



A common EU approach to
liability rules and
insurance for connected
and autonomous vehicles

European Added Value
Assessment

Accompanying the
European Parliament's
legislative own-initiative
report (Rapporteur: Mady
Delvaux)

STUDY

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The European added value of a common EU approach to liability rules and insurance for connected and autonomous vehicles

Study

In accordance with Article 225 of the Treaty on the Functioning of the European Union, the European Parliament has a right to request that the European Commission take legislative action. The Conference of Presidents of the European Parliament therefore authorised its Committee on Legal Affairs (JURI) to draft a legislative initiative report on the civil law rules on robotics.¹

All European Parliament legislative initiative reports (INI) must automatically be accompanied by a detailed European added value assessment (EAVA). Accordingly, the JURI Committee asked the Directorate-General for Parliamentary Research Services (EPRS) to prepare an EAVA to support the legislative initiative report on civil law rules on robotics prepared by Mady Delvaux.

The purpose of the European added value assessment is to support a legislative initiative of the European Parliament by providing a scientifically based evaluation and assessment of the potential added value of taking legislative action at EU level. In accordance with Article 10 of the Interinstitutional Agreement on Better Law-Making,² the European Commission should respond to a request for proposals for Union acts made by the European Parliament by adopting a specific communication. If the Commission decides not to submit a proposal, it should inform the European Parliament of its detailed reasons, including a response to the analysis on the potential European added value of the measure requested.

Abstract

The findings of this European added value assessment (EAVA) suggest that it is necessary to revise the current legislative EU framework for liability rules and insurance for connected and autonomous vehicles. Not only would revision ensure legal coherence and better safeguarding of consumers rights but it would also be likely to generate economic added value. It is argued that accelerating the adoption curve of driverless or autonomous vehicles (AVs) by five years has the economic potential to generate European added value worth approximately €148 billion.

¹ Report with recommendations to the Commission Civil Law Rules on Robotics, [2015/2103\(INL\)](#), European Parliament, Rapporteur: Mady Delvaux (S&D, Luxembourg).

² Interinstitutional Agreement between the European Parliament, the Council of the European Union and the European Commission on Better Law-Making, [OJ L 123](#), 12.5.2016, pp. 1-14.

This analysis has been drawn up by the European Added Value Unit within the European Parliamentary Research Service (EPRS). It builds on two expert research studies carried out by the Utrecht Centre for Accountability and Liability Law and RAND Europe for the European Added Value Unit of the European Parliament's DG EPRS. The two expert research papers are presented in full in Annex I and Annex II

Annex I

Legal analysis of the EU common approach on the liability rules and insurance related to connected and autonomous vehicles, by Dr E.F.D. Engelhard and R.W. de Bruin, LL.M., within the Utrecht Centre for Accountability and Liability Law

Annex II

Socio-economic analysis of the EU common approach on the liability rules and insurance related to connected and autonomous vehicles by Charlene Rohr and Fay Dunkerley at RAND Europe and by Professor David Howarth from the University of Cambridge.

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Executive summary

Two key trends are shaping the future of personal mobility: first, a shift from human (driver-driven) to machine (driverless-supercomputer driven) control of vehicles and second, a shift from individual to shared ownership of vehicles. This European added value assessment (EAVA) focuses on the first trend, the **shift from driver-driven to autonomous personal mobility**, and more specifically on the **regulation of civil liability for autonomous vehicles (AVs) at EU level**. The main objective of this EAVA is to assess whether regulatory action on civil liability for AVs is justified at EU level and, if so, what would be the expected benefits and costs of such intervention. The analysis of European added value is informed by two expert studies specifically commissioned by the EPRS: 'Socio-economic analysis of the EU common approach on liability rules and insurance related to connected and autonomous vehicles' and 'Legal analysis of the EU common approach on the liability rules and insurance related to connected and autonomous vehicles'; it also draws on the results of the European Parliament's public consultation on robotics and artificial intelligence and on publicly available statistical data and publications.

Accelerating the adoption curve for driverless or autonomous vehicles (AVs) by five years has the economic potential to generate European added value worth approximately €148 billion. It is therefore in the interest of the public regulator to ensure that the regulatory framework facilitates the adoption of AVs, thus helping to generate economic value. The expert national committees of Member States, high level expert groups set up by the European Commission, and recently adopted European Parliament resolutions have all underlined that the liability issues related to the adoption and use of AVs need to be clarified.

The appropriation of risks in relation to the use of motor vehicles is currently regulated by two main EU legislative acts governing liability rules: the Motor Insurance Directive (2009/103/EC) and the Product Liability Directive (85/374/EEC). The current EU system of appropriation of risks related to motor vehicles generally works well and, as a comparative legal analysis suggests, would in principle be able to deal with the introduction of AVs to the market. However, **the application of the existing rules to AVs will likely shift the existing balance in liability distribution between consumers and producers, further accentuate existing gaps, and could potentially contribute to legal and administrative costs in connection with uncertainties.**

If the current EU framework is not adjusted, in addition to existing gaps in the current EU legal framework, the introduction of AVs will contribute to the emergence of new gaps and legal grey areas. This is because the current legal framework was not developed to deal with the liability issues of AVs, which are technologically complex and stand distinctly apart from the motor vehicles currently on the roads. Four main categories of risk relating to the liability issues raised by AVs are likely to emerge or become significantly more prominent with the mass roll-out and use of AVs. The new risks include: risks relating to the failure of operating software enabling an AV to function, risks relating to network failures, risks related to hacking and cybercrime, and risks/external factors relating to programming choices. These four issues are not at all or not sufficiently addressed under the current Product Liability Directive - Motor Insurance Directive framework.

If the above issues are not specifically addressed by the legislator, the current regulatory framework will result in many uncertainties, in particular relation to the new groups of risk identified above. In this context, it is likely that the cost of scientifically unknown risks will be

borne by the injured parties and consumers will find it increasingly difficult to claim damages. **This could ultimately lead to reduced consumer confidence in AVs and, consequently, to slower uptake of AVs in the market.**

An analysis of the gaps and limitations of the existing EU regulatory framework suggests that **EU policy needs to respond by regulating liability issues relating to the roll-out and introduction of AVs.** EU action should address three main sets of issues: first, the limitations and gaps relating to the current framework, specifically the shift in liability between parties; second, the need to adjust the current framework or introduce new rules to cover new risks; and third, the need to adjust or introduce new procedural rules allowing liability to be established for damages involving or caused by AVs.

Four policy options to address the current shortcoming of the EU liability framework are compared and analysed: the status quo (Option 1); reform of the Product Liability Directive (Option 2); or Motor Insurance Directive (Option 3); and the introduction of new EU legislation and setting up of a no-fault insurance framework for damages resulting from AVs (Option 4). A comparative assessment is made of these policy options applying seven qualitative criteria: legal certainty, potential litigation burden, impact on innovation, impact on level of consumer protection, political acceptance, degree of regulatory intervention needed, and degree of dependence on soft law. On this basis **it is argued that Option 4 (new EU legislation and insurance framework) is preferable as it has the greatest potential** of the four policy options to address three sets of outstanding issues and gaps identified through comparative legal analysis.

Revision of the existing regulation and/or the introduction of additional regulation on the allocation of risks related to AVs has the economic potential to generate European added value that could be lost if the no-action option is chosen. The European added value generated from the roll-out of AVs would be generated mainly by legislative measures facilitating their earlier adoption. Further added value from EU action could be generated at the mass AV adoption stage by measures aimed at reducing transaction and litigation costs arising from regulatory divergences between differing jurisdictions and measures to boost consumer trust in the new technologies.

Coordinated action at EU level has the potential to contribute further to European added value by reducing the transaction costs resulting from the fragmentation of national legal systems and minimising litigation costs. Insufficient coordination among several jurisdictions on the adoption of regulatory rules enabling the testing, licensing and operation of autonomous technologies and vehicles could ultimately lead to unnecessary barriers to the development and deployment of new technological solutions. Clear rules at EU level would meanwhile contribute to legal certainty and would help to avoid transaction costs arising from divergent national legal rules.

1. Introduction

1.1. Background

Driverless or autonomous vehicles (AVs) promise to bring substantial economic and societal benefits. It is widely assumed that driverless cars would have the potential, for example, to save human lives, minimise the financial cost of car accidents, improve urban mobility, decrease congestion and negative environmental impacts, provide more inclusive forms of mobility for the elderly and people with special needs, and increase productivity.³ According to World Economic Forum estimates there is substantial economic value at stake for the industry (US\$ 0.67 trillion) and society (US\$ 3.1 trillion) as a result of digital transformation in the automotive industry already in the period between 2016 to 2025.⁴

Connected and autonomous vehicles are significant sector of the EU economy. In 2016 the EU-28 accounted for 21 % of global passenger car production⁵ with 12.6 million people employed in the automotive industry.⁶ It is forecasted that by the year 2050, this sector of the industry will contribute €17 trillion to the European economy⁷ and as of 2020 (the year AVs are expected to be introduced) add 0.15 % to Europe's annual gross domestic product (GDP) growth rate.⁸

However, motor vehicles, and road mobility more generally, also create risks and thus require public coordination, supervision and enforcement. **The motor vehicles and road transport sector is a densely regulated area.**⁹ At international level: the United Nations 1968 Vienna Convention on Road Traffic regulates standard traffic rules; while the 1958 and 1998 Agreements of the United Nations Economic Commission for Europe regulate technical requirements and type-approval for motor vehicles.¹⁰ The European Union also has a wide range of competences relating to the production and use of motor vehicles. As a result there is a large number of EU regulatory acts in the wide spectrum of policy areas relating to motor vehicles, including civil law (e.g. liability, insurance, data protection, licensing and type approval); public law (e.g. traffic regulations and safety) and norms and standards (e.g. consumer protection, and technical and environmental standards).¹¹

The future of personal mobility is in the process of major qualitative change. This change is deemed by experts to be akin to the shift from horse to automobile as a means of transportation or the introduction of the railway. AVs are not yet another product improvement in a traditional automotive industry. They are ushering in a disruptive technology that has the potential to

³ For an overview and analysis see, for example, [Autonomous Vehicle Implementation Predictions, Implications for Transport Planning](#), Victoria Transport Institute, 26 January 2018; and '[Autonomous Vehicles: Are You Ready for the New Ride?](#)', *MIT Technology Review Insights*, 9 November 2017.

⁴ Digital transformation: [Reinventing the wheel: digital transformations in the automotive industry](#), World Economic Forum, 2016.

⁵ [2016 Production Statistics](#), International Organization of Motor Vehicle Manufacturers, see also [Key Figures](#), European Automobile Manufacturers Association.

⁶ See footnote above; also information provided by the [European Commission](#).

⁷ F. Ranft, [Freeing the Road: Shaping the future for autonomous vehicles](#), London, 2016.

⁸ Ibid.

⁹ For a regulatory overview of the main legislation at international and EU level see S. Pillath, [Automated vehicles in the EU](#), EPRS, European Parliament, January 2016.

¹⁰ Ibid.

¹¹ There are more than 1800 [EU regulatory acts](#) relating to 'motor vehicles'.

change what is now our conventional understanding of mobility, ownership and security. In this context there is increasing evidence and growing numbers of calls from various stakeholders arguing that the **current regulatory framework**, developed when the roll-out of autonomous vehicles was, if anything, a very indistinct reality, **is inadequate when faced with the current state of innovation and digitalisation in the automotive industry**.

This explains why now at all levels of governance – national, EU and international – there are intensive discussions on the need and urgency to revise the current law and policy to enable the testing of AVs and their introduction to the market. Indeed, AVs are already being widely tested on public roads around the globe and according to the most recent estimates **driverless, fully autonomous vehicles will be on the market by 2020**.¹² The representatives of the automotive industry consider that the countdown to the mass production of autonomous cars has already started and has come much sooner than most experts expected. This earlier than expected roll-out of driverless vehicles is possible, inter alia, due to the cooperation between connected industries, know-how and substantial financial investment in this type of technology.¹³

Two key trends are shaping the future of personal mobility: first, a shift from human (driver-driven) to machine (driverless-supercomputer driven) control of a vehicle and, second, a shift from individual to shared ownership of vehicles.¹⁴

1.2. Methodology and scope of the European added value assessment

This **European added value assessment (EAVA)** focuses on the first trend, a **shift from driver-driven to autonomous personal mobility and, more specifically, on the regulation of the civil liability of motor vehicles at EU level**. According to a 2015 study published by the Organisation for European Cooperation and Development (OECD) 'liability remains an important barrier for the manufacturers and designers of autonomous vehicles'.¹⁵ A similar conclusion is also reached by the UK's Department for Transport, which finds it necessary to 'provide additional clarity and certainty in legislation, to provide a sound basis upon which to allocate criminal and civil liability'.¹⁶ The consideration of issues relating to liability has also been on the agenda of all major EU expert group discussions facilitated by the European Commission (i.e. GEAR 2030) and road maps of Member States.

Against this backdrop, **the main objective of this EAVA is to assess whether regulatory action on the civil liability of AVs is justified at EU level; and if so what would be the expected benefits as well as costs of such intervention**. European added value is assessed both quantitatively (economic analysis) and qualitatively (comparative legal analysis). **The former** is based on the economic analysis of the possible added value of legislative developments in the EU

¹² See for example also Uber/Volvo framework agreement to introduce robot taxis as early as 2019. Volvo Group media statement from '[Volvo Cars to supply tens of thousands of autonomous drive compatible cars to Uber](#)', 20 November 2017.

¹³ J. Becker, '[BMW's driverless cars: A quantum leap to Level 5](#)', 2025 AD, November 2017; see also '[Chipmaker Nvidia's CEO sees fully autonomous cars within 4 years](#)', Reuters, October 2017.

¹⁴ Deloitte, '[The future of mobility](#)', January 2017.

¹⁵ [Automated and Autonomous Driving, Regulation under uncertainty](#), OECD, 2015, p.6.

¹⁶ [The pathway to driverless cars: summary report and action plan](#), UK Department for Transport, 2015, p. 10.

liability framework on earlier deployment of AVs. A **cost-benefit analysis** (CBA) is applied to explore the scale of social and economic benefits of a faster roll out and take-up of AVs in the EU.¹⁷ European added value is thus measured and quantified in terms of socio-economic costs and benefits relating to a possible earlier than anticipated baseline roll-out of AVs.

This quantification approach and methodology is based on an assumption that AVs will bring substantial economic and social benefits for the EU's legal and private persons and that therefore their earlier roll-out in the EU would be advantageous. The quantitative analysis contributes to the understanding of the scope of possible socio-economic gains for the EU related to earlier roll-out of AVs as well as the influence of developments in EU liability legislation on the earlier deployment of AVs. This analysis also informs a policy debate on the possible impact of EU regulatory intervention on the industry's willingness to introduce AVs to the EU market. This economic quantification however does not fully measure or quantify other aspects relating to possible costs and benefits and wider possible impacts of the revision of EU civil liability rules in relation to AVs. For example, the possible impact of the revision of the EU civil liability framework on the coherence of the EU legal system, the achievement of the EU's objectives, and the protection of fundamental free movement rights and fundamental freedoms are not (or not fully) measured by the CBA.

To account for these limitations of the quantitative approach, the economic analysis is supplemented by a **qualitative assessment**. The qualitative assessment approaches the question of European added value from a broader policy perspective. It focuses not only on the prerequisites of earlier deployment of AVs but also on the necessity and impact of possible EU legislative intervention for the legal certainty and coherence of the EU's legal system, the scope of legal protection provided by EU law, and efficiency of the EU rules.

The qualitative assessment is twofold. First, a **comparative legal analysis** is conducted to identify **legal gaps and shortcomings of the existing EU liability framework** as applied to AVs. A detailed inventory of applicable EU rules is necessary to understand whether and how the scope of legal protection would change as a result of the roll-out of AVs; whether the current EU system of rules will allow for efficient resolution of possible disputes, and how the coherence and consistency of the EU legal system would be affected. Second, based on the review of gaps and shortcomings, four policy options are suggested. The potential European added value of the four policy options suggested is then measured and assessed on the basis of **seven qualitative criteria**; these aim to **measure the effectiveness, efficiency, coherence and political feasibility of possible regulatory intervention**. Effectiveness is measured in terms of the ability of the policy intervention to address current legislative gaps and uncertainties; efficiency is measured in terms of ease of applicability of the policy by stakeholders; coherence is measured as the ability of the adopted rules to facilitate national and cross-border claims settlement and resolution of conflict of law issues; finally, political feasibility is measured in terms of the legal procedure and the scope of regulatory change needed.

¹⁷ For a detailed description of the methodology, method and model for quantification applied please see Annex II (RAND study).

Table 1 – Methodology for measuring European added value¹⁸

	Scope	Method	Outcome
Quantitative analysis	<ul style="list-style-type: none"> Economic analysis of the possible EU added value of legislative changes to the EU liability framework of earlier deployment of AVs 	<ul style="list-style-type: none"> Cost-benefit analysis Expert interviews with stakeholders to verify assumptions for the quantification 	<ul style="list-style-type: none"> Monetised estimate of European added value in terms of earlier deployment of AVs
Qualitative analysis	<ul style="list-style-type: none"> Legal analysis of gaps and shortcomings of the Product Liability Directive and Motor Insurance Directive Comparative legal analysis of selected national traffic regulation rules Legal analysis of EU and national rules on cybersecurity, hacking and data protection 	<ul style="list-style-type: none"> Legal analysis of application of EU law Comparative legal analysis of national regulation of liability issues in Germany, Sweden, the UK, the Netherlands and Belgium European added value is measured by the ability of the EU legislative intervention to contribute to the reduction of inefficiency, ineffectiveness and incoherencies of the current legislative framework European Parliament public consultation on Robotics and AI 	<ul style="list-style-type: none"> Qualitative assessment of potential European added value measured against seven qualitative criteria
Limitations	<ul style="list-style-type: none"> Issues of criminal liability or other adjunct areas of law, including for example a detailed analysis of data protection and privacy, are excluded. A comprehensive comparative analysis of all EU Member State legislation and policy is beyond the scope of the present analysis. 		

Source: Information compiled by the author.

This EAVA does not cover issues of criminal liability or other related areas of law, nor does it provide for example a detailed analysis of data protection and privacy. It focuses primarily on EU-level regulation and thus comprehensive comparative analysis of Member State legislation and policy is beyond its scope.

The EAVA is structured as follows: after this introduction, Section 2 outlines the current EU regulatory framework for civil liability and explains how this framework could be applied to AVs. Section 3 presents an analysis of the gaps and limitations of the current framework as applied to the AVs. Building on this analysis, Section 4 focuses on possible EU policy responses and discusses what action could be taken at EU level to address the current gaps. Finally, Section 5 brings all the analysis together by providing an assessment of the European added value of taking action at EU level.

¹⁸ A quantitative analysis and expert interviews were conducted by RAND Europe Consultancy (Cambridge) at the request of the EPRS. The full study is available in Annex II. The comparative legal analysis was conducted by Utrecht University at the request of the EPRS and it is available in Annex I. The European Parliament's public [consultation on robotics](#) was requested by the Legal Affairs Committee and conducted by the EPRS European Added Value Unit.

The analysis of European added value is informed by the two expert studies specifically commissioned by the EPRS: 'Socio-economic analysis of the EU common approach on liability rules and insurance related to connected and autonomous vehicles' and 'Legal analysis of the EU common approach on the liability rules and insurance related to connected and autonomous vehicles', results of the European Parliament public consultation on robotics and artificial intelligence, and also publicly available statistical data and publications.

2. EU law and policy context

2.1. Applicable EU law

The appropriation of risks in relation to the use of motor vehicles is currently regulated through two main EU legislative acts governing liability: the Motor Insurance Directive (2009/103/EC) and the Product Liability Directive (85/374/EEC). This system is based on the highly harmonised EU framework for liability of a producer of a defective product and very limited EU framework (mainly establishing third-party liability insurance cover and procedure for claims resolution) on civil liability for victims of road traffic accidents. When it comes to the substantive rules relating to road traffic accidents, national rules on liability and the calculation of damages for victims apply.

Table 2 – Main EU legal and policy instruments on civil liability relating to motor vehicles

<p>EU law</p> <ul style="list-style-type: none"> • Product Liability Directive (PLD) 85/374/EEC¹⁹ • Motor Insurance Directive (MID) 2009/103/EC²⁰ <p>EU policy instruments</p> <ul style="list-style-type: none"> • 2017 European Parliament resolution on civil law rules on robotics²¹ • 2016 Declaration of Amsterdam – Cooperation in the field of connected and automated driving²² • 2017 Letter of Intent on the testing and large scale demonstration of Connected and Automated Driving²³ <p>Other action at EU level</p> <ul style="list-style-type: none"> 2017 European Commission public consultation on PLD 2017 European Commission public consultation on MID²⁴

Source: Information compiled by the author.

¹⁹ Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, OJ L 210, 7.8.1985.

²⁰ Directive 2009/103/EC of the European Parliament and of the Council of 16 September 2009 relating to insurance against civil liability in respect of the use of motor vehicles, and the enforcement of the obligation to insure against such liability (Text with EEA relevance), OJ L 263, 7.10.2009.

²¹ Resolution of 16 February 2017 on civil law rules on robotics, European Parliament.

²² Declaration of Amsterdam – Cooperation in the field of connected and automated driving, 15-16 April 2016.

²³ Letter of intent on the testing and large scale demonstrations of connected and automated driving (CAD), 23 March 2017.

²⁴ REFIT review of the Motor Insurance Directive; Public consultation on REFIT review of Directive 2009/103/EC on motor insurance.

The Product Liability Directive (PLD) establishes a harmonised EU framework for the liability regime for producers that, inter alia, is applicable to car manufacturers.²⁵ The PLD, as interpreted by the Court of Justice of the European Union, sets out rules relating to the liability of producers and the rights of consumers. This framework is based on a no-fault liability regime.²⁶ This means that the producer of a defective product must compensate for personal injuries and damage to private property irrespective of the negligence of an individual. The rights of consumers to claim damages under the provisions of the PLD cannot be limited by the contractual clauses included by the producer.²⁷ The PLD however provides a limited list of derogations in Article 7 that waives liability of the producer. National rules on civil liability still apply, for example on the determination on non-material damages or definition of causality.

The Motor Insurance Directive (MID) provides a less harmonised framework for motor vehicles. The substantive rules on liability for damages resulting from motor vehicle accidents are not harmonised at EU level and thus individually regulated by the Member States. The various Member States have adopted differing liability systems, for example, the Netherlands has a semi-strict liability system, France has very strict liability system (no fault regime), and the United Kingdom system has a 'no strict liability' regime based on negligence rules. The MID prescribes only minimum third party liability insurance cover in EU Member States.

These two legislative acts cover very different areas, provide different degrees of harmonisation on civil liability rules and also have different purposes. Indeed the purpose of the PLD, which applies to all EU products, is to facilitate competition and the free movement of goods within the internal market and protect consumer against damage caused by a defective product. The purpose of the MID, meanwhile, is to facilitate the free movement of people through EU by providing a mechanism for the protection of road traffic accident victims.

2.2. EU programming documents relating to AVs

The digitalisation of transport was one of the key priorities of the Estonia and Netherlands Council presidencies in 2017. Most recently, on 5 December 2017, the **Council adopted conclusions** calling on the Commission 'to work together with Member States and stakeholders, including at international level, to analyse the liability regime in the context of the digitalisation of transport, addressing especially data quality, data integrity and traffic of connected and automated vehicles, vessels and drones'.²⁸

The 2016 Declaration of Amsterdam on cooperation in the field of connected and automated driving and the **2017 Letter of intent** on the testing and large scale demonstration of connected and automated driving,²⁹ signed at EU Member State ministerial level, call for closer cooperation

²⁵ For a review of the application in the Member States, see the [Fourth report on the application of Council Directive 85/374/EEC](#) of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products amended by Directive 1999/34/EC of the European Parliament and of the Council of 10 May 1999.

²⁶ Article 1, PLD.

²⁷ Preamble and Article 13, PLD.

²⁸ [Council conclusions of 5 December 2017](#) on the digitalisation of transport.

²⁹ [Letter of intent](#) on the testing and large scale demonstrations of connected and automated driving (CAD), March 2017.

and exchange of information among Member States on actions leading to the testing and deployment of AVs.

Moreover, in 2017 the **European Parliament adopted a resolution on civil law aspects of robotics and artificial intelligence (AI)**.³⁰ The European Commission's 2015 digital single market strategy,³¹ its 2016 communication on digitising European industry,³² and its 2017 communication on building a European data economy,³³ all address, in a more general context, the liability issues relating to new technologies, the internet of things, and autonomous systems.

2.3. Position of the European Parliament

In the light of the rapid developments in the area of robotics and artificial intelligence, the European Parliament Committee on Legal Affairs (JURI) set up a working group in 2015 on legal questions relating to the development of robotics.³⁴ The aim set out in the working group mission statement was 'to reflect on legal issues and especially to pave the way to the drafting of civil law rules in connection with robotics and artificial intelligence'. The working group engaged intensively with the topic of robotics and AI, consulted with experts and various stakeholders,³⁵ and as a final outcome drafted a report on civil law rules on robotics.³⁶ This latter provided a basis for the European Parliament resolution adopted in February 2017 outlining its main framework and vision on the topic of robotics and AI.³⁷

The resolution devotes considerable attention to issues of liability that, according to the EP, should be analysed and addressed at Union level.³⁸ In the introduction and general principles section Parliament calls for the development of civil liability rules that reflect European and universal values,³⁹ discusses in detail challenges arising from the general liability issues associated with autonomous robots and AI, questions the sufficiency of the current liability framework, and underlines the limits in the substantive (i.e. persons that can be held liable) and material scope (i.e. only damages resulting from manufacturing defect) of the current legislative framework. The resolution calls on the European Commission to submit a proposal for a directive on civil law rules on robotics on the basis of Article 114 of the Treaty on the Functioning of the European Union (TFEU). More specifically, as regards liability issues, the Commission is urged to submit a legislative proposal, accompanied by non-legislative instruments, to address legal issues relating to the development and use of robotics and artificial intelligence, including AVs.⁴⁰

³⁰ [Resolution](#) of 16 February 2017 on civil law rules on robotics, European Parliament.

³¹ [Communication](#) on a digital single market strategy for Europe, COM(2015) 192, European Commission, 2015; see also the [communication](#) on the mid-term review of the digital single market strategy, COM(2017) 228, European Commission, May 2017.

³², [Communication](#) on digitising European industry reaping the full benefits of a digital single market, COM(2016) 180, European Commission, April 2016.

³³ [Communication](#) on building a European data economy, COM(2017) 9, January 2017.

³⁴ The minutes of the working group on robotics and artificial intelligence meetings are available here: <http://www.europarl.europa.eu/committees/en/juri/subject-files.html?id=20150504CDT00301>

³⁵ See the [proceedings](#) of the working group.

³⁶ Draft [report](#) with recommendations to the Commission on Civil Law Rules on Robotics, Rapporteur: Mady Delvaux.

³⁷ [Resolution](#) of 16 February 2017 on civil law rules on robotics, 2015/2103 (INL), European Parliament.

³⁸ Resolution 2015/2103, Liability, para. 49.

³⁹ Resolution 2015/2103, General Principles, Sections U and Y.

⁴⁰ Resolution 2015/2103, Liability, para. 51.

In developing a legislative instrument on civil liability and carrying out an impact assessment, the Commission is called upon to consider the following elements:

- *Limitations to liability.* The type or the extent of the damages that may be recovered and the forms of compensation offered to the aggravated party should not be restricted or limited solely on the basis that the damage is caused by a non-human agent (para 52).
- *System for determination of liability.* In-depth analysis is necessary to determine whether the EU should adopt the strict liability (no-fault) or the 'risk management' approach (paras 53-55). Whatever system is preferred, 'liability should be proportional to the actual level of instructions given to the robot and of its degree of autonomy' (para 56).
- *Obligatory insurance scheme and guarantee fund.* The European Parliament stresses that compulsory insurance for robotics is a possible solution to the allocation of responsibility for damages caused by autonomous robots (paras 57, 59a). This insurance system could be supplemented by a guarantee fund to ensure compensation in cases of damage caused by unidentified or uninsured subjects (paras 58, 59b-e).

The European Parliament has been working continuously on the issue of robotics and artificial intelligence. Together with the adoption of the resolution, in February 2017 the European Parliament's Legal Affairs Committee launched a public consultation on robotics and artificial intelligence.⁴¹ The aim of the consultation was to invite and involve all stakeholders, including private individuals, to express their views on the subject. Following the results of the public consultation, at the request of the Legal Affairs Committee, the European Parliamentary Research Service is preparing an in-depth study on the cost of non-Europe for robotics and artificial intelligence.⁴² Robotics and AI will also be one of the topics debated during European Youth Event in Strasbourg in spring 2018.⁴³

2.3.1 Results of the European Parliament's public consultation

The 2017 public consultation on the civil law rules on robotics covered, among other topics, issues relating to the liability of autonomous vehicles. The main objective of the consultation was to obtain views from wide a range of stakeholders on developments in the area of robotics and AI in order to define further possible measures, both legislative and non-legislative.⁴⁴

The results of the consultation showed that 74 % of respondents, in the context of robotics and AI, felt concerned about liability issues. As the graph below indicates, in fact, liability was among the top three concerns related to robotics and AI as indicated by the respondents.

One of the elements that emerged was the preference, among stakeholders, for action at EU level as opposed to national level. Indeed, of those favouring a regulatory approach, an overwhelming majority preferred action at EU or international level rather than action at Member State level. The arguments supporting regulatory action at this wider level were, among others, the need to protect EU values (especially data protection, privacy and ethics), to ensure the EU's global competitiveness, to secure EU primacy as a standard setter in international fora, to avoid a 'race to the bottom', and to promote fair competition within the internal market. Compared with the

⁴¹ The public consultation was prepared and scientifically coordinated by Tatjana Evas, European Added Value Unit, EPRS, European Parliament.

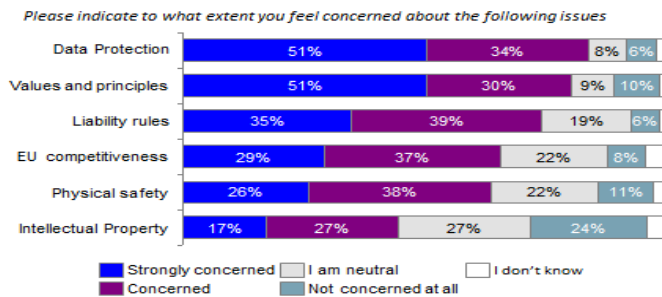
⁴² The Cost of Non-Europe on Robotics and Artificial intelligence report will be published in 2018-2019.

⁴³ [European Youth Event](#), European Parliament.

⁴⁴ The consultation was open from February to June 2017 and received almost 300 replies (259 from private individuals, 37 companies, and 2 from public authorities or international organisations). An overview of the aims and the results of the public consultation are available on the European Parliament [website](#).

national level, respondents also considered the EU as more efficient, not only in legislating but also in ensuring better enforcement of adopted regulation.

Figure 1 – Stakeholders' concerns about liability issues

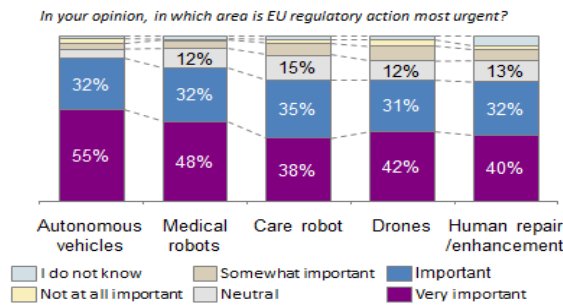


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Source: Data compiled by the author.

The stakeholders were asked which policy area would require, in their opinion, the most urgent regulatory action, should EU action be considered. 87 % of respondents indicated that action in the area of autonomous vehicles was a top regulatory priority.

Figure 2 – Stakeholders' opinions on most urgent regulatory action



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Source: Data compiled by the author.

In conclusion, the European Parliament position on the liability issue, supported by the results of the public consultation, suggests that liability issue should be addressed by at EU level as a matter of priority. The current regulatory framework, as defined by PLD and MID, seems insufficient and requires a review in terms of both substantive and material scope. This is why in its resolution the European Parliament invited the European Commission to conduct an in-depth analysis of possible policy options at EU level to address liability issues.

2.4. Position of the European Commission

The European Commission (EC) is managing a wide range of initiatives, funding programmes and expert groups on automated driving, coordinated by different directorates general (DGs).⁴⁵ The activities of the Commission relating to the deployment of AVs can be broadly summarised as follows:

Table 3 – Main activities of the European Commission in relation to the deployment of AVs⁴⁶

1. Programming documents	<ul style="list-style-type: none"> 2016 European strategy on C-ITS, a milestone towards cooperative, connected and automated driving⁴⁷
2. Review of existing legislation	<ul style="list-style-type: none"> REFIT review of Directive 2009/103/EC relating to motor insurance third party liability⁴⁸ including a public consultation Evaluation of Directive 85/374/EEC concerning liability for defective products⁴⁹ including a public consultation
3. Studies/initiatives related to the future deployment of AVs	<ul style="list-style-type: none"> GEAR 2030 High Level Group (which concluded its activities in October 2017) C-ITS Platform Phase I and Phase II C-ROADS
4. Funding programmes	<ul style="list-style-type: none"> Horizon 2020 – dedicated calls to tender on automated road transport and internet of things

Source: Information compiled by the author.

