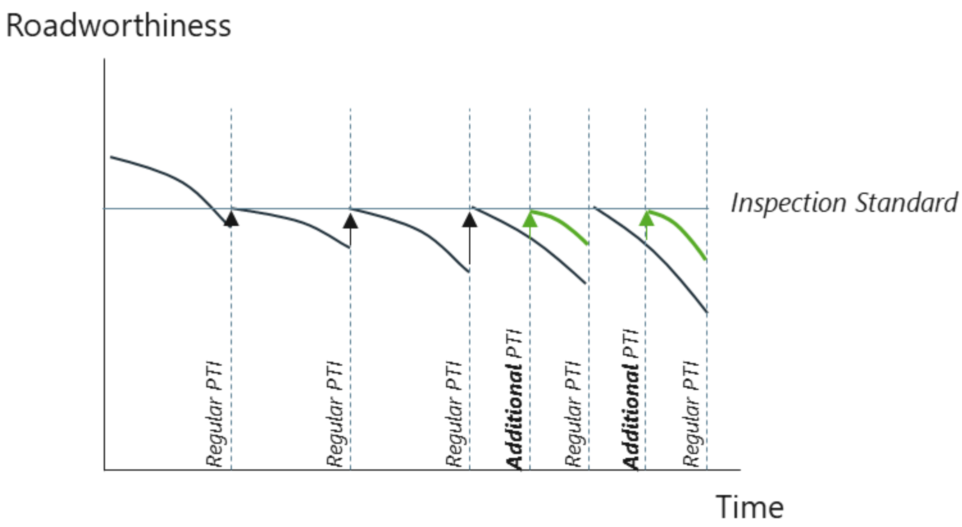


Figure 54: Effect of reducing the inspection frequency to ensure higher levels of roadworthiness (inspections indicated by vertical dashed lines) (CITA, 2024)

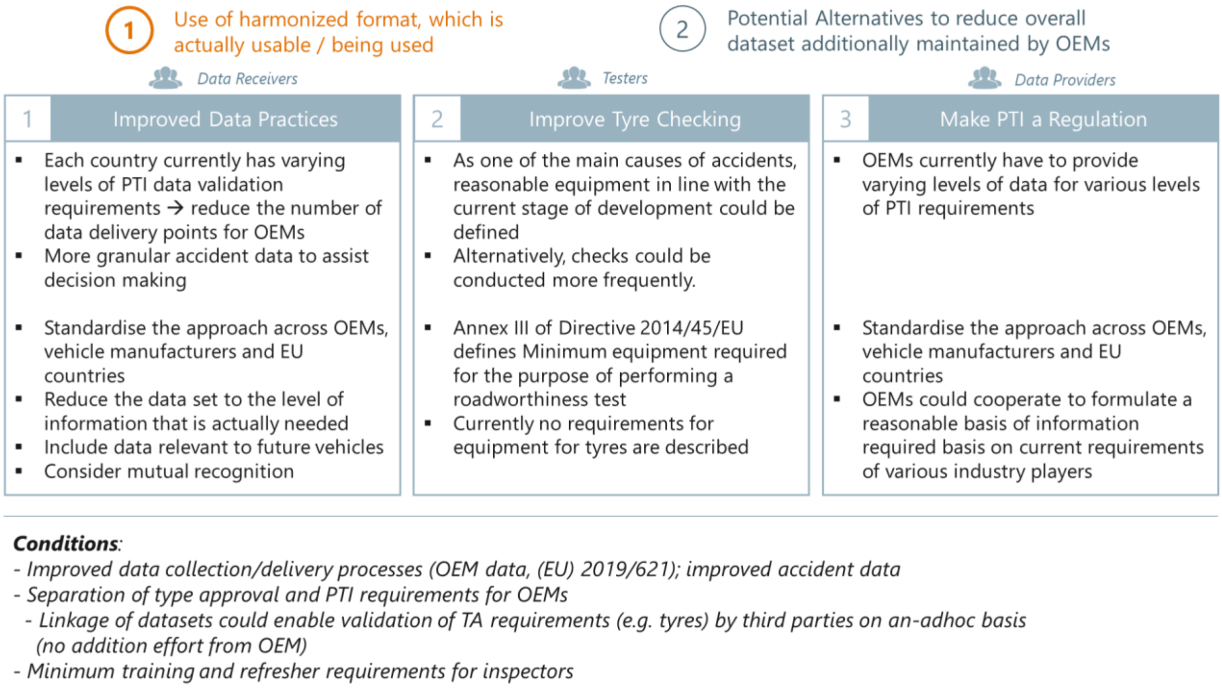


Figure 55: Overview of potential measures based on project results

Further conditions could also be defined. Currently, data is provided within the scope of the type-approval regulation described in Section 2.3. The difference between the processes governing type and approval and periodic technical inspections should be clearly delineated. In France, the UTAC has created Technical Instructions for use by operators for certain functions in order to reduce disparity of test results between countries due to divergent technical instructions, as discussed in Section 5.4.

With a view toward holistic process improvement, minimum training requirements could be increased. Currently, inspectors in certain European countries are required to demonstrate a minimum number of hours spent on training, with examination. In Germany, a Bachelor’s degree is required.

10 Summary

Section	Point to be addressed	Summary of Results
2. Legislative Factors in PTI at EU level	Transposition and mandate of the provisions of EU PTI / RSI directives nationally and what it means for vehicle manufacturers from design and cost perspective.	Member states were to adopt and publish laws, regulations and administrative measures at a national level necessary to comply with Directives 2014/45/EU, 2014/46/EU and 2014/47/EU by 20 May 2017 and apply those measures from 20 May 2018. Conversely, Commission Implementing Regulation (EU) 2019/621 concerning data requirements is binding at EU level. Variations are evident in topics such as scope (vehicle category), minimum interval, categorisation of deficiencies, structure of required tests (2014/45/EU Annex I), training of inspectors. These variations could be reduced by increasing the level of harmonisation by making PTI a regulation. Slight variations are evident in topics such as quality assessment, cargo securing, exchange of information. Directive 2014/46/EU exhibits a high degree of standardised adoption.
	Literature review of existing studies and outcomes / conclusions. (key words: PTI, RSI, Accidents due to poor maintenance, PTI effectiveness for reducing road accidents, etc.).	Review of non-technical documents and studies has been conducted. Roadworthiness legislation and type-approval legislation are typically clearly and separately defined. Design requirements for vehicles should be laid down exclusively in type-approval regulations, including aspects relating to the testability of functions.

3. Factors related to road safety	Literature review of existing studies and outcomes / conclusions. (key words: PTI, RSI, Accidents due to poor maintenance, PTI effectiveness for reducing road accidents, etc.).	Review of non-technical documents and studies has been conducted. Current goals of the RWP are not being met with respect to achieving the reduction targets specified. Accidents are largely caused by human error or exogenous factors, subject to enforcement procedures. Of many identified issues, a vehicle data solution is unlikely to help. Accident data are generally not granular enough.
		Case studies reviewed typically involve multiple failure modes and/or driver distraction and relate to: - 1 x Speedometer (Sweden) - 1 x Shock absorbers/driver not wearing seatbelt, (Germany) - 1 x tachograph manipulation (Germany) - 1 x driver distraction/no lane keeping system (Germany) - 2 x Commercial Vehicle/inadequate VRU sensor field of vision (Germany) Whereas PTI may catch issues with inaccurate speedometers, PTI cannot improve situations where occupants are not wearing seatbelts. PTI is also unlikely to help catch type-approved sensors with an inadequate field of view. Design requirements for vehicles

		including aspects relating to the testability of functions should be adequately defined in type-approval regulations.
4. Factors related to PTI and RSI	Literature review of existing studies and outcomes / conclusions. (key words: PTI, RSI, Accidents due to poor maintenance, PTI effectiveness for reducing road accidents, etc.).	Review of technical documents and studies has been conducted. Accidents are largely cause by human error or exogenous factors. Technical deficiencies make up a small proportion of total fatalities, injuries and damage to property. Of vehicles involved in accidents with component failures, tyres and brakes represent a large proportion of vehicle defects. The police arriving at the scene must make a judgement call regarding the cause of the accident. The proportion of commercial vehicles inspected which are foreign to the German market was 65% in 2018 and 73% in 2022. Load securing, equipment issues and labelling and marking constitute a reasonable proportion of failed RSI. For certain identified issues (e.g. tyres), a data solution is unlikely to help. Although granularity of the Destatis data set is above average, there is still an “other” category which provides limited information

5. Member State Consultations	Transposition and mandate of the provisions of EU PTI / RSI directives nationally and what it means for vehicle manufacturers from design and cost perspective.	Member states have adopted various approaches with respect to transposition. Although providing "flexibility" for the Member States, a unified and harmonised approach to reducing road fatalities is made more complicated. Sweden: national legislation covers all mandatory requirements in EU legislation, but uses a different structure. Germany: carried over mandatory requirements and included additional other points, which were in repealed national legislation. In rating deficiencies, a fourth column (unfit for traffic) is also used. A tiered rating system is used for simple vs more advanced failure, where more advanced failures are rated in accordance with EU directive. Italy has broadly carried over the EU legislation directly into their national documents. Scope is extended to cover a broader range of vehicles to ensure high safety. France has no inspection requirement for L-category vehicles (TBD: 15 April 2024, 5-3-3). Use a 2-tiered system for categorising deficiencies ("minor" for simple failure, "major" for advanced failure) in some instances where the European requirement defines a "major" category only. Among the largest differences between Member States are the inspection intervals, the rating system of

		deficiencies and the training of inspectors.
	Collect views on effectiveness of current inspection mechanism through conducting interviews and what exact information from vehicle manufacturers or business operators are need to fulfil the objectives of PTI.	Improvements to the level of harmonisation would be welcomed. Parkour testing and testing of advanced functions is under consideration for ADAS functions. This currently drives cost at testing centres. The current usage of the Malfunction Indicator Lamp (MIL) currently does not provide significant insight for determining faults in complex systems. This functionality has however been proved out through various design verification testing phases and should be able to determine if a PTI issue is detected and if further investigation should take place. Import vehicles have much lighter data provision requirements. Factors relating to the minimum level of harmonisation, ePTI, relevant OBD and ADAS functionality data are being discussed.
6. OEM consultations	Recommend best way forward for exchange of information (online / offline-> up to date), considering cyber security risk and track latest software version.	Data provision within the scope of Commission Implementing Regulation (EU) 2019/621 does not reliably ensure fast and effective PTI processes. A lack of harmonisation is evident. Furthermore, there is no requirement to use these data points. An exact analysis of what is actually required should be conducted in order to steer discussion on which data points should be included in new legislation.

		As a result, data offered via the online portal are largely unused. Options regarding a best way forwards derived from key findings can be presented as two options: 1. Harmonised Status Quo: utilisation of an existing data set with proven usage and functional safety characteristics. 2. Harmonised format with reduced data scope: look for other existing methods of making information available before standardising a reduced data set. Although currently prevented by competition laws, OEM cooperation could enable efficient and feasible identification of an existing and improved data set with a reasonable and effective level of granularity.

	Review of impact of the PTI cost considering GSR (EU 2019/2144) requirements to be checked in comparison to current PTI scope.	Newer vehicles already exhibit high levels of auditability and functionality compared to the level required by RWP. An increase in RWP requirements would necessitate more examiners due to the increase in time needed to check a vehicle. A more accurate view over Diagnostic Trouble Codes (DTCs) would also be required. This may also have implications for data management. Costs are generated by administrative / IT back-end processes, which are needed to make data available, especially for individual/specific users. Manipulation of data needs to be considered. Costs are not justified if data is not used. When compared to Directives 2014/45/EU and 2014/47/EU, larger design deltas are incurred by additional GSR-related requirements during PTI.
7. Review of critical test requirements and procedures to current state of vehicle technology and the exact information needed to fulfill PTI objectives	Review of existing critical test requirements and procedures to current state of vehicle technology (Suspension tester, Noise, Braking, etc.) and recommend new state of art methodologies for effective and cost efficient PTI (ISO 20730 ePTI, common diagnostic equipment, etc.)	Certain systems can currently be checked electronically (e.g. lighting) other pose more difficulties (e.g. turning). Current electronic methods leverage OBD systems via the read out of diagnostic trouble codes (DTCs). Advanced methods such as electronic PTI (ePTI, based on ISO 20730) are emerging, and represent forward thinking methodologies which can provide a standardised solution via collaborative means. Harmonisation of multiple aspects (e.g. inspection device/tool) ought to occur in an initial step/phase.

		Minimum requirements regarding roadworthiness facilities and test equipment from Annex III (procedures) can be compared and contrasted with the deficiency ratings from Annex I (requirements). Interestingly, there is little detail in the requirement for the testing equipment of tyres in Annex III of Directive 2014/45/EU. Testing of suspension systems can currently be influenced by a range of factors. Standardisation of this procedure and these variables will be necessary before it can be adopted at scale. Further quality assurance systems, such as ISO 17020 accreditation and qualifications of inspectors must also be considered.
8. Discussion of Results	Top 10 major defects as a reason for a failed PTI (major defects) in last 5 years across EU member states	Aspects appearing Destatis data set (passenger car): 1) Lighting equipment, (~25% of failed PTI), 2) Brakes (~16% of failed PTI), 3) Defects in axles, including wheels (14% of failed PTI), 4) Tyres (64% of fatalities), Aspects appearing in a case study (passenger car): 5) Speedometer (1 x case study, no fatality),

		6) Shock absorber (1 x case study, 1 x fatality – driver not wearing seatbelt), Aspects appearing in Section 4.3 data (commercial vehicles): 7) Equipment manipulation (disabling), 8) Steering/ towing device, 9) Cargo securing and overloading, 10) Labelling and Documentation
	Recommend best way forward for exchange of information (online / offline-> up to date), considering cyber security risk and track latest software version.	Options regarding a best way forwards derived from key findings can be presented as two options: 1. Harmonised Status Quo: utilisation of an existing data set with proven usage and functional safety characteristics. 2. Harmonised format with reduced data scope: look for other existing methods of making information available before standardising a reduced data set. Although currently prevented by competition laws, OEM cooperation could enable efficient and feasible identification of an existing and improved data set with a reasonable and effective level of granularity.

9. Potential Measures	A holistic recommendation is envisaged for PTI	Potential Measure 1: Improved Data Practices Potential Measure 2: Improve Tyre Checking Potential Measure 3: make PTI a regulation (harmonised PTI) Subject to conditions e.g. relating to simplified data collection, linkage of data sets and training of inspectors.

11 Appendices

11.1 Appendix 1: Overview of Member State Feedback

Type	Section in RWP	Article in RWP	Count
General Comments	Scope	Article 2	**3**
	Date and frequency of testing	Article 5	**5**
	Contents and methods of testing	Article 6	**15**
	Assessment of deficiencies	Article 7	**2**
	Testing facilities and equipment	Article 11	**11**
	Testing centres	Article 12	**10**
	Inspectors	Article 13	**5**
	Electronic vehicle information platform	Article 16	**9**
	Access to Data/Updates	-	**5**
	Property Transfer	-	**2**
	Coordination of TA	-	**3**
	Opt-in/out	-	**1**
	ePTI	-	**7**
Comments wrt 2014/45/EU	Scope	Article 2	**1**
	Date and frequency of testing	Article 5	**2**
	Contents and methods of testing	Article 6	**1**
	Mandatory ADAS testing	Article 6	**5**
	Emissions Testing	Article 6	**4**
	Equipment/automation of data transfer	Article 11	**2**
	Tyre Tread Indicators	Article 11	**1**

	Simple, quick and inexpensive testing	Article 11	**1**
	Inspectors	Article 13	**3**
	Conflicts of Interest	Article 13	**3**
	Electronic Vehicle Information Platform	Article 16	**3**
	Harmonisation	-	**6**
	Access to data	-	**9**
	Access to data (specifically (EU) 2019/2144 data	-	**4**
	Personal Data	-	**1**
	Cyber security	-	**4**
	Electric and Hybrid vehicles	-	**2**
	Unique Wording for Reasons for Failure	-	**1**
	Connected Infrastructure	-	**2**
	Conditions of glass	-	**1**
	Corrosion Assessment	-	**1**
Comments wrt 2014/47/EU	Scope	Article 2	**1**
	Valid CRW	Article 8	**1**
	Equipment/automation of data transfer	Article 11	**1**
	Inspectors	Article 13	**1**
	Electronic Vehicle Information Platform	Article 16	**2**
	Environmental checks	-	**1**
	Cargo Securing	-	**1**
	Opt-in/out	-	**1**
	Unique Wording for Reasons for Failure	-	**1**

11.2 Appendix 2: Overview of National Transposition

11.2.1 Transposition of Directive 2014/45/EU

The colour in the left-hand column indicates the extent of variation (green: small, yellow: moderate, red: high). Text in orange indicates a difference in the EU/Italian formulation.

	EU (Italy)	Germany	Sweden
Scope	M1, M2, M3, N1, N2, N3, O1, O2, O3, O4, L1-7e	Motor vehicles (≥6 km/h)	M1, M2, M3, N1, O1, O2
Minimum Interval	M1, N1, T5: 4-2-2 M2/3, N2/3, O3/4: 1-1-1 L: 4(1)-2(1)-2(1)	M1: 3-2-2 M2/3: 1-1-1 N: 1-1-1 L: 2-2-2 O: 3-1(2)-1(2)	M: 2-2-2 N1: 3-2-14 months L, T5: 4-2-2 O1, O2: 4-2-2
Testing Centres	3. When carrying out a technical inspection, the inspector must be free from **conflicts of interest**, so as to ensure that a high level of impartiality and objectivity ...	2.12 In order to avoid **conflicts of interest**, the BIV or the recognised workshop may not...	I ch. 4 Section 2 h of the Vehicle Act (2002:574) contains rules on the **independence** of inspection bodies. An inspection body's **independence** must also be ensured
Deficiencies	a) minor deficiencies that have no significant consequences on the vehicle safety ... b) serious deficiencies that may jeopardize the safety of vehicle ...; c) dangerous deficiencies that constitute a direct risk ...	15. result: a) main inspection "no defects found", "minor defects", "significant defects" or "unsafe for road use" or b) of the safety inspection with the indication "no defects found", "defects" or "defects directly jeopardising road safety". **HU-Guidelines incl. "dangerous defect" column**	deficiencies ... only simple and did not occur at the last control inspection or flying inspection so deficient that it cannot be used without an obvious danger to traffic safety
Certificate (CRW)	1)vehicle identification number; 2)registration plate of the vehicle and symbol of the State of registration; 3)place and date of the check 4)odometer reading, if available; 5)vehicle category, if available; 6)deficiencies detected and level of severity; 7)result of the roadworthiness test 8)date of next roadworthiness test or expiry of current certificate, ...; 9)name of the body carrying out the inspection... 10) other information	(1) Vehicle identification number (VIN or chassis number) (2) Vehicle registration number and country code of the country of registration (3) Place and date of the inspection (4) Odometer reading at the time of the inspection (if available) (5) Vehicle class (if applicable) (6) Defects found and their severity (7) Result of the inspection (8) Date of the next inspection or expiry date of the current inspection certificate... (9) Name of the inspection organisation or inspection body ... (10) Other information	1. the registration number, 2. the date of first registration or the year of manufacture of the vehicle, 3. the name and address of the person to whom the certificate has been issued, 4. the manufacturer's name or trade mark, 5. the vehicle's production or serial number, 6. the vehicle's total weight, if the vehicle is intended for freight transport, and 7. the period of validity of the proof, When traveling with an unregistered trailer in international road traffic in Sweden... If a rolling brake test has been carried out on a vehicle with a pneumatic brake system...
Tests according to Annex 1	*See next slides*		

Tests according to Annex I are summarised below. Additional or slight deviations in requirements are underlined.

	EU (Italy)	Germany	Sweden
ID of vehicle	0. VEHICLE IDENTIFICATION	0 . Identification and description of the vehicle	9.3 REGISTRATION DETAILS
Braking Equipment	1.1. Mechanical condition and functioning 1.2. Performance and efficiency of the service brake 1.3. Performance and efficiency of the emergency brake 1.4. <u>Handbrake</u> performance and efficiency 1.5. System performance <u>electronic braking</u> 1.6. Anti-lock braking system (ABS) 1.7. Electronic braking system (EBS) 1.8. Brake fluid	1.1 . Mechanical condition and function 1.2. Service brake: effect, effectiveness 1.3. (auxiliary brake emergency brake): effect and effectiveness (if separate system) 1.4. Parking brake: effect and effectiveness 1.5 Effectiveness of the continuous braking system 1.6 Automatic anti-lock device (ABV) 1.7 Electronic braking system (EBS) 1.8 Brake fluid	4.1 SERVICE BRAKE – PERFORMANCE 4.2 SERVICE BRAKE – FUNCTION 4.3 SERVICE BRAKE – OPERATION 4.4 PARKING BRAKE – TRANSMISSION 4.5 PARKING BRAKE – ADJUSTMENT 4.6 SERVICE BRAKE –ENERGY SUPPLY 4.7 PARKING BRAKE
Steering	2.1. Mechanical condition 2.2. Steering wheel, column and bar 2.3. Steering play 2.4. Wheel alignment 2.5. Steering axle of the trailer 2.6. Electric Power Steering (EPS)	2.1. Steering , steering gear and steering transmission parts 2.2. Steering wheel, handlebars, steering column 2.3 Steering play 2.5. Turntable/turntable 2.6. Electronic power steering	5.1 CONTROL MECHANISM 5.2 LINKAGE
Visibility	3.1. Field of vision 3.2. Condition of the glass 3.3. Mirrors or devicesrear-view mirrors 3.4. Windshield wiper front 3.5. Windscreen washers	3.1 Field of view 3.2 Condition of the panes 3.3 Rearview mirrors or rearview devices 3.4 Windshield wipers 3.5 Windshield washer system	7.1 VISION AID 7.2 LIGHT MARKGINGS 7.3 SIGNALS