2.4.1 Review of existing legislation

In 2017 the European Commission started the evaluation of the PLD and the REFIT of the MID.⁵⁰ According to the 2017 **inception impact assessment of the MID**, the evaluation pillar of the REFIT will focus, among other things, on the 'suitability of the directive in the light of technological developments (electric bicycles, Segways, semi-automated and automated vehicles) and on whether the liability system it provides will suit future needs'.⁵¹ In the context of the public consultation carried out from July to October 2017,⁵² questions 33 and 34 (Q33 and Q34) were particularly relevant in relation to liability issues linked to the deployment of AVs.

⁴⁵ For an up-to-date overview of European Commission initiatives see for instance the [Automated Driving Roadmap](#), European Technology Platform, 2017.

⁴⁶ This table only presents measures and activities that cover or mention the issue of liability or regulatory cooperation among Member States. Projects and activities relating, for example, to road safety, technical standards or the environment are not included.

⁴⁷ Communication on A European strategy on cooperative intelligent transport systems, a milestone towards cooperative, connected and automated mobility, [COM\(2016\)766](#), November 2016.

⁴⁸ [REFIT review of Directive 2009/103/EC relating to motor insurance third party liability](#).

⁴⁹ See the [Roadmap for evaluation](#).

⁵⁰ REFIT is shorthand for the European Commission's [Regulatory Fitness and Performance Programme](#).

⁵¹ Inception Impact Assessment, [Ares\(2017\)3714481](#), REFIT review of Directive 2009/103/EC relating to motor insurance third party liability.

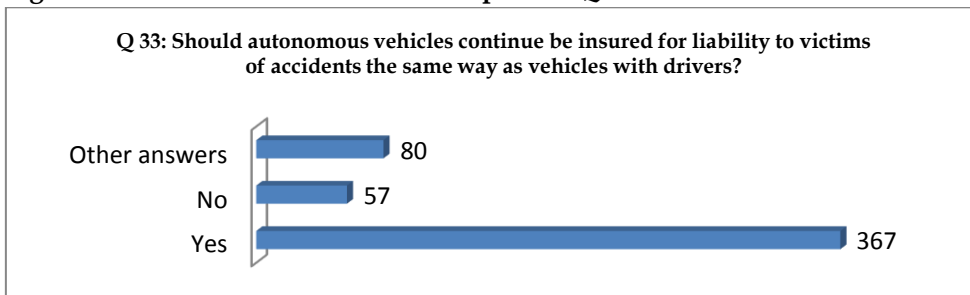
⁵² [Public consultation](#) on the REFIT review of Directive 2009/103/EC on motor insurance.

'Question 33: Should autonomous vehicles continue be insured for liability to victims of accidents the same way as vehicles with drivers?

Question 34: Should MID be clarified in any way to reflect the development of autonomous vehicles? If so, please substantiate your answer and explain how.'

At the time of writing, in January 2018, the results of the public consultation, in the form of the analytical report, have yet to be published. However an analysis of the replies submitted, available on the web page of the consultation, reveals that 73 % of the respondents who answered Q33⁵³ considered that AVs should continue to be insured for liability to victims in the same way as vehicles with drivers. Considering however, that only 14.5 % of all respondents answered this optional question, it could be argued that respondents found it difficult to answer.

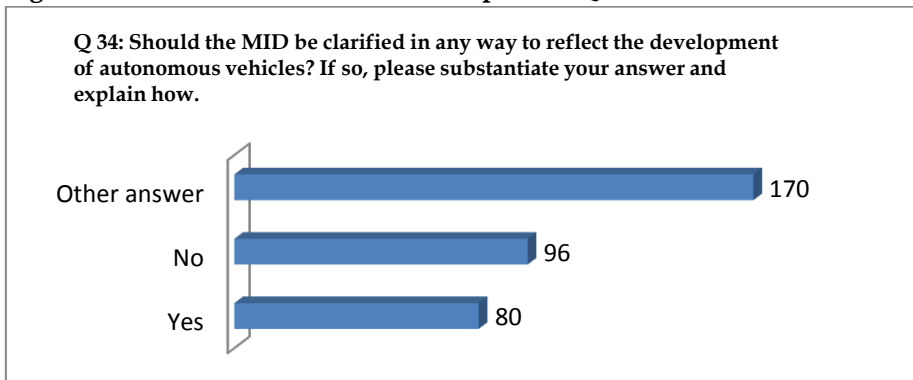
Figure 3 – Overview of stakeholders' replies to Question 33



Source: Data compiled by the author.

The replies to Q34, which asks more specifically whether and how MID should be clarified to reflect the development of autonomous vehicles, leave respondents even more divided.

Figure 4 – Overview of stakeholders' replies to Question 34



Source: Data compiled by the author.

The results of the public consultation seem to suggest that further in-depth analysis on the topic is necessary. It remains to be seen how the European Commission will interpret the results of the public consultation and whether or not it will suggest any reviews of the MID in relation to AVs.

⁵³ There were 504 answers to Q 33 out of a total of 3 478 replies submitted to the consultation.

In parallel to the REFIT of the MID, the European Commission is also conducting an **evaluation of the PLD**.⁵⁴ According to the roadmap, one of the purposes of the evaluation is to 'assess the coherence of the directive with other relevant EU actions and whether it still corresponds to the stakeholders' need and has EU added value. The evaluation will also assess if the directive is fit-for-purpose vis-à-vis the new technological developments such as the internet of things and autonomous systems'.⁵⁵ The roadmap specifically refers, inter alia, to the 2017 European Parliament resolution on civil law aspects of robotics and AI as one of the grounds for carrying out the evaluation. In providing justification for the evaluation, the roadmap states the following as regarding liability in context of new technological developments:

'Recently, liability issues are progressively being investigated notably within the framework of the digital single market strategy (DSM). In the context of preparing the free flow of data initiative, a key issue is to reflect whether Directive 85/374/EEC is fit for purpose vis-à-vis new technological developments (i.e. software, Cloud, internet of things (IoT), advanced robots and automated systems) and whether it covers cases of malfunctioning apps and non-embedded software. Furthermore, issues have been raised on whether the unintended, autonomous behaviour of an advanced robot could be considered a defect and how should strict liability for damages be allocated between the different participants in the internet of things or, in more general terms, in case of connected objects relying on each other.'⁵⁶

As part of the evaluation process, at the beginning of 2017, the European Commission also organised a public consultation.⁵⁷ The brief summary of the consultation results suggests that, even now, with autonomous vehicles not yet en masse on public roads, 58 % of consumers and 45 % of producers consider that for products like autonomous vehicles the application of the directive might be problematic or uncertain. It is interesting to note, however, that only 25 % of producers consider that the directive needs to be adapted for innovative products such as autonomous vehicles. This is in contrast to 54 % of consumers and 40 % of other respondents (including public authorities and civil society) who consider adoption of the directive to be necessary.⁵⁸

2.4.2 Studies on AVs

The European Commission has arranged a large number of initiatives and expert groups in relation to the automotive sector and AVs, covering a wide range of topics connected with the testing and roll-out of AVs. The main positions and conclusions arising from these AV-related studies AVs, as specifically related to liability issues, are summarised in the table below:

⁵⁴ 2017 evaluation of the Directive 85/374/EEC concerning liability for defective products.

⁵⁵ [Roadmap](#) for the 2017 evaluation of the Directive 85/374/EEC concerning liability for defective products.

⁵⁶ Ibid.

⁵⁷ The [Public consultation](#) on the rules on liability of the producer for damage caused by a defective product.

⁵⁸ [Brief factual summary on the results of the public consultation](#) on the rules on producer liability for damage caused by a defective product. The summary does not specifically mention autonomous vehicles but refers for instance to 'products where software and applications from different sources can be installed after purchase, products performing automated tasks based on algorithms, data analytics, self-learning algorithms or products purchased as a bundle with related services'.

Table 4 – Main studies related to liability issues for AVs by the European Commission

Year	Document	Main Conclusions
2017	GEAR 2030 HLG Final Report 18/10/2017	<ul style="list-style-type: none"> 'Regarding compensation of victims, GEAR 2030 HLG is of the opinion that motor insurance and product liability directives are sufficient at this stage, at least for systems expected by 2020.' 'There are diverging views as to whether it is necessary, or even desirable, to harmonise more the different national liability regimes.' 'Therefore the European Commission will monitor the need to revise the MID and PLD (e.g. definition of product/service, definition of defect) as well as the need for additional EU legal instruments with the future development of technologies.'
2016	GEAR 2030 HLG Roadmap	<ul style="list-style-type: none"> For the current state of development of connected and autonomous vehicles, the existing legal framework on liability and risk appropriation is sufficient.⁵⁹ However, with increasing connectivity and automation of vehicles a complete revision or shift in liability rules between the parties involved (i.e. driver, manufacturer, software provider, etc.) might be necessary.⁶⁰
2015	Business Innovation Observatory/ Study by PwC commissioned by DG GROW	<ul style="list-style-type: none"> 'with the technology for assisted and autonomous driving developing rapidly, uncertainty on liability is a growing concern. [...] Without clarity, insurance companies will not know where they can rightfully claim the damages and companies will not be able to assess their liability.'⁶¹ 'By quickly developing a harmonised European legal framework that addresses concerns on liability and self-driving functionality, especially for semi-autonomous and fully autonomous vehicles, Europe can gain a competitive edge over other regions where such a framework is not yet in place (e.g. the USA).'⁶²
2015	C-ITS Final Report ⁶³	<ul style="list-style-type: none"> As long as the driver remains in the control of the vehicle no changes concerning liability are necessary.⁶⁴ However, considering the 'trends towards higher levels of connectivity and automation, where information provided via C-ITS may trigger subsequent action from the vehicle', the final C-ITS report recommended re-evaluating the question of liability for these cases in the second phase of the C-ITS platform.

Source: Information compiled by the author

The dominant view taken by the expert studies commissioned by the European Commission from 2015 to the present day is that the current regulatory framework will suffice at least until 2020 when mass roll-out of AVs is expected. Future technological developments might require

⁵⁹ 'It is anticipated that at least in the short run the legal position for liability in relation to features on vehicles which incorporate higher levels of automation would not be significantly different to those presently assisting the driver. In case of accident, each of the parties involved (manufacturer, driver, etc.) may be found to be civilly (or in some cases criminally) liable to a greater or lesser extent depending on the exact circumstances of the situation.' GEAR 2030 Discussion Paper, [Roadmap on Highly Automated Vehicles](#), p.8.

⁶⁰ Ibid.

⁶¹ [Internet of Things, Connected Cars](#), Case study 43, European Commission, Business Innovation Observatory, 2015, p. 11.

⁶² [Internet of Things, Connected Cars](#), p. 14.

⁶³ C-ITS stands for Cooperative Intelligent Transport Systems. On the platform see information provided on the Commission [website](#).

⁶⁴ [Internet of Things, Connected Cars](#), p. 13., 'the driver always remains in control of the vehicle, and therefore there are no changes concerning liability compared to the current situation and the current amendment to the Vienna Convention (Amendment Article 8, paragraph 5) will be sufficient'.

adjustments to the current system but this is as yet uncertain and thus would not require regulatory intervention at this stage. In this context, the scope and options for future possible adjustments have not yet been fully analysed in depth by the Commission. As the October 2017 GEAR 2030 report suggests, the Commission will monitor developments relating to the application of MID and PLD to the roll-out of AVs to the market and leave resolution of the possible problems and disputes to the courts and other bodies on a case by case basis.

This position stands in contrast to the position of the European Parliament, which is calling for a pro-active in-depth analysis of the possible regulatory response before mass roll-out of AVs. The results of the European Parliament public consultation, especially relating to the PLD suggests that consumers also feel a need for adjustments to the current system. It remains to be seen what action the European Commission will take on the liability issues associated with AVs in the light of the results of the ongoing REFIT of the MID and evaluation of the PLD.

3. Limitations of and gaps in the current framework

This section describes in more detail the limitations of and gaps in the current EU legislative framework that could potentially have a significant impact when AVs take to public roads en masse.

The current EU system of appropriation of risks related to motor vehicles generally works well. Based on the review of the PLD and MID⁶⁵ as well as the public consultations carried out by the European Commission, the majority of stakeholders believe that the current EU liability framework provides a working system that ensures an appropriate balance of interests and responsibilities of all parties involved.⁶⁶ The results of the European Commission's 2017 public consultation on the PLD indicate that 82.5 % of respondents representing organisations believe that the PLD provides for a fair balance between the interests of producers and those of the consumers.⁶⁷ Private individuals and other respondents seem however to be less confident, as in total (all replies considered) only 68 % believe that the directive provides for a fair balance between the interests of producers and those of consumers.⁶⁸ Respondents also consider that the, roll-out and in particular the mass penetration of AVs into the market would likely have a significant effect on the existing system of appropriation of risks relating to motor vehicles.

The current liability system is based on the understanding that there are two main types of risk relating to the operation of motor vehicles: first, the failure of the hardware, i.e. it is the product that triggers product liability, and second, the action of (and/or damage to) a driver, which triggers liability under national traffic laws and is also covered by the MID. Table 5 below summarises the new types of risk that could be generated by the introduction of AVs to the market. Considering the nature of AVs as products characterised by increased complexity of

⁶⁵ Directive 2009/103/EC of the European Parliament and of the Council of 16 September 2009 relating to insurance against civil liability in respect of the use of motor vehicles, and the enforcement of the obligation to insure against such liability.

⁶⁶ See the European Commission's 2017 public consultation on the REFIT review of Directive 2009/103/EC on motor insurance; and the summary of the European Commission's 2017 public consultation on the rules on liability of the producer for damage caused by a defective product.

⁶⁷ See replies to question 13, European Commission, [Brief factual summary on the results of the public consultation on the rules on producer liability for damage caused by a defective product](#), p. 24.

⁶⁸ [Ibid](#), p. 3.

hardware and software as well as crucial reliance on connectivity and networks, at least six main risks affecting liability can be identified. The existing risks, i.e. failure of hardware and liability based on personal conduct of a driver will be substantially impacted. This could potentially lead to a shift in risk distribution between for example consumer and producer. The new risks that would emerge with the roll-out of AVs are currently not specifically covered by the EU liability framework.⁶⁹ Thus, the current set of rules would have to be interpreted in such a way as to account for the 'new risks'. This legal ambiguity could lead to increase in litigation and possible divergent interpretation in various Member States. Finally, the current rules of evidence, i.e. the rules establishing fault and therefore liability would need to be adjusted, possibly through the introduction of legislation on detection technology, i.e. event data recorders.

Table 5 - Main risks in the current system versus those in a mobility system based on AVs

	Current system of mobility	System of mobility based on AVs	Current legislative coverage	Existing gaps and limitations	Main impacts relating to the use of AVs
Existing risks	Hardware failure	Hardware failure (but with additional components, such as sensor failure)	PLD	<ul style="list-style-type: none"> • Concept and scope of defectiveness • Scope of available defences • If driver or operator suffers damage him or herself as a result of a sensor being faulty because of 'wear and tear' there is no protection under the PLD or the MID. 	<ul style="list-style-type: none"> • If current rules remain there will be de facto a major shift in liability transfer, and thus the current balance will be upset, most likely to the disadvantage of the consumer. • It will create legal uncertainty and potential increased litigation.
	Action of a driver	Action of a driver	MID National traffic rules	<ul style="list-style-type: none"> • Insured risk of motor liability insurance is assessed differently within the EU. • Member States with a risk-based liability regime exclude or limit the protection of the owner/ possessor/ keeper of vehicles, if they suffer damage themselves. 	<ul style="list-style-type: none"> • Liability based on the personal fault of the driver will decrease while liability based on the failure of the technology will increase
New risks		Software failure	Issues/risks that currently are not explicitly or sufficiently clearly regulated by EU law		New risks are currently not (or not fully) covered by existing EU legislation. If these are not addressed it will lead to increased legal uncertainty (divergent
		Network failure			
		Hacking/ cybercrime			

⁶⁹ Though some risks, for example those relating to data protection, are covered by EU legislation, see discussion below in Section 3.2.

		Programming choice externality		interpretations of current rules in various jurisdictions). • Higher volume and costs of litigation
Procedural rules	Evidence	Evidence	National traffic liability rules/ MID	• Claimants will potentially increasingly encounter problems with delivering proof of defects, where without in-built associated detection technology (such as an event data recorder) it may be difficult to prove the defect.

Source: Information compiled by the author.

3.1. Existing risks: shift in liability

The roll-out of autonomous vehicles calls for a fitness check of the current regulatory framework on liability in order to understand (i) how risks would be allocated among the parties involved and (ii) whether current balance between the parties would be preserved. The key question is whether the process of digitalisation in the automotive industry, in particularly the roll-out and the mass adoption of AVs, would impact the current balance between parties in risk appropriation. If roll-out of AVs would result in liability transfer between the parties, the question is whether and to what extent an adjustment and/or introduction of a new regulation would be necessary. AVs require special regulatory attention and a review of the current framework not only because of their significant economic and societal value but also because AVs are a disruptive technology that have the potential to change what is now our conventional understandings of a product, mobility, ownership and security. In other words, roll-out and mass adoption of AVs are not another upgrade or improvement of the traditional product of the automotive industry, a vehicle, but rather a qualitatively new product. This new product is technologically sophisticated with many components, software, hardware and algorithms where, among other things, the line between product and service becomes increasingly blurred.

3.1.1 Product Liability Directive and Motor Insurance Directive⁷⁰

The PLD is generally a fair instrument for balancing the distribution of risks between producers and consumers of products. However, if applied to the mobility system based on AVs, existing gaps and limitations could potentially limit the scope and effectiveness of the PLD and affect the existing balance between the parties.⁷¹ The three main groups of issues are the following:

- **First, the PLD has limited substantive scope and covers only liability of producers for defective products.** The concept of 'defectiveness' is narrowly defined and difficult to establish for technically complex products such as AVs. As it stands now, damage arising for example from a vehicle's wear and tear, bad repair, the way vehicle has been used, the road situation, or weather conditions will be not covered by the PLD. Developers, producers, component makers, importers, distributors, and car-dealers could rely on a number of defences provided by the PLD to minimise liability, which in relation to highly technological products, could provide a wide safety net for producers to the disadvantage of consumers. For this reason, several parties (including rental companies

⁷⁰ For a comprehensive, detailed overview of the gaps in and limitations of the current framework see the study by Engelhard and Bruin in Annex I.

⁷¹ Ibid.

and other service providers, pure developers of the operating technology and testing companies) will not incur risk-based liability for defectiveness, but only fault-based liability. The definition of product also remains an open question, more specifically whether software is a product or not.

- Second, the **cost of scientifically unknown risks will be shouldered by the injured party**.
- Third, **the high-tech nature of AVs combined with the broad provisions of the PLD on defences**, in particular in relation to the concept of 'reasonableness' may overburden national courts. National courts interpreting and applying the PLD to disputes involving AVs will be called upon to settle very complex technological issues.

Table 6 – Summary of the main gaps under the current PLD regulation that could potentially have a negative effect on consumers in the light of the introduction of AVs⁷²

- [substantive scope] **Several parties responsible** for the design and/or manufacture of autonomous vehicles **are not covered by the risk-based liability imposed by the PLD**.
- [material scope]
 - The consumer must show that the product was **defective** at the moment a vehicle left the factory, this is technically difficult and also involves a normative judgement on the required safety standard for the new technology.
 - Producers have a wide margin of possibilities to shift costs of scientifically unknown risks through 'compliance risk' and 'development risk' defences to the consumer.
 - The PLD does not cover damage to the autonomous vehicle itself and it is limited with regard to property damage.
 - The PLD does not cover damages resulting from 'wear and tear' or other parties' interventions or failure of telecom networks.

Source: Information compiled by the author.

In conclusion, application of the PLD to autonomous vehicles will provide a certain degree of protection. However, there are a number of legal and factual issues that, if not addressed, could potentially lead to decreased scope of protection and increased costs for consumers as well as increased legal uncertainty for all parties involved. Specifically, these issues include: the limited reach and meaning of product liability, and the limited list of liable persons and evidentiary burdens currently provided under the PLD.

Another legal mechanism to claim compensation for damages caused by motor vehicles is to rely on traffic liability rules. Substantive traffic liability rules and levels of compensation fall within the competence of the Member States. National rules are divergent and include fault-based systems, mixed, and strict-liability systems (no fault). At EU level the MID regulates procedural, adjunct issues relating to motor insurance policy. For example, importantly, it covers the obligation for all EU vehicles to hold third-party liability insurance and establishes the mechanisms for the simplified settlement of claims. AVs will fall under the definition of a vehicle currently included in Article 1 of the MID and, thus, all damages to persons others than the driver or user, keeper or owner of the vehicle will be covered by mandatory insurance as provided by the MID, subject to the limitation provided by the MID. Currently, the national systems are based on the assumption that the driver is in the control of the operation of the vehicle. In the fault-based systems in particular, the link between fault of the driver and the accident is crucial to

⁷² The summary is based on the analysis provided by Engelhard and Bruin see Annex I.

establish the right to compensation. The introduction of AVs assumes that a human driver will be fully replaced by technology. Therefore the 'fault' of the driver becomes a notion that needs to be reconsidered and or adjusted accordingly. Adjustment of the risk-based system would be necessary, specifically in relation to the concept of driver-victim.

Table 7 - Summary of the main gaps under current MID and national traffic liability rules ⁷³

- [substantive scope]
 - o Traffic liability rules are not harmonised at EU level. Traffic liability rules at national level diverge and thus insured risk of motor liability insurance is assessed differently across the EU.
 - o The MID provides for mandatory liability insurance to cover damages to other traffic members but not to the driver or user, keeper or owner of the vehicle itself.
- [material scope]
 - o Member States with fault-based liability systems - interpretation of the concept and legal test for 'fault'
 - o Member States with risk-based liability systems - many Member States systems exclude the driver or user, keeper or owner of the vehicle itself; in some systems property damage is not or not fully protected; legal tests to avoid strict liability as well as assessment and/or calculation of the damage greatly differ among Member States.

Source: Information compiled by the author.

All in all, as the analysis by Engelhard and Bruin suggests, **if the current framework is not reviewed** in the light of special features relating to AVs as a product, **application of the PLD to AVs will have a significant negative impact on consumer protection**. Thus, while the current system of risk allocation would in principle be able to deal with the introduction of AVs, there would be a shift in the current balance between the parties involved. Application of the current EU liability framework to the roll-out and adoption of AVs highlights a number of existing gaps and shortcomings that could potentially disturb the current balance in risk allocation. Both industry and consumers need legal clarity on whether the current liability system is to be maintained or regulatory changes are to be introduced.

3.2. New risks not explicitly addressed by current EU legislation on motor vehicles

The current EU legal framework applicable to motor vehicles is, in principle, able to settle liability and insurance issues. However, as was argued in the previous section, the application of the existing rules to AVs will likely shift the existing balance in liability distribution between consumers and producers, further accentuate existing gaps and potentially contribute to legal and administrative costs arising from uncertainty. If the current EU framework is not adjusted, in addition to the existing gaps in the current EU legal framework, the introduction of AVs will contribute to the emergence of new gaps and legal grey areas. This is because the current legal framework was not designed to deal with the liability issues of AVs, which are technologically complex and stand distinctly apart from the motor vehicles currently on the roads.

⁷³ Summary based on the analysis provided by Engelhard and Bruin, see Annex I.

Four main categories of risk relating to the liability issues associated with AVs are likely to emerge or become significantly more prominent with the mass roll-out and use of the AV. These new risks include:

- (1) risks relating to the failure of the operating software that enables the AVs to function,
- (2) risks relating to network failures,
- (3) risks relating to hacking and cybercrime, and
- (4) risks/externalities relating to programming choice.

These four issues are not at all or not sufficiently addressed under the current PLD or MID framework.

1. Risks relating to software failure

This set of issues concerns situations where damage results from a failure in the AV's operating software. The legal concerns relating to software failure in AVs are connected with two main issues: first, when and under what conditions the software producer (rather than the car producer) could bear the cost; and second, under what conditions failure of the software can be considered within the scope of the PLD's 'defectiveness' standard. Under the PLD, the legal question as to whether the software is a product or not is not settled. If the software could be considered a product, then the questions raised would concern:

- (a) under what conditions software could be considered 'defective' within the meaning of the PLD, and what would be the scope of 'reasonable expectation' and 'development risk' defences; and
- (b) against which party the AV user should direct liability claims, i.e. the car producer or the software producer.

Under the current PLD framework – provided the software is considered a product – the AV driver or operator's right to compensation will depend on the reasons for the software failure. The risks relating to the operating software are covered by the PLD only if those risks could have been scientifically discovered before the AV's roll-out from the factory. Risks discovered or emerging after the time of production are not covered. The possible right of compensation under traffic liability rules for damages caused by software failure will depend on national traffic liability laws and, as it stands now, will differ widely among Member States.

2. Risks relating to network failure

This set of risks relates to the situation where damage occurs because of network failures. AVs will be heavily dependent on the network. Therefore, the central question is who and under what conditions would be liable for AV inability to obtain data or communicate with other traffic participants owing to network problems. Here, besides the AV user and car producer, a network provider could arguably potentially be a liable party.

The attribution of risks for network failure under the PLD will ultimately depend on whether the vehicle's network connection is a part of the package offered by the producer or not. If being connected is part of the package provided by the producer, then the car manufacturer is liable under the PLD for network problems, subject to the limitations and defences available under the PLD. As in other cases relating to proof of defects under the PLD, the reasonable expectation test and other defences are for the courts to apply in order to decide on the outcome. For the AV producer to be liable for the software or network failure, it must be proven that the vehicle was

already 'defective' at the time it left the production line. This proof of 'defectiveness', under the current PLD is already difficult for the standard hardware failures of motor vehicles currently on the roads, but will be even more difficult and uncertain for the software or network failures of AVs. The right to compensation under national traffic liability laws for damages caused by the network failure will again differ greatly among Member States. For example, under Swedish law all individuals involved will be entitled to compensation for damages caused by the network failure while in many risk-based countries the victim-driver/operator will not receive equal protection compared with other vehicles involved.

3. Hacking and cybercrime

Considering the nature of AVs, hacking as well as issues relating to data and the protection of privacy, will become significant new risks that are not yet covered by legislation specific to motor vehicles.⁷⁴ Similarly to the risks emanating from software and network failures, the AV producer could be liable for the damages resulting from a third party hacking the software of the vehicle if defects in the AV at the time of production could be proven. The technology used by the producer will have to be robust enough to protect the user of the AV against hacking attacks and malware. Product defects would be very difficult to prove. Moreover, it would be even more difficult to attribute liability if all necessary software was installed but cybercrime nevertheless occurred. The PLD seems to provide a very limited and uncertain avenue for compensation claims.

General civil liability rules in cases of hacking and other cybercrimes are not harmonised in the EU. Producers of AVs, in their capacity as controllers of personal data, can in principle be held liable under the Data Protection Directive (DPD) and the new General Regulation on Data Protection (GDPR). This is however subject to number of limitations. Producers can be held liable only if they fail to take appropriate measures to protect data from being hacked or if they infringe other obligations under the DPD or GDPR. However, it is not clear whether and to what extent producers of AVs can be held liable if they are *not* a controller of a processor of data within the meaning of the DPD or GDPR. Furthermore, the issue of whether the operator, or owner or keeper of an AV could be held liable for the damage resulting from his or her own failure to install or update software would be determined by national laws, which currently provide varying responses.

4. Programming choice

This set of risks concerns liability for programming choices causing damages. The central question here is when and under what conditions the producer of the AV could be held liable for programming choices. Can programming choice be considered a 'design defect', thus making a car manufacturer liable for a defective product? Furthermore, how broadly or narrowly should the design risk defence be interpreted by courts as specifically applies to the injuries suffered by third parties as a result of AV programming choices. As in the previously discussed cases, the current PLD framework is not specifically designed to address those complex legal issues. Under current PLD framework, the AV producer would be liable for damages resulting from software, network and programming failures only for product defects that could be attributed to the production process. Malfunctioning of the software or network as a result of 'wear and tear' or malfunctioning of the software or network as a result of actions by other parties (hacking, bad

⁷⁴ However, as will be explained below, the Data Protection Directive (DPD) and the General Regulation on Data Protection (GDPR) cover issues relating to data and privacy.

repair, etc.) and resulting damages caused by the AV are not within the scope of the liability covered by the PLD.

To conclude, if not specifically addressed by the legislator, the current PLD framework would result in many uncertainties relating to the new groups of risks identified above. While *prima facie* not totally excluded from the scope of the PLD, it would in practice be likely to be extremely difficult if not impossible for these risks to be covered by the PLD. As has been convincingly argued by Engelhard and Bruin 'the cost of risks that are not consequential to the production itself and the cost of scientifically unknown risks will be borne by the injured parties (and by their social and private insurance carriers). This may not be perceived as a secure or fair system and might reduce consumers' confidence in autonomous vehicles'.⁷⁵ The MID framework and national traffic laws also present limitations and difficulties for both existing and new risks. As substantive traffic liability rules are not harmonised at EU level, there are many national differences, which in fact mean that EU citizens are protected differently in different Member States. Risk-based national systems seem to be better suited to meeting the challenges of the AV, however, they are also limited by a number of considerations, such as for example the scope of compensation for damages caused to property or driver-victim.

3.3. Procedure and standards for establishing liability

In addition to the existing and new risks that would emerge as a result of mass use of the AV, issues relating to the procedure and standards for establishing liability would also need to be adjusted. Technically complex causal links leading to damages would significantly increase the evidentiary burden on the injured party and may impede recovery of the damages. In this context, there are strong arguments from the industry and insurance companies to introduce tracing technology (TT) that may help to establish the reasons for accidents and thus assign liability. As it stands now, it is up to each Member State to determine whether AVs' tracing data can be used as evidence for establishing liability. Furthermore, issues relating to AV-TT data collection, usage and storage need to be carefully assessed under the GDPR, to establish whether the current EU framework is sufficient for AV-TT technologies.⁷⁶

4. EU policy response to current gaps and limitations

Based on the analysis above, the EU policy response to the roll-out and introduction of AVs in terms of liability rules should therefore address the following sets of issues:

- first, limitations and gaps relating to the current framework and, more specifically, the shift in liability between parties;
- second, it should adjust the current framework or introduce new rules to cover new risks; and
- third, it should adjust or introduce new procedural rules allowing liability to be established for damages involving or caused by AVs.

Before analysing the specific policy options that would be able to address those three sets of issues, it is necessary to evaluate whether EU action is necessary and whether the policy action recommended would meet subsidiarity and proportionality tests.

⁷⁵ Annex I (Utrecht study), p. 36.

⁷⁶ For a detailed analysis of problematic issues that may arise under the GDPR see Annex 1 of this report, the Utrecht study, Chapter 4 'Hacking and privacy issues'.

4.1. Need to take action or intervene at EU level

The nature of the AV as a product that transcends the borders of individual Member States suggests that joint action at EU level is preferable to individual action by Member States. The EU has a wide range of competences relating to motor vehicles. For example, Article 114 TFEU can be used to adopt measures aimed at facilitating the free movement of motor vehicles in the internal market by setting up harmonised standards designed to achieve common environmental or safety objectives. EU action relating to civil liability for damages caused by AVs may be justified and necessary for the following main reasons:

- to ensure the functioning of the internal market, in accordance with the relevant provisions of the Treaties, by facilitating the free movement of goods and by establishing common rules and procedures to facilitate the roll-out and mass penetration of AVs (Articles 26 and 114 TFEU);
- to ensure a high level of consumer protection by adopting measures to secure the economic interests of consumers and their right to information (Article 169 TFEU);
- to facilitate the competitiveness of the EU automotive industry and boost the EU's global competitiveness by taking action to speed up the adjustment of the automotive industry to the structural changes caused by the roll-out and mass deployment of AVs (Article 173 TFEU);
- to facilitate completion of the internal market by adopting measures to diminish legal fragmentation.

Considering the economic potential of the sector and technological developments in the automotive industry, there is increased pressure on regulators to adjust legislative and policy frameworks to accommodate the new reality of autonomous vehicles. The current EU framework, as discussed above, has a number of gaps and shortcomings. Member States are becoming increasingly impatient and are taking individual measures to introduce new or amended regulation at national level in relation to connected and autonomous vehicles, including on liability issues.⁷⁷ While during the last two years a number of Member States have adopted policy documents outlining national road maps applicable to autonomous vehicles, Germany was the first EU country to introduce amendments to its current national legislation.⁷⁸ Commenting on the adoption of national legislation, the German authorities stated that: 'The car industry needs to know the legal requirements to proceed with their developments, so we didn't wait any longer and proceeded with a new law to give guidance to the rest of the EU'.⁷⁹

There is therefore a clear tendency and push on all regulatory levels to develop a regulatory approach to connected and autonomous vehicles. However, as is underlined in the OECD/ITF report⁸⁰ **there is little coordination among the several jurisdictions** that are working on or

⁷⁷ At least seven EU Member States, including Germany, Spain, Finland, France, the Netherlands, Sweden and the United Kingdom, are now in the process of developing a regulatory framework for the testing and use of autonomous vehicles. Meanwhile, at international level a review of the Vienna Convention is being carried out in order to allow for the testing of autonomous vehicles on public roads.

⁷⁸ [Achstes Gesetz zur Änderung des Straßenverkehrsgesetzes](#) from 16 June 2017 according to Article 1(c) it will be reviewed in 2019: 'Das Bundesministerium für Verkehr und digitale Infrastruktur wird die Anwendung der Regelungen in Artikel 1 des Gesetzes vom 16. Juni 2017 (BGBl. I S. 1648) nach Ablauf des Jahres 2019 auf wissenschaftlicher Grundlage evaluieren'.