	EU (Italy)	Germany	Sweden
Lamps, reflectors	4.1. Headlights 4.2. Front and rear position lights, side lights, clearance lights and daytime running lights 4.3. Stop lights 4.4. Direction and emergency indicator lights 4.5. Front fog light and rear fog light 4.6. Reversing lights 4.7. Rear license plate lighting device 4.8. Reflectors, markers (retro-reflective) and rear marking plates 4.9. Mandatory warning lights for the lighting system 4.10. Electrical connections between towing vehicle and the trailer or the semi-trailer 4.11. Electrical circuit 4.12. Headlights and reflectors not mandatory 4.13. Battery(s)	4.1. Low beam and high beam headlights 4.2. Marker and tail lights, side marker lights, clearance lights and daytime running lights 4.3. brake-lights 4.4. Direction indicators and hazard warning lights 4.5. Fog lights and rear fog lights 4.6. Reversing lights 4.7. License plate lighting 4.8. Reflectors, conspicuous (retroreflective) ... 4.9. Indicator lights for the lighting system 4.10 Electrical connections between towing vehicle 4.11 Electrical cables 4.12 Other active and passive lighting equipment 4.13 Battery(s)	7.1.3 Headlamps for full and dipped beam 7.1.4 Fog lights 7.1.5 Remote headlights 7.1.6 Reversing headlights 7.1.7 Work lighting
Axles, wheels, suspension	5.1 Axles 5.2. Wheels and tyres 5.3. Suspension system	5.1 Axles 5.2 Wheels and tires 5.3 Suspension	1.2 Attachment 2.1 Wheels 2.2 SPRING SYSTEM 2.3 AXLE/LINKAGE
Chassis	6.1. Chassis or body and elements fixed to the chassis 6.2. Cabin and bodywork	6.1 Chassis or frame and or parts attached thereto 6.2. Driver's cab, body, motorcycle clothing	1.1 SUPPORTING CONSTRUCTION 1.3 PROTECTION 3.1 POWER SOURCE 3.2 DRIVING (immobiliser) 6.1 BODY EXTERIOR 6.5 GAS CONTROL 8.1 TRAVEL INTRUMENTS 9.1 COUPLING DEVICE 9.2 TRAFFIC DANGEROUS DEVICES

	EU (Italy)	Germany	Sweden
Other	7.1. Seat belts/buckles and restraint systems 7.2. Fire extinguisher 7.3. Locks and anti-theft devices 7.4. Warning triangle (if prescribed) 7.5. First aid kit (if prescribed) 7.6. Wheel chocks (wedges) (if prescribed) 7.7. Acoustic signal 7.8. Speedometer 7.9. Tachograph (if fitted/required) 7.10. Speed limiter (if fitted/required) 7.11. Odometer if available 7.12. Electronic control of stability (ESC)	7.1. Equipment for active and passive safety 7.3 Security against unauthorized use 7.4 Warning triangle 7.5 First aid kit 7.6 Wheel chock 7.7 Sound signaling devices 7.8 Speedometer 7.9 Recording device and tachograph 7.10 Speed limiter 7.11 Odometer 7.12 ESP 7.13 eCall	6.2 PERSONAL SPACE 6.3 LOAD HANDLING 6.4 ADDITIONAL EQUIPMENT
Nuisance (emissions)	8.1. Noise 8.2. Exhaust emissions 8.3. Suppression of electromagnetic interference 8.4. Other items relating to the environment	8.1 Noises 8.2. Exhaust fumes 8.3 Electromagnetic compatibility 8.4 Other environmentally relevant positions	30.1 EXHAUST CLEANING - EQUIPMENT, ADJUSTMENT AND FUNCTION 30.2 EXHAUST GAS PETROL DRIVEN 30.3 EXHAUST GAS DIESEL DRIVEN 30.4 REFRIGERANT
Supplementary tests for passenger-carrying vehicles of categories M2 and M3	9.1. Doors 9.2. Anti-fog and anti-fog system defrost 9.3. Ventilation system or heating 9.4. Seats 9.5. Internal lighting and route indications 9.6. Corridors, spaces for standing passengers 9.7. Stairs and steps 9.8. Passenger communication system 9.9. Written directions 9.10. Transport of children 9.11. Transport of people with reduced mobility 9.12.1. Installations for food preparation 9.12.2. Sanitary	9. A. Additional tests for vehicles for commercial passenger transport 9.1 Doors 9.4 Seats 9.5 Interior Lighting 9.6 Aisles, standing room 9.7 Steps 9.10 . Transport of children/pupils 9.11 People with reduced mobility B. Additional checks for taxis and rental cars C. Additional tests for ambulances	13. FIRE PROTECTION CHECK OF BUS 13.1 POWER SOURCE 13.2 PERSONAL, CARGO AND ENGINE SPACE

11.2.2 Transposition of Directive 2014/47/EU

The colour in the left-hand column indicates the extent of variation (green: small, yellow: moderate, red: high). Text in orange indicates an additional text in the Italian formulation of the EU requirement.

	EU (Italy)	Germany	Sweden
Quality	1. The competent authority shall ensure that the selected vehicles, in accordance with the art. 9, are subjected to a technical check on initial road. In every initial roadside technical check carried out on a vehicle, the inspector: a) check the latest MOT certificate and the latest report on a technical roadside inspection, if available, kept on board or the relevant electronic certificates in compliance of the art. 7, p 1; b) carries out a visual assessment of the technical conditions of the vehicle; c) can proceed with a visual evaluation of the fixation of the loading of the vehicle, in accordance with the art. 13; d) can carry out technical checks **using any method deemed appropriat**e. 2. The technical controls referred to in paragraph 2 may be carried out to justify the decision to subject the vehicle to a more in-depth technical roadside inspection or to request that the deficiencies are rectified without delay pursuant to art. 14, paragraph 1. 3. The inspector checks that any have been rectified deficiencies reported in the previous roadside inspection report. 4. Based on the result of the initial inspection, the inspector decides whether the vehicle or its trailer must be subjected to a more thorough roadside inspection. 5. A more in-depth roadside technical check concerns the elements listed in Annex II that are considered necessary relevant, taking into account, in particular, the safety of brakes, tyres, wheels and chassis and harmful effects, and methods recommendations applicable to the control of these elements. 6. Where the audit certificate or an inspection report on the road demonstrates that one of the areas listed in Annex II is been the subject of an inspection during the previous three months, the inspector does not check it except in cases where this is the case justified by an obvious deficiency.	If the initial technical roadside inspection reveals that certain items listed in Annex II to Directive 2014/47/EU cannot be checked, but such a check is deemed necessary, the vehicle or its trailer shall be subject to a more thorough roadside inspection. The more thorough roadside inspection shall take particular account of the safety of the braking and steering systems, tires, wheels, chassis and environmental impact.	A bus, a heavy truck or a trailer with a gross weight in excess of 3.5 tonnes, which is stopped for a flying inspection, shall not be checked if the driver of the vehicle can demonstrate that the vehicle has, during the last three months, undergone 1. a full control inspection, 2. a flying inspection, or 3. a mandatory road safety test according to the European Parliament and Council Directive 2014/45/EU, in the original wording, in any other country. However, the first paragraph does not apply 1. if the vehicle is clearly defective, 2. if the check concerns any other equipment than the one that was checked at the previous flying inspection, or 3. checking that simple defects have been remedied.

	EU (Italy)	Germany	Sweden
Inspectors	2. When carrying out a technical roadside inspection, the inspector has the obligation to abstain in case of conflicts of interest that may arise in some way influence the impartiality and objectivity of his decision. 3. The inspectors are due a remuneration which is not directly connected to the results of technical checks on the road, initial or more in-depth investigations carried out by them, determined by the decree referred to the art. 15, paragraph 2	The inspectors and their representatives who carry out the more thorough inspection must meet the minimum qualification and training requirements set out in Article 13 and Annex IV of Directive 2014/45/EU.	§ 1 A police officer who is being trained for authorization F1 or F2 must undergo a special competency test that includes both practical and theoretical elements... Authorization levels F1, F2, F3
Training of inspectors	4. More detailed roadside technical checks are carried out by inspectors who meet the minimum competence requirements training provided for by the art. 13 and Annex IV of the directive 2014/45/EU. The inspectors, who carry out checks in special places systems for roadside checks or which use mobile units control, must meet these requirements or equivalent requirements approved by the competent authority.		In order to be certified as an inspection technician or to perform flying inspections with autohorisation F3, the applicant must have at least three years of documented experience or the equivalent such a documented mentoring or studies and appropriate training in the field of road vehicles as well as the required vehicle competence for the vehicle the authorisation refers to, the necessary competence to carry out inspections of vehicles in accordance with the Vehicle Act and the Vehicle Ordinance as well as the Swedish Transport Agency's regulations in a satisfactory correct safe and hassle-free manner. The competence requirement is set to ensure that the person who is certified as an inspection technician can independently and impartially ...

	EU (Italy)	Germany	Sweden
Control Equipment	3. The **mobile control units** and the appropriate systems for the roadside checks have adequate equipment for carry out a more in-depth roadside technical check, including the equipment necessary to evaluate the status and efficiency of the **brakes, steering, suspension and the harmful effect**s of vehicle as prescribed. If the mobile control units or the do not have special systems for roadside checks of the equipment needed to control an indicated item during the initial check, the vehicle is directed towards a control center or facility where it is possible to carry out a thorough inspection of the item in question.	(6) The more thorough technical roadside inspection shall be carried out in an inspection body in accordance with Annex VIIId of the Road Traffic Licensing Regulations, using a **mobile inspection unit** or in a special roadside inspection facility. If the more thorough check is to be carried out in an inspection body or in a special roadside inspection facility, the checks must be carried out as quickly as possible in one of the nearest usable inspection bodies or facilities. Mobile inspection units and special roadside inspection facilities shall have appropriate equipment to carry out a more thorough inspection, in particular to assess the condition of the **brakes and braking performance, the steering and suspension of the vehicle and the environmental impact of the vehicle**. ...	A more detailed technical road inspection must be carried out according to the applicable inspection program and with prescribed equipment, according to the Swedish Transport Agency's regulations and general advice (TSFS 2017:54) on inspection inspections. (TSFS 2018:47)
Discrimination	1. When selecting a vehicle to undergo an inspection technician on the road or in carrying out the said check, the inspectors do not practice any discrimination based on nationality of the driver or the country of registration or of placing the vehicle into service.	(1) The selection of a vehicle for the inspection and the performance of the inspections shall take place...2.without distinction as to the nationality of the driver or the State in which the commercial vehicle was registered or put into service,	§ 3 The vehicle must be checked so that it has not deteriorated to an impermissible degree according to the Swedish Transport Agency's regulations and general advice (TSFS 2017:54) on control inspections § 4 Flying inspection must primarily take place on vehicles with defects

	EU (Italy)	Germany	Sweden
Drivers / Certificate	1. The inspection certificate relating to the technical inspection most recent periodical or its copy or, in the case of a certificate electronic review, a certified paper copy or the paper original of this certificate and the related report at the last technical roadside inspection, are kept on board the vehicle. 2. Companies and drivers of a vehicle subjected to a technical road control collaborate with inspectors and allow access to the vehicle, its parts and all useful documentation for control purposes.	The inspection report according to number 1 and the inspection certificate according to number 2 must be carried in the vehicle for the purpose of the inspection.	Such flying inspection report referred to in Article 7 of Directive 2014/47/EU of the European Parliament and of the Council, in its original wording, must be carried in a bus, a heavy truck, a trailer with a total weight of more than 3.5 tons or a tractor b. The report must be shown on request to a car inspector or police officer if available and it is not unnecessary.

	EU (Italy)	Germany	Sweden
Deficiencies	Evaluation of shortcomings 1. For each element to be subjected to control, Annex II provides a list of possible deficiencies and their level gravity, to be used during technical checks on the road. 2. Deficiencies detected during roadside technical checks are classified into one of the following groups: a) minor deficiencies that have no significant consequences on the vehicle safety or environmental impacts and other cases slight non-conformities; b) serious deficiencies that may jeopardize the safety of vehicle or affect the environment or put it at risk the safety of other road users and other more significant non-conformities; c) dangerous deficiencies that constitute a direct risk immediate for road safety or which have repercussions on the environment. 3. A vehicle, with deficiencies that fall into more than one group of deficiencies referred to in paragraph 2, is classified in the corresponding group to the most serious deficiency. A vehicle that has several shortcomings relating to the same areas subject to roadside technical checks, defined in point 1 of Annex II, may be classified in group of deficiencies of the immediately higher level of severity, if the combined effect of such deficiencies is believed to result in a higher risk for road safety.	1. The deficiencies identified during the inspection shall be classified into one of the groups: minor deficiencies, major deficiencies or dangerous deficiencies, according to the assessment made in Annex II to Directive 2014/47/EU. If a vehicle has defects that fall into several defect groups, it will be placed in the group that corresponds to the most serious defect. A vehicle with several defects within the same test areas of the technical roadside inspection in accordance with point 1 of Annex II to Directive 2014/47/EU is classified in the next higher group of defects if it can be assumed that the combination of these defects results in a greater risk to road safety or the environment . (2) If significant or dangerous defects are discovered during the inspection of a vehicle, use of the vehicle may be temporarily prohibited until the defects have been eliminated. If dangerous defects have been identified, temporary use of the vehicle may be permitted solely for the purpose of correcting the defects if the operation of the vehicle does not pose any immediate danger to the safety of the passengers or other road users or to the environment. In the case of defects that do not need to be remedied immediately, the competent authority shall determine a reasonable period within which the deficiencies must be remedied. The authorization to temporarily continue using the vehicle can be subject to conditions and requirements.	If it turns out during a flying inspection that a vehicle has defects that are of only minor importance from a traffic safety or environmental point of view, the enforcement officer must point out the defects to the vehicle's driver. If the defects of an inspected vehicle are so great that the vehicle cannot be used without obvious danger to traffic safety, the administrator must issue a driving ban for it. If the vehicle during a flying inspection only has simple defects that did not occur during the last control inspection or flying inspection, the vehicle owner must remedy the defects. In such a case, what is said in §§ 18 and 19 applies if the repair and testing takes place within two months of the inspection. If, during a flying inspection, the vehicle has defects other than those referred to in §§ 25-27, the vehicle owner must remedy them and the bailiff instruct him to, within a certain time, 1. have the vehicle undergo a control inspection, 2. have the vehicle repaired and tested at demonstrate to an accredited workshop or to an inspection body that the deficiencies have been remedied, or 3. in the case of a vehicle that is not subject to registration according to the Act (2019:370) on vehicle registration and use, through a certificate or in any other reliable way evidence for the Police Authority that the deficiencies have been remedied. If an order according to the first paragraph has not been followed, the vehicle will be prohibited from driving. In the case of testing and repair at an accredited workshop, what is said in section 17, third and fourth paragraphs and section 19 applies in terms of certificates. Ordinance (2019:396). If it turns out during a flying inspection that a vehicle has been changed in such a way as referred to in ch. 4. Section 20, first paragraph, the bailiff must instruct the vehicle owner to have it undergo a registration inspection within one month. If the vehicle has not undergone a registration inspection within the prescribed time, it will be banned from driving.

	EU (Italy)	Germany	Sweden
Deficiencies (contd.)	Follow-up in case of serious or dangerous deficiencies 1. Without prejudice to the provisions of paragraph 3, the competent authority provides that any serious or dangerous deficiency found in a initial check or a more in-depth check, either rectified before the vehicle is put back into circulation on the public road network. 2. Following a roadside inspection of a registered vehicle on national territory, the inspector can decide to have the test submitted the vehicle itself to a complete technical check within a deadline specified. If the vehicle is registered in another Member State of the European Union, the competent authority may request to the competent authority of that State, via the contact points referred to in the art. 17, to carry out a new technical check of the vehicle according to the procedure referred to in art. 18, paragraph 2. If serious or dangerous deficiencies are detected on a registered vehicle outside the European Union, the competent authority can decide to inform the competent authority of the country of registration of the vehicle. 3. In case of deficiencies requiring rapid rectification or immediate due to a direct and immediate safety risk road, the competent authority orders that the use of the vehicle be limited or prohibited for as long as such deficiencies have been rectified. The use of the vehicle in question can be authorized so that it can reach one of the workshops closest mechanics where said deficiencies may exist rectified, provided that the deficiencies have been remedied dangers in question in such a way as to allow the vehicle to reach said workshop without immediate risk to safety its occupants or other road users. In case of deficiencies which do not require immediate rectification, the competent authority can decide under what conditions and for what reasonable period of time time the vehicle can be used before rectification of the deficiency. If the vehicle cannot be repaired in order to reach the workshop, it can be taken to a location available where it can be repaired.	(3) Without prejudice to paragraph 2, the competent authority may initiate the following measures in the event of significant or dangerous defects: 1. Transmission of the inspection report to the responsible registration authority so that it can decide on orders in accordance with Section 5 of the Vehicle Registration Ordinance, 2. the refusal of entry into the Federal Republic of Germany of commercial vehicles registered in a third country.	If a remark is directed at one or more defects on the vehicle with the assessment three (3) according to the control program, the vehicle shall be considered as defective that the vehicle cannot be used without obvious danger to traffic safety. A driving ban must then be issued for the vehicle in accordance with ch. 6. Section 16 of the Vehicle Ordinance (2009:211). If a remark is directed at one or more defects on the vehicle with assessment two (2) according to the control program, injunction according to ch. 6. Section 17 of the vehicle ordinance (2009:211) is notified. Deficiencies that interact in such a way that their combined effect is assigned a significantly greater negative significance from a traffic safety point of view than the individual defects individually, they must be assessed together if it can be assumed that the assessment result means that the vehicle, when used on the road, poses an obvious danger to traffic safety (assessment S). A cross (x) after assessment two (2) in the control program means that the individual deficiency is to be considered simple. However, this does not apply in cases stated in §§ 5 and 6. If it can be established that deficiencies with the assessment two (2) marked with a cross (x) amount to five or more, an injunction according to ch. 6. Section 17 of the vehicle ordinance (2009:211) is notified. If it can be established that a previously noted deficiency with the assessment two (2) marked with a cross (x), remains and includes the same description of the error as in the previous control inspection or flying inspection, injunction according to ch. 6. Section 17 of the vehicle ordinance (2009:211) is notified. If the vehicle is failed with the assessment "Change: - Deficiency to be remedied by restoration", the vehicle must only be approved if the vehicle is restored in the most recently approved design. If the vehicle has not been restored, an injunction according to ch. 6. § 20 vehicle transport

	EU (Italy)	Germany	Sweden
Cargo securing	Load securing check 1. During roadside checks a vehicle may be subjected to the inspection of the securing of his load in accordance with the Annex III, to ensure that the load is secured in such a way that it does not interfere with the safe operation of the vehicle or pose a threat for life, health, property or the environment. Controls can be carried out to verify that during all phases of vehicle operation, including emergency situations and starting maneuvers uphill, the loads can only be minimal changes in position relative to each other and with respect to walls and surfaces of the vehicle and cannot escape from compartment intended for goods or move outside the loading surface. 2. Without prejudice to the provisions applicable to the transport of certain categories of goods such as those covered by the Agreement European Union relating to the international transport of dangerous goods on road (ADR), load securing and control cargo securing can be carried out in accordance with principles and, where appropriate, the rules set out in Section I Annex III. You can use the latest version of the standards referred to in Annex III, Section I, point 5. 3. The procedures regarding the consequences, referred to in art. 14, they can also be applied in case of serious or dangerous deficiencies of load securing.	1. visual inspection of the securing of the vehicle's load in accordance with Section 22 (1) of the Road Traffic Regulations and Annex III Section II of Directive 2014/47/EU	1. that certain equipment must be of a type that has been approved by the board or any other authority, 2. which values may be used in local traffic regulations regarding maximum permitted speed and contain guidelines for how different values should be used, 3. requirements for securing loads on vehicles during travel, 4. requirements for characteristics of load securing equipment, and 5. requirements for documentation when securing loads. inspections carried out from 20 May 2018.

	EU (Italy)	Germany	Sweden
Exchange of information	Designation of a point of contact 1. For the purposes of this decree, the Ministry of Infrastructure and Transport - Department of Transport, Shipping, general affairs and personnel - General management for motorization, is designated point of contact. In this context: a) ensure coordination with the designated contact points by the other Member States of the European Union as far as they are concerned actions undertaken pursuant to art. 18; b) forwards the data referred to in art. to the European Commission. 20; c) ensure, where appropriate, any other exchange of information and assistance to contact points in other Member States of European Union.	The Federal Office for Logistics and Mobility is designated as the contact point responsible for the Federal Republic of Germany for the purposes of providing information and administrative assistance among the Member States and their authorities and for reporting to the Commission of the European Union in accordance with Sections 8 to 10 of this Regulation.	The Swedish Transport Agency is the national contact point according to Article 15 of the European Directive 2014/45/EU of the Parliament and of the Council, in the original wording, and according to Article 17 of Directive 2014/47/EU of the European Parliament and of the Council, in the original wording.

	EU (Italy)	Germany	Sweden
Transport companies with a high-risk profile	Risk classification system 1. For the vehicles referred to in art. 2, paragraph 1, letters a), b) and c), the competent authority shall ensure that the relevant information is provided the number and severity of the deficiencies referred to in Annex II and, if where applicable, in Annex III, detected in vehicles operated by individual companies are included in the classification system of risk established pursuant to art. 11 of the legislative decree 4 August 2008, n. 144. For assigning a profile to a company of risk, the competent authority may make use of the criteria referred to in Annex I. This information is used to submit to more rigorous and frequent checks on companies that present a high risk factor. The risk classification system it is managed by the competent authority. 2. For the purposes of applying paragraph 1, the competent authority use the information received to register the vehicle by the competent authorities of the other Member States of the Union European, pursuant to art. 18, paragraph 1. 3. The competent authority may provide for technical controls additional volunteers. Information on compliance with obligations of conformity relating to the conditions of the vehicles resulting from Voluntary checks may be considered for improve a company's risk profile. Inspection procedures 1. In identifying the vehicles to be subjected to a technical inspection on initial road, inspectors can select in street priority vehicles used by companies with a profile of high risk, pursuant to legislative decree 4 August 2008, n. 144. Vehicles may also be selected at random for inspection or if you suspect that they present a security risk road or the environment.	Regardless of suspicion or if there is a suspicion that the vehicle poses a risk to road safety or the environment or - as soon as and as far as possible - by identifying vehicles operated by companies with a high risk profile within the meaning of Article 6 of Directive 2014/47/EU.	§ 5 Flying inspection of commercial vehicles must primarily take place on vehicles owned or used by a company with a high risk value, or on vehicles that are driven with defects.