⁷⁹ '[German debates on automated driving legislation](#)', 27 July 2017.

⁸⁰ [Automated and Autonomous Driving, Regulation under uncertainty](#), OECD, 2015.

already have passed rules enabling the testing, licencing and operation of autonomous technologies and vehicles. This could ultimately lead to unnecessary barriers to the development and deployment of new technologies. To ensure that the EU is at the forefront of technological developments in the industry and to avoid unnecessary obstacles resulting from diverse regulatory approaches in various Member States, a review of legislation and action at EU level is necessary.⁸¹

In the light of the ongoing review of legislation at international and national levels in relation to connected and autonomous vehicles, **proactive policy initiatives** on liability rules initiated by the European Parliament and other EU institutions could potentially help to reduce costs and complexity for developers. They could also facilitate trust among consumers in connected and autonomous vehicles and thus facilitate innovation, technological development, competitiveness and economic growth in the EU.

4.2. Subsidiarity and proportionality

Any EU action must respect the principles of subsidiarity and proportionality as established under EU law. In general, the policy options considered below all meet the subsidiarity and proportionality requirements, as the measures suggested do not go beyond what is necessary to achieve the common objectives of ensuring the functioning the internal market and the free movement of goods while at the same time securing a high level of consumer protection and facilitating the competitiveness of the industry.⁸² If actions are taken individually by Member States to address existing gaps and shortcomings, this may entail a risk of creating obstacles to the roll-out and use of AVs across the EU. Action at EU level is therefore justified. However, the action taken by the EU must have a clear scope and coverage in accordance with the EU Treaties.

4.3. Policy options and their impact

There are four policy options that may be considered when addressing the current gaps and uncertainties.

Policy option 1: status quo – no adaptations for AVs

This policy option presupposes no change. Therefore the gaps and shortcomings of the existing system identified would be preserved. Intensive litigation could be expected to fill legal lacunae by means of case law. This may lead to different interpretations in the various jurisdictions. If legal doctrine on contested or not specifically regulated issues is established through jurisprudence at EU level it could potentially reduce legal uncertainty. However, the settlement of contested legal issues on a case-by-case basis through the courts rather than through action by legislators is arguably not the most effective, efficient and sustainable response.

⁸¹ The spectrum of the regulatory review necessary is broad and includes not only issues already covered by EU legislation (i.e. civil and contract law, insurance, consumer protection, safety, and technical and environmental standards for motor vehicles) but also related fields such as telecommunications, cybersecurity, privacy and data protection.

⁸² The policy options suggested provide only an initial outline. The subsidiarity and proportionality tests must be applied in more depth and more detailed policy options considered.

Table 8 – Policy option 1: baseline scenario

	Policy option 1: baseline scenario
Scope	Maintaining status quo.
Action required	No legislative changes to the PLD or the MID No need to introduce new EU legislation
Pros:	- On a procedural level, this option does not require any action by the legislator.
Cons:	- All identified gaps and uncertainties in the current system will remain, potentially with the introduction of AVs leading to (i) a weaker position for consumers; (ii) uncertainties for courts; (iii) increased costs of litigation; (iv) increasing differences between Member States' legislation - New risks will remain uncovered - Issues relating to the determination of liability in the event of accidents will not be addressed

Source: Information compiled by the author.

Policy option 2: reform of the PLD

This option would aim primarily to clarify the allocation of risks between manufacturers and consumers. It would involve addressing such issues as: the definition of the product, the definition of 'defect', the scope and limitation of available defences and the burden of proof. The main focus of this legislative intervention would be to ensure fair protection and compensation for damages resulting from AVs by enlarging the substantive and material scope of the PLD. This policy option would be difficult given that PLD is a directive that applies to all defective goods. Thus, it would therefore be extremely difficult to amend the directive so as to address existing gaps and limitations relating to AVs while also maintaining the directive's necessary flexibility as a general regulatory framework for all defective products. Also it is questionable from a legal-technical point of view to what extent it is feasible to cover all new risks by means of amendments to the PLD.

Table 9 – Policy option 2: reform of Product Liability Directive

	Policy option 2: reform of the Product Liability Directive
Scope	- Substantive revision of the substantive scope of the PLD to account for existing gaps and cover new risks, also potentially simplifying the procedure for liability claims akin to the procedure established by MID
Action required	- Legislative amendments to the PLD
Pros:	- PLD provides a highly harmonised framework
Cons:	- PLD applies to <u>all</u> defective products, therefore any changes to the PLD would impact not only AVs but potentially all products

Source: Information compiled by the author.

Policy option 3: reform of national traffic liability rules and the MID

This policy option would primarily harmonise national traffic liability rules and provide victims of accidents with a common system for claims resolution. Harmonisation of substantive traffic liability rules while arguably desirable for traffic participants, is currently not part of the MID. To amend the substantive scope of the MID in order to include substantive provisions on the determination of liability and compensation mechanisms would be extremely difficult.

Table 10 - Policy option 3: reform of the Motor Insurance Directive

Policy option 3: reform of the Motor Insurance Directive	
Scope	- Substantive revision of the substantive scope of the MID to account for existing gaps and cover new risks
Action required	- Legislative amendments to the MID and possible national traffic laws
Pros:	- MID provides a well-established mechanism for compensation
Cons:	- MID does not cover substantive liability law, harmonisation of national liability laws would be difficult

Source: Information compiled by the author.

Policy option 4: new instrument on AVs to cover emerging risks (no-fault insurance)

Amendments to neither the PLD nor to the MID alone would be able to address the existing gaps and limitations in full. Therefore, an EU instrument aiming to establish a framework for basic risk allocation relating to AVs could be desirable.

Table 11 - Policy option 4: new legislation and no fault insurance

Policy option 4: new legislation + no fault insurance	
Scope	- New instrument that would be specifically drafted to address issues related to AVs
Action required	- Adoption of new legislation on risk allocation related to AVs
Pros:	- A coherent framework specifically applicable to AVs
Cons:	- Could be lengthy and difficult to adopt - Possible overlaps with the PLD and MID

Source: Information compiled by the author.

5. European added value

Two studies have been commissioned by the European Parliamentary Research service's European Added Value Unit to measure European added value both quantitatively (economic analysis) and qualitatively (comparative legal analysis). The study by Engelhard and Bruin (University of Utrecht) focuses on analysis of gaps and constraints of the current legal framework for liability and motor insurance within the EU and accompanying regulatory challenges. This study measures European added value using a qualitative multi-factor approach. More specifically, the policy options are compared against three main indicators: first, legal certainty, second, consumer protection, and third, legal fragmentation.

The second study by Rohr, Dunkerley and Howarth (RAND Europe Consultancy) use economic analysis to measure the possible added value for the earlier deployment of AVs of legislative developments in the EU liability framework. They conduct a **cost-benefit analysis** (CBA) to explore the scale of social and economic benefits of faster roll-out and take-up of AVs in the EU.⁸³ European added value is therefore measured and quantified in terms of the socio-economic costs and benefits connected with the possible earlier than anticipated baseline roll-out of AVs.

5.1 Economic analysis⁸⁴

The main findings of Rohr and Dunkerley suggest the following:

- Accelerating the adoption curve of AVs by five years would have **the potential to generate European added value worth approximately €148 billion**. For details of the calculation see Table 12 below and Annex II.
- While the PLD is seen by experts to be of crucial importance for producers, its reform is not necessary at this time: it is not felt 'to provide benefits in terms of roll-out and take up' of AVs.
- The scale of the likely impact and the social and economic benefits to society resulting from possible amendments to the PLD bringing forward the roll-out of AVs would be relatively small.
- Based on interviews with experts, a number of legislative amendments (other than to the PLD) might be desirable to improve the effectiveness of AVs and the coherence of the current legislative framework. This could include: clarifying the concept of the 'driver', preconditions for the use of AVs by minors, conditions for criminal negligence while operating AVs and issues relating to the new risks, such as for example, cyber attacks and hacking as well as access to accident and driving data to enable determination of liability.

⁸³ For detailed description of methodology, method and model for quantification applied please see Annex II (RAND Europe study).

⁸⁴ The economic study is available in full in Annex II.

Table 12 – Summary of cost-benefit analysis of scenarios for the EU (€ billion in 2015 prices)⁸⁵

Consumer impacts	Insurance / liability scenarios				Sensitivity tests			
	S1: Earlier deployment	S2: Slower deployment	S3: No insurance costs	S4: Fully internalised costs	S5: Lower productivity	S6: Higher accident rate	S7: Increased AV safety	S8: 50 % shared AVs
Transport user impacts	116.53	-35.58	35.22	-23.95	-188.14	-879.04	17.18	315.29
Health impacts	-1.99	0.00	-0.59	0.19	2.09	0.03	-0.36	-4.21
External accident cost impacts	2.34	-0.81	-22.12	6.92	0.05	-49.24	1.27	-0.10
External environmental cost impacts	8.60	-3.01	-0.20	0.06	0.71	-0.03	-0.12	-1.44
Tax revenue	6.57	0.82	-4.96	1.55	-2.67	130.85	-2.97	-26.81
Wider economic impacts	16.11	-5.55	0.75	-0.24	-226.30	-15.41	0.45	5.43
Total	148.15	-44.13	8.10	-15.47	-414.27	-812.85	15.46	288.17

Source: Rohr, Dunkerley and Howarth, Table 4, Annex II

5.2. Comparative legal analysis

The study by Engelhard and Bruin provides a detailed legal analysis of existing EU product liability and traffic liability rules as well as comparative legal analysis of six EU Member States' liability rules, representing three different compensation regimes. Engelhard and Bruin find that the current legislative framework for civil liability would not provide a satisfactory regulatory framework if applied to claims for damage caused by AVs because of serious gaps and constraints. In relation to the gaps in the PLD, Engelhard and Bruin argue that if the current EU framework is not reviewed:

'First, consumers will experience difficulties to establish 'defectiveness' as it will generally not be considered 'reasonable' to expect a perfect product. Even with back-up systems and other forms of protection, the dependence of software and high-tech operation systems on a large scale, will have technology vulnerabilities. The safety level will be measured according to the standards as they were, at the time of production.

Secondly, the PLD regime does not expect producers to be a frontrunner in safety risks not yet commonly found in the branch at the time of production and, in fact, that the cost of scientifically unknown risks will be borne by injured parties.

Thirdly, courts may lack expertise to determine the legal standard for such high-tech products, causing uncertainty as to the exact legal safety level. Uncertainty of the law is further increased by national differences that remain under the PLD, which make it less transparent in cases that could be governed by more than one national jurisdiction. These constraints seriously impede the level of consumer protection.¹⁸⁶

⁸⁵ See Annex II.

⁸⁶ Engelhard and Bruin, Annex I.

Based on the review of EU Member States' various traffic liability compensation regimes, which could be broadly grouped into risk-based systems; fault-based systems and mixed systems, Engelhard and Bruin find that, in general, risk-based systems would adjust better to the introduction and roll-out of AVs than fault-based systems. However, even the current risk-based systems are not without gaps and limitations:

'However, even in countries that have risk-based liability for motor vehicles, the driver (or operator) of the motor vehicle is not (equally) protected, compared to other traffic members. That is unsatisfactory, given that his position, at least in cases of full automation, will not be different from 'regular' passengers of the vehicle. Further, the current justification grounds for far-reaching risk-based traffic liability calls for a reconsideration if it turns out to be true that, generally spoken, keepers and users of autonomous vehicles are in fact 'risk minimisers'.¹⁸⁷

Furthermore, analysis by Engelhard and Bruin finds that neither the PLD nor the EU's Data Protection Directive or General Regulation on Data Protection seem to provide for a comprehensive regime on liability for specific cases of hacking and other forms of cybercrime relating to AVs. They consider:

'As for the specific case of hacking or other forms of cybercrime, civil liability in general is again not harmonised in the EU. Since technically it will be difficult to prove who is responsible, CAV producers will be confronted with claims under the Data Protection Directive (DPD) and the new General Regulation on Data Protection (GDPR). They can be held liable in their capacity of controllers of personal data if they determine the purposes and the means of processing personal data, or as processors of personal data under the responsibility of a controller. But this will only be the case if a controller or processor for instance fails to take appropriate technical and organisational measures to protect the data from being hacked into or infringes other obligations under the DPD or GDPR. Yet, a regulatory answer may be sought to the question whether the producer of CAV TT could be held liable if a data breach occurs due to insufficient security measures taken by him, while he is *not* a controller or a processor under the DPD or GDPR, and taking sufficient security measures by him would thus not be required based on these rules. Neither the GDPR or the DPD, nor the PLD seems to provide satisfactory outcomes in this respect.'

Engelhard and Bruin conclude that there is a highly fragmented regulation of issues related to the civil liability of motor vehicles that if applied to AVs 'may be detrimental to the internal market for autonomous vehicles'.¹⁸⁸ They argue that the European added value of taking action at the EU-level is threefold:

Firstly, it seems imperative to promote **legal certainty** within the Community, which in turn could reduce transaction costs, adding to the EU's competitive gain in the transport sector.

Secondly, EU-action is imperative to further increase the **effectiveness** of consumer protection, as there are currently important legal gaps and challenges within the PLD that must be addressed before the roll-out of autonomous vehicles. This is Community law and may thus not be left to the discretion of the Member States to solve these legal issues. Also an added value argument can be made for EU-regulatory action to alter the national traffic liability laws and particularly to include the victim-driver in the scope of

⁸⁷ Ibid.

⁸⁸ Ibid.

protection. In fact, some member states have yet announced that their national laws will suffice, making it unrealistic to leave a revise in their hands.

Thirdly, EU regulatory action is necessary to create **a level playing field for producers and the member states**. This could facilitate the distribution of this means of transport within the internal market as the financial risk of liability is the same within the EU.¹⁸⁹

In assessing the policy options, Engelhard and Bruin argue that a no-fault insurance model would be the best regulatory response at EU level to allocate the risk of damage caused by AVs. This policy solution would help to address the current gaps and constraints, contribute to legal certainty and effectiveness, ensure consumer protection and provide certainty for producers.

Table 13 – Summary: potential European added value

	Scope	Main findings on EAV
Quantitative analysis	<ul style="list-style-type: none"> Quantification of socio-economic benefits of earlier (than baseline 2025) roll-out of AVs 	<ul style="list-style-type: none"> approximately €148 billion
Qualitative analysis	<ul style="list-style-type: none"> Qualitative assessment of effectiveness, efficiency and coherence 	<ul style="list-style-type: none"> reduction of transaction and litigation costs related to the fragmentation of EU law and divergence among MS regulations increase in legal certainty for producers increase in consumer trust in the new technologies

Source: Information compiled by the author.

5.3. Comparative assessment of policy options and European added value

Considering the objectives of the EU, and the current shortcomings of the EU liability framework, four suggested policy options are assessed and compared along with seven qualitative criteria: legal certainty, potential litigation burden, impact on innovation, impact on level of consumer protection, political acceptance, degree of regulatory intervention needed and degree of dependence on soft law (voluntary collaboration/settlements between industry and consumers, or other stakeholders).

⁸⁹ Ibid.

Table 14 – Comparative policy options – European added value assessment

	Criteria	Option 1 Status quo	Option 2 PLD reform	Option 3 MID Reform	Option 4 New Law + No-fault insurance
Fit with policy objectives	Legal certainty at EU-level				
	Minimized litigation burden (cost and time)				
	Safeguarding of consumer protection				
	Encouraging innovation				
Feasibility	Minimal scale of regulatory change needed				
	Ease of political acceptance				
	Not dependent on voluntary industry collaboration or settlement efforts				

Source: Information compiled by the author.

Legend: An empty circle suggests no impact, a filled circle suggests a significant benefit

The **seven qualitative criteria aim to measure the effectiveness, efficiency, coherence and political feasibility of possible regulatory intervention**. Effectiveness is measured in terms of the ability of the policy intervention to close current legislative gaps and uncertainties; efficiency is measured in terms of ease of applicability of the policy by stakeholders; coherence is measured as the ability of the adopted rules to facilitate national and cross-border claims settlement and resolution of conflict of law issues; finally, political feasibility is measured in terms of the legal procedure and scope of regulatory change needed.

Policy option 1 – status quo – scores well on feasibility as it does not require any legislative action on behalf of the EU legislator but it is the least preferable in terms of the ability to fill the existing lacunas and potential to contribute to the achievement of common EU objectives. In this sense this policy option provides least European added value.

Policy options 2 and 3 – which focus on the reform of the PLD (Option 2) or the MID (Option 3) – would help to address a number of existing shortcomings. However neither reform of the PLD nor alternatively reform of the MID alone would be able to address all the gaps. Moreover by reforming only one of the directives, there is a danger that 'The consumer may then, in some countries, in fact be paying twice, if one and the same risk is calculated in the price of autonomous vehicle and in their motor insurance premium. Ultimately, this could have implications for the roll-out of autonomous vehicles and might then create locational disadvantages for new developers of their technology'.⁹⁰ Options 2 and 3 will both result in European added value in terms of increased effectiveness and efficiency, however, not to the fullest potential.

Policy Option 4 suggests introducing new EU legislation and setting up a no-fault insurance framework for damages resulting from AVs. Comprehensive legislation at EU level would have the potential to address existing gaps and limitations in the best way. This option however requires most regulatory change and is thus likely to be most difficult in terms of political feasibility. Overall, however, in comparative terms, policy option 4, compared across seven qualitative criteria would be best able to contribute to European added value.

⁹⁰ Annex I, Utrecht Study, p. 72.

6. Conclusions

Accelerating the adoption curve for AVs by five years has the economic potential to generate European added value worth approximately €148 billion. Therefore public regulators have an interest in ensuring that the regulatory framework facilitates adoption of AVs and thus contributes to the generation of economic value. Expert national committees of Member States, high level expert groups initiated by the European Commission, as well as a recently adopted European Parliament resolution all underline that liability issues relating to the adoption and use of AVs need to be clarified.

The revision of the existing regulation and/or introduction of an additional regulation on the allocation of risks related to AVs has the economic potential to generate European added value that could be lost if the no-action option is preferred. The European added value of the roll-out of AVs would be generated mainly by legislative measures that would facilitate earlier adoption of AVs. Further added value of EU action at the stage of mass adoption of AVs could be generated through measures to reduce transaction and litigation costs relating to regulatory divergence among various jurisdictions and measures facilitating consumer trust in the new technologies.

Coordinated action at EU level has the potential to contribute further to European added value by reducing the transaction costs resulting from the fragmentation of national legal systems and minimising litigation costs. Insufficient coordination between several jurisdictions on the adoption of regulatory rules enabling the testing, licensing and operation of autonomous technologies and vehicles could ultimately lead to unnecessary barriers to the development and deployment of new technological solutions.⁹¹ Clear rules at EU level, would contribute to legal certainty and would help to avoid transaction costs resulting from divergent national legal rules.

⁹¹ OECD, Automated and Autonomous Driving, Regulation under uncertainty, 2015, p.6. Similarly, the UK Department for Transport finds it necessary to 'provide additional clarity and certainty in legislation, to provide a sound basis upon which to allocate criminal and civil liability'. 'The pathway to driverless cars: summary report and action plan, 2015, UK Department for Transport, p. 10.

Annex I

EU Common Approach on the liability rules and insurance related to Connected and Autonomous Vehicles

Final Report

by Dr E.F.D. (Esther) Engelhard and R.W. (Roeland) de Bruin, LL.M.



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Preface

Numerous companies and researchers are working hard on the development of motor vehicles that are more and more autonomous and even fully autonomous (driverless), sensing their environment and navigating without human input. Also, various cities in Europe are planning transport systems for driverless cars and several countries have already allowed these cars to be tested on public roads. In the meanwhile, the question arises as to where responsibility lies or should lie for damage resulting from casualties with semi-autonomous and autonomous vehicles. This study seeks to shed light on the applicability and gaps and constraints of the current legal frameworks for liability and motor insurance within the EU, and regulatory challenges that lie ahead. It focuses on the regulatory role that the EU, and the European Commission in particular, could play and the European Added Value.

The present report has been prepared for the Directorate for Impact Assessment and European Added Value, with the Directorate General for Parliamentary Research Services (DG EPRS) of the General Secretariat of the European Parliament. By issuing this report, we hope to make a positive contribution to the European debate on where liability for damage caused by or with autonomous vehicles should lie and how the balance can be struck between all the interests involved in this issue. The Utrecht Centre for Accountability and Liability Law, UCALL, conducts and commissions multidisciplinary research and studies, *inter alia* on issues involving liability, insurance and damage.

We would like to express our thanks to Tatjana Evas and to Prof. Ivo Giesen, for his feedback on an earlier draft of this report. Further, we have had the benefit of meetings at various occasions with researchers of Rand Europe, in particular Charlene Rohr and Fay Dunkerley, who were conducting an empirical study in the same project to quantify the social and economic impacts of different legislative scenarios, including changes to the Product Liability Directive, on roll out of fully autonomous, or self-driving, vehicles. The current report also benefited from the valuable exchanges of views with Prof. David Howarth of Cambridge University. Responsibility for the full text and ideas expressed in this report, however, lies solely with its authors.

The main part of Chapter 4 (sections 4.1-4.3) has been written by Roeland de Bruin; the other parts and chapters were written by Esther Engelhard.

The arguments expressed in this report are solely those of the authors, and do not reflect the opinion of any other party. Any errors that remain in the report are the responsibility of the authors. Comments or questions with regard to this report will be appreciated by the authors and can be directed to: E.Engelhard@uu.nl.

Utrecht, May 2017,

Esther Engelhard, project leader.

Summary

Who bears the risk that the new automation technology built in motor vehicles, that partly takes over tasks of the driver or even all driver tasks, causes damage to individuals (the owner or user of the autonomous vehicle itself and other traffic members)? Part 1 of the current report contains an assessment of how the current rules for product liability and traffic liability and the fault liability rules within six EU member states (*viz.* Belgium, France, Germany, the Netherlands, Sweden and the UK) could be applied to autonomous vehicles. Part 2 of the report contains a meta-legal analysis of the possible legal solutions. It identifies three solution models, which are analysed and evaluated as to each model's pros and cons, incorporating the different arguments and perspectives in the current debate and actual initiatives and developments in the member states.

In Part 1, the current study finds that, in the absence of legislative intervention, national risk-based and to a lesser extent fault-based rules for civil liability will become highly relevant if applied to claims for compensation after casualties with autonomous vehicles, but that these rules will not give satisfactory results as these contain serious gaps and constraints in this respect. Regulatory revision must therefore be considered.

These findings are based on an assessment of the national rules of civil liability law. Generally, these rules require personal fault of the party who is held liable, which have a limited role to play if the technology itself breaks down, fails, is being hacked, *etcetera*. More relevant is the product liability directive (PLD), which imposes liability on the producer of the motor vehicle for its defectiveness. An advantage of the PLD regime is that it does not require personal fault and that it also offers protection in cases of single-vehicle accidents. However, the PLD regime contains several gaps and constraints if applied to claims for damage caused by autonomous vehicles. First, consumers will experience difficulties to establish 'defectiveness' as it will generally not be considered 'reasonable' to expect a perfect product. Even with back-up systems and other forms of protection, the dependence of software and high-tech operation systems on a large scale, will have technology vulnerabilities. The safety level will be measured according to the standards as they *were*, at the time of production. Secondly, the PLD regime does not expect producers to be a frontrunner in safety risks not yet commonly found in the branch at the time of production and, in fact, *that the cost of scientifically unknown risks* will be borne by injured parties. Thirdly, courts may lack expertise to determine the legal standard for such high-tech products, causing uncertainty as to the exact legal safety level. Uncertainty of the law is further increased by national differences that remain under the PLD, which make it less transparent in cases that could be governed by more than one national jurisdiction. These constraints seriously impede the level of consumer protection.

Another route to claim compensation is to invoke the national rules on traffic liability. Claims for compensation against other traffic members are generally based on fault. This is most relevant for vehicles at SAE automation-levels 1 to 4 (section 1.3). At SAE automation-levels 5 and 6, there *can* be fault liability of the operator of the vehicle, but this will, on the average of cases, be exceptional. In some member states, owners and/or keepers of motor vehicles incur risk-based liability, which seems more in line with the fact that the technology which 'autonomises' the vehicle seeks to replace the human driver. For the majority of casualties, this means that claims for compensation will more easily succeed if based on these risk-based laws, in their current form, than on mere fault-based liability of the driver/operator of the autonomous vehicle. However, even in countries that have risk-based liability for motor vehicles, the driver (or operator) of the motor vehicle is not (equally) protected, compared to other traffic members. That is unsatisfactory, given that his position, at least in cases of full automation, will not be different

from 'regular' passengers of the vehicle. Further, the current justification grounds for far-reaching risk-based traffic liability calls for a reconsideration if it turns out to be true that, generally spoken, keepers and users of autonomous vehicles are in fact 'risk minimisers'.

Given these many gaps and difficulties under the current civil liability laws, suggestions have been made to either revise or complement civil liability law in light of autonomous vehicles. Several member states are currently considering how their domestic civil liability laws and other compensation schemes may affect the automotive producer/software producer, the owner and the user of the autonomous vehicle, rental companies, other road users, *etcetera*. Some member states are considering special legal arrangements to regulate civil liability for accidents caused by autonomous vehicles, such as the proposed 'Vehicle Technology and Aviation Bill' that was laid before the UK Parliament in February 2017. This bill holds third-party insurers in the UK primarily liable for damage caused by an automated vehicle when driving itself. But the fact that there are different domestic rules within the EU that govern the civil liability for the parties concerned, varying from lenient to very strict liability, is an impediment to the roll-out of automated vehicles in Europe, also in light of its competitiveness.

As for the specific case of hacking or other forms of cybercrime, civil liability in general is again not harmonised in the EU. Since technically it will be difficult to prove who is responsible, CAV producers will be confronted with claims under the Data Protection Directive (DPD) and the new General Regulation on Data Protection (GDPR). They can be held liable in their capacity of controllers of personal data if they determine the purposes and the means of processing personal data, or as processors of personal data under the responsibility of a controller. But this will only be the case if a controller or processor for instance fails to take appropriate technical and organisational measures to protect the data from being hacked into or infringes other obligations under the DPD or GDPR. Yet, a regulatory answer may be sought to the question whether the producer of CAV TT could be held liable if a data breach occurs due to insufficient security measures taken by him, while he is *not* a controller or a processor under the DPD or GDPR, and taking sufficient security measures by him would thus not be required based on these rules. Neither the GDPR or the DPD, nor the PLD seems to provide satisfactory outcomes in this respect. National law again determines whether the operator or owner/keeper of an autonomous vehicle has the obligation to install software (security) updates and whether, if he did not comply, he could be held liable for the damage a hack causes. In countries with risk-based traffic liability (Belgium, France, Germany, the Netherlands) or direct insurance (Sweden and the UK's current legislative proposal), this risk will generally fall under the scope of these laws and will then be borne by the owner or keeper of the autonomous vehicle or his liability motor insurance carrier. All in all, Part 1 reveals highly fragmented outcomes, which may be detrimental to the internal market for autonomous vehicles. Here lies an interest for the EU to regulate traffic liability at least for the extra strains put on protective law systems (France, Belgian, Sweden): in these countries the producer's risk will, at least *prima facie*, be borne by liability motor insurers. If in these member states risk-based liability for motor vehicles is an easier route to follow than claims based on product liability, then this could – *inter alia* – impact liability motor insurance premiums in those particular countries. The other side of this coin is that, if the paying motor insurer does not pursue its reimbursement claim, the producer's risk of liability will be smaller than in countries that have less 'claimant-friendly' (protective) traffic liability laws.

Part 2 of this report comprises of a normative analysis to assess the added value of taking legislative action at EU-level and to find the appropriate legal options.

The European Added Value is assessed through a multi-factor approach which has been regularly used. This is consistent with the purpose of striking a fair balance between innovation and legal protection of fundamental values such as personal safety. Regulatory action at EU-level in this context results from three factors.

Firstly, it seems imperative to promote legal certainty within the Community, which on its turn could reduce transaction costs, adding to the EU's competitive gain in the transport sector.

Secondly, EU-action is imperative to further increase the effectiveness of consumer protection, as there are currently important legal gaps and challenges within the PLD that must be addressed before the roll-out of autonomous vehicles. This is community law and may thus not be left to the discretion of the member states to solve these legal issues. Also an added value argument can be made for EU-regulatory action to alter the national traffic liability laws and particularly to include the victim-driver in the scope of protection. In fact, some member states have yet announced that their national laws will suffice, making it unrealistic to leave a revise in their hands.

Thirdly, EU regulatory action is necessary to create a level playing field for producers and the member states. This could facilitate the distribution of this means of transport within the internal market as the financial risk of liability is the same within the EU.

Three different legal solution models are investigated to allocate the risk of damage caused by autonomous vehicles: a reform of product liability, a reform of traffic liability and no-fault insurance. Based on the goals of legal certainty, the scope of protection and efficient claim handling, a no-fault insurance model is proposed to adequately help alleviate the current gaps and constraints.

List of abbreviations

BGB	<i>Bürgerliches Gesetzbuch</i> (the German Civil Code)
BGH	<i>Bundesgerichtshof</i>
BW	<i>Burgerlijk Wetboek</i> (the Dutch Civil Code)
CAV(s)	connected autonomous vehicle(s)
CC	<i>Code Civil</i> (the French Civil Code)
CJEU	Court of Justice of the European Union
DPD	Data Protection Directive
DPEC	Directive on Privacy and Electronic Communications
EC	European Community
ECC-net	Network of European Consumer Centres
ECHR	European Convention on Human Rights
ECR	<i>European Court Reports</i>
Ed(s).	Editor(s)
EDPA	European Data Protection Board
EEA	European Economic Area
EEC	European Economic Community
EFTA	European Free Trade Organisation
e.g.	<i>exempli gratia</i> (for example)
et al.	<i>et alii</i> (and others)
EU	European Union
EWCA Civ.	England and Wales Court of Appeal (Civil Division)
EWHC	England and Wales High Court
GPS	Global positioning systems
GPSD	General Product Safety Directive (Directive 2001/95/EC)
GDPR	General Data Protection Regulation
HR	<i>Hoge Raad</i>
ITF	International Transport Forum
LB	<i>Loi Badinter</i> (the French Road Traffic Act)
OECD	Organisation for Economic Co-operation and Development
OJ	<i>Official Journal of the European Union</i>
Para(s).	paragraph(s)
PIQR	Personal injuries and quantum reports
PLD	Product Liability Directive

pp.	page numbers
PLD	Product Liability Directive (Directive 85/374/EEC)
SAE	Society of Automotive Engineers
StVG	<i>Strassenverkehrsgesetz</i> (the German Road Traffic Act)
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union
TT	tracing technology
V2I	vehicle-to-infrastructure communication
V2V	vehicle-to-vehicle communication
V2X	vehicle-to-everything communication
WAM	<i>Wet aansprakelijkheidsverzekering motorrijtuigen</i>
WCAM	<i>Wet Collectieve Afwikkeling Massaschade</i> (the Dutch 'Collective Mass Settlement Act')

1. INTRODUCTION

1.1 Damage caused by (or through) the automation of vehicles

As cars are increasingly being equipped with technology that assists in certain aspects of driving, the question as to who should bear the damage in the case of accidents remains unclear. The current automotive technology includes lane keep assistance, emergency braking, parking assistance and adaptive cruise control. Yet higher levels of car automation and interconnection of cars with each other and other elements of road and telecommunications infrastructure have also been developed. Eventually this could lead to the wide introduction of fully autonomous vehicles: vehicles that are capable of operating on the roads without direct human intervention. Studies point to significant social and environmental future benefits, particularly improving safety.⁹² However, in some cases the automation and interconnection of motor vehicles *will* cause damage to individuals. A relatively small number of casualties has already been reported by the media.

In 2016, after some minor collisions of Google self-driving cars on public roads, Google's Lexus SUV test driver hit a bus in its attempt to avoid sand blocks as it expected the public transit bus approaching from behind to stop.⁹³ But the first fatal accident caused by the automation of a semi-autonomous vehicle has also been reported. It involved one of Tesla's model S cars that crashed while using its AutoPilot function, advanced cruise control that includes lane keep, changing lanes and adjusting speed in response to traffic. The car made no attempt to apply the brakes when in front of it, on a Florida highway, an 18-wheel tractor-trailer turned left. According to Tesla, neither AutoPilot nor the driver had noticed the trailer's white side against the brightly lit sky: '*(...) the system is new technology and still in a public beta phase before it can be enabled. When drivers activate Autopilot they are warned to keep their hands on the steering wheel at all times*'.⁹⁴

In February 2017 a legislative proposal has been laid before the UK Parliament that addresses this issue. Under this so-called 'Vehicle Technology and Aviation Bill' third-party insurers would primarily be liable for damage caused by an automated vehicle when driving itself.⁹⁵ Several other Member States of the EU have also come up with initiatives to consider whether or not to introduce special rules of liability for autonomous vehicles.⁹⁶ In the absence of special legislation, claims for compensation of the damage will be governed by the current national liability rules. Under the current rules several parties could be held liable for accidents caused by autonomous or semi-autonomous motor vehicles: the automotive/software producer, the owner and/or user of the autonomous vehicle, rental companies, other road users, *etcetera*. But the current rules have not been designed for these claims for compensation as the technological developments referred to above took place long after these rules were created. Consequently, there is a need to assess how the current civil liability rules can be applied to accidents caused by (the testing or regular use of) automated vehicles and to explore the legal possibilities in order to improve these current rules and/or to find new rules upon which to allocate civil liability.⁹⁷

⁹² KPMG, 2015; Atkins Ltd., 2015.