	EU (Italy)	Germany	Sweden
Nuisance (emissions)	8.2.1.1. Control system of exhaust gas emissions exhaust emissions Visual inspection (a) Emission control device fitted by the manufacturer missing modified or obviously defective (b) Leaks which could affect emission measurements. (c) Fault indicator does not follow the correct sequence 8.2.1.2. Gaseous emissions - For vehicles belonging to emission classes EUR 5 and Euro V or lower (7) - Measurement by means of a exhaust gas analyser exhaust gas analyser according to requirements 1 or reading of the OBD device. The control of the exhaust pipe (a) Gaseous emissions exceed the levels specified by the manufacturer (b) Or, if this information is not available, the CO emissions exceed (i) for vehicles not controlled by an advanced emission control system emissions, - 4,5 %, o 8.2.1.2. Gaseous emissions - For vehicles belonging to emission classes EUR 5 and Euro V or lower (7) - Measurement by means of a exhaust gas analyser exhaust gas analyser according to requirements 1 or reading of the OBD device. The control of the exhaust pipe shall be the standard method for assessing of exhaust emissions. On the basis of an assessment of equivalence and taking into account the relevant legislation on type-approval legislation, Member Member States may authorise the use of the OBD device, in in accordance with the manufacturer's recommendations manufacturer's recommendations and other requirements. - For vehicles belonging emission classes EUR 6 and Euro VI or higher (7): - measurement by means of a exhaust gas analyser exhaust gas analyser according to requirements 1 or reading of the OBD device in accordance with the recommendations of the manufacturer's recommendations and other requirements 1. - Measurement not applicable to two-stroke engines - Alternatively, measurement by means of a remote sensing equipment to be confirmed by standard test procedures 8.2.2. Emissions from compression ignition engines 8.4. Other elements related to the environment	(3) Each initial technical roadside inspection shall include: 1. an examination of the last inspection report drawn up for the commercial vehicle relating to an inspection under Directive **2014/47/EU**, including verification that the deficiencies identified therein have been rectified, 2. an inspection of the last certificate of inspection in accordance with Directive **2014/45/EU** 3. a visual inspection of the technical condition of the commercial vehicle.The inspection report in accordance with number 1 and the inspection certificate in accordance with number 2 must be carried in the vehicle for the purpose of the inspection. (4) In addition to the types of inspection referred to in paragraph 3, the initial technical roadside inspection may include the following: ... 2. technical inspection of items listed in Annex II of Directive **2014/47/EU** by any method deemed appropriate.	A check of the vehicle with regard to emissions or leaks of gas, liquids and solid objects must be done. A check must be carried out when unnatural sounds and visible smoke occur for the type of vehicle. (TSFS 2018:47)

	EU (Italy)	Germany	Sweden
Nuisance (noise)	8.1.1 Noise protection system from noise (+ E) Subjective assessment (unless unless the inspector considers that the sound level is at the permissible limits, in which in which case a carried out a measurement of the noise emitted while the vehicle stationary by means of a phonometer) (a) Noise levels exceeding those permitted by requirement 1 b) Any element of the noise protection system noise protection system is incorrectly fixed, is damaged, incorrectly mounted missing or clearly modified in such that it has an adverse effect on noise level. Very serious risk of detachment.	[see previous slide]	[see previous slide]

11.3 Appendix 3: Overview of points in (EU) 2019/621 Annex with information requirement with corresponding deficiencies classification according to (EU) 2014/45

11.3.1 Overview of points in (EU) 2019/621 Annex with information requirement for accident prone categories

Potential measure	Item	Method	Information Needed according to (EU) 2019/621	Type of Vehicle	Deficiencies according to (EU) 2014/45		
					Min	Maj	Dang
Training (UN rqmt)	1.1.3. Vacuum pump or compressor and reservoirs	Visual inspection of the components at normal working pressure. Check time required for vacuum or air pressure to reach safe working value and function of warning device, multi-circuit protection valve and pressure relief valve.	Pressure/max. cut out – min. cut in [bar] See UN R13 5.1.4.5.2 Multi-circuit protection valve static closing pressure [bar] See UN R13 5.1.4.5.2	> 3,5 t, T		X	X
Workshop manual (vehicle specific)	1.1.6. Parking brake activator, lever control, parking brake ratchet,	Visual inspection of the components while the braking system is operated.	General description for electronic parking brake	< 3,5 t, > 3,5 t, T	X	X	

	electronic parking brake						
Training (UN rqmt)	1.1.13. Brake linings and pads	Visual inspection.	Method of assessing wear and wear limit See UN R13 5.2.1.11.2 and 5.2.2.8.2.	< 3,5 t, > 3,5 t, O, L,		X	X
Training (UN rqmt)	1.1.14. Brake drums, brake discs	Visual inspection.	Method of assessing wear and wear limit See UN R13 5.2.1.11.2 and 5.2.2.8.2.	< 3,5 t, > 3,5 t, O,		X	X
Training (UN rqmt)	1.1.16. Brake actuators (including spring brakes or hydraulic cylinders)	Visual inspection of the components while the braking system is operated, if possible.	Brake cylinder type Service/Parking Maximum stroke [mm] Lever length [mm] See UN R13 5.1.4.5.2	> 3,5 t, O,	X	X	X
Training (UN rqmt)	1.1.17. Load sensing valve	Visual inspection of the components while the braking system is operated, if possible.	Input pressure [bar] Output pressure for x % of maximum axle load [bar] UN R 13 Annex 1 7.4 + Diagram 5	> 3,5 t, O,	X	X	X
Training (UN rqmt)	1.1.18. Slack adjusters and indicators	Visual inspection.	Maximum stroke [mm] See UN R13 5.1.4.5.2	> 3,5 t, O,		X	

			working principle [automatic/manual adjusted]				
Training (UN/EU rqmt)	1.1.22. Test connections (where fitted or required)	Visual inspection	Location and identification of test connections See UN R 13 5.1.4.2 Location and identification of test connections See 2015/68 Annex I. 2.1.8.1	> 3,5 t, O, T	X	X	
Structured format	1.2.1. Performance	During a test on a brake tester or, if impossible, during a road test, apply the brakes progressively up to maximum effort.	Specific requirements for testing vehicle on a brake tester (test mode)	< 3,5 t, > 3,5 t, O, L, T		X	X

Training (UN rqmt)	1.2.2. Efficiency	Test with a brake tester or, if one cannot be used for technical reasons, by a road test using a deceleration recording instrument to establish the braking ratio which relates to the maximum authorised mass or, in the case of semi-trailers, to the sum of the authorised axle loads.	Design system pressure for maximum load [bar] See UN R13 5.1.4.5.2 Reference brake force [kN] at input pressure [bar] axle 1 Reference brake force [kN] at input pressure [bar] axle 2 Reference brake force [kN] at input pressure [bar] axle 3 Reference brake force [kN] at input pressure [bar] axle 4 See UN R13 5.1.4.6.2 Calculation pressure for each axle	> 3,5 t, O,		X	X
Structured format	1.3.1. Performance	If the secondary braking system is separate from the service braking system, use the method specified in 1.2.1.	General description of system including circuits (clear definition of the secondary brake)	< 3,5 t, > 3,5 t, T		X	X
Structured format	1.4.1. Performance	Apply the brake during a test on a brake tester.	General description of system including recommended test procedure if dynamic test (on brake tester or road test) not possible	< 3,5 t, > 3,5 t, O,		X	X

Workshop manual (vehicle specific)	1.5. Endurance braking system performance	Visual inspection and, where possible, test whether the system functions.	General description	> 3,5 t,		X	
Electronic Interface Tool Information Requirement	1.6. Anti-lock braking system (ABS)	Visual inspection and inspection of warning device and/or using electronic vehicle interface.	instructions for the use of the electronic vehicle interface	< 3,5 t, > 3,5 t, O, L, T		X	
Electronic Interface Tool Information Requirement	1.7. Electronic brake system (EBS)	Visual inspection and inspection of warning device and/or using electronic vehicle interface.	instructions for the use of the electronic vehicle interface	< 3,5 t, > 3,5 t, O, T		X	
Workshop manual (vehicle specific)	2.2.2. Steering column/yokes and forks and steering dampers	With the vehicle over a pit or on a hoist and the mass of the vehicle on the ground, push and pull the steering wheel in line with column, push steering wheel/handle bar in various directions at right angles to the column/forks. Visual inspection of play, and condition of flexible couplings or universal joints.	Steering damper fitted (YES/NO)	L,		X	X

Electronic Interface Tool Information Requirement	2.6. Electronic Power Steering (EPS)	Visual inspection and consistency check between the angle of the steering wheel and the angle of the wheels when switching on/off the engine, and/or using the electronic vehicle interface	instructions for the use of the electronic vehicle interface	< 3,5 t, > 3,5 t,		X	X
Workshop manual (vehicle specific)	4.1.1. Condition and operation	Visual inspection and by operation.	Category of light source […,…]	< 3,5 t, > 3,5 t, L, T	X	X	
Structured format	4.1.2. Alignment	Determine the horizontal aim of each headlamp on dipped beam using a headlamp aiming device or using the electronic vehicle interface.	Alignment of dipped beam [per cent] for both vertical inclination and direction instructions for the use of the electronic vehicle interface For determining the horizontal aim by using the electronic vehicle interface information on the actuation of the headlamp beam movement to allow assessment of alignment	< 3,5 t, > 3,5 t, L,		X	

Electronic Interface Tool Information Requirement	4.1.3. Switching	Visual inspection and by operation or using the electronic vehicle interface	instructions for the use of the electronic vehicle interface	< 3,5 t, > 3,5 t, L,	X	X	
Electronic Interface Tool Information Requirement	4.1.5. Levelling devices (where mandatory)	Visual inspection and by operation, if possible, or using the electronic vehicle interface.	Operation mode [manual/automatic) instructions for the use of the electronic vehicle interface	< 3,5 t, > 3,5 t, L,		X	
Workshop manual (vehicle specific)	4.1.6. Headlamp cleaning device (where mandatory)	Visual inspection and by operation if possible.	Device mandatory [Y/N]	< 3,5 t, > 3,5 t,	X	X	
Workshop manual (vehicle specific)	4.2.1. Condition and operation	Visual inspection and by operation.	Fitment of daytime running lamps, [Y/N]	< 3,5 t, > 3,5 t, L,	X	X	
Electronic Interface Tool Information Requirement	4.3.2. Switching	Visual inspection and by operation or using the electronic vehicle interface.	Fitment of emergency stop signal, [Y/N] instructions for the use of the electronic vehicle interface	< 3,5 t, > 3,5 t, O,	X	X	X

Structured format	4.11. Electrical wiring	Visual inspection with vehicle over a pit or on a hoist, including inside the engine compartment (if applicable).	Wiring/cable identification (e.g. colour, shielding, cross section, size), insulation monitoring (high voltage) Location of any high voltage wiring	< 3,5 t, > 3,5 t, L,	X	X	X
Workshop manual (vehicle specific)	4.13. Battery(ies)	Visual inspection.	Location of battery(ies) Number of batteries Special arrangements for high voltage batteries Vehicle (VIN) specific information on battery switch [Y/N] Vehicle (VIN) specific information on battery fuse [Yes/No] Vehicle (VIN) specific information on battery ventilation [Yes/No] Vehicle (VIN) specific information on operation principle	< 3,5 t, > 3,5 t, L, T	X	X	
Workshop manual (vehicle specific)	5.1.1. Axles	Visual inspection with vehicle over a pit or on a hoist. Wheel play detectors may be used and are recommended for vehicles having a maximum mass exceeding 3,5 tonnes	General description, number of axles	< 3,5 t, > 3,5 t, O, L, T		X	X

Workshop manual (vehicle specific)	5.2.2. Wheels	Visual inspection of both sides of each wheel with vehicle over a pit or on a hoist.	Wheel size/dimensions/offset	< 3,5 t, > 3,5 t, O, L, T		X	X
Dedicated Approach	5.2.3. Tyres	Visual inspection of the entire tyre by either rotating the road wheel with it off the ground and the vehicle over a pit or on a hoist, or by rolling the vehicle backwards and forwards over a pit.	Tyre size, load capacity, speed category Tyre pressure monitoring system [N/Y] direct/indirect	< 3,5 t, > 3,5 t, O, L, T	X	X	X

11.3.2 Overview of points in (EU) 2019/621 Annex with information requirement for categories not directly related to accident data

Evaluation	Item	Method	Information Needed	Type of Vehicle	Assessment of deficiencies (summarised)		
					Min	Maj	Dang
Workshop manual	6.1.3. Fuel tank and pipes (including	Visual inspection with vehicle over a pit or on a hoist, use of leak	General description and location including shielding	< 3,5 t, > 3,5 t, L, T	X	X	X

(vehicle specific)	heating fuel tank and pipes)	detecting devices in the case of LPG/CNG/LNG systems.					
Workshop manual (vehicle specific)	6.1.4. Bumpers, lateral protection and rear underrun devices	Visual inspection.	Exempt side guards and or rear underrun (Y/N)	> 3,5 t, O,		X	X
Structured format	6.1.9. Engine performance (X)2	Visual inspection and/or using electronic interface	Engine Control Unit valid configuration Instructions for the use of the electronic vehicle interface Instructions on how to read the Calibration Identification Information about the valid Calibration Identifications Software identification number including checksums or similar integrity validation data.	< 3,5 t, > 3,5 t, L, T		X	X
Workshop manual	6.2.6. Other seats	Visual inspection.	Max Number of seats total (excluding driver's seat) Number of rear-facing seats	< 3,5 t, > 3,5 t,	X	X	

(vehicle specific)							
Workshop manual (vehicle specific)	7.1.1. Security of safety-belts/buckles mounting	Visual inspection.	Number and location of safety belt anchorage points	< 3,5 t, > 3,5 t, L, T		X	X
Workshop manual (vehicle specific)	7.1.2. Condition of safety-belts/buckles.	Visual inspection and by operation.	Safety belt category for each sitting position	< 3,5 t, > 3,5 t, L, T	X	X	X
Electronic Interface Tool Information Requirement	7.1.3. Safety belt load limiter	Visual inspection, and/or using electronic interface	instructions for the use of the electronic vehicle interface	< 3,5 t, > 3,5 t, L,		X	X
Electronic Interface Tool Information Requirement	7.1.4. Safety belt Pre-tensioners	Visual inspection, and/or using electronic interface	instructions for the use of the electronic vehicle interface	< 3,5 t, > 3,5 t, L,		X	X
Structured format	7.1.5. Airbag	Visual inspection, and/or using electronic interface	Number of airbags and location instructions for the use of the electronic vehicle interface	< 3,5 t, > 3,5 t, L,		X	X

Electronic Interface Tool Information Requirement	7.1.6. SRS Systems	Visual inspection of MIL, and/or using electronic interface	instructions for the use of the electronic vehicle interface	< 3,5 t, > 3,5 t, L,		X	X
Electronic Interface Tool Information Requirement	7.8. Speedometer	Visual inspection or by operation during road test or by electronical means.	instructions for the use of the electronic vehicle interface	> 3,5 t,	X	X	
Workshop manual (vehicle specific)	7.9. Tachograph (if fitted/required)	Visual inspection.	Sensor location Location of seals	> 3,5 t, T		X	
Electronic Interface Tool Information Requirement	7.11. Odometer if available (X)2	Visual inspection, and/or using electronic interface	Instructions for the use of the electronic vehicle interface	> 3,5 t, T		X	
Electronic Interface Tool Information Requirement	7.12. Electronic Stability Control (ESC)	Visual inspection, and/or using electronic interface	Instructions for the use of the electronic vehicle interface	> 3,5 t, T		X	

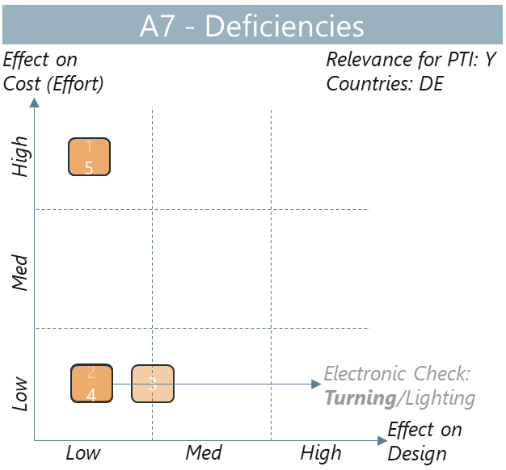
	if fitted/required						
Structured format	8.1.1. Noise suppression system	Subjective evaluation (unless the inspector considers that the noise level may be borderline, in which case a measurement of noise emitted by stationary vehicle using a sound level meter may be conducted)	Noise levels of stationary vehicle [dB(A) at 1/min].	> 3,5 t, T		X	
Workshop manual (vehicle specific)	8.2.1.1. Exhaust emissions control equipment	Visual inspection	Emission control system general description. Particulate trap installed [Y/N]	> 3,5 t, T		X	
Structured format	8.2.1.2. Gaseous emissions	Exhaust gas analyser, varies by Euro emission class	Levels of gaseous emissions if given by the manufacturer. Vehicle (VIN) or Engine Code specific information For tail-pipe testing: Engine preconditioning requirements such as min. Oil temp./water temp. [°C] and procedures to bring engine to	> 3,5 t, T		X	

			Type II testing mode- Type II emission test results- Engine idle CO [%]- High idle CO [%]- Lambda [] For OBD use: Connector & Communication protocol (Standard, power supply voltage, location)- List of DTCs (class A, B1 and B2 currently for HDV only)				
Workshop manual (vehicle specific)	8.2.2.1. Exhaust emission control equipment	Visual inspection.	Emission control system general description. Such as DeNOx system [Y/N] Particulate trap installed [Y/N] EGR location (Vehicle (VIN)/) engine type specific information	> 3,5 t, T		X	
Structured format	8.2.2.2. Opacity	Exhaust gas opacity, varies by Euro emission class	Vehicle (VIN) engine type specific information For tail-pipe testing: Engine preconditioning requirements such as min. Oil temp./water temp. [°C] and procedures to bring engine to Type II testing mode- k-value	> 3,5 t, T		X	

			recorded on the manufacturer's plate on the vehicle (type II emission test result)- Cut off Engine speed at Type II tests- Engine speed limiter for acceleration without load [Y/N]- Description for de-activation of Engine speed limiter to perform free acceleration test; For OBD use: Allowed DTC's at OBD scan {codes for NOx group 3 for LDV}- Connector & Communication protocol (Standard, power supply voltage, location)- List of DTCs (class A, B1 and B2 currently for HDV only)				

11.4 Appendix 4: Review of Impact on Design and Cost with respect to 2014/45/EU

Directive 2014/45/EU pertaining to Periodic Technical Inspection (PTI) applies to vehicles for the carriage of persons and their luggage (categories M_1, M_2, M_3), for the carriage of goods (N_1, N_2, N_3), trailers (O_3, O_4), light vehicles (L3e, L4e, L5e, L7e) and fast tractors (T5). The number in the orange boxes represent the chronological order of the interview that took place, where the interviewee (OEM representative) was requested to estimate effect on cost (effort) and effect of design for selected aspects of the legal document.



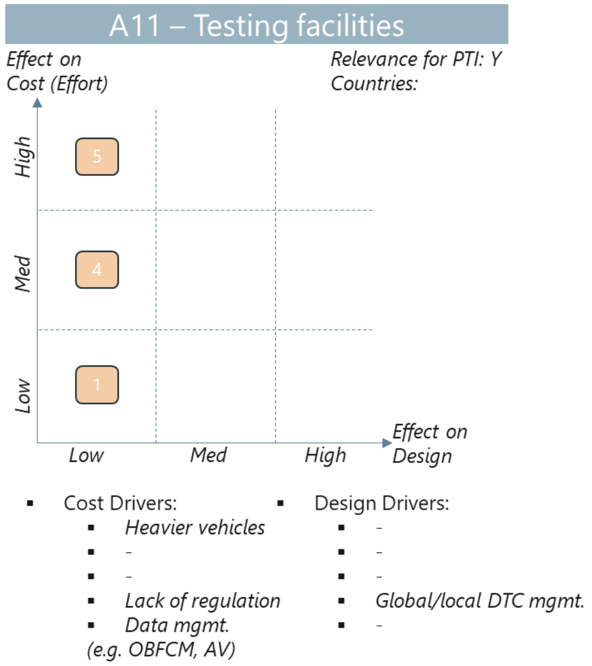
- Cost Drivers:
  - *EV battery repl.*
  - *User profile*
  - *(Garage visits)*
  - *Electronic checks (lighting)*
  - *Body components*
- Design Drivers:
  - *Obsolescence*
  - *Emissions*
  - *Data from garages*
  - *Electronic checks (lighting/**turning**)*
  - -

Impact on cost: varies

Potential additional impact on cost (↗): -

Impact on design: Low

Potential additional impact on design (↗): Electronic checks currently under development for turning/lighting (previously done by visual inspection) and required by countries such as Germany drive design changes.

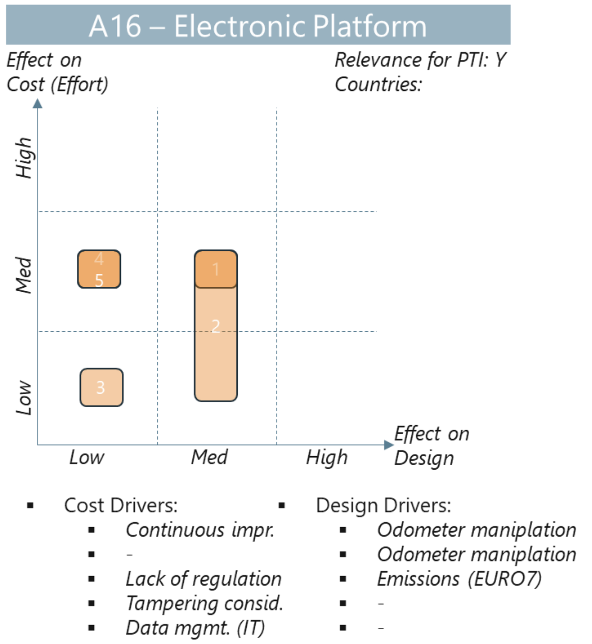


Impact on cost: varies

Potential additional impact on cost (↗): -

Impact on design: Low (vehicles are typically designed, testing facilities are designed around these parameters)

Potential additional impact on design (↗): -



Impact on cost: varies

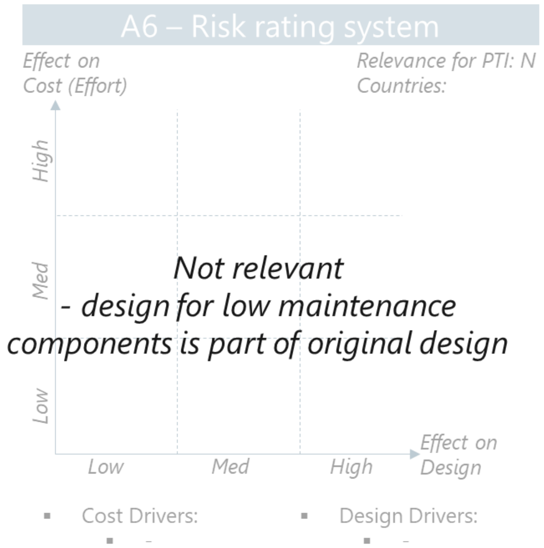
Potential additional impact on cost (↗): -

Impact on design: varies

Potential additional impact on design (↗): -

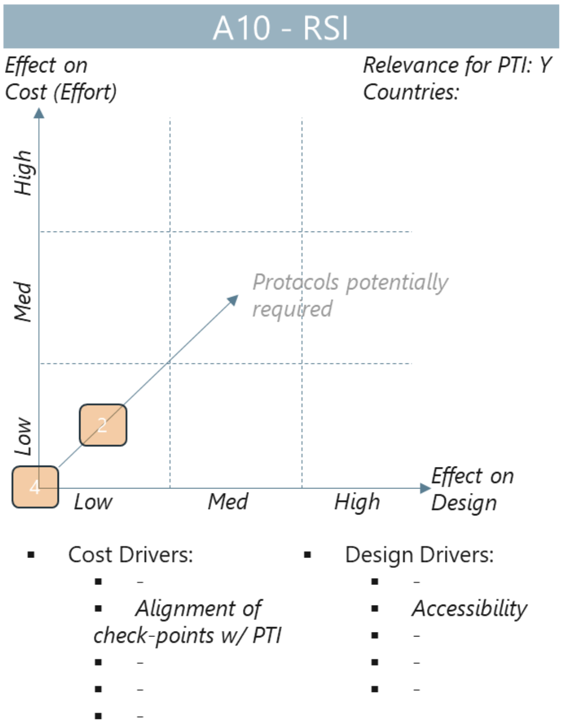
11.5 Appendix 5: Review of Impact on Design and Cost with respect to 2014/47/EU

Directive 2014/47/EU pertaining to Roadside Inspections (RSI) applies to vehicles for the carriage of persons and their luggage (categories M_2, M_3), for the carriage of goods (N_2, N_3), trailers (O_3, O_4) and fast tractors (T5).