⁹³ <http://www.wired.com/2016/02/googles-self-driving-car-may-caused-first-crash/>.

⁹⁴ At https://www.teslamotors.com/en_GB/blog/tragic-loss?redirect=no (30 June 2016).

⁹⁵ House of Commons Bill 143, 22 February 2017. See further *infra*, section 3.2.3.

⁹⁶ See the overview presented in section 3.2.3 below, with references.

⁹⁷ *Ibid.* the UK Department for Transport, 2015, p. 10; OECD/ITF, 2015, p. 6-7.

The choice on whom to impose civil liability clearly has consequences. Uncertainty and unpredictability of liability law may detract from consumer confidence in autonomous vehicles and from the eagerness of developers and investors (and thus, ultimately, their success rate). Users, developers, producers and insurers want to know the risks before they take the initiative to use, create, test and market. The high potential of the autonomous vehicles sector marks the necessity of an adequate regulatory framework for civil liability and insurance. Who will bear the costs if autonomous vehicles cause damage? For what types of situations can developers and producers of autonomous vehicles expect to be held liable? To what extent can drivers/operators of autonomous vehicles be held liable for damage suffered by third parties?

Legal uncertainty is further increased by the many differences that currently exist between national jurisdictions. Within the EU, different domestic rules govern the civil liability of car owners, drivers/operators, producers and alike. Consequently, these parties incur civil liability on different legal grounds, varying from lenient to very strict liability. A commonly heard statement is that this is (or could be) a serious impediment to the roll-out of automated vehicles in Europe,⁹⁸ also in light of its competitiveness.⁹⁹

1.2 Central research questions and methodology

The purpose of this study is to investigate the possible scope and added value of taking legislative action on the EU level. It is based on a legal assessment of the current legal framework at the level of the EU and the national level, the latter in the form of a comparative legal analysis. The central questions are:

1. *Is there a need for amendments to the current regulatory framework on civil liability for the testing and the use of (connected and) autonomous vehicles?*
2. *What is the added value of regulatory action by the EU to establish these amendments and in what form should such action be relevant?*
3. *What legal solutions must be considered and which legal solution is preferable?*

The first research question calls for an inventory and analysis of *existing* laws, whereas the last two research questions are 'design questions' to find possible new solutions, for example by remodelling or designing laws. In line with this, the methodology that was used for this research is two-fold. First, current civil liability rules were inventoried and analysed to discover whether and how these rules can be applied to autonomous vehicles (Part 1 of this report). Then, potential legal solutions were modelled and investigated as to their pros and cons and the question whether EU intervention is feasible (Part 2 of this report). This two-fold methodology will now be explained.

For the first research question, a legal inventory was made to assess how the rules for product liability and traffic liability and the fault¹⁰⁰ liability rules within a number of EU Member States could be applied to autonomous vehicles. Given the limited timeframe available for the current

⁹⁸ C-ITS Deployment Platform, 2016, p. 13; Schellekens, 2015.

⁹⁹ Lengton, *et al.*, 2015, p. 14.

¹⁰⁰ *I.e.* the general fault liability rules, not specifically designed for specific damage causing objects or activities such as products, traffic or alike.

research, a selection was made of six countries and their main rules: Belgium, France, Germany, the Netherlands, Sweden and the UK. These countries represent three systematically different and opposite legal compensation mechanisms in the EU for the damage caused in traffic. As will be shown in Chapters 2, 3 and 4 of the report, several points were found under the current civil liability rules that call for solutions.

The second and third research questions are addressed in Part 2 of this report, chapters 6 and 7. This part of the study comprises of a normative analysis to assess added value of taking legislative action at EU level with regard to the civil liability (and insurance) for damage caused by autonomous vehicles. The underlying issue is how the risk of causing damage presented by autonomous vehicles can be regulated: who must legally bear the damage caused by autonomous vehicles, what are possible legal alternatives, does this call for EU regulatory action and if so, in what form?

The focus in this part of the report is on the pros and cons of allocating the cost of accidents caused by autonomous vehicles to different parties under these three models, roughly spoken: to the industry, the owner, driver/operator, other parties, or combinations. The 'ideal' legal arrangement finds a balance between, on the one hand, promoting and facilitating the mobility of individuals and stimulating economic and social advantages of autonomous vehicles and, on the other hand, offering adequate protection to individuals against the damage suffered thereof and respecting fundamental rights of individuals (in particular the right to life, bodily integrity and privacy).

Based on the available literature, reports and other documents (that will be referred to), the researchers investigated ways to allocate the risk and translated these into three legal solution models. Since these are hypothetical models, designed for future law, their value cannot be measured. Rather, the evaluation is based on three normative criteria: legal certainty, the scope of protection and efficient claim handling. Legal certainty is a leading factor that is missing in the current legal framework as this was not designed for autonomous vehicles: the law must enable the parties to the scope of protection must be wide enough in terms of the categories of victims protected. Efficient claim handling means that the process enables victims to receive monetary compensation against relatively low costs for both parties involved. Costs are not measured in monetary terms but rather in terms of the presumed effort, length of procedure and possible expenses for both parties in order to solve the claim.

1.3 Definitions and levels of automation

'Autonomous technology' is a broad concept. It is hard to capture by a single definition. It may, generally, be characterised as: '*items that do not require human engagement*',¹⁰¹ at least not in the actual operation of their system. It also covers single devices, such as airbags and parking assistance. 'Autonomous vehicle technology' sees to the '*technologies and developments that enable a vehicle to assist, make decisions for, and, ultimately, replace a human driver*'.¹⁰² This study is concerned with autonomous vehicles or, dependent on the context, more specifically so-called 'connected and autonomous vehicles', hereinafter: CAVs. The last type consists of three elements.

¹⁰¹ Funkhouser, 2013, p. 441.

¹⁰² Rand report, 2009, p. 3 and Funkhouser, 2013, p. 441.

- *Vehicles* are taken to be motorised cars, used for the transportation of goods and/or people and for carrying out services, including consumer cars, commercial cars and trucks.
- *Autonomy* relates to the level of human intervention necessary for operation, which can be seen as a spectrum: a lower need for human intervention implicates a higher level of autonomy (see below). Software operating the vehicle is intelligent, it can perceive its surroundings, and is able to adapt the driving behaviour to changing environments. It includes the ability to learn, to process complex information and to solve problems.¹⁰³
- The notion that vehicles are *connected* implicates that these are connected to other CAVs (vehicle-to-vehicle, or V2V communication) and/or to telecommunication infrastructure (vehicle-to-infrastructure, or V2I communication). Other technologies connect the vehicle to all appropriate technologies (vehicle-to-everything, or V2X).

This report sees to both fully autonomous and to semi-autonomous vehicles, with a specific focus, if relevant, on those autonomous vehicles that are connected. At certain points in the report, it is necessary to be precise as to the exact level of autonomy of the vehicle concerned. The Society of Automotive Engineers (SAE) identifies six levels of driving automation. These so-called SAE-levels will be used in the current report as point of reference.¹⁰⁴ The six SAE-levels vary from 'no automation' (level 0) to 'full automation' (level 5). It can be assumed though that even with fully autonomous vehicles, a basic level of human control will be maintained, by setting the car or instructing it to get ready and to find a certain destination and stopping it when and if desired. The four levels in between span from:

- vehicles that offer driver assistance by the execution of only one specific task, being either the steering or the acceleration/deceleration of the vehicle, while the driver monitors the environment and performs all other aspects (level 1, 'mere' driver assistance),
- vehicles that execute both the steering and acceleration/deceleration, leaving other tasks including monitoring to the driver (level 2, partial automation),
- vehicles that perform all tasks automated but with the expectation that the human driver will respond appropriately to a request to intervene (level 3; conditional automation), to
- vehicles that only request that the driver will respond in critical circumstances (level 4; high automation).

Below, from level 1 upward, all levels of automation are included when using the terms 'autonomous vehicles' and 'CAVs'. All are object of this study.

¹⁰³ De Cock Buning, Belder and De Bruin, 2012, p. 198.

¹⁰⁴ www.sae.org/misc/pdfs/automated_driving.pdf; Gasser, Arzt, Ayoubi, a.o., 2013.

1.4 Six scenarios

To make the assessment of the current rules more concrete, six scenarios will be referred to throughout this report. The first three concern technical defects.

1. **Scenario 1: hardware failure.** This scenario concerns the driver/operator of an autonomous vehicle who is confronted with a sensor that has not properly detected a sudden lane closure for repair work with conflicting road lines.¹⁰⁵ This raises the question who would or should be liable if the failing sensor caused the car to slip.
2. **Scenario 2: software failure.** This scenario is different from the former in that instant malfunctioning of its software that caused the car to slip. Undefinable symbols appear on the user's display. This scenario introduces the software producer as a possible cost bearer. As will be seen below, this case also stands for the intricate complexities of the question as to 'defectiveness'.
3. **Scenario 3: wireless network collapse.** In this scenario, there was an unplanned construction of a roundabout during the night.¹⁰⁶ The next morning the car is, due to network problems, unable to obtain these data before and while it is used. It fails to download the information in time. As a result, it has to make an emergency stop, causing it to slip and crash into the barrier. Next to the operator and the manufacturer of the vehicle (or its software), this scenario introduces the wireless network provider as a potentially liable party.

Scenarios four and five involve human behaviour and are not primarily caused by mechanical malfunctioning.

4. **Scenario 4: users' personal fault.** Here, the driver/operator of the automated vehicle is at fault for not following the instructions properly, by not updating the software or not keeping his hands on the steering wheel.
5. **Scenario 5: third parties' hacking.** This concerns the 'hacking' of the programming software of the autonomous vehicle by third parties, due to which the autonomous vehicle is no longer responding and crashes.

Scenario six involves the particular programming choice.

6. **Scenario 6: programming choice.** This scenario presents a case in which the autonomous vehicle tries to avoid hitting a house, but collides with a pedestrian, who is seriously injured.

These scenarios may involve different aggrieved parties and heads of damage for which there are different legal rules. Personal injuries, physical or mental (trauma) can lead to pecuniary losses (the loss of earnings, medical expenses, rehabilitation costs, and other costs). Also immaterial damage may result from this, such as pain and suffering, specific inconveniences and cosmetic defects. *Fatal* injuries may cause the financial dependants to suffer a loss of maintenance, extra housekeeping costs and funeral expenses. Individuals may suffer property damage, for example

¹⁰⁵ Aon Risk Solutions, 2015, p. 6-7.

¹⁰⁶ See <http://www.blmlaw.com/publications/20684/pdf/127.09.2015%20-%20ER%20-Driverless%20Cars%20latest%20A4%20web.pdf>

for their car, bicycle or cell phone and incur repair costs, replacement costs, costs of car rental or lost profits.

We will refer to the above scenarios in different contexts throughout the report.

1.5 Structure of this report

This report consists of two parts. Part 1 presents the legal analysis of the current civil liability rules and the need for regulatory action (Chapters 2, 3 and 4). Part 2 presents an assessment of the European added value and the EU's regulatory tools (Chapter 6), followed by an inventory and normative analysis of the legal solutions (Chapter 7).

Part 1 of the report

Chapters 2, 3 and 4 review the current civil liability rules if applied to autonomous vehicles. These chapters indicate constraints, gaps and regulatory challenges within the current legal framework. In Chapter 2 the *EU* (and national) rules for defective products will be analysed in respect of its relevance for testing and the use of autonomous vehicles, both at EU level and the national level. In Chapter 3 national rules on traffic liability (and relevant EU rules) of the six countries as aforementioned will be analysed with regard to their relevance for the testing and the use of autonomous vehicles. In Chapter 4 attention will be paid to the different national rules on fault liability and the specific topics of hacking and privacy. Chapter 5 presents the main conclusions of Part 1 of the current report.

Part 2 of the report

Chapter 6 reflects on the question whether member states would benefit from EU-intervention and what possible *legal options* the EU has to enhance the options as proposed. This includes legal-technical grounds for authority in community law and the form(s) in which action could be taken in respect of the liability for autonomous vehicles.

Chapter 7 presents three different solution models to make civil liability law more 'fit' for the introduction of autonomous vehicles: a reform of product liability, a reform of traffic liability and no-fault insurance. Each model will be investigated as to what the model entails and its pros and cons in respect of the gaps and constraints that were presented in Part 1 of this report. These models will also be assessed on the basis of three normative criteria as aforementioned: legal certainty, the scope of protection and efficient claim handling.

The conclusions and recommendations are presented in Chapter 8.

PART 1

ANALYSIS OF THE CURRENT CIVIL LIABILITY RULES, APPLIED TO CLAIMS FOR DAMAGE CAUSED BY CAVS

This part of the report provides an analysis of how the current national rules on civil liability law can be applied to cases that involve damage caused by autonomous vehicles. To the extent that the damage is not covered or remedied by other private insurance, such as medical insurance and hull insurance, and/or social arrangements, individuals themselves must rely on civil liability law and liability insurance (third-party insurance). The EU member states each have their own national rules on civil liability.

The roll-out and testing of automated vehicles will mainly affect three domains of civil liability law: rules on liability of manufacturers for defective products (product liability), rules on liability of motor vehicle owners/keepers (traffic liability) and the general fault liability rules.¹⁰⁷ The following three chapters will explore the relevance, legal challenges and constraints of these rules in their current form. What are the legal implications if these rules are applied to autonomous vehicles? The goal is to assess whether these rules, in their current form, call for legislative action.

The set-up of this part is as follows. Chapter 2 will deal with product liability law, Chapter 3 with traffic liability law and Chapter 4 with the general fault liability rules in the Member States (applied to hacking and with their relevance for some related issues of sharing of data and information). These chapters each have the same structure: after a basic explanation of the legal background, we will treat the applicability to CAVs, possible constraints, gaps and the challenges of the existing rules. What follows, lastly, is our conclusion of this Part of the report.

¹⁰⁷ *I.e.* fault liability rules that are not specifically designed for particular damage causing activities or objects such as products, traffic and alike.

2. The current product liability rules applied to CAVs

2.1 Introduction

In this chapter the applicability, challenges and constraints of civil liability rules for products will be analysed in respect of autonomous vehicles. Its set-up is as follows. First, an analysis is made of how product liability could be applied to casualties with autonomous vehicles (section 2.2) and to the six scenarios as were set out above (section 2.3). What follows, is an overview of the constraints, gaps and regulatory challenges (section 2.4) and the conclusion (section 2.5).

2.2 Regime of the Product Liability Directive applied to CAVs

2.2.1 Rationale

In the current system, producers' liability is governed by national law. National rules determine whether or not the producer can be held liable to compensate the inflicted damage. The claim for damages against the producer can be based on negligence (fault) or on so-called strict liability: risk-based liability, regardless of fault. The Product Liability Directive (PLD)¹⁰⁸ harmonises the national rules on strict liability within the EU. That is: as far as producers can be called in action for the defectiveness of their products. Its purpose is manifold:¹⁰⁹ *'guaranteeing that competition will not be distorted, facilitating trade within the common market, consumer protection and ensuring the sound administration of justice'*.¹¹⁰

The PLD came about after great efforts to find consensus.¹¹¹ It imposes a regime of strict liability on producers *for any defectiveness of their products*. It prescribes that EU and EFTA member states impose risk-based liability for the product's defectiveness in their national laws. Each member state must implement the ruling as prescribed. The PLD lays down the conditions and available defences for this risk-based liability, the expiration period, the onus of proof, *etcetera*. National implementations have taken either the form of (part of) specific legislation in some countries or are laid down in their Civil Codes.¹¹²

The various national implementations of the PLD account for a great number of legal differences within the EU. Firstly, national interpretations of the PLD differ per member state. Secondly, the PLD leaves several topics open to the member states' discretion, such as the rules of civil procedure and particularly regarding the exact level of proof that is required, the assessment of the facts and the calculation of damages. Thirdly, the PLD has a rather limited scope. It does not harmonise *other* possible grounds for civil liability of producers than *defectiveness of the product*. It leaves fault liability (and contractual liability) of producers untouched. Thus, there are differences in the related national rules of civil procedure law, contract and tort law. All in all, claims for defective products are treated differently in the national regimes within the EU. These differences

¹⁰⁸ Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, *OJ* August 7, 1985, L 210, pp. 29-33, as amended by Directive 1999/34/EC of the European Parliament and of the Council of 10 May 1999, *OJ* June 4, 1999, L 141, pp. 20-21.

¹⁰⁹ Van Dam, 2013, p. 420.

¹¹⁰ CJEU 25 April 2002, Case C-52/00, *ECR* 2002, I-3827, para. 29; *cf.* the recital of the PLD.

¹¹¹ See Shears, 2007.

¹¹² Per October 1, 2016 the current French implementation of the PLD, Article 1386 of the French *Code Civil* (CC), was renumbered as Article 1245 CC.

account for different outcomes,¹¹³ which has led some authors to claim that the PLD falls short in its purpose to provide harmonised consumer protection and to create a level playing field for the industry.¹¹⁴ Be this as it may, in its observations in 2006 the European Commission claimed the national differences did not negatively affect the functioning of the Internal Market.¹¹⁵

2.2.2 The 'common core': main rules of the PLD

The PLD prescribes under which conditions liability of producers and suppliers may arise for the defectiveness of products put into circulation within the EEA (EU, Norway, Liechtenstein and Iceland). It defines which parties are qualified as producer (or supplier) and – in general terms – what can be qualified as a 'product' and when that product must be characterised as 'defective'. The latter does not depend on fault or negligence of the producer. The PLD creates strict (risk-based) liability. If the consumer shows that the product was defective and that this caused the damage, the producer is liable. The producer can then only raise the available defences (see section 2.2.5).

2.2.3 Liable parties under the PLD: who bears the risk?

Producers and developers. The PLD is relevant for several parties involved in the creation and marketing of automated vehicles. Its risk-based liability rests on the 'producer', which is not limited to the traditional automotive industry and other manufacturers of autonomous vehicles. It also rests on '*any person who, by putting his name, trade mark or other distinguishing feature on the product presents himself as its producer*'. This may include developers who use their own brand. It includes the manufacturer of components, such as wheels, airbags and sensors. Technology providers are thus also included, if they deliver technology which is subsequently being used as a component of the vehicle. The PLD also imposes risk-based liability on importers.¹¹⁶

The producer can escape liability based on the defence that he has not put the product into circulation. Testing companies and developing companies may claim this (or claim that they are not the producer). If aware of certain risks, the latter companies (such as Google) could still be liable based on *other (fault-based) national rules on civil liability*. Similarly, other parties-that-are-not-the-producer, *inter alia* public authorities that grant permits for the roll-out and the use of autonomous vehicles, may be liable for not adequately ensuring road safety in cases of malfunctioning. Liability will then generally be fault-based: the victim must claim how the testing company, technology developer or public authority has violated his individual interests.

Component makers. The term 'producer' includes producers of components of the vehicle such as the sensing hardware and operating software. According to the PLD, component producers incur liability for defects found in the vehicle. Hardware and software producers thus also bear the risk of defects other than those specifically produced by their particular technology.

¹¹³ Also other factors can be pointed at, such as national variations in consumer attitudes. These were findings in the Lovell's report, 2003; *cf.* Shears, 2007, p. 907.

¹¹⁴ Jones Day, 2012, p. 4.

¹¹⁵ European Commission, 2006, p. 11.

¹¹⁶ Article 3 (1) of the PLD.

However, as any producer, the component producer has a list of defences to his avail. This list of defences is in the PLD, as cited in this report.¹¹⁷ The last defence in this list (defence sub f) is particularly relevant. Producers of a component escape liability if the damage is caused by a 'design defect' or an 'information defect'. They can only be held liable for so-called 'manufacturing defects'. The claimant has the choice whether to sue the producer of the autonomous vehicle and/or the producer of a component. To the extent that one of the producers compensates the claimant, the former may address others for reimbursement in accordance with each producer's share. The PLD does not indicate how the contributions of each producer must be divided, albeit there may be contractual arrangements to determine this.

Software (and hardware) makers. The term 'product' under Article 2 of the PLD includes those '*incorporated into another movable or into an immovable*'. This means that components of the autonomous motor vehicle, such as its operating software system and/or hardware, can also be qualified as a product of their own – separate from the vehicle as a whole. If the vehicle's software or hardware was produced by another company (*e.g.* the American Cybernet Systems) and if it is defective, then that company may also incur strict liability under the PLD. Although legal-technically not yet decided, the facts indicate that software should be included in the definition of 'product' under Article 2. The European Commission has argued in favour of a broad definition, a view that is supported by a majority of academics;¹¹⁸ the CJEU has not yet decided on this matter.¹¹⁹ This approach can, obviously, only be successful if it can be shown that the software or hardware itself was defective. That may involve specific knowledge that neither the injured party nor the court may possess. Moreover, it is presumed that the software producer is traceable while not much is known about the supply chain of the software, as this is classified information for most manufacturers.¹²⁰

Car-dealers, suppliers. If the manufacturer cannot be identified, the distributor or the supplier (seller) can be held liable within the scope of the PLD, unless he informs the injured person within a reasonable time of the identity of the producer or of the person who supplied him with the product.¹²¹ The CJEU has on several occasions decided that '*the choice was made to allocate liability for defective products in principle to producers and only in certain defined cases to importers and suppliers*'.¹²²

If the manufacturer can be identified by distributors or suppliers, or if the latter have adequately informed the injured person as aforementioned, they do not risk liability under (the national implementations of) the PLD. The distributor or supplier may still incur liability on other grounds such as fault. The same is true for other parties that are not the producer, such as purely

¹¹⁷ See *supra*, section 2.2.5.

¹¹⁸ *Pub. EC C 114/4*; Van Wees, 2015, section 3.3; De Vey Mestdagh and Lubbers, 2015, p. 275, Van Eijck and Van Dijck, 2015, section 3.2.

¹¹⁹ See Alheit, 2001 and Vihul, 2014.

¹²⁰ This is different for companies like Google that use the hardware (the *chassis*, sensors, *etc.*) to test and use the software that has been developed by them. These are producers of the final product (the CAV) and will incur liability as such under the PLD.

¹²¹ Article 3 (3) of the PLD.

¹²² CJEU 10 January 2006, case C-402/03, para. 29 and CJEU 21 December 2011, case C-495/10, para. 25.

intellectual developers of the autonomous vehicle or its software (as mentioned above) and public bodies. One can further think of rental companies. The latter category calls for a brief explanation.

Rental companies (or other service providers such as taxi companies). The class of liable persons under the PLD does not extend to service providers, such as companies that would put autonomous vehicles up for rent by consumers¹²³ or professionals. Rental companies may, however, incur liability based on national liability for motor vehicles, special rules to transport carriers liability or on the rental contract and related rules of contract law.¹²⁴ If service providers have compensated the injured party, they may seek recourse *vis-à-vis* the producer.

Alternative grounds for liability of parties outside the scope of the PLD. The liability of distributors and suppliers conforming to their information duty, and testing and rental companies is generally fault-based. National courts will carefully balance both parties' interests and particularly factors such as whether the injured party was exposed to an excessive danger, whether the testing company knew or could have known that the autonomous vehicle did not yet function as the 'perfect human driver', whether the injured party was informed of the technical limitations of the vehicle, *etcetera*. Clearly, that will generally not be an easy route for the aggrieved party. Only in specific cases there will be fault, for example if the rental company did not yet have a permit or alike.

Some EU member states, such as the Netherlands and France, also have liability rules that are risk-based. The Dutch Civil Code provides for civil liability to rest on '*the possessor of a movable thing, of which it is known that it may cause a particular danger for people and property, provided it does not meet the standards which in the circumstances may be set for such equipment*'.¹²⁵ Rental companies will risk liability under this clause. This is secondary to the PLD; producer's liability comes first. Article 1384 of the French Civil Code similarly imposes risk-based liability on possessors or keepers of movable objects that cause harm to others.

2.2.4 Defectiveness and new technologies

Measures as to the level of safety. According to the PLD a product is defective if it '*does not offer the safety that a person is entitled to expect, considering all the circumstances*'.¹²⁶ This calls for an objective test, having regard to the reasonable expectations of the public at large.¹²⁷ Article 6 (1) rules that an assessment must be made of *inter alia* the presentation of the product, the reasonably expected use of the product and the time when it was put into circulation. The CJEU has also mentioned other factors for this assessment, namely: '*the intended purpose, the objective characteristics and properties of the product in question and the specific requirements of the group of users for whom the product is intended*'.¹²⁸ The mere fact that afterwards a better product has been brought on the market does *not* constitute defectiveness. Relevant factors are the product's advantages and downfalls and also the availability of alternatives. However, in some countries it is

¹²³ Van Dam, 2013, p. 427.

¹²⁴ See *infra*, section 2.4.

¹²⁵ Article 173 of Book 6 of the Dutch Civil Code.

¹²⁶ Article 6 of the PLD.

¹²⁷ CJEU March 5, 2015 in joined cases C-503/13 and C-504/13, para. 37.

¹²⁸ *Id.*, para. 38.

considered inappropriate to outweigh the *social benefits* of the product in relation to its risks. National interpretations thus appear to be different as to whether these objective and social factors can be included.¹²⁹

What may the public expect in terms of the safety and functioning of autonomous vehicles? A distinction is made between three categories of defects:

1. Manufacturing defects. These defects are in the vehicle (or its components) and present an anomaly, which makes them depart from the intended design. For example: malfunctioning sensors or an incidental brake failure.
2. Information defects. Producers must provide users with all the information necessary to keep and use it safely. This includes the user's manual with instructions and warnings concerning its (possible) side-effects, also on the display. Information defects are particularly relevant for autonomous vehicles, given their high-technology. They must be repeated if need be. Producers must take into account that the driver/operator may easily forget instructions and that he may also underestimate the risks. Additional appearance on the display in the vehicle can be necessary to remind the operator once behind the wheel.¹³⁰ Credible advertisements that make it appear as if no more caution of the operator is needed may also constitute defectiveness.¹³¹
3. Design defects. These defects are in the product design, which typically involves numerous vehicles or '*an entire line of automobiles*'.¹³² For example: autonomous vehicles with too limited testing scenarios or with an acceleration defect.

The answer to the question above is generally least difficult to give for the first category of defects. In the absence of special warnings, consumers may expect the motor vehicle to be free of manufacturing defects. They cannot expect it to be 100 percent free from design and instruction defects,¹³³ unless 'promised' by the producer. The expectations of autonomous vehicles concerning their safety are currently quite high. Yet, the expectations are technology-based, whereas technology is constantly up for improvements. It is for the industry to actively 'correct' unrealistic expectations. If producers have not taken on responsibility to do this, then, in legal terms, these expectations may determine the safety standard. The producer must inform consumers properly of the possible side-effects: frequently, by adequate means (in the user manual and on the vehicle display), using understandable wording/signs, and alike. But warnings and instructions do not automatically exonerate the producer of liability for vehicles that are unsafe in certain circumstances. The product design must, regardless of the information given, meet consumers' reasonable safety expectations.

When are consumers' safety expectations of autonomous vehicles 'reasonable'? It has been asserted that operators may expect their autonomous vehicle at least to drive as the 'perfect' *human* driver. This would mean that the vehicle is defective if for example at the SAE automation-level 5¹³⁴ it causes a collision by making an emergency stop for a newspaper flying on the road,

¹²⁹ Lovell's report, 2003, p. 48; Jones Day, 2012, p. 2 of the Chapter concerning the UK.

¹³⁰ Van Wees, 2015, section 3.2, with the example of warnings against low sun.

¹³¹ Gasser, Arzt, Ayoubi, a.o., 2013, p. 20.

¹³² Funkhouser, 2013, p. 449.

¹³³ Van Dam, 2013, p. 431 and Van Wees, 2015, section 3.4.

¹³⁴ See *supra*, section 1.7.

similar to how it would have stopped for a concrete block.¹³⁵ What 'reasonable' entails will need to be clarified by the courts, however, case-by-case, after the roll-out.

Degree of proof; specificity. Since quite some time, there have been concerns that representatives of consumer(s) experience practical problems in terms of not having the means and information to prove defectiveness, particularly for technical products and complicated injuries.¹³⁶ One of the main challenges for autonomous vehicles is to determine the required safety standard for this new technology. To what extent may consumers expect safety *beyond* the standard of the perfect human driver?¹³⁷ There is no uncertainty if a radar sensor was not properly installed according to specification.¹³⁸ But specifically having to prove that the operating software was defective, may easily create problems and leads to uncertainty for consumers.

This lack of clarity is further complicated by the diversity of laws within the community. EU member states give different interpretations of 'defectiveness', both in their country and compared to one another. And they will also be different as to how far the claimant must go to prove the defectiveness.¹³⁹ It is clear though, that consumers do *not* need to prove a high degree of specificity in this respect. As held by the High Court of Justice in the UK, the claimant will '*not have to specify or identify with accuracy or precision the defect in the product he seeks to establish, and thus prove. It is enough for a claimant to prove the existence of a defect in broad or general terms, such as 'a defect in the electrics of the Lexus (motor car)'.¹⁴⁰* Even so, one must have an understanding of the cause of damage and the technique used as well as the risks involved, possible alternatives, *etcetera*. That may be quite difficult for any 'outsider', as is known from cases involving conventional vehicles: claimants encounter problems delivering proof of defects.¹⁴¹ For some specific cases, consumers are further helped in certain ways. The CJEU has ruled that '*where it is found that products belonging to the same group or forming part of the same production series, such as pacemakers (...), have a potential defect, such a product may be classified as defective without there being any need to establish that the product has such a defect*'.¹⁴² The CJEU argues it is consistent with the objectives pursued by the EU legislature to ensure '*a fair apportionment of the risks inherent in modern technological production between the injured person and the producer*'.¹⁴³ At the practical level, detection technology such as an 'event data recorder' may offer relief, especially if made mandatory. But this raises privacy-related questions that will be treated in Chapter 4.

¹³⁵ Van Wees, 2015, section 3.4.

¹³⁶ Lovell's report, 2003, p. 47.

¹³⁷ Aside from the situation in which the producer allows or even promotes (through advertisements and alike) overly high expectations of autonomous vehicles to exist.

¹³⁸ Funkhouser, 2013, p. 453.

¹³⁹ Cf. Lovell's Report, 2003, pp. 48-49.

¹⁴⁰ *Hufford v Samsung Electronics (UK) Ltd.* [2014] EWHC 2956 (Technology & Construction Court), para. 25, with reference to *Ide v ATB Sales Ltd. & Lexus Financial Services v Russell* [2008] PIQR P13; [2008] EWCA Civ 424.

¹⁴¹ EC COM(2006) 496 final, Third report on the application of the PLD. Cf. *Lesley Anne McGlinchey v General Motors UK Ltd.* [2012] CSIH 91, WL 6774476 : was the movement within the handbrake grip affecting the position of the pawl due to a defective design or had it been worn and disengaged?

¹⁴² CJEU March 5, 2015 in joined cases C-503/13 and C-504/13, para. 41.

¹⁴³ CJEU March 5, 2015 in joined cases C-503/13 and C-504/13, para. 42.

Norms and standards for defectiveness. Even if technical expertise is present, the most intricate question to answer is what level of safety may be expected of autonomous vehicles *from a normative point of view*.

Firstly, how secure must software be? The 'reasonable expectation-test' will be a serious obstacle for software vulnerabilities that cause autonomous vehicles to malfunction. An often heard statement is that: '*defect free software is an illusion and no customer can expect any complex software products to be flawless.*'¹⁴⁴ However, case-law may well determine that in the specific context of autonomous vehicles a higher degree of safety expectations is reasonable. The subsequent question is who bears responsibility for bugs that only appear after-the-fact and that were not and could not be detected. For example, if the laptop of the mechanic in the garage appears to have a 'new', unknown bug that infects the software of the autonomous vehicle under repair; is that software (and the vehicle) defective? If it is, can producers avoid liability by invoking the development risks defence?

Secondly, when are programming choices considered to be unacceptable, so as to qualify as a defect of the vehicle? For example, is an autonomous vehicle deemed to be defective for the sole reason that its software is set-up in such a way that it slams on the brakes to avoid an accident with a toddler who runs across the street in front of it?¹⁴⁵ Decisions as to what level of risk is acceptable are based on *normative* judgments, but courts may lack expertise to determine the legal standard for such high-tech products¹⁴⁶ (limited to certain periods of time, in which certain levels of technological knowledge were available and certain practices were common within the branche). The court may hear experts about this and form its judgment on that basis, but that will be a costly and slippery route to follow, surrounded by legal uncertainty.

2.2.5 Defences under the PLD

Limited list. Based on Article 7 of the PLD, several defences can be invoked by the producer. These may relieve him entirely from liability. The producer shall not be liable, in the words of the Directive, '*if he proves*:

- a. *that he did not put the product into circulation; or*
- b. *that, having regard to the circumstances, it is probable that the defect which caused the damage did not exist at the time when the product was put into circulation by him or that this defect came into being afterwards; or*
- c. *that the product was neither manufactured by him for sale or any form of distribution for economic purpose nor manufactured or distributed by him in the course of his business; or*
- d. *that the defect is due to compliance of the product with mandatory regulations issued by the public authorities; or*
- e. *that the state of scientific and technical knowledge at the time when he put the product into circulation was not such as to enable the existence of the defect to be discovered; or*
- f. *in the case of a manufacturer of a component, that the defect is attributable to the design of the product in which the component has been fitted or to the instructions given by the manufacturer of the product'.*

The defences mentioned under *a*, *d* and *e* call for close interpretation. The legal defence under *a* is especially relevant for companies that develop and/or test (the software for) autonomous

¹⁴⁴ Răman, p. 417.

¹⁴⁵ Example given by Funkhouser, 2013, p. 454.

¹⁴⁶ Cf. Răman, p. 436.

vehicles. They will be excused from liability if they have not put the vehicle (or its software) into circulation. They could be held liable on another ground for liability, which in most countries will come down to fault-based liability.

The defences mentioned at *d* and *e* show characteristics of a 'lack of fault' defence. The defence as mentioned under *d* depends on the technical public law regulations, most of which are currently still being developed or are yet in the future. The defence mentioned at *e* ('development risks' defence) is an optional defence, but only a few countries (Finland and Luxembourg and Norway from the European Economic Area) have left it out. In some countries it has only been excluded for some types of products (especially pharmaceutical). In the majority of countries, the development risks defence will be highly relevant for connected autonomous vehicles. The CJEU interprets it strictly: the producer must prove that, taking into account all of the available scientific and technical knowledge, it was impossible for him to discover the risk. Common practice to put vehicles with a particular safety standard on the market does not disculpate the producer. Decisive is the objective knowledge that producers are presumed to have at '*the most advanced level and not restricted to the relevant industrial sector*',¹⁴⁷ provided it was accessible to the producer.¹⁴⁸ There are in fact only a few cases in which the development risks-defence has been accepted.¹⁴⁹ The CJEU rejects the defence if the existence of a general defect was known or if the producer should have been aware of the generic risk based on the accessible information, despite the fact that the producer did not know in which particular product that risk might appear and despite the fact that the known risk was unavoidable in a specific product.¹⁵⁰

How exactly the development risks-defence will be interpreted for autonomous vehicles is uncertain. The objective knowledge can, for instance, be asserted by testimonies in expert circles, and must be assessed by the professional standards at the time of marketing. But lawmakers will, in their interpretation of the law and its application to the facts, also consider policy arguments. For example, in the sense that a strict interpretation of this defence may have 'chilling' effects on innovation.¹⁵¹ Subsequently, we expect this defence to be a serious route to block claims for technological risks of autonomous vehicles yet to be discovered. It may take several decades or longer to discover all the actual risks presented by the use of autonomous vehicles. Future uncertainties are inevitable and the possibilities for testing autonomous vehicles are limited.¹⁵² If these inevitable technological future uncertainties befall the individual injured party, then that could, perhaps, have an impact on the consumers' confidence in the product.

Victim's own sphere of risk. Contributory negligence of the aggrieved party himself may also be raised for a defence. This will reduce liability *pro rata*. The injured driver/operator of the defective motor vehicle may not have followed instructions or may not have taken it for maintenance, *etcetera*. This is for the producer to prove. This defence, again, raises questions as to the exact standard of care that can be expected of the owner and especially of the driver/operator. Will the standard be adjusted to consumers who are not fully accustomed to these vehicles? For example,

¹⁴⁷ CJEU May 29, 1997, case C-300/95, ECR 1997, I-2649, *Commission v UK*, paras. 26-27.

¹⁴⁸ *Id.*, para. 28. See, more elaborate, Van Dam, 2013, p. 435.

¹⁴⁹ CJEU May 29, 1997, case C-300/95, ECR 1997, I-2649, *Commission v UK*; cf. European Commission, 2006, p. 11; Van Dam, 2013, p. 435.

¹⁵⁰ *A v National Blood Authority* [2001] 3 All ER 289.

¹⁵¹ A.o.: Shears, 2007; Colonna, 2012; Schellekens, 2015.

¹⁵² Rand reports, 2014 and 2016b.

could one say that the driver of the Tesla S in the accident described in Chapter 1,¹⁵³ was contributory negligent for (allegedly) not holding on to the steering wheel against Tesla's repeated instructions? Or is this a risk that must be borne fully by the producer?

2.2.6 Other causes of action (outside the PLD-scope)

For claims concerning the defectiveness of a product, the PLD provides for so-called 'total' or 'maximum' harmonisation. It allows the EU member states to maintain fault liability rules, contractual and non-contractual, applicable to producers.¹⁵⁴ The Member States *are* free to create or to keep other national liability rules for producers, but only to the extent that these rest on fault or another ground for liability than risk-based liability for defective products (such as knowingly withholding information or a too limited testing of the product). Also permitted is a '*specific scheme limited to a given sector of production*',¹⁵⁵ but this only sees to liability regimes that already existed prior to the PLD. Thus, there is no room for a new liability rule for the defectiveness of autonomous vehicles.

The PLD allows actions based on fault liability of the producer. Generally, such clauses exist in the EU member states, in addition to contractual claims that consumers may have. Each country has its legal requirements.¹⁵⁶ The consumer may derive safety duties from (the national implementation of) the General Product Safety Directive (2001).¹⁵⁷

2.2.7 External defendants; joint liability

Article 5 of the PLD holds that if two or more parties are liable for the same damage *under the Directive*, then they are 'jointly and severally' liable. This means that the consumer can seek full liability from either one of the parties, regardless of what their share or role was in causing the damage. The consumer may choose to sue either one of the parties or all. It is left to the national law of the member states to determine whether the paying parties have the right to recourse (reimbursement) by the other liable parties. Is the producer of the autonomous vehicle entitled to *full* reimbursement from a software developer, arguing that the accident was caused by an error in the software? Or should he bear part of the damages because he chose to fit it in the vehicle and took profits from the end-product?

What if external parties are liable on *other* grounds than the PLD? Article 8 (1) determines liability of the producer shall not be reduced '*when the damage is caused both by a defect in the product and by the act or omission of a third party*'. The injured party chooses to claim compensation from the driver

¹⁵³ *Supra*, section 1.1.

¹⁵⁴ Article 13 of the Product Liability Directive holds that the Directive '*shall not affect any rights which an injured person may have according to the rules of the law of contractual or non-contractual liability or a special liability system existing at the moment when this Directive is notified*'.

¹⁵⁵ CJEU April 25, 2002, case C-154/00, *ECR* 2002, p. I-03879, paras. 17-19. See further CJEU April 25, 2002, case C-183/00, *ECR* 2002, p. I-03901.

¹⁵⁶ Cf. the Lovell's report, 2003, p. 16ff.

¹⁵⁷ Directive 2001/95/EC of the European Parliament and the Council of 3 December 2001 on general product safety, *OJ* January 15, 2002, L 11, pp. 4-17, repealing as from January 15, 2004, Council Directive 92/59/EEC of 29 June 1992 on general product safety (*OJ* August 11, 1992, L 228, p. 24), and as amended by EC Regulation 765/2008 of 9 July 2008 (*OJ* August 13, 2008, L 218, p. 30), and EC Regulation 596/2009 of 18 June 2009 (*OJ* July 18, 2009, L 188, p. 14).

or operator of the autonomous vehicle or hackers. The manner in which the right of contribution or recourse is regulated is again left to the member states.

2.3 Back to the six scenarios

Several challenges were identified above that parties will encounter if the rules on product liability are applied to autonomous vehicles. Below, the working of this regime will be investigated at the concrete level of six scenarios. The aim is to get a better understanding of how the PLD works for autonomous vehicles. Therefore, each scenario will not be worked out in detail or with the purpose of completeness. This paragraph will focus on producers as the liable party, as the focus of this chapter is on the PLD and its meaning and challenges in these scenarios. Bearing this in mind, the following can be said.

Scenario 1 – The failing sensor

The first scenario involved the driver/operator of an autonomous vehicle, who suffered damage from one of its sensors that had not detected a sudden lane closure. Following the PLD, he may sue the automotive producer or the hardware producer (or another component maker), assumed that these are two different parties. His right to compensation will depend on the reason for the sensor to miss the lane closure. Was the sensor malfunctioning (or 'defective'), for example by not being properly installed? If the claimant *can* argue defectiveness, then the producer may escape liability based on one of the enumerated defences. For example, the producer may argue convincingly (and can prove if need be) that the sensor has in fact failed due to the normal 'wear and tear' or due to a bad repair by the garage only after it was put into circulation.¹⁵⁸ Or the producer may show that the state-of-the-art was such, that the defect could never have been detected before the vehicle was put in circulation. But national interpretations may differ.

Further, damage to the defective vehicle is *not* recoverable following the PLD, only on a fault basis. Other kinds of property damage are protected if these exceed 500 Euro. If the claimant has obtained compensation from the vehicle maker, the latter may seek reimbursement from the hardware maker (if that is another company). This is left to national law to decide.¹⁵⁹

Scenario 2 – Sudden interruption of the software

The second scenario involves malfunctioning of the software (undefinable symbols appear on the display). It is yet uncertain if software can be qualified as a product. But the more intricate question is whether an unexpected interruption of the operating software will make it 'defective'. Clearly, if such interruptions happen on a large scale, affecting a large number of vehicles with the same software or production series, this will point to defectiveness. But if the software interruption only affected the vehicle in this individual case, the 'reasonable expectation test' calls for a careful balance to be made. Users may not expect software in general to be without interruptions. On the other hand, as concerns the software of their motor vehicle the 'reasonableness' standard may be higher than it is for regular software in private computers and alike. In our estimation, it will be 'reasonable' for consumers to at least expect a back-up system that in principle protects them against malfunctioning software. Nevertheless, inherent to the use of software is that it will have flaws, weaknesses or vulnerabilities and that not all of these will exist or may be detected at the moment of production or during (and immediately after) updates.

¹⁵⁸ Article 7 (b) of the PLD.

¹⁵⁹ Article 5 of the PLD.

The development risks-defence may entail that in the cases where there *is* defectiveness, the scientific technical knowledge was not such, as to prevent this particular disruption or to detect it prior to its market launch (and its updates).

One might further argue that the defect was in the vehicle. The vehicle was defective for not responding in a safer way to the software interruption (with a safety back-up). The claimant would then have to direct his claim solely to the producer of the vehicle, not to the software producer. For other aspects, see scenario 1 above.

Scenario 3 – Unavailability of wireless network frustrates download

The situation may be different in scenario 3, where the wireless telecom network is unavailable and, contractually, was *not* part of the package offered by the producer. If the latter has committed to responsibility for the wireless connection of the vehicle, its unavailability will in principal fall within the producer's sphere of risk. But if being connected was *not* an integral part of the 'package' offered by the producer, the question will be whether the vehicle can be regarded as 'defective'. In other words: may the group of users reasonably have expected it to have a back-up system for network lapses, and/or that the user be warned in time and perhaps even that the vehicle would automatically stop and park at an appropriate place? This matter is for domestic courts (or the CJEU) to decide, and is too uncertain to predict, although in our view, this would have 'good cards' to be qualified as 'reasonable'.

If the vehicle *is* 'defective' for reasons as those that were just given, then liability of its producer will *not* be limited by the mere argument that the telecom provider is (also) liable for the network lapse.¹⁶⁰ For other aspects, the case is similar to scenarios 1 and 2, as discussed above.

Scenario 4 – Driver/operator neglects instructions

In scenario 4, the damage was caused by the fact that the driver/operator has violated the instructions in the user guide or manual. For product liability to arise here, again, defectiveness must be proven by the injured party. Dependent on more facts than were given, there could be an information defect: did the producer provide instructions that were adequate, clear, unambiguous, repeated, *etcetera*? The autonomous vehicle may have an information defect and/or a design defect if it is not equipped with a system that gives adequate and repeated timely warnings and the technology to intervene at the right point if the driver/operator remains passive. If there *is* defectiveness (but this does not immediately appear to be the scenario as sketched), then the producer can raise a contributory negligence defence, by arguing that the user was at fault.¹⁶¹ The fact that the driver/operator has ignored instructions may be qualified as contributory negligence (and limit or even exclude the producer's liability). This can limit or, dependent on each particular national law system, even exclude the producer's liability. For other aspects, see scenario 1 above.

Scenario 5 – Hacking of software by third parties

The fifth scenario concerns hacking of the operating software of the vehicle. This case raises questions as to the programming of the software (or software updates), used in the vehicle. As motor vehicles are (and will be) made more autonomous and connected, it seems reasonable of

¹⁶⁰ Article 8 (1) of the PLD.

¹⁶¹ Article 8 (2) of the PLD.

users to expect adequate protection from the producer. The technology used (which for vehicles currently on the market includes internet-connected entertainment systems and radio's) must of course be protected against hacking attacks and malware, also in the form of periodic updates. Drivers/operators of the motor vehicle must further be adequately warned of the risks and other knowledge that the producer may have and that can be shared, and recalls must be made, if need be. But such equipment could also be installed in the vehicle and functioning as should be, while the vehicle was nevertheless hacked. The user may, again, not expect 100 percent safety and the development-risks-defence may excuse the producer from liability. This makes the outcome of these hypotheticals uncertain and heavily reliant on expert testimonies. This could even be made more complex, as will appear in Chapter 4, if the vehicle was hacked through the driver/operator's own mobile device or alike. For other aspects, see scenario 1 above.

Scenario 6 – Injuring a pedestrian when trying to avoid a house

The sixth scenario asks whether the producer must bear responsibility for the fact that the autonomous vehicle has severely injured a pedestrian, as it tried to avoid hitting a house. The central question is whether this is a design defect: should the vehicle have prioritised to avoid hitting the pedestrian instead of to avoid hitting the house (and consequently injuring persons in the house). If this programming choice would qualify as defective, the producer might invoke the development-risks defence.¹⁶²

2.4 Possible constraints, gaps and regulatory challenges

The preceding sections pointed to various challenges and constraints of the PLD, in its current form and substance, if applied to autonomous vehicles. Five key areas will briefly be outlined.

The first main point above was that several parties responsible for the creation and/or the making and testing of autonomous vehicles are *not* covered by the risk-based liability imposed by the PLD. Mere testing companies can raise the defence of not having put the vehicle into circulation. The status of *software producers* is not entirely clear, but most signals point in the direction that the operating software in autonomous vehicles can be seen both as a product and as a component. However, presenting it as a product means that, for the claim to succeed, the consumer must show its defectiveness. That may be impossible for consumers to put their finger on (see below). To qualify the software as a component part of the autonomous vehicle means that the software producer can only be held liable for 'manufacturing defects'.

Secondly, the question is when a product, being either the software or the autonomous vehicle as such, can be qualified as 'defective'. Surely, this is *difficult on the practical level of being able to point to technological failure*. Although the CJEU has made it clear that to establish 'defectiveness' no high-technical specificity is involved, difficulties can even be expected on the general level of pointing to any malfunctioning. In any case, technical knowledge and expertise will be imperative. The onus of proof lies primarily with the injured party and may easily be problematic: the consumer must show that the defectiveness was already present at the moment the vehicle left the factory gates. This can even be difficult for manufacturing defects, as the producer may be convincing in his claim that these could also be due to wear and tear. *But more importantly, all this involves a normative judgment*: what level of safety and what level of testing are expected of the producer and at which level is the vehicle unsafe and its design deemed to be defective? The

¹⁶² *Supra*, section 2.2.5: the defence mentioned at *e* in the list.

exact levels of safety that may be expected are not at all clear and thus surrounded by legal uncertainty.

It is also far from clear whether more fundamental factors may play a role here.¹⁶³ Is the (on average) *increased* level of road safety of autonomous vehicles included in the assessment of whether its design is 'defective'? For information given, it needs to be clarified what this means in respect of the risks presented by this new technology, more particularly the software that these cars run by: what risks should the instruction manual warn against, what steps are there to take for drivers/operators? If, for example, the software is being hacked and the producer had signs of the concrete risk that this might happen (but could not stop it), does this make the software 'defective'?

Thirdly, particularly the 'compliance risk' defence and optional 'development risks'-defence (in the majority of countries that allow the latter defence) call for a careful balancing of the consumers' protection interest versus innovation. Both defences may lead to the result that injured parties bear the cost of risks scientifically unknown at the time of production. On the other hand, abolishing these defences altogether may have 'chilling effects' on the particular industry. The same can be said for the contributory negligence defence: liability of the producer may be limited or excluded if the injured person himself was at fault. Typical examples are that the driver/operator continued to use software of which he knew or ought to have known that it was malfunctioning. But, in a way, users are 'guinea pigs' in this development: knowledge about the risks or the impact of certain user modes will only be gained from using the vehicle and both consumers and the industry will learn from casualties. Given this reality, and the need for a steady balance between protection and innovation, what level of knowledge and anticipation can be expected from both?

Fourthly, the scope of protection of the PLD is limited, especially with regard to property damage. Damage to the autonomous vehicle itself is excluded from this risk-based liability, which means that the owner of the vehicle must invoke the national rules on fault-based liability (and thus prove fault) in order to receive compensation for the damage caused to his vehicle. Other kinds of property damage are limited to property for private use, and only compensated if the damage exceeds 500 Euro.¹⁶⁴ This may call for reconsideration as motor vehicles *are* becoming more and more autonomous and connected. The trend to autotomise motor vehicles may make them safer (*i.e.* it reduces the occurrence of accidents), but the high level of technology and connectedness will easily make the repair costs and/or lost value higher than for traditional vehicles.

Fifthly, the six scenarios as sketched in this report are illustrative of how limited the PLD is in this context. Sensors and software will always malfunction as a result of the normal 'wear and tear' and other parties' interventions (vandalism, bad repair) and telecom network will cause new risks. It is not realistic to expect producers to be able to anticipate on all this, nor are they able to produce materials incapable of degradation or free of vulnerabilities or of user's errors.

¹⁶³ See also Palmerini, E., Azzarri, F. and Battaglia, F., *et al.* 2014.

¹⁶⁴ Article 9 of the PLD.

2.5 Conclusion

Representatives of both producers and consumers are, on the average, satisfied with the PLD and how it works.¹⁶⁵ Yet the analysis above raised a number of constraints and gaps, particularly for the injured party.

First and foremost is the **limited reach and meaning of product liability** as a compensation mechanism for damage caused by autonomous vehicles. The legal standard for product liability is that the vehicle was not doing what can be reasonably expected of it by its user group. Generally, it will not be 'reasonable' to expect a perfect product. Even with back-up systems and other forms of protection, the dependence of software and high-tech operation systems on a large scale, will always have technology vulnerabilities. And the safety level will be measured according to the standards as they *were*, at the time of production. Defects that, at the time of production, were scientifically unknown or undetectable or that have only arisen after the market launch or complied with regulations at the time of production are, in principle,¹⁶⁶ excluded from compensation following the PLD. The law, therefore, does not expect the producer to be a frontrunner in safety risks not yet commonly found in the branch at that time. Therefore, in fact, *the cost of risks that are not consequential to the production itself and the cost of scientifically unknown risks* will be borne by injured parties (and by their social and private insurance carriers). This may not be perceived as a secure or fair system and might reduce consumers' confidence in autonomous vehicles.

On the practical side, **evidentiary burdens and a lack of information** may seriously impede adequate protection as the requirement of defectiveness and (many of) the available defences call for factual, technological and scientific knowledge that consumers will typically not have. For example, the producer will escape liability if it is 'probable' that the defect occurred after the product was brought on the market. But can it be proven when the defect has occurred? Especially for defects in the software, this may be difficult to rebut.

Further, not just factual uncertainty but also **legal uncertainty** increases the legal cost and procedural risk of claim handling and may be a barrier to innovation. One often heard, yet rather small, point of uncertainty, is whether software is deemed a 'product' under the Product Liability Directive. A large majority of authors argue that it *is*, although formally it was not yet decided. More intricate uncertainties include the question what technical and design problems may be qualified as 'defects', whether 'mere' choices as to how the vehicle responds may qualify as a defect and how high the legal standard for safety is. These issues are also relevant to determine the division of responsibility if the producer seeks reimbursement from the software developer for certain program choices or weaknesses in the software.

These points of legal uncertainty are further complicated by **legal diversity** amongst the member states concerning the level of proof that they ask of the consumer to prove the defectiveness, the available defences for producers, and possible monetary caps. Also, the level of compensation varies significantly within the EU. This may lead to different degrees of internalising the cost of accidents in the price of autonomous vehicles, which *could*, in theory, ultimately frustrate the internal market for these vehicles. But this is not certain. That may explain why the argument did not gain much weight in the political arena, when it was made for defective products in general.

¹⁶⁵ This was already noted in the Lovell's report, 2003, pp. 46-47 but it also seems to have been confirmed in the Rand-study parallel to this current report.

¹⁶⁶ An exception must be made for those (few) countries that do not allow the development risks-defence (as it is optional). See *supra*, section 2.2.5.

Less apparent, at first sight, is the **limited list of liable persons** under the PLD. *In theory* liability befalls not only car manufacturers, but also component makers, importers and distributors, but its *actual* width is much more limited. *De facto* excluded are: (a) component producers in respect of design or information defects of the vehicle, (b) distributors/sellers of the vehicle who have provided the injured party with 'track-and-trace' information, (c) pure developers of technology and/or testing companies (not using their brand or putting the vehicles on the market), and (d) rental companies or other service providers such as taxi companies.

Despite these constraints and gaps, product liability **does offer a solution for single-vehicle accidents**. For example, the driver or operator of an autonomous vehicle who sustains personal injuries after it bumps into the crash barrier can claim damages *vis-à-vis* the producer. He may also be entitled to payments on the basis of voluntary insurance or objective insurance (as in Sweden) and may then use the product liability-route for the uninsured part of his damage.

Lastly, traffic victims on the average may receive willingness from the industry to find agreement to settle their cases out-of-court, as a way for it to take responsibility for the technological uncertainties, to avoid reputational damage and perhaps strengthen consumers' confidence. But it would be a **serious miscalculation** to think that liability for autonomous vehicles will almost exclusively befall the industry. To what extent product liability will cause a shift in liability, **depends, in particular, on the national rules on traffic liability**. These will now be explored and evaluated, in order to understand their applicability, constraints and gaps for autonomous vehicles.

3. The current traffic liability rules applied to CAVs

3.1 Introduction; why claimants will prefer traffic liability over the PLD

In the last two sections, serious constraints and challenges were found to exist within the EEA, if victims of autonomous vehicles pursue a product liability claim. Autonomous vehicles and their operating software will inevitably have shortcomings, but it is unclear when these will be qualified as 'defects' – both from a technical *and* a *normative* point of view. The risk that operating software has shortcomings that could not scientifically be discovered before its roll-out will thus generally be borne by the consumer.¹⁶⁷ Moreover, the PLD provides no remedy for defects of the vehicle after the time of production (due to 'wear and tear', weather conditions, vandalism or bad repair). In these cases, victims must rely on *other* grounds to pursue a claim for damages, such as *traffic liability*.

Also regardless of the PLD, traffic victims may 'naturally' be inclined to primarily direct their claim for damages towards the party who was actually involved in their traffic accident. Damage suffered by the *driver* and passengers of motor vehicles is in many countries, to some extent, covered by *voluntary* private insurance.¹⁶⁸ But to the extent that damage of passengers and damage of other traffic victims, is uninsured, it can be more practical for victims to invoke traffic liability rules, rather than to claim compensation from the producer. Emanating from the Fifth EU Directive on motor insurance,¹⁶⁹ the risk of liability for motor vehicles 'normally based' in EU member states is covered by mandatory liability insurance. CAVs are captured by its definition of 'vehicle' in Article 1. EU (and EEA) wide,¹⁷⁰ this means that the risk that CAVs cause damage to *others* than the driver/user, keeper or owner of the vehicle is covered by mandatory insurance for *minimum* insured sums, periodically indexed, ranging currently, roughly spoken, from 1.220.000 Euro per victim to 6.070.000 Euro per claim.¹⁷¹ In some member states the insured sum is not limited to a certain Euro-amount.

The system upheld by the motor insurance directives has the advantage that the liable party will have a deep pocket as damages will be paid through insurance. Financial strength can of course, in principle, also be expected from producers (the automotive industry) as the liable party, if claimants pursue product liability-claims, although liability insurance is not compulsory for producers. But the Motor Insurance Directive (MID) offers other practical advantages in the form of 'claimant-friendly' insurance rules, such as an *action directe* (right of action) *vis-à-vis* the third-party motor insurer of the liable party,¹⁷² information rights and the right to proceed before a court in their country. Also, these are minimum standards only, whereas the substantive rules of

¹⁶⁷ Except in the few member states that have not opted for the development-risks defence; *supra*, section 2.2.5.

¹⁶⁸ Albert, 2008, p. 320. In the Netherlands per 1 January 2017 through no-fault insurance.

¹⁶⁹ EU Directive 2009/103/EC, *relating to insurance against civil liability in respect of the use of motor vehicles, and the enforcement of the obligation to insure against such liability*, which repeals the earlier Directives on liability motor insurance (Directives 72/166/EEC; 84/5/EEC; 88/357/EEC and 90/232/EEC and 2000/26/EEC 2005/14). Hereafter: Motor Insurance Directive.

¹⁷⁰ Liability insurance for motor vehicles is made mandatory within the European Economic Area (EEA) and is thus not limited to the EU but also mandatory in Norway, Liechtenstein and Iceland.

¹⁷¹ Article 9 and Communication from the Commission 10.5.2016, COM(2016), 246 final.

¹⁷² Article 18 of the Fifth Motor Insurance Directive; see Engelhard and Koudstaal, 2014, pp. 471ff.

the PLD entail total harmonisation. Thus, member states may choose to make motor insurance more protective than prescribed by the MID.

Yet, the *substantive* traffic liability rules have *not* been harmonised¹⁷³ and vary between member states – from a very protective risk-based liability (France) to fault liability (the UK). In Sweden, traffic victims have an insurance claim on a 'no-fault' basis, irrespective of *personal* liability of the owner or driver of the motor vehicle. These legal differences give in fact quite different outcomes. This means that the insured risk of motor liability insurance is assessed differently within the EU. Ultimately, the question whether traffic liability offers claimants a more beneficial route to compensation than product liability, depends on each country's traffic liability rules. One must be careful, drawing conclusions from comparisons of the national rules on traffic liability. Many of these rules offer no, or limited, protection to drivers and to owners of motor vehicles who suffer damage. But these victims are often protected by voluntary insurance,¹⁷⁴ on a no-fault basis. Then again, the insurance coverage is usually limited, and a product liability claim may still be relevant for the part of the damage that is uninsured.

Hereinafter, an assessment will be made of how the substantive traffic liability rules could be applied to cases that involve accidents with autonomous vehicles (section 3.2) and to the central six scenarios as presented in Chapter 1 (section 3.3). The constraints, gaps and regulatory challenges as found will be presented (section 3.4), followed by the conclusion (section 3.5).

3.2 Comparative overview of national traffic liability rules applied to CAVS

Can substantive rules on traffic liability that currently exist within the EU, be applied to cases involving autonomous motor vehicles and are there points of concern? Three systems of traffic liability will be explored in the following sections, to find answers to that question: fault-based personal liability (section 3.2.1), risk-based personal liability (section 3.2.2) and the Swedish insurance model of objective no-fault liability (section 3.2.3).

3.2.1 Claims for damages against the driver or 'operator':¹⁷⁵ fault-based

In far most European countries,¹⁷⁶ *drivers* of motorised vehicles can only be liable for damage of other traffic members if the driver was personally at fault. In some of these countries, such as Britain and Malta, this is (currently)¹⁷⁷ the *only* ground to claim damages for traffic accidents. Other countries *also* impose risk-based liability on owners/keepers of motor vehicles. 'Fault', as a legal concept, means: wrongful behaviour for which the person who has caused damage can

¹⁷³ CJEU 23 October 2012, no. C-300/10; the Motor Insurance Directives do not regard substantive national traffic liability, they only see to the insurance coverage, *cf.* a.o. CJEU 14 September 2000, no. C-348/98, Jur. 2000, p. I-6711, *Mendes Ferreira and Delgado Correia Ferreira*, paras. 23 and 29.

¹⁷⁴ Albert, 2008, p. 112.

¹⁷⁵ Depending on the level of autonomy of the autonomous vehicle, it may be more appropriate to refer to the 'operator' (or 'user') instead of the 'driver' of the vehicle: full autonomy indicates that there would be hardly any 'driving' involved anymore.

¹⁷⁶ This includes German law, although it has a legal *presumption* of fault of the driver. The exceptions include France (where risk-based liability is imposed on both drivers and keepers of the motor vehicle) and Sweden (an insurance system for personal harm, which will be treated separately).

¹⁷⁷ For the UK a legislative proposal is currently pending, see *infra*, section 3.2.3.

legally be blamed. The technology in the vehicle is meant to replace the human driver. Subsequently, risk-based laws (see section 3.2.2) seem to be more in line with this technological development than law systems that solely rely on fault as the basis for liability of the driver/operator of the autonomous vehicle.

Fault liability will remain mostly relevant for vehicles at SAE automation-levels 1 to 4.¹⁷⁸ An example can be derived of the Tesla case that was described in section 1.1, assuming that another party than the user himself would suffer damage. At SAE automation-levels 5 and 6,¹⁷⁹ there *could* be fault liability of the operator of the vehicle, but this will, on the average of cases, be exceptional. Examples may include the operator's omission to update the vehicle's control system, using it under special circumstances in which one could foresee that it might cause damage (extreme weather conditions or driving in crowded places),¹⁸⁰ or even: taking the chance that the vehicle becomes more vulnerable to hacking. The requirement of personal (human) fault will, from the injured party's point of view, be more difficult to grasp as motor vehicles become more autonomous and connected. Logically, as the autonomy (and connectivity) of vehicles increases, the objective possibility that human behaviour contributes to the accident will generally decrease.¹⁸¹ Consequently, fault liability of operators (drivers) of autonomous vehicles will then play a much less significant role on the average than it does currently, for damage caused by conventional drivers.¹⁸² In national law systems that have no additional risk-based liability for motor vehicles and that rely only on personal fault, victims are more likely to pursue a claim for damages based on *product* liability.

A crucial question for fault-based liability will be: to what extent may drivers and operators of autonomous vehicles rely on the hardware and software technology of their vehicle in cases where it fails on them? And more generally, how 'strict' must the fault requirement be applied in cases concerning the use of autonomous vehicles?

In several member states, the current case law expects drivers of conventional motor vehicles to be an experienced driver, even if the individual driver of a motor vehicle in reality was *not* experienced.¹⁸³ This objective approach requires rethinking for autonomous vehicles, as their users will generally not be familiar with these new technologies and continuous streams of information, such as electronic horizon (eHorizon).¹⁸⁴ To the extent that the driver or operator of an autonomous vehicle does not follow instructions, the law could maintain the high level of care ('the perfect user') as is currently found in many national traffic liability regimes within the EU for drivers of conventional motor vehicles. Some circumstances will put strict interpretations of what constitutes 'fault' to the test: what if the driver or operator of an autonomous vehicle is confronted with software that is not responding or that misinterprets signals or entirely misses them, for instance those of a traffic manager? To the extent that users of autonomous vehicles with high or full automation do not have actual control of the car, the current duties of care will lose relevance and new, judge-made duties of care must be created.

¹⁷⁸ See *supra*, section 1.3.

¹⁷⁹ *Supra*, section 1.3.

¹⁸⁰ Tjong Tjin Tai and Boesten, 2016, p. 660.

¹⁸¹ Van Wees, 2015.

¹⁸² A fatality with a Tesla Model S, on 7 September 2016, appeared to have been caused while its driver did *not* use the AutoPilot and was, allegedly, speeding, which caused the vehicle to crash and damaged its main battery, resulting in a short-circuit and overheating and eventually fire.

¹⁸³ Cf. Court of Appeal 30 June 1971, [1971] EWCA Civ 6, 2 QB 691.

¹⁸⁴ Aon Risk Solutions, 2015, p. 5.

But not only personal fault as such calls for rethinking, also the division of responsibility between various parties involved may be an issue. An illustrative case concerns a recent fatality in the Netherlands with a Tesla Model S, on 7 September 2016. According to the media, this was caused while its driver did *not* use the AutoPilot and was speeding. Allegedly, this caused the vehicle to crash and damaged its main battery, resulting in a short-circuit and overheating and eventually fire. Suppose now, that rescuers would be electrocuted in their attempt to free the driver from the vehicle. Could that be attributed to the latter and/or to Tesla for (alleged) defectiveness, or to both parties?

Other legal attribution complexities may arise in the context of the innovative technique of 'truck platooning': *'a number of trucks equipped with state-of-the-art driving support systems – one closely following the other. This forms a platoon with the trucks driven by smart technology, and mutually communicating.'*¹⁸⁵ Assuming all trucks profit from the lower fuel consumption, how fair is it to hold the driver of the first truck, who is in charge of speed and steering, liable for damage of the third truck in the column behind him?¹⁸⁶ These examples also illustrate another difficulty in most of the national traffic liability laws EU-wide: causation. It will not be easy for injured parties to show that new (connected) technologies incorporated in autonomous vehicles or new forms of using it, were in fact the cause of their damage.

So far is clear, the new automotive technologies will generate a number of legal and factual questions and uncertainties such as those aforementioned. These will be faced in all EU member states, to the extent that they rely on fault liability. If these are left to the creation of case-law by courts, particularly national courts under national fault rules, it seems safe to predict a considerable period of legal uncertainty, resulting in legal transaction costs and 'gaps' in terms of adequate protection of traffic victims.

3.2.2 Claims for damages against the owner/keeper: risk-based

In addition to fault liability of the driver, a number of EU member states impose risk-based liability on the owner, possessor and/or keeper of conventional motor vehicles that cause damage to another person. *In his capacity as owner, possessor or keeper of the motor vehicle*, he must carry the risk that the motor vehicle causes damage, regardless of his (or the driver's) personal conduct or blameworthiness. Technical defects of the motor vehicle are typically regarded as being part of the risks borne by its owner, possessor and/or keeper.¹⁸⁷ If the motor vehicle causes damage, whether due to technical defects or to the person driving it (aside from specific circumstances such as joyriding or theft), its owner, possessor and/or keeper is in principle liable. Below, several national regimes of risk-based liability will be explored.