Impact on cost: -

Impact on design: -

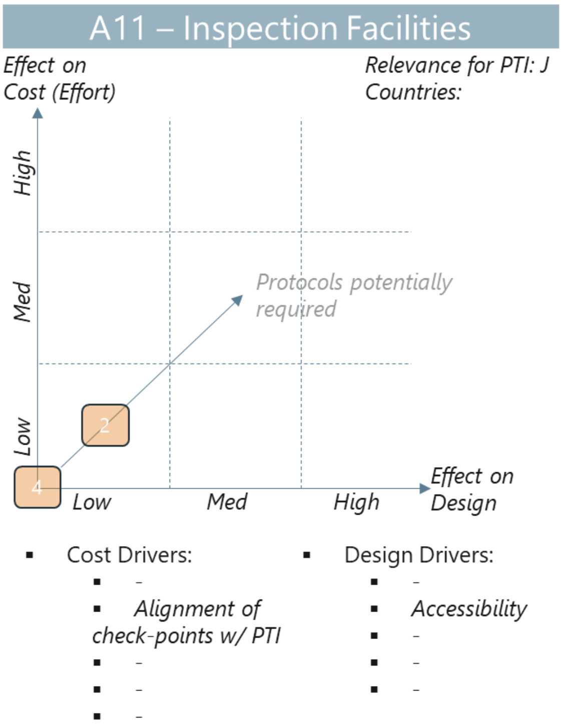


Impact on cost: Low

Potential additional impact on cost (↗): protocols for checking digital systems could drive cost.

Impact on design: Low

Potential additional impact on design (↗): protocols for checking digital systems could drive design requirements (accessibility)



Impact on cost: Low

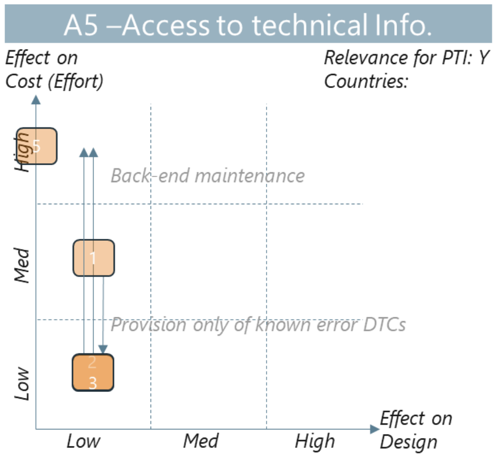
Potential additional impact on cost (↗): protocols for checking digital systems could drive cost.

Impact on design: Low

Potential additional impact on design (↗): protocols for checking digital systems could drive design requirements (accessibility)

11.6 Appendix 6: Review of Impact on Design and Cost with respect to (EU) 2019/621

Implementing Regulation (EU) 2019/621 applies to vehicles subject to roadworthiness tests pursuant to Directive 2014/45/EU.



- Cost Drivers:
  - *DTC mgmt*
  - *IT-Backend*
  - *Web-portal*
  - -
  - *Lack of regulation*
- Design Drivers:
  - -
  - -
  - -
  - -
  - -

Impact on cost: varies

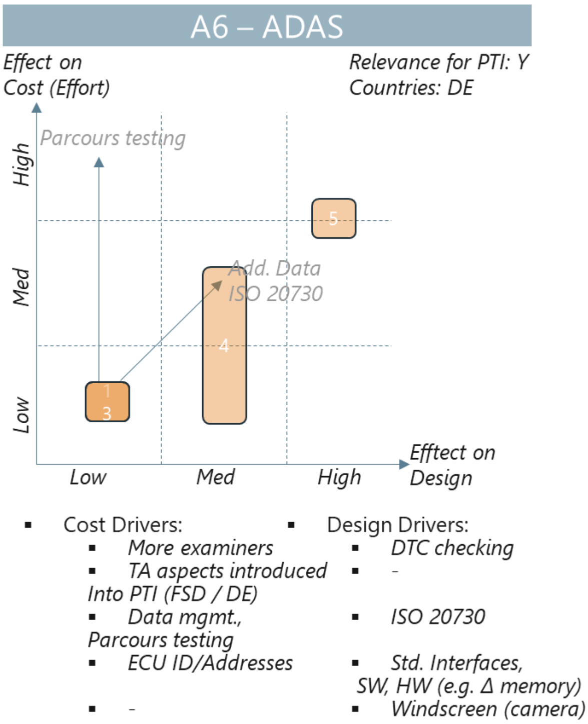
Potential additional impact on cost (↗): Maintenance of backend systems resulting from high or increased usage has potential to drive costs greatly. Conversely, provision of smaller data sets (e.g. required DTCs only, instead of all non-required DTCs) could have potential to reduce costs.

Impact on design: Low

Potential additional impact on design (↗): -

11.7 Appendix 7: Review of Impact on Design and Cost with respect to (EU) 2019/2144 (including delegated regulations)

Regulation (EU) 2019/2144 on general safety applies to vehicles of categories M, N and O, as defined in Article 4 of Regulation (EU) 2018/858.



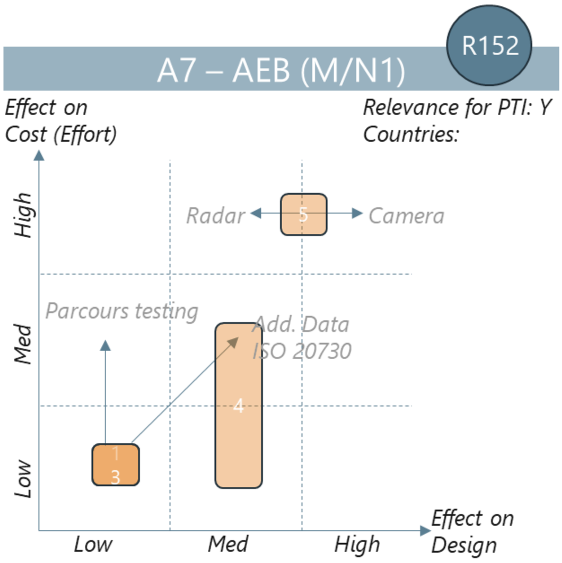
Vehicle Scope: M, N and O

Impact on cost: varies

Potential additional impact on cost (↗): additional data, ISO 20730 (ePTI) requirements, parkour testing

Impact on design: varies

Potential additional impact on design (↗): additional data, ISO 20730 (ePTI) requirements



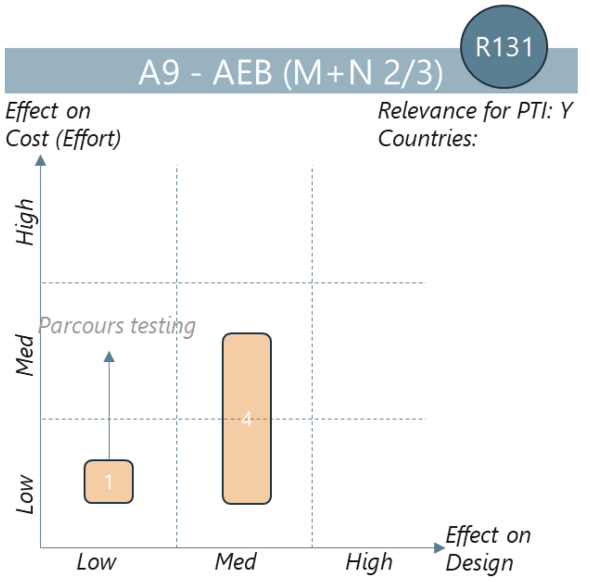
Vehicle Scope: M, N and O

Impact on cost: varies

Potential additional impact on cost (↗): additional data, ISO 20730 (ePTI) requirements, parkour testing

Impact on design: varies

Potential additional impact on design (↗): additional data, ISO 20730 (ePTI) requirements



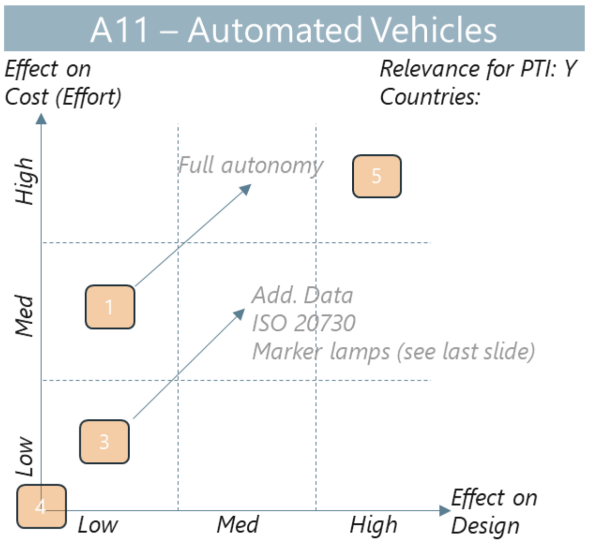
Vehicle Scope: M, N and O

Impact on cost: varies

Potential additional impact on cost (↗): Parkour testing

Impact on design: varies

Potential additional impact on design (↗): -



- Cost Drivers:
  - *Reduction PTI interval*
  - *TA aspects introduced Into PTI (FSD / DE)*
  - -
  - -
  - *Examiners*
- Design Drivers:
  - *Cyber security**
  - -
  - *AV function monitoring*
  - -
  - -

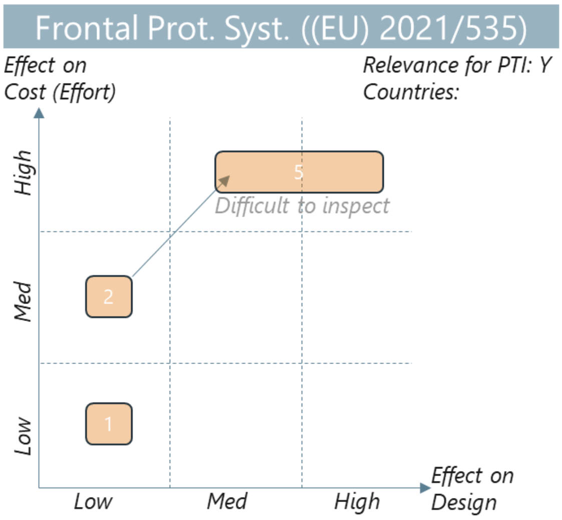
Vehicle Scope: M, N and O

Impact on cost: varies

Potential additional impact on cost (↗): additional data, ISO 20730 (ePTI) requirements, auditing of fully autonomous systems

Impact on design: varies

Potential additional impact on design (↗): additional data, ISO 20730 (ePTI) requirements, auditing of fully autonomous systems