Two particular gaps and challenges in national regimes of risk-based liability for motor vehicles can already be considered in advance here, for the coming of autonomous vehicles.

The first gap builds on the discussion above: many risk-based liability regimes exclude (or: limit the protection of) the driver and the owner/possessor/keeper of conventional motor vehicles, if these parties suffer damage themselves. In the Netherlands injured passengers of motor vehicles are also excluded from risk-based liability for motor vehicles, but this has recently been

¹⁸⁵ <https://www.eutruckplatooning.com/About/default.aspx>.

¹⁸⁶ AonRisk Solutions, 2015, p. 6.

¹⁸⁷ This can be seen in the countries under review that have a strict liability for motor vehicles: Germany, the Netherlands, Belgium and France (and similarly in Sweden).

compromised by insurers.¹⁸⁸ 'Motorised' victims are less protected than other traffic members; they have to base their claim for damages on fault liability (or call in voluntary insurance of the car owner or themselves). This is based on the fact that using a motor vehicle creates *Betriebsgefahr*: the danger inherent to mass and speed. But if it would appear that autonomous vehicles in fact decrease the accident rate, as is expected, it could be more appropriate to offer 'motorised' victims similar protection as non-motorised victims. One might argue that using *any* motorised vehicle, even CAVs, will negatively impact the seriousness of the harm, once it *does* come to an accident, compared to other, non-motorised forms of transport. Even then, national legislators may want to reconsider the fact that the rules for risk-based liability currently treat the injured driver of a motor vehicle different from injured passengers of that same motor vehicle. In cases of (almost) full automation (SAE-levels 4 and 5), the 'driver' will not have a much different role to play in the vehicle than other passengers in the vehicle. Why should he be treated any less favourable?

The second point relates to the fact that rules on risk-based liability for motor vehicles differ from country to country. These rules vary as to whether, how and to what extent defects of the vehicle and human conduct are relevant circumstances to avoid risk-based liability of its owner, possessor or keeper (next to other national differences with regard to the scope of protected persons and heads of damage and the level of compensation).¹⁸⁹ In some countries, the owner, possessor or keeper of a motor vehicle may avoid liability with a *force majeure* defence whereas in other countries the same circumstances do *not* have that effect. If the cost of liability is off-set in the price (or in other ways passed onto the consumer), this price effect will vary with the particular national rules at hand.

Both points made above, call for a closer discussion of national risk-based liability systems, varying from quite absolute systems, in which fault hardly plays any role anymore, to mixed systems, that are risk-based but that still use fault elements. Below, the discussion will start with personal liability for motor vehicles that is almost similar to insurance, as currently exists in France.

France. French law has adopted an almost absolute liability for keepers of motor vehicles in the so-called *Loi Badinter*.¹⁹⁰ The keeper is liable *vis-à-vis* all traffic members (non-motorised and motorised), with the exception of the driver of his motor vehicle (if the latter was another person than the keeper). If the victim was the driver of *another* motor vehicle, the keeper is automatically liable, but he may avoid liability by proving that he or the driver of his motor vehicle was not at fault (fault liability with a reversed burden of proof). Other victims (pedestrians, cyclists, passengers) profit from an even more favourable risk-based liability. These victims must only claim and, if needed, prove that they suffer damage from a traffic accident and that the motor vehicle was directly 'involved' in that accident. Mere involvement (*implication*) will suffice; a causal role between the operation of the motor vehicle is not necessary to establish strict liability under the *Loi Badinter*. This is intended to relieve victims of causality issues.

¹⁸⁸ Per 1 January 2017 the Dutch Association of Insurers has declared that liability motor insurers shall compensate passengers of the insured motor vehicle on a no-fault basis.

¹⁸⁹ See *supra*, section 3.4.

¹⁹⁰ Loi de 5. Juillet 1985, *tendant à l'amélioration de la situation des victimes d'accidents de la circulation et à l'accélération des procédures d'indemnisation*.

The available defences under the *Loi Badinter* are limited. Absence of fault, an external cause or Act of God are *not* valid defences. Moreover, the contributory negligence defence is limited if the victim was non-motorised or a passenger: he only loses his claim if he intentionally got hurt or committed an 'inexcusable fault' which was the exclusive cause of the accident. The *faute inexcusable* defence cannot be raised by law if the victim was, at the time of the accident, younger than 16, older than 70 or disabled over 80 percent. For property damage, the traditional contributory negligence defence applies: the victim's right to compensation will be limited in accordance with his own contribution to the damage. In 2005 it was proposed to extend the victim-friendly approach regarding contributory negligence to the injured driver,¹⁹¹ but this has not been followed up by the legislator.

This regime of risk-based traffic liability, in its current form, could equally apply to autonomous motor vehicles. Mere involvement (*implication*) of the vehicle is the necessary ingredient to establish liability; this would avoid causation issues as mentioned above. The French model seems most fit at levels 5 and 6, as it also protects the user (driver). It does not allow the keeper of the autonomous vehicle to raise an Act of God (or external cause) defence, for example by arguing that the vehicle had lost its telecom connection. In less strict systems, as exist in Germany and the Netherlands for example,¹⁹² such no-fault defences *are* allowed, different from France (and Belgium and Sweden, see below). But these defences will only be successful in certain circumstances as there is a high standard of care for the driver: the owner, possessor or keeper of the motor vehicle can avoid liability if the accident was caused by external circumstances (*e.g.* weather, third parties or a deer on the road). These must have been unforeseeable and unavoidable to the driver. The latter may also invoke the contributory negligence defence, which can reduce the amount of compensation or even exclude the risk-based liability for motor vehicles altogether.

Germany. The German legislator currently considers the need for amendments to its liability law and this is being discussed in round tables sessions initiated by the German Transportation Ministry.¹⁹³ However, as new laws have not yet been initiated, the producer and other parties such as the owner or keeper of the motor vehicle will risk liability under the general rules of civil liability law. Section 7 of the Road Traffic Act (*Strassenverkehrsgesetz vom 19 Dezember 1958, StVG*) holds the keeper of a motor vehicle liable for its 'operational risk' (*Betriebsgefahr*), both if the risk has materialised from a driving error or from a technical defect. In itself, this may equally be applied to autonomous vehicles.¹⁹⁴ Different from France and Belgium, the keeper of the motor vehicle can avoid liability by proving an external cause (*höhere Gewalt*): this means an unforeseeable and unavoidable external cause of the traffic accident, such as extreme weather conditions or the intervention of a third party.¹⁹⁵ Damage related to personal injuries, death and

¹⁹¹ See *Avant project de réforme du droit des obligations (Articles 1101 à 1386 du Code civil) et du droit de la prescription (Articles 2234 à 2281 du Code civil)*, www.justice.gouv.fr/art_pix/RAPPORT_CATALASEPTEMBRE2005.pdf.

¹⁹² Other countries that are said to follow this route (strict liability for motor vehicles) are Czech Republic, Estonia, Greece, Hungary, Lithuania, Poland, Slovenia, Slovakia, and Spain, see Albert, 2008, pp. 98-99.

¹⁹³ Norton Rose Fullbright Whitepaper, July 2016, p. 45.

¹⁹⁴ Gasser, Arzt and Ayoubi, 2013, p. 18.

¹⁹⁵ Van Dam, 2013, p. 412.

property damage are equally protected by the *Strassenverkehrsgesetz*, but the amount of compensation is limited to maximum sums.¹⁹⁶

One justification ground for this risk-allocation to the keeper of the motor vehicle is that, generally spoken, motor vehicles create the risk of mass and speed (*Betriebsgefahr*), to which other traffic members are exposed. This risk is still present in autonomous vehicles, although the accident rate is expected to drop significantly in time. Other justifications are that the keeper profits from the use of his vehicle and has '*the power to decide for what purposes and at what times the vehicle may be used*'. These justification grounds are said to also apply to autonomous vehicles with the result that the keeper would still be liable under this clause for damage caused by the automation of his vehicle.¹⁹⁷

Section 18 of the StVG holds the driver liable on the basis of a rebuttable presumption of fault. It has been asserted that this last section is less appropriate for vehicles with a high level or even full automation but that '*this does not result in a legally unsolvable situation, because the driver still has the option to provide proof of exoneration*'.¹⁹⁸

The Netherlands. According to Article 185 of the Dutch Road Traffic Act (*Wegenverkeerswet 1994*), the owner and the keeper of a motor vehicle are liable for damage caused to non-motorised persons and objects not being a motor vehicle. Different from German law, passengers are *not* protected by this risk-based liability, which must be reconsidered for autonomous vehicles. A point of similarity between Dutch and German law is that risk-based liability is imposed regardless of the cause of the accident and that it covers both driving errors and technical defects of the motor vehicle. In the absence of legislative intervention, of which there are currently no concrete signals, this provision will apply to autonomous vehicles.¹⁹⁹

For conventional motor vehicles, it has been established in case law that the owner or keeper, in the absence of gross negligence or intent of the non-motorised victim, is in principle always liable for at least 50 percent of the damage.²⁰⁰ 'In principle', because the owner or keeper of the motor vehicle may convince the court that there was an 'unforeseeable and unavoidable'²⁰¹ external cause of the accident (such as extreme weather conditions). However, for non-motorised victims who were under the age of fourteen years old at the time of the accident, the owner/keeper cannot avoid liability by proving an external cause. For these minors, the owner or keeper is fully liable, unless there was gross negligence or intent of the victim (the child).²⁰² These rules are all judge-made and are referred to as the '50 percent rule' and the '100 percent rule'. These rules apply equally to damage related to personal injuries and death and to property damage of the non-motorised victim.

¹⁹⁶ A maximum capital of around 300,000 Euro for damage to the person, see section 12 StVG. Beyond that amount, the claimant can invoke the rules on fault liability.

¹⁹⁷ Gasser, Arzt and Ayoubi, 2013, p. 19.

¹⁹⁸ Gasser, Arzt and Ayoubi, 2013, p. 19.

¹⁹⁹ Vellinga, 2014; Tjong Tjin Tai and Boesten, 2016.

²⁰⁰ HR 28 February 1992, NJ 1993, 566 IZA/Vrerink (as interpreted by later case-law).

²⁰¹ HR 22 May 1992, NJ 1992, 527 ABP/Winterthur.

²⁰² HR 1 June 1990, NJ 1991, 720 Ingrid Kolkman (no contributory negligence defence); HR 31 May 1991, NJ 1991, 721 Marbeth van Uitregt (no 'external cause' defence).

It appears from the overview above, that various national differences exist as to the availability and interpretation of fault-based defences to avoid the strict liability for motor vehicles (external cause, Act of God, *force majeure* and contributory negligence). Other national differences exist, *inter alia*, in respect of the kinds of damage: not all national regimes of risk-based liability for motor vehicles (fully) protect property damage and the meaning of heads of damage and what they may include, let alone the assessment and/or calculation of the damage, differ widely.

Furthermore, serious national differences exist as to the categories of protected victims. For example, in the Netherlands *non*-motorised traffic members benefit exclusively from risk-based liability for motor vehicles, whereas passengers *are* included in Germany and France (and Belgium and Sweden, see below). France even includes victims that were the driver of another motor vehicle than the motor vehicle under the third-party insurance, with a reversed burden of proof regarding fault. German and Dutch law (and also Belgium, see below) exclude any driver of a motor vehicle from this risk-based liability for motor vehicles.

3.2.3 Claims for damages against the no-fault insurer: objective liability

Within the EU the victim can obtain compensation directly through the liability insurance which rests on the motor vehicle. In the risk-based liability systems as discussed above (French, German and Dutch law), this means that the traffic victim can obtain compensation from the liability motor insurer regardless of fault. But these risk-based rules are based on personal liability: the keeper of the motor vehicle or his liability insurer can still invoke defences to escape liability. One step further towards improving victims' right to recovery is to make the insurer's obligation to pay compensation more objective: *independent of personal liability*. Examples of objective liability can be found in Belgium, Sweden and in a legislative proposal specifically designed for autonomous vehicles currently pending in the UK. These will be discussed below.

Belgium. The Belgian Deputy prime minister and minister of Employment, Economy and Consumer Affairs, in charge of Foreign Trade declared recently that, in the near future, a special working group on Liability Insurance of the advisory Commission for Consumer Safety will consider whether legislation for the responsibility and insurance of self-driving vehicles would be feasible.²⁰³ He also asserted that until then, the current liability regime will govern accidents caused by automated vehicles. The current traffic liability ruling is Article 29*bis* of the 'Code concerning mandatory liability insurance for motor vehicles' (*Wet betreffende de verplichte aansprakelijkheidsverzekering inzake motorrijtuigen, WAM-wet*). Art. 29*bis* was created in 1995 in the context of the need to reduce social insurance payments: this insurance system would not just benefit the injured party; it would also relieve his social insurance carrier. Medical costs caused by motorised traffic would then, ultimately, not be borne by the social insurance carriers, but instead by the liability motor insurer.²⁰⁴

Art. 29*bis* was directly inspired by the French model: it too introduced a direct obligation for the motor liability insurer to pay compensation to victims of traffic accidents in which the insured motor vehicle was (merely) 'involved'. Absence of fault, an external cause or Act of God is not a valid defence. Belgian law offers this special protection solely for damage consequential to

²⁰³ Answer to question 7 of a Member of Parliament, *Questions et réponses écrites 2016-2017*, 30 November 2016, 4th session of the 54th legislative period, p. 126.

²⁰⁴ *Gedrukte Stukken*, 1993/94, nr. 980/no. 3 (Verslag Aarts), p. 16; Engelhard, 1998, p. 23.

personal injuries and death of the victim. Property damage is not protected with the exception of the victim's cloths.

From the victim's perspective, art. 29bis is even more favourable than French law if the victim was non-motorised (pedestrians, cyclists) or a passenger who claims personal injuries: his fault (contributory negligence) does not take away or reduce liability *in any way*, unless the victim has acted intentionally (for example to commit suicide).²⁰⁵ On the other hand, it is narrower than the French *Loi Badinter*: Article 29bis excludes all *drivers* of motor vehicles from the right to compensation, also those from another motor vehicle than the one under the paying insurance.

Sweden. On 31 March 2017 a proposal was presented to the Minister for Infrastructure for the regulation of trials using self-driving vehicles on roads. In this proposal it is stated that the current laws on compensation for traffic accidents can be applied to all levels of automated vehicles.²⁰⁶ In Sweden, and for example (slightly different) Norway, a regime of no-fault insurance applies which is not based on fault, nor even on risk or other forms of personal (human) liability, but on solidarity. Under the Swedish Traffic Damage Act (*Trafikskadelagen*, 1975/1410), victims injured by the operation of a motor vehicle can seek recovery from the liability-motor-insurance taken out by its keeper. The right to recovery is directly based on the insurer's objective liability: it is not dependent on *personal* responsibility of the driver or owner, possessor or keeper of the motor vehicle. Liability has been transferred from the owner, possessor or driver of the vehicle, onto his liability insurer. In Sweden, the rules on fault-based liability can still be invoked, at the victim's choice, but in practice this option is hardly ever used.

Although this is similar to the French and Belgian system of 'automatic compensation', as discussed above, the latter have kept more characteristics of the adversarial model: the liability insurer of the liable party may raise defences that contest the facts, for example by claiming that the accident was caused by inexcusable fault of the claimant himself. The Swedish insurance model rests, as said, on a community basis: the principle that all traffic members equally have the right to compensation for damage related to personal injury or death caused by motor vehicles. This explains why it differs from countries with personal, risk-based liability with regard to: (a) contributory negligence, and (b) the legal position of drivers of motor vehicles who suffer damage.²⁰⁷

(a) In cases of contributory negligence (the injured party's own fault), the right to compensation is only reduced with 'usually' 30 to 50 percent²⁰⁸, and even no reduction at all for income losses, unless the accident was caused by the injured party's intent or gross negligence or through drunk-driving in combination with negligent driving.

(b) Different from the other countries, the Swedish Traffic Damage Act *equally* protects motorised and non-motorised traffic victims. Both have a direct right to compensation against the insurer: it is the insurer's liability, not the insured's personal liability that is the basis of the claim for compensation. This is based on the social believe that the injured party '*should not regard the motorist responsible for the accident or anyone else as his adversary as far as compensation is concerned*'.²⁰⁹

²⁰⁵ Engelhard, 1998, p. 38ff and p. 47; cf. Van Dam, 2013.

²⁰⁶ *Vägen till självkörande fordon – försöksverksamhet*, Stockholm 2016.

²⁰⁷ Köhler, 1997, p. 71.

²⁰⁸ Köhler, 1997, p. 71.

²⁰⁹ Hellner, 2001, p. 257.

Rather, traffic victims should '*turn to the insurer as the party that handle[s] the administration of the compensation system*'.

In cases where two or more motor vehicles are concerned, *non-motorised victims* may choose to whom they direct their claim. The risk of personal injury or death of *motorised victims (the driver and passengers)* is covered by the liability motor insurer of their motor vehicle. The latter has a right to reimbursement against the liability insurer of another party who was at fault or, if the latter cannot be identified or is uninsured, against the Guarantee Fund. Most remarkably, and different from other EU member states, drivers are even entitled to compensation if theirs was the only motor vehicle involved in the accident (single-vehicle accidents). In academic writings it is admitted, that this right to recovery of the driver against his own liability motor insurer is inconsistent: one cannot be liable towards himself.²¹⁰ Nevertheless, it is upheld based on the argument '*that the driver is as much in need of insurance protection as anyone else injured by motor traffic*'.²¹¹ The Swedish experience, prior to the existing law, was that the level of protection offered by the voluntary insurance for drivers '*was not sufficient for cases of serious injury*'.²¹²

Both pecuniary and non-pecuniary damage related to *personal injury or death* fall directly under the liability motor insurance that rests on the motor vehicle. This is, however, supplementary to the highly developed social insurance, which lies at the basis of personal injury compensation.²¹³ To the extent that victims (also) suffer property damage (car, bicycle, cell phone, *etc.*), they must bring an action for damages based on fault liability. However, their right to compensation is then not limited by their own contributory fault. Following the Tort Damages Act (*Skadeståndslagen*, 1972), the right to compensation can only be reduced by the victim's intent or gross negligence.²¹⁴ If the traffic accident has led to medical disability or death, the liability motor insurer must request a recommendation (non-binding advice) from an impartial body, albeit maintained and financed by liability insurers, the Road Traffic Injuries Commission (*Trafikskadenämnden*).

United Kingdom. Currently the UK is a frontrunner in initiating legislation that introduces a special compensation system for damage resulting from accidents with autonomous vehicles. On 22 February 2017 a special legislative proposal was laid before the UK House of Commons that, in addition to less relevant issues here such as electric driving and aviation, seeks to address liability for fully autonomous (driverless) motor vehicles. According to this proposal,²¹⁵ the liability motor insurer incurs liability for the damage that results from an accident '*caused by an automated vehicle when driving itself*' if '*an insured person or any other person suffers damage as a result of the accident*'. For certain motor vehicles for which there is no liability insurance, because these are owned by public bodies or alike, the proposal shifts liability onto the owner (the public body). The liability insurer is only liable for death, personal injury and – very limited – to property damage: the property damage does *not* include damage to the automated motor vehicle, nor, *inter alia*, property in the custody or under the control of the insured person.

²¹⁰ Hellner, 2001, p. 258.

²¹¹ *Ibid.*

²¹² *Ibid.*

²¹³ Hellner, 1988, p. 17. *I.e.* to the extent that it is not already covered by social insurance or another insurance.

²¹⁴ Hellner, 2001, p. 255.

²¹⁵ Subsection 2 (1) of Part 1 of the (proposed) *Vehicle Technology and Aviation Bill* of 22 February 2017 currently laid before the UK Parliament.

Interestingly, the contributory negligence defence will, according to this proposal, not be applied any different than in regular cases. This means that the claim for compensation of the injured person is limited in accordance with his own contribution to the accident or to the damage. To this extent, this proposed UK bill still has characteristics of personal responsibility: the victim's own contribution to the accident will limit his entitlement to obtain compensation. Thus, the proposed UK bill offers less protection than French, Belgian and Dutch traffic liability law do (and is, to this extent, similar to traditional fault-based liability for motorised traffic in the UK). Furthermore, subsection 4 of the proposed bill allows liability insurers to exclude or limit their liability in their policies (thus contractually) against an insured person if the latter has failed to install software updates or has made alterations to the vehicle's operating system that were prohibited under the policy.

Also important to note is that, according to this proposed bill, liability of the insurer (or in some cases the vehicle owner) *'does not affect any other person's liability in respect of the accident'*.²¹⁶ Subsection 5 ensures that the liability insurer has a right of action against 'any other person liable to the injured party in respect of the accident'. This will entitle the liability insurer to seek repayment from the producer, in cases of defectiveness, or from other traffic members who were at fault.

3.3 Back to the six scenarios

Below, the aforementioned law systems will be applied to the six scenarios as described in Chapter 1. The focus will be on the main results, the scenarios will not be worked out in detail. Further, the discussion will exclusively focus on traffic liability and its meaning and relevance for each of these scenarios.

Scenario 1 – The failing sensor

The first scenario concerns the malfunctioning of one of the sensors of an autonomous vehicle, due to which a sudden lane closure was not properly detected, causing the car to slip. It was argued that a product liability claim will depend on whether the sensor was defective at the time of production, which necessitates the parties to gain knowledge in respect of the precise cause of the malfunctioning. If the producer is able to show that it was caused by the normal 'wear and tear' or that the malfunctioning is due to a risk that could not have been discovered at the time of production, the product liability-route will not lead to compensation.

But to whom can the damage be allocated if the victim's personal injuries claim is based on liability for traffic accidents? If the driver/operator himself suffers damage, there will, with the exception of Sweden, not be special protection. He could only obtain compensation from the car owner or his liability insurer (e.g. if the owner has allowed a relative or a friend to use his car), if there is personal fault. In the Swedish model as well as in the proposed 'Vehicle Technology and Aviation Bill' pending in the UK, drivers receive automatic compensation from the liability insurance that rests on their motor vehicle, even in single-vehicle accidents. Motorised victims hold the same position as other traffic victims do.

In countries that impose risk-based liability on the owner/keeper of a motor vehicle, only *non-motorised* traffic members are protected, and in France and Germany also passengers. In Germany and the Netherlands, the owner or keeper may avoid liability by proving an 'external cause'. In

²¹⁶ Subsection 2 (7) of Part 1 of the (proposed) *Vehicle Technology and Aviation Bill*.

Belgium, France and Sweden he will *not* have such defences to his avail. However, defects of the motor vehicle will often *not* bar liability. In countries with a mere fault-based traffic liability, such as currently the UK and Malta, victims will not be entitled to compensation, unless they can prove fault.

Scenario 2 – Sudden interruption of the software

The second scenario is only different from the former to the extent, that it is not one of the sensors, but instant malfunctioning of the software (undefinable symptoms on the driver's or operator's display) that causes the autonomous vehicle to slip. It was argued in the context of product liability, that the software producer and the producer of the vehicle may contest the defectiveness and can possibly raise the development risks defence. As for traffic liability, this scenario will have different outcomes throughout the EU. Countries that exclusively have fault-based liability, such as (currently) the UK and Malta, will not impose liability on the driver/operator or owner of the autonomous vehicle, unless he must have been aware of this risk and could have prevented it. The onus of proof is on the injured party.

In countries that impose a risk-based liability on the owner, possessor or keeper of the autonomous vehicle, with the exception of Sweden, the scope of protection is limited to specific categories of victims: non-motorised traffic members and, in some countries, passengers. See scenario 1. As argued, some of these countries may allow the defence of external cause, but this often does not include defects of the motor vehicle. Whether the sudden interruption of the vehicle's software will be treated as such, is yet uncertain. In Sweden and the UK's legislative proposal all victims will in principle receive compensation. But this proposal allows the insurance carrier to use contract clauses that exclude or limit liability if the insured person has failed to update the software or alike.

Scenario 3 – Unavailability of wireless network frustrates download

In the third scenario, the autonomous vehicle is unable to obtain data regarding unplanned construction works. The producer will be liable if 'being connected' is part of the package offered by him or if there is defectiveness in any way, for example in the absence of a back-up system.

Traffic liability law will produce very different results within the EU. Under Swedish law and the UK's legislative proposal, all traffic members are entitled to compensation *vis-à-vis* the motor insurance in this scenario. In the other countries under review victims will have a much less favourable position, for two reasons. First, the victim-*driver/operator* does not receive equal protection compared to other traffic members. In fact, in the other countries under review (including currently the UK), he does not fall within the scope of protection of risk-based liability for motor vehicles.²¹⁷ Other traffic members can invoke risk-based liability for motor vehicles (except currently in the UK), but Germany and the Netherlands²¹⁸ allow the keeper to escape liability based on the defence of external cause (provided the network lapse was unforeseeable and unavoidable for the driver/operator of his autonomous vehicle).

Scenario 4 – Driver/operator neglects instructions

²¹⁷ The French *Loi Badinter* does impose liability on the keeper of a motor vehicle against the victim-driver of another motor vehicle, but only if the latter was not at fault himself.

²¹⁸ Exceptions are Sweden, France and Belgium.

In scenario four, the driver/operator of the autonomous vehicle did not follow the vehicle instructions properly. This could lead to a product liability claim if there was a defect, for example an information defect; even then, damages could be reduced on the basis of contributory negligence.

In France, Sweden and the UK's legislative proposal that is currently pending, the driver/operator in this scenario will be entitled to full compensation. The fact that he has neglected instructions will not limit his claim, albeit the UK's proposal allows insurers to use contract terms to the contrary (see scenario 2). In all other law systems under review (including currently in the UK), he will have to prove that another traffic member was at fault, which is not apparent from the scenario as sketched.²¹⁹ Even then, his right to compensation could be reduced for the fact that he has neglected the instructions.

Scenario 5 – Hacking of software by third parties

Scenario five concerns the 'hacking' of the programming software of the autonomous vehicle by third parties. The producer would incur liability if there is defectiveness in any way, for example in the absence of a back-up system. Claims based on traffic liability will produce outcomes very similar to those as were indicated for scenario 3. The UK's legislative proposal, in its current form, would allow the insurance carrier to use contract clauses that exclude or limit liability if the insured person has failed to update antivirus software and alike.

Scenario 6 – Injuring a pedestrian when trying to avoid a house

Scenario six presents a case in which the autonomous vehicle has severely injured a pedestrian when it tried to avoid hitting a house. It was argued above, that this could constitute a design defect, but could this scenario, aside from product liability, (also) give rise to traffic liability?

In all law systems under review except currently in the UK, the pedestrian will in principle be entitled to compensation from the owner, possessor or keeper of the vehicle. In Germany and the Netherlands, the latter can, in theory, escape liability based on an external cause defence, but programming choices will most likely fall within their own sphere of risk. In the UK, as it currently stands, the pedestrian would not be entitled to compensation from the user or car owner, unless there was objective fault (e.g. if the user should have managed to regain control to avoid the crash). That would depend on the factual circumstances of the case and the standard of care demanded of the driver/operator, which is still uncertain.

3.4 Possible constraints, gaps and regulatory challenges

The discussion above, concretised in the six scenarios, points to three concerns. Firstly, it was found that many national differences still exist between the liability rules for traffic accidents within the EU. The UK currently only resorts to fault-based liability; other law systems are risk-based. Both Sweden and the current legislative proposal for the UK offer direct insurance payments based on objective liability. Belgium and France are similar, but exclude/limit the right to compensation of the injured driver of a motor vehicle. German and Dutch law also exclude the driver and for other traffic victims both law systems allow defences to avoid liability by proving

²¹⁹ A few countries (the Netherlands, France) also have risk-based liability for 'dangerous objects', that would cover, for example, bicycles that carry no light, *etcetera*.

an Act of God, external cause or contributory negligence of the victim. Property damage receives less protection. In the Netherlands all injured *passengers* are excluded from risk-based liability for motor vehicles. Some countries limit the liability for motor vehicles to a maximum statutory capital, whereas most others do not.

Secondly, particularly the risk-based law systems use concepts such as driver, passenger, owner, possessor and keeper for important legal consequences: passengers are in most countries protected by risk-based liability whereas drivers are not. This deserves reconsideration with the coming of autonomous vehicles, dependent by whom exactly these vehicles will be owned or kept in the future. Related to this, the exclusion of the victim-driver from the protection offered by risk-based liability requires attention in light of the increased safety level introduced by autonomous vehicles. Both the more traditional risk-based liability systems (Germany and the Netherlands) and the 'insurance modelled' liability systems (France and Belgium) may want to reconsider their limitations with regard to the driver-victim.

Thirdly, exclusively fault-based systems are ill-suited for autonomous vehicles at SAE automation-level 3 and particularly at levels 4 and 5.²²⁰ The role of the driver/operator changes drastically and is reduced to a mere 'turning on and off' at levels 4 and 5. In the absence of human activity, there can be no fault. At the very least, new standards of care must be developed. Similarly, the more traditional risk-based traffic liability systems (Germany, the Netherlands) seem ill-equipped for automation-level 3 and particularly the levels 4 and 5 as these systems still use fault-based elements. A more revolutionary approach to find 'solutions', that is currently debated, would be to attribute fault *to the vehicle*. But even then, it will be problematic for victims to prove a causal link between (failure of) the technology of the vehicle and their damage. The risk-based liability systems of France and Belgium relieve victims of the requirement of causality as they refer to the motor vehicle's 'mere involvement'.

3.5 Conclusion

All in all, the following can be concluded. With the exception of Sweden, the national rules on traffic liability are based on personal responsibility of the driver for driving the motor vehicle and of the keeper for material defects in the vehicle (concerning its engine, brakes, *etc.*). However, **the central concepts of driver, owner and possessor must be critically reconsidered** for their applicability in cases involving autonomous vehicles. By whom will these vehicles be owned and/or kept? To what extent is the user still in control? Particularly, if the current national rules for risk-based liability are applied to these cases, these concepts are currently used as justification grounds: the 'user' is, in the context of conventional vehicles, seen as the creator of risks and the 'driver' as the one being in control. In the context of autonomous vehicles, these roles, however, will change, which makes these **justification grounds for imposing liability less convincing**: autonomous vehicle *are* also seen as 'risk minimisers', although these too have a higher impact in terms of damage than non-motorised vehicles. Dependent on the degree of automation, the 'driver' cannot automatically be treated as the one being in control.

For the risk-based national liability regimes for motor vehicles, this also calls for **serious rethinking of the current position of the driver-victim**: drivers of motor vehicles, who suffer damage, are generally excluded from risk-based liability for motor vehicles. Only in the Swedish no-fault model they receive equal protection, compared to the protection of other traffic members.

²²⁰ See *supra*, section 1.3 for an overview of the SAE-levels of automation.

Especially in cases of full automation, it will no longer be obvious to offer less protection to the user of the vehicle than to other traffic members.

For the fault-based rules on traffic liability, particularly at the SAE levels 2 to 4 (limited autonomous driving),²²¹ **new judge-made duties of care will have to be created** to assess the driver's or operator's availability, monitoring and alertness to signals that he should resume driving the vehicle in particular circumstances. These involve the question to what extent the driver/operator may rely on hardware and software technology of his autonomous vehicle. Also for *fully* autonomous vehicles, new duties of care will need to be developed for the operator and for the owner/possessor/keeper, on the basis of which they or parties responsible for them (*i.e.* their employer) may incur liability. Inevitably, **countries in which liability is exclusively based on fault (in the absence of risk-based liability), will not be able to offer satisfying solutions at SAE-levels 4 and 5** (almost full and full automation).²²² A revolutionary approach to find 'solutions', that is currently debated, would be to attribute fault to the vehicle itself. That, however, would still not relieve the victim of the difficulty of determining if and when there is 'fault', and the subsequent onus of proof, nor does it solve causality issues (*viz.* the question whether the vehicle's alleged omission to respond differently was in fact the cause of the victim's damage).

²²¹ See *supra*, section 1.7.

²²² See *supra*, section 1.3.

4. Hacking and privacy issues

4.1 Introduction

This chapter focuses primarily on cases of hacking or cybercrime. Autonomous vehicles are vulnerable to hacking, due to the fact that they rely heavily on software for their operation and, as for CAVs, the fact that they are connected to each other through *vehicle-to-vehicle* communication technology (hereinafter referred to as *V2V*), or to a larger infrastructure using *vehicle-to-infrastructure* communication technology (hereinafter referred to as *V2I*). Clearly, this has implications as to the liability for damage caused by hacked autonomous vehicles. This will be discussed in the first part of this chapter.

Secondly, this chapter will pay attention to another, yet related issue, *viz.* data and the protection of privacy. Autonomous vehicles will be equipped with software and hardware able to process and store several forms of data and information, to collect this in black boxes and/or share it real-time with road users and other third parties. Data generated, stored and communicated could help in solving liability issues, for instance in determining the precise cause of accidents after these have occurred, who was at fault, and who may be held responsible. Data and information sharing technology could even prevent accidents from happening. Privacy of operators of (connected and) autonomous vehicles and other citizens in the vicinity of those vehicles must, however, be taken into account at all times. To what extent may personal data be processed using autonomous vehicles under the current and forthcoming rules on personal data protection? And what regulatory challenges lie ahead when data and information sharing technology will be deployed in autonomous vehicles?

First, hacking will be discussed (section 4.2), followed by privacy issues (4.3) and the conclusion (section 4.4).

4.2 Cyber liability and hacking of autonomous vehicles

4.2.1 Introduction

For the purposes of this research, *hacking* can be understood to include all activities in which autonomous vehicles' technology is used in other ways than was intended by the producer.²²³ Hacking can have problematic consequences. This can be seen, for example, in cases in which third parties other than the producer, distributor or 'legitimate' operator (such as drivers, owners, keepers and license holders) circumvent security measures and access the computer systems that operate an autonomous motor vehicle, and/or the data gathered by, stored in and processed through autonomous vehicles. Already, hackers have proven in practice that they are able to break through the technological security measures currently implemented in cars, alter the software and take over the vehicles' operation.²²⁴ It is self-evident that when (connected and) autonomous vehicles are being hacked into, and third parties become in control of their operation, this may lead to accidents, and damage.

Civil liability for hacking in general is not harmonised in the EU. Under the national jurisdictions of the member states a hacker may be held liable for the damage caused after hacking into autonomous vehicles. However, since hackers often are highly skilled in the 'job', they may be

²²³ See a.o. Stallman, and <http://cyber.laws.com/hacking>.

²²⁴ See Greenberg, 2015.

able to hide their tracks and be hard to identify and locate. It will therefore often be hard to establish who is responsible and should be held liable for breaking into the vehicle's software. Therefore, the following sections will explore which consequences third-party hacking of autonomous vehicles may have for the liability position of producers in terms of the PLD, and for operators of (connected and) autonomous vehicles (in the broad sense: drivers, license holders, owners or keepers of the autonomous vehicle) in terms of specific national regimes addressing liability for motor vehicles. A distinction is made between physical damage resulting from hacking, and non-physical damage in the form of personal data breaches. Furthermore, some suggestions will be posed to the European regulators in order to mitigate the identified challenges.

4.2.2 Liability of the producers of hacked autonomous vehicles

Producers of autonomous vehicles can be liable for the damage resulting from defects of the vehicle after they have put it into circulation. It was established in section 2.2 that autonomous vehicles will generally fall under the scope of the PLD, but that it is questionable when these vehicles are deemed not to provide the level of safety which the public may reasonably expect.

As for the risk of hacking, to a certain extent, it is accepted that software will always contain certain faults (bugs), and that, while these bugs must be avoided as much as possible, a software producer has ample opportunity to fight off a product liability claim based on the development risks defence.²²⁵ That is the case if the defect could not have been discovered taking all available scientific and technical knowledge into account. Thus, it can be construed that autonomous vehicles' software is defective when it contains bugs that *could* have been avoided which enabled the hacking thereof; taking into account all relevant information present at the moment the autonomous vehicle was marketed. The producer must then compensate damage following from death, personal injury and, more limited, damage to goods. When an autonomous vehicle hack for instance leads to an accident, the resulting material damage may have to be remunerated by the producer of the autonomous vehicle.

The Data Protection Directive (hereinafter also referred to as DPD) and the new General Regulation on Data Protection (hereinafter referred to as GDPR, which has been adopted by the European Parliament and the Council in April 2016, and will likely enter into force in 2018,²²⁶ by then replacing the DPD) provide that controllers or processors can be held liable to compensate both material and immaterial damage resulting from their infringement of the harmonised rules as set forth.²²⁷

Producers of (connected and) autonomous vehicles are *controllers* of personal data, when they determine the purposes and the means of processing personal data, or *processors* when they process personal data under the responsibility of a controller. When a controller or processor for instance fails to take appropriate technical and organisational measures to protect the data from being hacked into;²²⁸ or when a system is hacked and this causes a personal data breach, fails to notify the supervisory authority and/or the people whose data have been revealed by the hack,²²⁹

²²⁵ See *supra*, section 2.2.5; *ibid.* Vihul, 2014, pp. 9-10 and Alheit, 2001, pp. 203-204.

²²⁶ See European Commission, 2015c and the final text of the GDPR can be accessed here: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL-ST_5419_2016_INIT, until publication in the *Official Journal of the European Union*.

²²⁷ Article 82 (1) of the GDPR and Article 23 of the DPD.

²²⁸ Article 5 (1) (f) and Chapter IV (Article 24ff) on data security in the GDPR.

²²⁹ Article 33 of the GDPR.

this may invoke his liability. When an autonomous vehicle-producer is however *not* a processor or a controller in the sense of the DPD and GDPR, he cannot be held liable for damage resulting from a personal data breach caused by a hack of the autonomous vehicle that he marketed.

4.2.3 Liability of operators of hacked autonomous vehicles

National law, again, determines whether the operator of an autonomous vehicle has the obligation to install software (security) updates and whether, if he did not comply, he could be held liable for the damage a hack causes. In general, under the national jurisdictions that have installed risk-based liability of drivers (such as France) or of owners/keepers (such as France and the Netherlands) for damage caused by their motor vehicles, it is likely that also damage caused by third-party hacking of autonomous vehicles is included in the scope of the regimes. In order to establish whether or not the operator of an autonomous vehicle can be held liable in the UK, it must be assessed if, and to what extent, he has breached his duty of care in relation to taking measures to prevent hacking.

When operators of autonomous vehicles qualify as controllers or processors of personal data, they can be liable to compensate material and immaterial damage when they act in conflict with the DPD or the GDPR. This will not often be the case, since they will be mostly using just their own personal data for operating autonomous vehicles.

4.3 Issues concerning sharing of data and information

4.3.1 Introduction

CAVs are expected to be equipped with software and hardware able to process and store several forms of data and information, to collect this in black boxes and share it, using V2V and/or V2I technology. Traditional motor vehicles are often fitted with *black boxes*, which are also referred to as *event data recorders*.

V2V technology connects vehicles to each other in a decentralised way, and shares car data such as speed, acceleration and braking, vehicle location and other driving activity real time with other road users. The same types of data can be shared using a centralised infrastructure through V2I technology.²³⁰ Based on vehicle data shared through V2I and/or V2V communication (hereinafter referred to as V2X communication), motor vehicles can adapt their own driving behaviour. If, for instance, a traffic incident happens, other vehicles on the road can be warned through V2X communication, and cars fast approaching the incident location can be instructed to activate emergency brakes. Furthermore, V2X communication may facilitate *platooning* (road trains, where cars automatically follow a lead vehicle, see *supra*, section 3.2.1), which leads to reduced fuel usage, less carbon dioxide emissions less congestion.

Benefits of CAVs equipped with event data recorders, and/or communicating through V2X technology (hereinafter referred to as *tracing technology*, or *TT*) in terms of liability include the following: logged vehicle and driving behaviour data could be used to help determining the precise cause of accidents after these have occurred, who was at fault, and who may be held responsible.²³¹ Moreover, V2X communication could even prevent accidents from happening by sharing real-time information on the whereabouts of other autonomous vehicles on the roads.

Information privacy of CAV operators, drivers, owners, keepers, passengers and other citizens in the vicinity of those vehicles must be taken into account when deploying tracing technology.

²³⁰ See for a concise typology Glielmo, 2011.

²³¹ De Bruin, 2016. See *supra*, section 2.5.

When TT-data are *personal data* in sense of European regulatory framework on data protection,²³² these must be stored and processed in conformity with current (strict) rules from *inter alia* the DPD.²³³ Even stricter forthcoming rules will become applicable in the EU after the GDPR has come into force.

In the following sections, it will be (1) explored to what extent TT-data may be processed using CAVs under the current and forthcoming EU data protection regime, and (2) which are the most problematic regulatory challenges that lie ahead when tracing technology will be deployed by autonomous vehicles in terms of stimulating innovation on the one hand, and facilitating societal acceptance by protecting the privacy rights of citizens on the other hand.²³⁴

4.3.2 Legal conditions for processing TT-data in the EU

4.3.2.1 Applicable legal framework

There are a number of harmonisation directives providing rules on information privacy of citizens in the EU. Currently, the DPD forms the core of EU legislation on data protection. Furthermore, the Directive on Privacy and Electronic Communications (DPEC)²³⁵ is applicable, however materially less relevant to be discussed into detail than provisions of the DPD. The DPD and the DPEC have been implemented in national regimes of the member states.

As was already mentioned, the DPD will be replaced by the GDPR, which will likely enter into force in 2018.²³⁶ Therefore, primarily the DPD will be discussed in the next sections. References are made to corresponding provisions of the GDPR. Some novelties in the GDPR applicable to TT-data will be discussed.

4.3.2.2 TT-data, personal data?

'Any information relating to an identified or identifiable natural person'²³⁷ is understood as *personal data* in sense of the DPD and the GDPR. A person is *identifiable* when he can be identified, directly or indirectly, 'in particular by reference to an identification number or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity'.²³⁸ The GDPR explicitly adds, amongst other things, 'location data' to be included in the realm of personal data.²³⁹ A distinction is made between regular personal data, and special categories of personal data. The latter include

²³² http://ec.europa.eu/justice/data-protection/law/index_en.htm, viewed 28 March 2016.

²³³ Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data.

²³⁴ The text of the next sections is partly on the findings in De Bruin, 2016 (forthcoming). References to that text will be made where necessary, and to sources used in that article accordingly.

²³⁵ Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector, as amended by Directive 2009/136/EC.

²³⁶ See European Commission 2015c, and the final text of the GDPR can be accessed here: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_5419_2016_INIT, until publication in the *Official Journal of the European Union*.

²³⁷ Article 3 (1) of the DPD; Article 4 (1) of the GDPR.

²³⁸ Article 2 (a) of the DPD.

²³⁹ Article 4 (1) of the GDPR.

information revealing for example someone's race, ethnicity, political opinions, religion, health and sex life.²⁴⁰

Data gathered, processed and stored through TT will often in some way relate to a natural person. Most *technical data* (such as motor behaviour, fuel use- and actuator data) fall outside the scope of the privacy rules, while other forms qualify as personal data (describing the behaviour of the driver). Most types of *user introduced data* will be personal data in sense of the DPD and the GDPR. Also, when, for example, (audio)visual recordings are made in side or around the vehicle, from which people can be recognised, these are personal data. Video recordings will even qualify as special category data, as these reveal the race of the depicted persons.²⁴¹ Furthermore, location data, indicating the whereabouts of the CAV and those transported inside the car can be personal data. These do not directly represent a natural person. However, it can be construed that when data from different sources are combined, for instance location data of the CAV on working days between 8.00 and 8.30, plotting the route from Y (a house address) to Z (a certain office address), these can identify the owner of a vehicle who happens to live at Y and work at Z, which qualifies the location data as personal data.²⁴² The same applies for example to location data of a rental car, which reveal the identity of the renter when combined with the rental company's customer administration. When data cannot be related to a natural person, the EU framework on data protection will not apply.

4.3.2.3 Controllers, processors and data subjects

The individuals, to which personal data relate, are defined as *data subjects*.²⁴³ The drivers, keepers, owners, passengers and all other people in the vicinity of autonomous vehicles, whose personal data are gathered, processed and stored, are thus data subjects. Those who determine the '*purposes and the means of the processing of personal data*' are *controllers*.²⁴⁴ *Processing* is defined as '*any operation or set of operations which is performed upon personal data, whether or not by automatic means*'.²⁴⁵ If the processing of personal data takes place by another party, on behalf of the controller, that party is referred to as *processor*.²⁴⁶

Producers of autonomous vehicles who incorporate tracing technologies in the vehicle, can be controllers when they determine which (personal) data are processed, when and how these will be stored, and under which conditions these data can be retrieved at a later stage. Third parties, such as insurers using the TT-data to *inter alia* calculate insurance premiums, are also controllers. When controllers use services of third parties in order to, for example, communicate and/or store TT-data to enable V2X communication, the latter (third parties) are processors in sense of the DPD and the GDPR.

²⁴⁰ Article 8 (1) of the DPD; Article 9 (1) of the GDPR.

²⁴¹ See also Article 29 of the Data Protection Working Party 2007, p. 8.

²⁴² This example was also illustrated in De Bruin, 2016.

²⁴³ Article 2 (a) of the DPD; Article 4 (1) of the GDPR.

²⁴⁴ Article 2 (d) of the DPD, Article 4 (7) of the GDPR.

²⁴⁵ Article 2 (b) of the DPD; Article 4 (2) of the GDPR.

²⁴⁶ Article 2 (e) of the DPD; Article 4 (8) of the GDPR.

4.3.2.4 Fair and lawful processing

Personal data may only be processed '*fairly and lawfully*'.²⁴⁷ Processing personal data is only considered *fair* when this is done in a transparent way for the data subject, which means that the persons concerned must be aware of the processing.²⁴⁸ The DPD and the GDPR provide limitative criteria to determine the *lawfulness* of data processing.²⁴⁹ Lawful data processing includes, for instance, processing in accordance with *freely given informed consent for specific purposes*;²⁵⁰ processing that is necessary *for the performance of a contract* to which the data subject is party.²⁵¹ Or processing that is necessary for the purposes of the *legitimate interests* pursued by the *controller* or a *third party*, except where such interests are overridden by the interests or fundamental rights and freedoms of data subjects,²⁵² especially those of minors. Rules for processing special categories of personal data are even stricter.²⁵³

Personal data may only be '*collected for specified, explicit and legitimate purposes*'.²⁵⁴ This implies that before processing takes place, the purposes must have been determined, and brought to the knowledge of data subjects. Any processing beyond the original purposes is illicit. Furthermore, the *data minimisation* principle²⁵⁵ explicates that no more data than necessary for the original purposes may be processed. Personal data may in principle not be stored longer '*than is necessary for the purposes for which the personal data are processed*'.²⁵⁶ The GDPR requires that when personal data are processed using '*new technologies*', while there is a '*high risk for the rights and freedoms of individuals*', a so-called '*data protection impact assessment*' must be carried out before processing takes place.²⁵⁷ Also, when developing new technologies that enable the processing of personal data, principles of *data protection by design* and *by default* must be obeyed.²⁵⁸ Thus, CAV tracing technology must be aimed at processing as little personal data as possible and privacy settings should avoid collection and processing of personal data by default as much as possible.

4.3.2.5 Rights of data subjects

Data controllers must make sure that data subjects are *informed* of: a) the *identity of the controller* (and processors); b) the *purposes* for which personal data are processed; c) any *further information* such as (types of) recipients of personal data; their rights in terms of whether or not they should provide certain information, and their rights to access and rectify processed data.²⁵⁹

²⁴⁷ Article 6 (1) (a) of the DPD; Article 5 (1) (a) of the GDPR.

²⁴⁸ Article 5 (1) (a) of the GDPR; See also Article 29 of the Working Party 2014, p. 16.

²⁴⁹ Article 7 of the DPD; Article 6 of the GDPR.

²⁵⁰ Article 7 (a) of the DPD; Article 6 (1) (a) of the GDPR.

²⁵¹ Article 7 (b) of the DPD; Article 6 (1) (b) of the GDPR.

²⁵² Article 7 (f) of the DPD; Article 6 (1) (f) of the GDPR.

²⁵³ Article 8 of the DPD; Article 9 of the GDPR.

²⁵⁴ Article 6 (1) (b) of the DPD; Article 5 (1) (b) of the GDPR.

²⁵⁵ Article 5 (1) (c) of the GDPR. See also Article 29 of the Working Party 2014, p. 16.

²⁵⁶ Article 6 (1) (e) of the DPD; Article 5 (1) (e) of the GDPR.

²⁵⁷ Article 35 of the GDPR.

²⁵⁸ Article 25 of the GDPR.

²⁵⁹ Articles 10 and 11 of the DPD (see sections 2 for the relevant exemptions); Article 12 of the GDPR.

Data subjects have the *right to access* the personal data processed that relate to them, in an intelligible form, also regarding the sources from which data are obtained.²⁶⁰ Persons whose data are processed using TT, have the right to access the obtained data, either in raw format,²⁶¹ or as provided in the GDPR, '*in a structured and commonly used machine-readable format*' while the data subject has the right to transmit those data to another controller, which embodies the *right to data portability*.²⁶² Furthermore, data subjects have the *right to revoke* earlier given *consent*, and the *right to rectification* of wrong data entries.²⁶³ The GDPR introduced the *right to be forgotten*, which entails the right to restrict further processing, when for instance the accuracy of data is contested, or when processing is unlawful.²⁶⁴ This implicates that individuals whose location data are processed via TT, may *inter alia* claim insight in the logged data, may request a usable copy of these data in order to have these stored and processed elsewhere, and may require that their personal data are not further processed.

4.3.2.6 Data security

Controllers are responsible for the integrity and the confidentiality of personal data they process. Therefore, they must take '*appropriate technical and organizational measures to protect personal data against accidental or unlawful destruction or accidental loss, alteration, unauthorised disclosure or access, in particular where the processing involves the transmission of data over a network, and against all other unlawful forms of processing*'.²⁶⁵ The GDPR provides a non-limitative indication of appropriate protection measures. Pseudonymisation and encryption of data; the ability to ensure the ongoing confidentiality, integrity, availability and resilience of (electronic) systems and services which are used for processing; swift possibilities for back-up and restore of access to and availability of personal data after an incident took place; and an ongoing process for testing, assessing and evaluation of technical and organisational measures are listed in Article 32 (1) of the GDPR.

Both the DPD (implicitly) and the GDPR (explicitly) leave room for certain forms of non-public regulation in order to further fill in *inter alia* which protection measures are appropriate. Article 40 (1) of the GDPR states that the European Data Protection Board (hereinafter referred to as EDPA) and the European Commission '*shall encourage the drawing up of codes of conduct intended to contribute to the proper application of this Regulation, taking account of the specific features of the various data processing sectors [...]*'. Eventually, the European Commission may decide that a code of conduct should have general validity within the EU.²⁶⁶ A similar system is in place for '*the establishment of data protection certification mechanisms and of data protection seals and marks for the purpose of demonstrating compliance with this Regulation of processing operations carried out by controllers and processors*'.²⁶⁷

Currently, several initiatives are taken to prepare codes of conduct for CAV tracing technology as mentioned above. In Germany for example, the 'Verband der Automobilindustrie' has issued

²⁶⁰ Article 12 of the DPD; Article 15 of the GDPR.

²⁶¹ See also Article 29 of the Working Party 2014, pp. 19-20.

²⁶² Article 20 of the GDPR.

²⁶³ Article 14 of the DPD; Article 16 of the GDPR.

²⁶⁴ Article 17 of the GDPR.

²⁶⁵ Article 17 (1) of the DPD; see also Article 5 (1) (f) and Chapter IV (Article 24ff) on data security in the GDPR.

²⁶⁶ Article 40 (9) of the GDPR.

²⁶⁷ Article 42 (1) of the GDPR.

'Data Protection Principles for Connected Vehicles'.²⁶⁸ On a broader level, the 'European Automobile Manufacturers Association' has drafted their 'ACEA Principles of Data Protection in Relation to Connected Vehicles and Services'.²⁶⁹ However, the results of both initiatives so far merely comprise principles and starting points; eventual codes of conduct that fit the requirements of the GDPR will have to be more extensive and detailed than the documents that are available to date.

4.3.2.7 Personal data breaches, liability and fines

Controllers must notify a supervisory authority within 72 hours after they became aware of a *personal data breach*, unless it is not likely that this data breach would *'result in a risk to the rights and freedoms of natural persons'*.²⁷⁰ Processors must inform controllers likewise *'without undue delay'*.²⁷¹ A personal data breach likely resulting in *'a high risk to the rights and freedoms of natural persons'* must also be reported to the data subject by the controller.²⁷² A personal data breach is defined as *'a breach of security leading to the accidental or unlawful destruction, loss, alteration, unauthorised disclosure of, or access to, personal data transmitted, stored or otherwise processed'*.²⁷³

Data breaches are thus defined rather broadly; they can include, *inter alia*, the accidental or deliberate disclosure of the contents of a database in which TT-data are stored located at the controllers' or a processors' premises. And also when an event data recorder gets hacked into, or when an individual accidentally discloses his login credentials to the user data he introduced, this may be included in the scope.

Any person, who suffers damage resulting from an infringement of the GDPR by a controller or a processor, may claim damages from the respective controller or processor.²⁷⁴ Liability primarily rests with the controller to compensate damage caused by an infringement; a processor can only be held liable for infringements of the GDPR that are specifically directed to processors, or when they have acted *'outside or contrary to lawful instructions of the controller'*.²⁷⁵ Article 82 (4) of the GDPR creates a one-stop-shop to request full compensation for persons who suffered damage resulting from infringements by multiple actors in controller – processor chains, who have a right of reimbursement *vis-à-vis* other infringing actors.²⁷⁶

The GDPR stipulates in Article 83 that supervisory authorities are entitled to impose administrative fines that are *'effective, proportionate and dissuasive'* on controllers or processors infringing it. In certain circumstances, these fines may add up to 20 million Euro, or, whenever higher, 4 percent of the total annual worldwide turnover.

²⁶⁸ Verband der Automobilindustrie, 2015.

²⁶⁹ European Automobile Manufacturers Association, 2015.

²⁷⁰ Article 33 (1) of the GDPR.

²⁷¹ Article 33 (2) of the GDPR.

²⁷² Article 34 (1) of the GDPR.

²⁷³ Article 4 (12) of the GDPR.

²⁷⁴ Article 82 (1) of the GDPR.

²⁷⁵ Article 82 (2) of the GDPR.

²⁷⁶ Article 82 (3) of the GDPR.

4.3.2.8 Concluding remarks

Surely TT could, when widely deployed, assist in preventing accidents. When nonetheless accidents do happen with autonomous vehicles, TT may help assessing how these originated, who was responsible, and in – at least in some jurisdictions – who could be held liable. However, the question whether or not CAV TT-data may actually be used as evidence to establish liability, is not harmonised on the EU level. One trade-off from the deployment of TT is that drivers will have virtually no other option than to choose CAVs with tracing technology,²⁷⁷ which probably comes at the cost of the information privacy of drivers, passengers and other people in the vicinity of CAVs, since the use of TT will often result in processing personal data. While massive amounts of personal data can be obtained, stored and otherwise processed in conformity with the rules, these large data sources will be vulnerable to hacking and other unintended uses in practice,²⁷⁸ which may have a negative impact on the societal acceptance and the deployment of autonomous vehicles in society.²⁷⁹

Rationales behind the current strict and even stricter future harmonised framework on information privacy include that intercommunal trade is facilitated, while at the same privacy rights are guaranteed, also when the data of EU citizens are exported to non-EEA countries. Strongly safeguarded information privacy, as well as transparency regarding the processing of personal data, favours consumer protection, contributes to consumers' trust, and therefore societal acceptance of autonomous vehicles.²⁸⁰ Principles laid down in the GDPR concerning, for example, privacy-by-design, privacy enhancing technologies and privacy by default, will challenge producers to develop and incorporate TT that is aimed at protecting the privacy of CAV operators and bystanders.

4.4 Conclusion

Under the DPD and the new GDPR producers could be liable in their capacity of controllers of personal data, when they determine the purposes and the means of processing personal data, or as processors of personal data under the responsibility of a controller. But this will only be the case if a controller or processor for instance fails to take appropriate technical and organisational measures to protect the data from being hacked into or infringes other obligations under the DPD or GDPR. Most types of *user introduced data* and even location data (if for example as combined data these can reveal one's identity) will be personal data in sense of the DPD and the GDPR. Personal data may only be processed '*fairly and lawfully*' and be '*collected for specified, explicit and legitimate purposes*', that are brought to the knowledge of the data subjects. CAV tracing technology must be aimed at processing as little personal data as possible and privacy settings should avoid collection and processing of personal data by default as much as possible.

Several regulatory challenges regarding the EU privacy framework must be addressed in the light of emerging CAV tracing technology. First, considering the probable length of CAV data processing chains and the number of actors involved, all individual controllers and processors should be stimulated to actively participate in the drafting process codes of conduct and certification mechanisms that comply with the GDPR. The current data protection principles endorsed by European automotive producers yet available may provide a good starting point. It

²⁷⁷ See Acharya, 2014, p. 11; also Glancy, 2012, p. 1172; De Bruin, 2016.

²⁷⁸ See Glancy, 2012, p. 1196-1197.

²⁷⁹ See Glancy, 2012, p. 1225.

²⁸⁰ De Bruin, 2016.

is likely that whenever controllers and processors of personal data are involved throughout the whole process, they will better adhere to these rules, then when they are left out of the regulatory loop, which serves privacy protection in general. The European regulator could therefore take on an active role in the interplay between private actors, national supervisory authorities and the EDPA, which is nicely facilitated in the (new) GDPR.

Second, since many processors of CAV data will be based in the United States, attention must be drawn to the export of personal data to the US. The *Max Schrems* decision has led to the annulment of the 'safe harbour framework', which was largely used as a basis for the processing of EU personal data in the US.²⁸¹ It is still possible to rightfully exchange personal data with the US, when for instance *standard contractual clauses* of the EC are incorporated in agreements with processors based in non-EEA countries, or in case processing takes place within a multinational company, *binding corporate rules* apply ensuring *inter alia* the lawfulness of the processing activities.²⁸² However, a more generic new system which builds upon certain (still valid) principles of the safe harbour framework, taking due account of the findings of the Court of Justice of the European Union in the *Max Schrems* decision, is required to practically and efficiently facilitate the exchange of CAV data with the US. The Courts' decision was partly based on the findings that US legislation permits public authorities (such as the National Security Agency) to have access to (personal) data incorporated in electronic communications on a general basis, which is contrary to the right to privacy of EU citizens.²⁸³ After the *Schrems* ruling, the EC and the US have in close collaboration drafted the text for an 'EU-US Privacy Shield' (hereinafter referred to as Privacy Shield).²⁸⁴ According to the Commission, the Privacy Shield *inter alia*: will provide stronger obligations on US companies to protect personal data of EU citizens; will enable stronger monitoring and enforcement of the rules by the US Department of Commerce and Federal Trade Commission; should no longer enable the generalised access by US public authorities and provide clear conditions, limitations and oversight for (incidental) access to personal data; and will install an Ombudsperson for EU citizens to raise enquiries or complaints.²⁸⁵ Despite these ambitions, the Electronic Frontier Foundation first observed that the *Privacy Shield* still holds openings for generalised access to personal data.²⁸⁶

Robert Litt, general counsel of the US Office of the Director of National Intelligence, declared in his letter which is part of the text of the Privacy Shield, that whenever practicable '*U.S. Signals intelligence activity must always be tailored as feasible [...] This means, among other things, that whenever practicable, signals intelligence collection activities are conducted in a targeted manner rather than in bulk*'.²⁸⁷ The opinion that this statement actually still enables mass surveillance is shared by among others the Electronic Privacy Information Center, who also observe that '*the US must formally commit to substantial reforms respecting human rights and international law in order to meet the standards set forth by the CJEU and the Article 29 Working Group*', and that the

²⁸¹ CJEU, Case C-362/14, *Schrems*.

²⁸² See also European Commission, 2015b.

²⁸³ European Commission, 2015b, p. 3; *Schrems*, paras. 90-94.

²⁸⁴ United States Department of Commerce, 2016; European Commission, 2016; and the Draft Commission Implementing Decision, 2016.

²⁸⁵ European Commission, 2016, second section *ff*.

²⁸⁶ O'Brien and Reitman, 2016, p.1.

²⁸⁷ Litt, 2016, p. 3.

Privacy Shield should include '*provisions to ensure appropriate redress and transparency*' for EU citizens whose data are processed in the US.²⁸⁸

The Article 29 Working Party in this respect observes that the Privacy Shield indeed sets a large step forward compared to the Safe Harbour framework by identifying that '*possible access to data processed under the Privacy Shield for purposes of national security and law enforcement*' is extensively addressed. However, recalling its '*long standing position that massive and indiscriminate surveillance of individuals can never be considered as proportional and strictly necessary in a democratic society*', the Working Party takes notice of the aforementioned letter of Robert Litt, which does not exclude mass surveillance, and states to look forward to '*forthcoming rulings of the CJEU in cases regarding massive and indiscriminate data collection*'.²⁸⁹

Third, a regulatory answer may be sought to the question whether or not a producer of CAV TT could be held liable if a data breach occurs due to insufficient security measures taken by him, while he is *not* a controller or a processor under the DPD or GDPR, and taking sufficient security measures by him would thus not be required based on these rules. Neither the GDPR or the DPD, nor the PLD seems to provide satisfactory outcomes in this respect. The GDPR institutes, from a consumer protection perspective, a fair system for appointing liability to controllers and processors who infringe its provisions. For example, the CAV producer who collects and stores personal data through tracing technology for the improvement of 'his own' CAV driving technology, and who does not obey the GDPR, will be liable for compensating damage resulting from a data breach. The same producer however, cannot be held liable when he has provided just the same - unsafe - tracing technology, where he does not determine the means and purposes for data processing nor processes under the responsibility of a controller. When for example the consumer himself decides to share certain personal data with others using tracing technology, the producer of the technology cannot be held liable under the GDPR, as long as he is not an actor in the data processing chain.

The PLD provides that a producer can be held liable when a defective product he has put into circulation causes damage to persons or goods. It may thus be that the CAV producer, who marketed tracing technology that lacks the level of information safety the public may reasonably expect, could be liable for the resulting damage. But damage resulting from unsafe tracing technology does not consist of personal injury or death or damage '*intended and/or used for private consumption*'²⁹⁰ by the injured person, will not have to be compensated by the producer. Thus, a significant portion of potential damage resulting from the abuse of vulnerabilities in CAV tracing technology is not covered within the EU regulatory framework on liability and data protection to date.

²⁸⁸ EPIC, 2016.

²⁸⁹ Article 29 of the Working Party 2016, p. 4.

²⁹⁰ As stipulated by the PLD, see *supra*, section 2.3.

5. Conclusions of part 1

In this chapter the conclusions of the previous chapters will be presented and brought together so as to reflect on the current legal framework as a whole.

5.1 Product liability presents serious points of concern

As for the PLD, the conclusion is that, generally and in its current form, its practical relevance may in fact be more limited than is often heard. It is rather demanding for consumers in cases that involve high-tech products such as autonomous vehicles. Defectiveness is determined on the basis of what the user group may 'reasonably' expect and this is assessed by the standards at the time of production. Dependent on the legal interpretation of 'reasonableness', this will limit the scope of the PLD. This calls for calculable legal standards: 'In how far can users expect their autonomous vehicles to be free from shortcomings or *imperfections*?' In the absence of such standards, that alone, may take years or decades of legal uncertainty, and costly proceedings through which the law will be shaped, case-by-case.

Also, a number of risks are excluded from the PLD. It does not extend to 'new' risks that at the time of production were not yet foreseen by the legislator and could not be detected by the producer. Nor does it cover defects that only came to existence after it was launched on the market or that were not yet captured by safety regulations that the producer has complied to. Most defects causing casualties will therefore, in our estimation, not be included.

5.2 Alternative route: traffic liability. Concern: not harmonised

It follows, that the current framework for defective products liability presents, if applied to damage caused by autonomous vehicles, important gaps and limitations. In certain EU member states, these may be 'circumvented' rather easily by consumers who choose to direct their claim for damages against the liability motor insurance and base it on traffic liability. Liability insurance for motor vehicles is mandatory EU (and EEA)-wide and victims enjoy an '*action directe*' and other forms of protection, which may give them a good incentive to turn to the liability motor insurance. Whether they will *in fact* do so, will depend on the substantive law (traffic liability legislation).

Traffic victims under Swedish, French and Belgian law,²⁹¹ and those covered by the UK's legislative proposal for the 'Vehicle Technology and Aviation Bill', are most likely to follow the route of traffic liability. Product liability claims will, in these countries, remain relevant for the eventual financial arrangement: recourse (repayment) claims by liability motor insurers *vis-à-vis* the producer of the autonomous vehicle involved. Risk-based liability for autonomous motor vehicles may prove to be an easier route to obtain compensation than the PLD currently provides for. Under Belgian, French and Swedish law (as well as in the aforementioned bill, proposed in the UK), the liability motor insurer will *de facto*, in its relation towards the victim, take over many technical risks that are excluded from the PLD.

At the same time, the preceding chapters reveal a highly fragmented outcome, which could be detrimental to the internal market for autonomous vehicles. Here lies an interest for the EU to regulate traffic liability at least for the extra restraints in the insurance modelled systems (France, Belgian, Sweden): producers' risks will - at least *prima facie* - easily be borne by the liability motor insurers. The exact route chosen (will the injured party's claim be directed against the industry or

²⁹¹ For Belgium an exception must be made for the driver-victim.

will it be directed against the liability motor insurer?) ultimately determines who bears the financial risk. If risk-based liability for motor vehicles is an easier route to compensation than the product liability-track, then this could – *inter alia* – impact liability motor insurance premiums in the particular countries. If the paying motor insurer does not pursue its recourse claim, the producer's risk of liability will be smaller than in countries that have less 'victim-friendly' traffic liability laws. Liability motor insurers may well refrain from civil actions because of the constraints of the PLD, next to private international law issues (foreign court, enforcement mechanisms).

Summarising the above, there may be good arguments for harmonising a basic level of risk allocation. These arguments also oppose to regulatory interventions that focus solely on the product liability, overlooking the impact of the risks introduced by autonomous vehicles on liability motor insurance. The consumer may then, in some countries, in fact be paying twice, if one-and-the same risk is calculated in the price of autonomous vehicles and in their motor insurance premium. Ultimately, this could have implications for the roll-out of autonomous vehicles and might then create locational disadvantages for new developers of their technology.