- Cost Drivers:
  - *Examiners*
  - *Lack of regulation*
  - -
  - -
  - *Examiners*
- Design Drivers:
  - -
  - -
  - *Interference, damper systems*
  - -
  - -

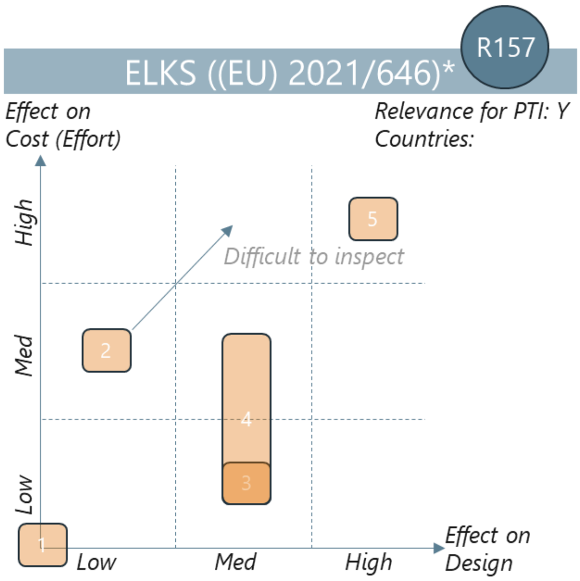
Vehicle Scope: M, N and O

Impact on cost: varies

Potential additional impact on cost (↗): difficulty of inspection

Impact on design: varies

Potential additional impact on design (↗): difficulty of inspection, integration with key components



- Cost Drivers:
  - *Parcours testing*
  - -
  - *Data mgmt.*
  - *ECU ID/Addresses*
  - -
- Design Drivers:
  - -
  - -
  - *Elec. Architecture (cf. ISA)*
  - *Std. Interfaces*
  - *Camera module*

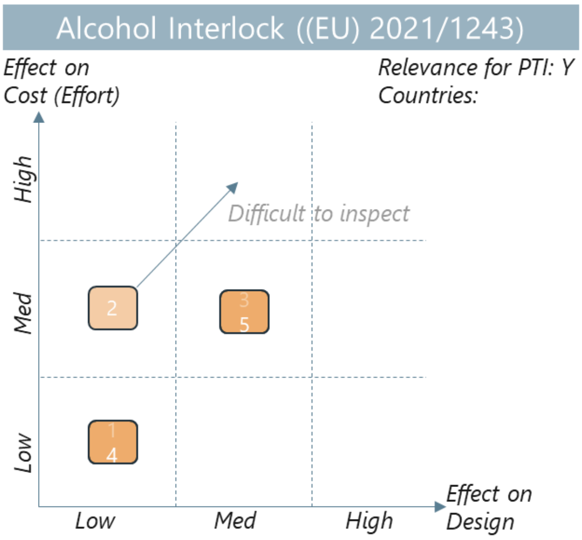
Vehicle Scope: M, N and O

Impact on cost: varies

Potential additional impact on cost (↗): difficulty of inspection

Impact on design: varies

Potential additional impact on design (↗): difficulty of inspection, integration with electric architectures



- Cost Drivers:
  - *DTC possible*
  - *Potential testing*
  - *Interface mgmt*
  - *Interface mgmt*
  - *Interface mgmt*
- Design Drivers:
  - *DTC possible*
  - -
  - *Elec. Architecture*
  - *Installation of plug*
  - -

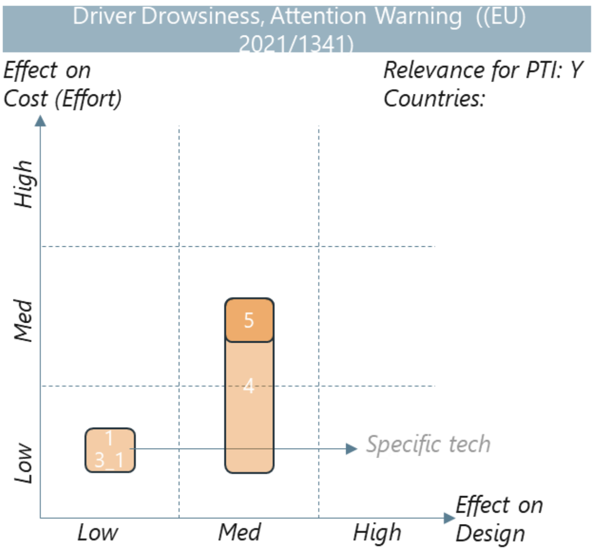
Vehicle Scope: M and N

Impact on cost: varies

Potential additional impact on cost (↗): difficulty of inspection, interface management

Impact on design: varies

Potential additional impact on design (↗): difficulty of inspection, integration with electric architectures



- Cost Drivers:
  - *Checking difficult*
  - *Checking difficult*
  - -
  - *ECU ID/Addresses*
  - -
- Design Drivers:
  - *Modes activated via SW*
  - -
  - *(1) No impact (2) Spec. infrared cameras*
  - *Std. Interfaces*
  - *Camera / steering wheel*

Vehicle Scope: M and N

Impact on cost: difficulty of inspection

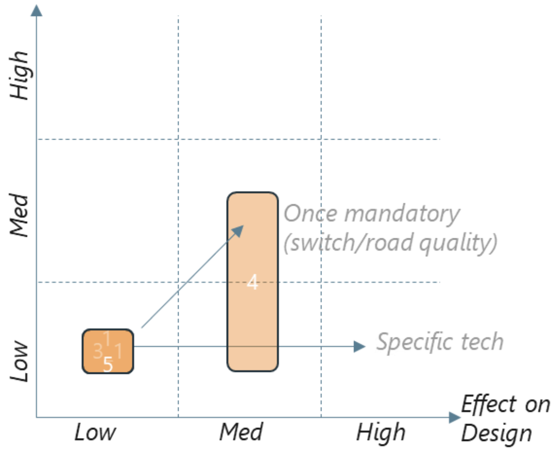
Potential additional impact on cost (↗): -

Impact on design: varies

Potential additional impact on design (↗): difficulty of inspection, method of drowsiness detection (specific technologies)

Intelligent Speed Assistance ((EU) 2021/1958)

Effect on Cost (Effort) *Relevance for PTI: Y*
Countries:



- Cost Drivers:
  - *Parcours testing*
  - *Checking difficult*
  - *Data mgmt.*
  - *ECU ID/Addresses*
  - -
- Design Drivers:
  - -
  - -
  - *(1) camera can be used for ALKs (2) separate systems*
  - *Std. Interfaces*
  - *False positivies*

Vehicle Scope: M and N

Impact on cost: varies

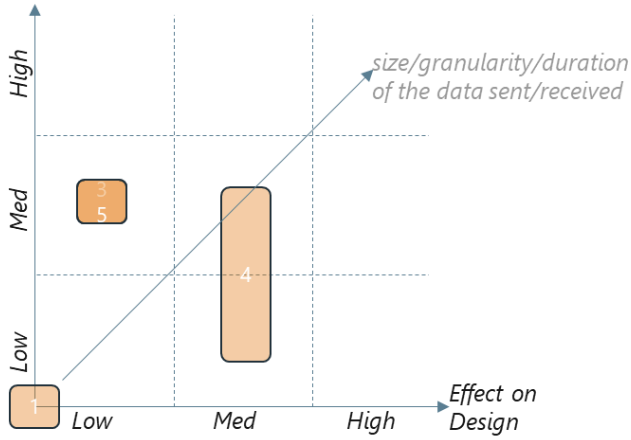
Potential additional impact on cost (↗): mandatory use (instead of optional), poor quality of roads (lane keeping functions)

Impact on design: varies

Potential additional impact on design (↗): mandatory use (instead of optional), poor quality of roads (lane keeping functions), method of assistance (specific technologies)

Electronic Data Rec. ((EU) 2022/545)

Effect on Cost (Effort) *Relevance for PTI: Y*
Countries:



- Cost Drivers:
  - *Granularity of data*
  - *Checking difficult*
  - *Granularity of data*
  - *ECU ID/Addresses*
  - *Airbag implications*
- Design Drivers:
  - -
  - -
  - -
  - *Std. Interfaces*
  - -

Vehicle Scope: M_1 and N_1

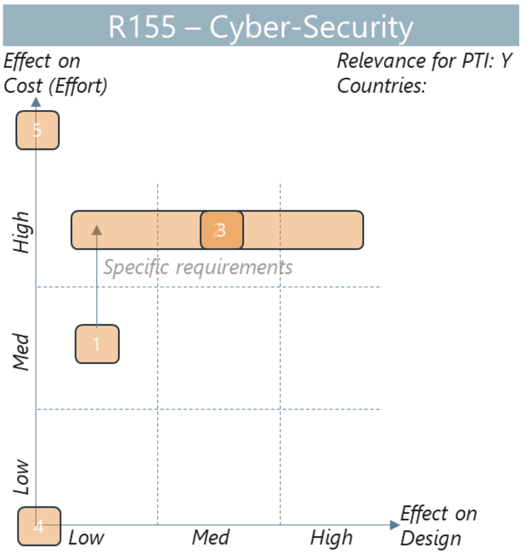
Impact on cost: varies

Potential additional impact on cost (↗): increase in data volume, granularity

Impact on design: varies

Potential additional impact on design (↗): increase in data volume, granularity

11.8 Appendix 8: Review of Impact on Design and Cost with respect to selected UNECE Regulations



- Cost Drivers:
  - IT Backend, Individual requirements
  - IT Backend
  - Compliance mgmt.
  - (TA issues)
  - IT Backend
- Design Drivers:
  - OBD locking / restricted access
  - RXSWIN
  - Accessibility (vehicle vs company)
  - (TA issues)
  - SW validation

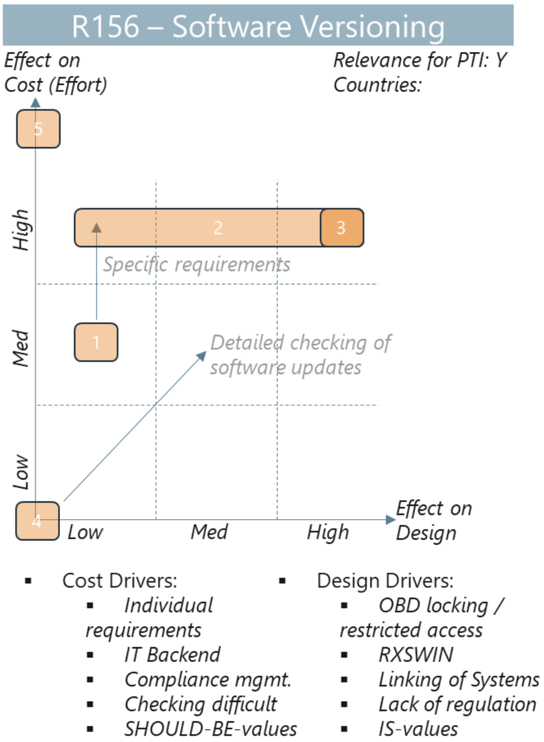
Vehicle Scope: M and N

Impact on cost: high (potentially very high)

Potential additional impact on cost (↗): enabling of user-specific features

Impact on design: varies

Potential additional impact on design (↗): -



Vehicle Scope: M, N, O, R, S and T (that permit SW updates)

Impact on cost: varies (potentially very high)

Potential additional impact on cost (↗): enabling of user-specific features, detailed checking of software updates

Impact on design: varies

Potential additional impact on design (↗): detailed checking of software updates

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