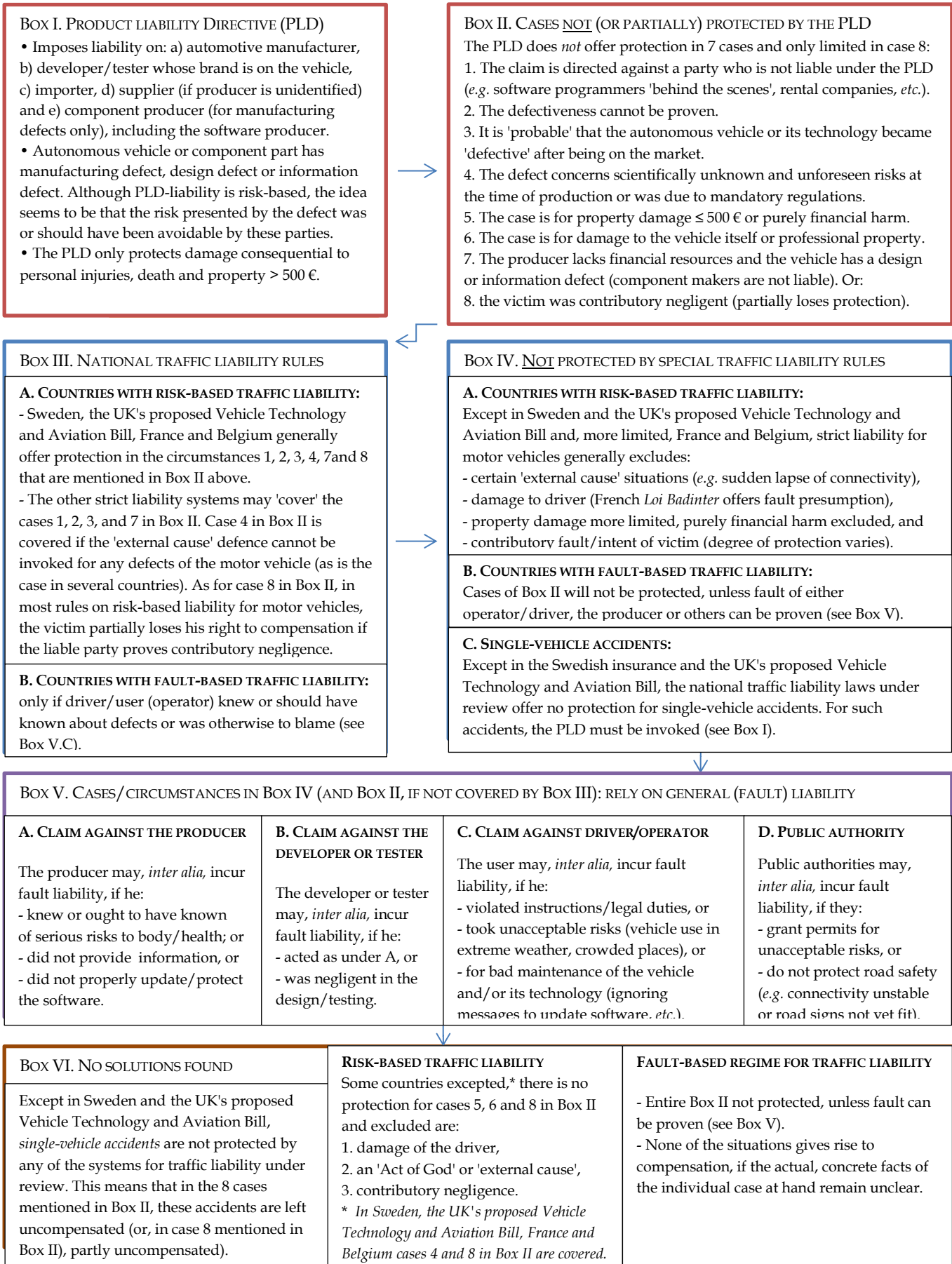
5.3 Fault liability rules: limited role for damage caused by CAVs

Local differences regarding (general)²⁹² rules on non-contractual and contractual fault liability must not be underestimated. Aside from the fact that conventional vehicles may stay on the roads for years to go, even with fully autonomous vehicles there will always be *some* human behaviour. Also others may incur fault or strict liability, such as telecom providers, public authorities and transport companies.²⁹³ If the software in the vehicle is hacked, these cases too are governed by different rules and will be treated differently across the internal market.

²⁹² *I.e.* fault liability rules that are not specifically designed for particular damage causing activities or objects such as products, traffic and alike.

²⁹³ *Cf.* for the latter, next to the national liability rules, the Convention on the contract for the international carriage of goods by road (CMR).

Scheme of the basic findings in Part 1



PART 2

ANALYSIS AND EVALUATION OF NEW WAYS TO REGULATE CIVIL LIABILITY FOR CAVS

Part 2 of the current report focusses on future law. It seeks to investigate both the added value of action taken by the EU regulator and different manners in which the right to compensation for accidents with autonomous vehicles could be regulated most effectively. Different from Part 1, the following part of this report is thus not concerned with the current positive law rules. Rather, it asks whether and how new laws could provide solutions for the constraints and gaps that were found in the analysis of the current laws. This is based on a normative analysis that aims to find a balance between stimulating (or at least not discouraging) innovation and safeguarding personal safety, property and privacy.

The set-up of this part is as follows. Chapter 6 will explore the European added value and the possibilities for regulatory action at EU-level. In Chapter 7, three different solution models will be investigated with the goal to resolve the main current legal constraints and gaps in the form of regulatory action at EU level and/or national level respectively. The focus and nature of these two chapters is therefore different. Chapter 6 seeks to investigate what regulatory role the EU could play; the analyses are partly of a meta-legal nature (as to the European added value) and partly legal-technical (as to possible regulatory interventions at EU-level). Chapter 7 presents a theoretical analysis of three solution models and a normative evaluation of each model's pros and cons. What follows, lastly, is the over-all conclusion of this report.

6. European added value

6.1 Introduction

This chapter focuses on the question whether and how regulatory intervention at EU-level could solve the legal gaps and challenges as were discussed in Part 1 of the current report. First, the European added value and policy reasons for intervention will be explored (section 6.2). Then, the legal-technical grounds, limits and scope of regulatory intervention by the EU will be treated (section 6.3), also in light of the principles of subsidiarity and proportionality (section 6.4). Lastly, the main findings of this chapter will be presented (section 6.5).

6.2 European added value

The feasibility of EU intervention can be translated into the value that would be 'additional to the value otherwise created by actions of Member States alone', so-called European Added Value.²⁹⁴ To determine added value is challenging, as the added value of EU regulatory intervention in the current context can hardly be monetised on a sound basis, given its intangible nature. Below, it will be expressed and investigated in terms of its attainment to common European objectives. Further, empirical research could only be conducted *after* regulatory intervention at EU-level has been undertaken or initiated. In the absence of any actual initiatives, the European added value can be fairly assessed on the basis of expectations provided these are supported by the relevant facts, arguments and assumptions. Some of these are contested or cannot simply be accepted or extrapolated to the current question as to the added value; this calls for a critical discussion.

For example, it has been suggested that EU regulatory intervention which aims to relieve consumers of the onus of proof under the PLD would strengthen their legal position and therefore protect their economic interests under Article 169 of the Treaty on the Functioning of the EU (hereinafter TFEU).²⁹⁵ That, by itself, is not persuasive as there could be other, far more urgent obstacles that withhold consumers from pursuing a claim for damages under the PLD than those for which the EU-intervention creates relief.

Determining the (expected) European Added Value is further challenging as it can be approached from different perspectives. If the political choice was made to exclusively prioritise consumer protection (and protection of traffic victims), the added value would be assessed by focusing on the consumers' health and safety. If, on the other hand, priority would be given to the industry interests concerning the internal market, a level playing field could be seen as imperative for liable parties such as automotive producers and, ultimately, for the Member States since it helps to eliminate distortions within the Community.²⁹⁶ Both arguments were combined, one could say, to extend the PLD to agricultural products after the Mad cow disease. Consumer protection was

²⁹⁴ See Commission Staff Working Document, SEC (2011) 867 final, p. 2.

²⁹⁵ Article 169(1) of the TFEU reads: '*In order to promote the interests of consumers and to ensure a high level of consumer protection, the Union shall contribute to protecting the health, safety and economic interests of consumers, as well as to promoting their right to information, education and to organise themselves in order to safeguard their interests*'.

²⁹⁶ Cf. Commission Staff Working Document, SEC (2011) 867 final, p. 26.

considered vital to restore consumer confidence in the safety of agricultural products, thereby protecting the market as well.²⁹⁷

The more convincing approach, advocated by the EC and to be found in other European Added Value assessments,²⁹⁸ is to investigate added value resulting from multiple factors: promoting legal certainty, the effectiveness of consumer protection and a level playing field. This is consistent with the fact that the current report aims at balancing the strive for innovation and respecting the fundamental values of personal safety, property and privacy of traffic victims. Harmonising (certain aspects of) the current legal framework for compensation, either through civil liability or through insurance, must:

- a. promote legal certainty for developers of (the software for) autonomous vehicles as to their risk and the cost of civil liability;
- b. create a harmonised level of effective consumer protection within the common market and
- c. create a level playing field for the member states,

thus enabling the successful rollout of autonomous vehicles, with all its possible economic benefits. These three factors will be explained further below.

The first factor concerns legal certainty. From the preceding chapters it follows, that there is currently uncertainty as to the legal position of automotive and software producers' and of liability motor insurers, and the related financial risk. Our expectation is that this increases transaction costs for producers and it is inefficient as to the determination of the price of liability insurance. Partly, this uncertainty is due to national diversity, for which not one member state in particular could be held accountable, and which are easily compromised in the political process of each member state. Regulatory action at EU-level could thus be a necessary means to decrease the related transaction costs and subsequently add to the EU's goal to be a competitive player on this market.

Secondly, serious legal gaps and constraints were found that frustrate effective consumer protection. Given the fact that the PLD is community law, and that it is interpreted by the CJEU as providing 'total harmonisation',²⁹⁹ the member states have no discretion to solve these issues. As to EU-regulatory action to alter national traffic liability laws, the added value lies in the fact that this concerns a topic of political controversy that is best not made dependant of the legislative process of each member states as this will result in different laws. The main legal gap found in chapter 3 is that the victim-driver is currently excluded from the scope of protection of many national risk-based laws. This legal gap will, if left to the national legislatures, be addressed differently around the EU. In fact, some member states have already announced that their national laws will suffice, whereas the UK's proposal for a 'Vehicle Technology and Aviation Bill' introduces a legal arrangement through insurance (in which the victim-driver *is* protected). To the extent that EU regulatory intervention would address these legal gaps or constraints in the substantive product and traffic laws, this could strengthen victims' rights and, indirectly,

²⁹⁷ Directive 1999/34/EC of the European Parliament and of the Council of 10 May 1999, *OJ* June 4, 1999, L 141, pp. 20-21 (at Recital 5).

²⁹⁸ Commission Staff Working Document, SEC (2011) 867 final, p. 3.

²⁹⁹ *Supra*, section 2.2.6.

complement the added value of the ECC-net, which supports consumers in more practical ways to seek redress from traders in cross-border cases.³⁰⁰

Thirdly, Chapters 2, 3 and 4 point to great national diversity regarding the risk of liability: in some Member States automotive and software producers and/or motor insurers can be expected to run significantly higher risks of civil liability than in others. Given the EU's high ambitions on technological innovation,³⁰¹ this gives strength to the argument to create a level playing field for producers and thus member states. This, in its turn, could facilitate the distribution of autonomous vehicles technology throughout the internal market.³⁰²

These three factors do *not* necessarily call for full harmonisation to the extent that the actual amounts of compensation would be made similar within the EU. That would not only be difficult to achieve without harmonisation of social security laws, private insurance policies, civil procedural law and the litigation costs as well but it would also not be in line with variable standards of living. Rather, this report would support the idea of harmonising the allocation of the risks inherent to the technology used in autonomous vehicles and the legal position of the parties concerned.

Clearly, the decision to create an EU programme to take regulatory action based on the expected added value is at the discretion of EU institutions and resulting from the underlying political process.³⁰³

6.3 Legal basis, limits and scope

The options for regulatory action at EU-level also deserve attention from a legal-technical viewpoint. The institutions of the EU can bring about legislation if it has been granted the authority to do so. This 'principle of conferral' has been laid down in the Treaty on the European Union (hereinafter: TEU). It means that '*the Union shall act only within the limits of the competences conferred upon it by the member states in the Treaties to attain the objectives set out therein. Competences not conferred upon the Union in the Treaties remain with the member states*'.³⁰⁴ For the drafting as well as its choice for the policy instrument used to provide legislation, the principles of subsidiarity and proportionality must be respected (Article 5(1) of the TEU). For the principle of subsidiarity, in areas which do not fall within its exclusive competence, such as rules or mechanisms for damage caused by autonomous vehicles, the TEU stipulates that:

'the Union shall act only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the member states, either at central level or at regional and local level, but can rather, by reason of the scale or effects of the proposed action, be better achieved at Union level' (Article 5(3) of the TEU).

National initiatives to introduce rules on the compensation of damage caused by autonomous vehicles will show great differences, leading to different legal outcomes. This may disturb the internal market to the extent that the risks involved with car driving will be allocated differently

³⁰⁰ Commission Staff Working Document, SEC (2011) 867 final, p. 38.

³⁰¹ See Communication from the Commission Europe 2020, A strategy for smart, sustainable and inclusive growth, COM (2010) 2020 final.

³⁰² In these words also De Bruin, 2016.

³⁰³ Commission Staff Working Document, SEC (2011) 867 final, p. 3.

³⁰⁴ Sections 1 and 2 of Article 5 of the TEU.

within the EU. Intervention on the supranational level thus seems necessary in order to harmonise these rules and/or mechanisms, at least to a minimum level of protection.

Under the principle of proportionality, the TEU holds that:

'the content and form of Union action shall not exceed what is necessary to achieve the objectives of the Treaties' (Article 5(4) of the TEU).

This means that both in respect of substance as well as the chosen instrument EU-intervention must not go further than necessary to enable harmonisation. The instrument chosen and its content must leave as much scope for national decision as possible while achieving satisfactorily the objectives test as set out below.

6.4 Policy instruments, subsidiarity and proportionality

According to Article 289 of the TFEU, legislative acts in the EU-context can take the form of regulations or directives (or decisions, but these generally concern specific addressees and/or issues).³⁰⁵ The merits of these policy instruments must be carefully considered for the topic at hand, particularly in the light of the aforementioned principles of subsidiarity and proportionality. Both instruments are different and have different effects. Yet, the chosen instrument must be proportionate given the size and nature of the identified problem, which means here: given the national private law differences with regard to the nature, requirements and scope of monetary compensation for the damage caused by autonomous vehicles.³⁰⁶

Generally, it can be noted that regulations are directly applicable as part of domestic law from the moment they gain force and are then binding to citizens in the member states, without any transposition, whereas directives are only binding on the member states themselves and impose an obligation on the latter to create a certain result. Directives are more flexible since the member states have the power to choose how and in what specific form to transform them into their national laws.³⁰⁷ This also means that regulations are typically regarded as more appropriate than directives if the topic of EU-intervention would demand a high level of precision and uniformity.

Legislative interventions from the EU to harmonise private law rules, aiming at no more than to wash away some of the national differences, usually take the form of a directive. In fields of community intervention where a true *uniform* implementation of the chosen policy is necessary, such as in the internal market or, for private law, the field of civil procedural law and the field of private international law, this may also take the form of a regulation. A directive that imposes on member states the duty to introduce a no-fault insurance to cover the damage caused by autonomous vehicles, would probably be most fit to achieve the goals as aforementioned (and not exceed them).

³⁰⁵ See more in depth Eijsbouts c.s., 2012, p. 56ff.

³⁰⁶ http://ec.europa.eu/smart-regulation/guidelines/tool_15_en.htm#sdfootnote120anc

³⁰⁷ Article 288 and 289 of the TFEU; Craig and De Burca, 2011, p. 112, Chalmers, Davies and Monti, 2014, p. 112.

If the purpose is to harmonise – rather than to regulate in detail – the different laws in respect of a particular topic, such as liability for defective products, choosing the form of a directive is found to be more appropriate than to opt for the form of a regulation.³⁰⁸ In regulations 'every't' must be crossed and every 'i' must be dotted.³⁰⁹ As for the introduction of a no-fault insurance, member states need room to determine its technicalities and to incorporate it in their framework of liability and/or insurance rules.

6.5 Conclusion

The European Added Value of regulatory action at EU-level was assessed through a multi-factor approach, as advocated by the EC and common practice in other assessment reports. This approach is consistent with the current report's aim to find the balance between technological innovation and respecting and protecting safety of traffic victims.

The added value in the current context results from three factors. Firstly, regulatory action at EU-level seems imperative to promote legal certainty within the Community, which in its turn could reduce transaction costs related to dealing with different national liability laws for damage caused with autonomous vehicles. This will support the competitive gains of the EU in autonomous vehicle technology. Secondly, EU-action is imperative to further increase the effectiveness of consumer protection, given the serious legal gaps and challenges that product liability law will prove to have after the roll-out of autonomous vehicles. As the PLD is community law and entails 'total harmonisation', it cannot be left to the discretion of the member states to solve these legal issues. Regulatory action to alter national traffic liability laws and particularly to include the victim-driver in the scope of protection, cannot be left to the member states as some have yet announced that their national laws will suffice, whereas the UK is considering a bill that will offer automatic compensation to the victim-driver. That would mean that the driver's legal position will be entirely different under some law systems than under others. Related to this is, thirdly, the added value argument that regulatory action at EU-level is necessary to create a level playing field for automotive producers and member states to facilitate the distribution of this means of transport as one of the driving forces of the internal market.

Legislative interventions from the EU in order to harmonise private law rules come in the shape of directives. In fields of community intervention where a *uniform* implementation of the chosen policy is necessary, such as in the internal market or, for private law, the field of civil procedural law and the field of private international law, this may also take the form of regulations. The technical form depends on the solution chosen. This will be treated in the next chapter.

³⁰⁸ Craig and De Burca, 2011, p. 106.

³⁰⁹ Craig and De Burca, 2011, p. 106.

7. Three legal 'solution models'

7.1 Introduction

This chapter presents an analysis of possible legal solutions. Three models will be highlighted: the model that comprises modifications (or revisions) of product liability law, the model that comprises modifications in traffic liability laws, and the no-fault insurance model. These three solution models will be explored and evaluated based on their respective pros and cons and regulatory challenges. Yet another option would be, in theory, to do nothing: to leave the current legal framework for liability and insurance untouched. But since that would bring us back to the gaps and constraints as discussed in Part 1, it will not be treated.

The set-up of this chapter is as follows. The three legal solution models will be set out (section 7.2). Each model will be treated: product liability reform (section 7.3), traffic liability reform (section 7.4) and no-fault insurance (section 7.5).

7.2 Three legal 'solution models' (with combinations and variations)

Solutions for the legal gaps and constraints found in Part 1 of this report can be found in product liability law, traffic liability law and/or insurance. Each of these three areas may present a variety of solutions, of which several may also be combined. Calling them legal solution models brings out that these are three separate directions to find legal-technical solutions, more particularly:

1. product liability reform, and/or
2. traffic liability reform, and/or
3. no-fault insurance, drafted for autonomous vehicles (or with a larger scope: for autonomous objects).

These three models will be treated separately, including the pros and cons and regulatory challenges. For the evaluation each model will be assessed on the bases of three criteria: legal certainty, the scope of protection and efficient claim handling as were set out in section 1.2 of the Introduction.

7.3 Model 1: Product liability reform

7.3.1 Basic model

The first model in which to find solutions consists of modifications of product liability law, to make it more fit for the coming of connected and autonomous vehicles. In Chapter 2, various legal aspects were discussed that are in need of clarification or substantive improvement.³¹⁰ Several points of uncertainty under the PLD were mentioned above: is software a product, when

³¹⁰ See *supra*, sections 2.4 and 2.5.

is it defective, to what extent are paying automotive producers entitled to reimbursement *vis-à-vis* producers of the software or hardware of the vehicle, *etcetera*.

As for substantive modifications, our main conclusion was that the current product liability regime has a rather limited role to play for autonomous vehicles as, generally spoken,³¹¹ it is limited to defects or risks that already existed prior to production and, more particularly, those that were scientifically known to or detectable for the producer, while also its scope of protection is limited (*e.g.* not all property damage is recoverable, the 500 Euro threshold, and, in some countries, monetary caps for compensation). The main³¹² constraints are the practical burdens (financial and technical) and normative uncertainty to establish 'defectiveness' and fault to the extent that some available defences introduce fault elements. Several modifications are thus necessary, if the current product liability-regime will be destined as the main source of compensation for damage caused by autonomous vehicles complementing the injured party's entitlement to social benefits and (in a number of cases) conventional private insurance.

7.3.2 Ways (and degrees in which) to change product liability law

Several modifications must be considered for this purpose. The first would be to submit a proposal to include software of connected and autonomous vehicles or software as such in the concept of 'product' under the PLD. This alone would not suffice as it would leave the other gaps and constraints untouched. It could also be considered to replace the 'reasonable expectations'-test that constitutes 'defectiveness' by a stricter criterion (or to abandon this test), at least for design-defects. US experience also shows that '*in most design-defect situations, this determination (of defectiveness) turned out to be extremely complicated*'.³¹³ The excluded kinds of property damage and monetary thresholds under the PLD may be reconsidered, to improve its accessibility as a compensation system for injured parties.

To increase the relevance of product liability, more fundamentally, the question must be addressed to what extent new technological risks can be attributed to the industry. The PLD relieves producers from liability for risks that were objectively unknown or that were scientifically not detected at the time of production, for compliance to existing rules and everyday's-risks (of 'wear and tear', vandalism, bad repair, *etc.*). The latter category of risks is rather obvious, as these risks are not industrial. But the former two categories, unknown and undetectable risks, consist of professional business risks and producers may in fact already treat them as such, albeit not in the context of their liability. It sees to technological vulnerabilities, software bugs, design risks, and alike, that were not yet known or detectable at the time of production. To include these in the PLD implicates changing its concept of defectiveness and abandoning the development risks defence (Article 7, sub *e* of the PLD).

These are not mere technical but in fact fundamental adjustments. Embedding risks scientifically unknown or identifiable means: to let go of a fault element in the PLD, that expects no more of the producer than to comply with the state-of-the-art. If producers will no longer avoid liability by conforming to the state-of-the-art, that may encourage their research and development (which, ultimately, will be calculated in the price of the product).

³¹¹ The focus will be on the law as it is in almost all member states. Exceptions are those member states that have abandoned the development risks-defence.

³¹² Various constraints for the claimant could be mentioned here, such as the relatively short prescription period, but we have focused on the constraints typically relevant for the specific case of autonomous vehicles.

³¹³ Rapaczynski, 2016, p. 19.

Opposite that, it would seem difficult to justify making fundamental changes exclusively for autonomous vehicles and not for the other products covered by the PLD (including conventional motor vehicles). More importantly, even if the risks as aforementioned *would* be brought under the producer's liability, the practical relevance of the PLD will be limited: it will always, to some degree 'compete' with the applicable national liability rules for motor vehicles, if these are risk-based. In some countries, the latter rules are much more advantageous to traffic victims than product liability. This is partly so, because some national systems of risk-based liability for motor vehicles are close to a 'guarantee' to traffic victims that they are entitled to compensation (as for instance in Swedish, French, Belgian and partially Dutch traffic liability). For the other part, it is a procedural matter: in the context of traffic liability, the liable party (liability motor insurer) is bound to make the victim a compensation offer (or a provisional offer), within certain time periods and sanctioned by the law.³¹⁴ Indirectly, this may frustrate the 'level playing field' of producers in the market for autonomous vehicles: in some countries their liability risk is high (*viz.* in countries with traffic liability laws that offer a moderate or low level of protection) and in other countries producers may hardly face claims due to the strict liability for motor vehicles imposed on the owner or keeper of the vehicle (*viz.* in countries with a high level of protection through traffic liability, such as France, Belgium and Sweden).

It follows, that if the regulator wishes to *canalise* liability to the industry (the producer), he must consider substantive and procedural improvements within the regulatory framework of the PLD, that weigh up against the benefits of the strict liability rules for motor vehicles (and liability motor insurance directives). For example, by eliminating or modifying the requirement of defectiveness and/or by eliminating certain defences of the PLD, particularly its development risks defence. By strengthening the claimant's procedural position, for instance through the imposition of time-limits for claim-handling on producers and sanctioned by an obligation to pay statutory interest.

7.3.3 Pros and cons of allocating the damage to 'the' producer

The question will be whether it is considered *feasible* to impose liability on the industry for yet unknown risks related to autonomous vehicles, more than under the current law. First, arguments in favour of improving (and extending) producer's liability will be discussed, and then the arguments against it.

One reason to shift the burden of liability onto the producer is that the latter is, according to proponents, 'the cheapest cost avoider'.³¹⁵ Producers are viewed as being in the best position to provide full information in term of risks warnings and instructions to avoid accidents, to control the manufacturing process, prevent abnormalities and to establish future design improvements. Producers '*have by far the best access to information about the safety of their products, the best technical expertise necessary to assess the areas of possible improvement, and the best ability to devise new technological solutions to safety problems*' and '*access to the capital necessary for the implementation of all the safety decisions*'.³¹⁶ Imposing liability on them by abandoning the development risks defence forces producers to internalise all the costs of product-related accidents. This gives them an

³¹⁴ See *e.g.* France (Articles 12ff of the *Loi Badinter*) and Belgium (Articles 13 and 14 of the *Wet betreffende de verplichte aansprakelijkheidsverzekering inzake motorrijtuigen*). The procedure prescribed by EU Directive 2009/103/EC for international traffic claims is also sometimes seen as 'best practice' for purely national claims, Van Boom, 2011, p. 81.

³¹⁵ A.o. Rapaczynski, 2016.

³¹⁶ Rapaczynski, 2016, p. 6.

incentive to assess and properly outweigh the product's costs and its benefits and to take safety measures to efficiently minimise risks.³¹⁷

Secondly, some would argue that it would be more 'fair' or 'just' to canalise liability to the producer, since he benefits from the market launch and sales of the product.³¹⁸ This may be most convincing with regard to technological risks that could not be detected at the time of production: that entails a typical 'business' risk. The argument would be that since it is the producer who develops the autonomous vehicle, he must be the party carrying the costs if it later appears to have risks.

Thirdly, modifying product liability would mean that the costs will ultimately be borne by the consumers who benefit from its use. The producer may pass these costs onto the consumer, for example by raising the initial purchase price.³¹⁹ This way, the price of the product reflects its 'true' social costs, also to the consumer who may have too high expectations of its safety. Related to this, is the consideration that by including the expected cost of accidents in the price of the product, strict products liability might affect the demand for autonomous vehicles, which could, in the long run, (further) reduce the number of casualties with motorised vehicles (less cars, even if autonomous, means less related incidents concerning motorised traffic).³²⁰

On the other hand, a short-term effect of the latter might also be that any contributions to the relatively high price of autonomous vehicles, may make consumers more hesitant to replace their own conventional vehicles by autonomous vehicles (and subsequently would only delay the safety benefits expected of autonomous vehicles). Actually, even the proponents cast doubt whether including the expected cost of accidents in the price would *actually* – substantively – affect the demand for motor vehicles in the European context. The correlation between price and demand may be complex already, but the argument is even more complicated by the fact that the increased safety of autonomous vehicles is expected to bring down the premiums for the liability motor insurance. For consumers, the costs of their liability motor insurance will then be 'replaced', one could say, by the increased purchase price, at least if producers pass their cost of risk-based liability onto the consumer.³²¹

Furthermore, holding the producer liable does not necessarily incentivise the industry to improve *ethical* choices. This refers to choices that are made by software developers and 'installed' in operating software for driverless vehicles. If producers are driven by the fear or costs of being held liable, that may encourage them to make safety improvements but it will not necessarily improve their choice of whether the vehicle should stop for a deer crossing the road. To this extent, liability will only have a limited role to play; rather it is for public intervention, next to market mechanisms, to give direction here.³²²

As for deterrence, this is best be left to public regulation. An interesting point in this regard, relates to the current expectation that producers of autonomous vehicles (and perhaps service-providers) may be able to monitor the vehicle and how it is being used after the sale. Rapaczynski

³¹⁷ Rapaczynski, 2016, p. 6.

³¹⁸ Cf. Graham, 2012, p. 1260, who warns that '*responsibility for the harm may be shifted away from the technology itself and toward the user's decisions vis-à-vis the innovation*'.

³¹⁹ Rapaczynski, 2016, p. 7.

³²⁰ Rapaczynski, 2016, p. 26.

³²¹ *Ibid.* Rapaczynski, 2016, p. 26.

³²² Which may not at all be easy, as Bonnefon, Shariff and Rahwan, 2016 illustrate. Their study indicated that consumers may not buy cars that do not protect them at all costs. This could mean '*regulating for utilitarian algorithms may paradoxically increase casualties by postponing the adoption of a safer technology*'.

claims that '*the computerization involved is also likely to enable manufacturers to maintain a detailed driving record of each self-driving automobile, registering (and perhaps storing in a general database) not just the amount of driving, but also its quality, external conditions, passenger behaviour, and a host of other potentially relevant factors*'.³²³ For the current purposes, the question must be to what extent competing developers and producers will have the proper incentive to react or intervene *vis-à-vis* their shared target group of customers. The relevance of the ability of producers to monitor is, that through public regulation or alike, specific duties to update software, monitor, control, *etcetera* could be imposed on them and on mere developers. The possibility to act upon the aforementioned information in terms of internalising it in the cost of autonomous vehicles however, would probably be better left to insurers, who do not benefit from any market share in the sales, but are faced with the cost of accidents and thus have a proper incentive to minimise that cost.

Aside from the debatable issue of deterrence, there are strong voices, particularly amongst US academics that propose limitations or forms of immunity for the industry.³²⁴ Fears are '*that the existing tort law may slow down technological progress and that a reasonable reform is necessary*',³²⁵ although US practice differs from the European position. The argument could be upheld that product liability would have a 'chilling effect', if extended to products that are not defective or to scientifically unknown risks.

In its basic form the argument holds that autonomous vehicles are socially desirable as they make the roads safer,³²⁶ and that if the industry contributes to that, it should not be confronted with more claims than before it introduced these advantages.

7.3.4 Regulatory challenges

Modifications of product liability law to include and improve the protection of traffic victims against possible risks of autonomous vehicles, would require regulatory intervention of the EU. What perhaps could be used as a point of departure here, is that every five years the Commission must present a report to the Council on the application of the PLD and, if necessary, it '*shall submit appropriate proposals*' to the directive. But admittedly, the last report, of 2011, does not demonstrate the desire to modify the PLD in respect of the development risks defence and a small number of other critical points that had been noted in a previous report. On the contrary, the conclusion highlights the importance of having a liability instrument that balances the interest of consumer protection and the producers' interests and expresses the belief '*that the Directive strikes this balance by reconciling the said interests*'.³²⁷

Moreover, canalisation of liability to producers could have adverse effects. To the extent that the financial risk of damage related to the testing, deployment and use of autonomous vehicles would be carried by producers, the costs of production will be affected. That could have 'chilling' effects on innovation, as aforementioned, in the EU in this field, which could be seen as disadvantageous to society as a whole. But it may also result in producers offsetting the cost of their risk of liability through liability insurance or through the price of their vehicles.³²⁸ The latter may have the

³²³ Rapaczynski, 2016, p. 31.

³²⁴ A.o. Colonna, 2012, Duffy and Hopkins, 2013 and Funkhouser, 2013. Further in favour of limitations to limit producers' liability in Dutch academics Schreuder, 2014.

³²⁵ Rapaczynski, 2016, p. 3.

³²⁶ Van Wees, 2015, section 3.4.

³²⁷ European Commission, 2011, p. 11.

³²⁸ Cf. Rapaczynski, 2016, p. 25.

advantage that the price of autonomous vehicles would reflect their actual price (*viz.* in terms of the accident risk they still present), yet this may also have negative consequences for the competitive edge of the EU.

7.3.5 Conclusion

The conclusion is that the PLD has room for improvements, but that other regulatory instruments must be considered and prioritised to achieve adequate consumer protection against scientifically unknown risks.

7.4 Model 2: Traffic liability reform

7.4.1 Basic model

The second solution model concerns the harmonisation or unification of national traffic liability rules, or, ultimately, the imposition of risk-based liability on owners or keepers of autonomous vehicles for the damage caused by their vehicle, regardless of fault.

7.4.2 Ways to change and harmonise the laws on traffic liability

In theory, this could be achieved in different ways. EU-intervention to move member states in the direction of a risk-based liability for motor vehicles could be done through regulatory intervention (*hard law*, which means binding law, for example in the form of a directive) or more gradually, by developing common legal ideas (*soft law*). But given the need for certainty of the law in this field,³²⁹ the latter option is more theoretical than it is of practical value. A regulatory intervention could involve exclusively autonomous vehicles by imposing on the member states the duty to introduce a risk-based liability for these vehicles only, or go as far as to introduce risk-based liability for *all* motor vehicles, both conventional and autonomous (and all of the automation variants in between).

An EU-wide risk-based liability would mean that the damage consequential to accidents with autonomous vehicles is canalised to the owner or the keeper of the vehicle. If the requirements of damage and the causal link between the injured party's damage and the motor vehicle (or: its automation) are left to the member states,³³⁰ this will give rise to serious national differences (*e.g.* with the French requirement that the motor vehicle was 'implicated' or involved in some way or another).³³¹ To find a middle-way between fault-based and risk-based systems of traffic liability for motor vehicles, it could be considered to make the available defences optional. This would create scope for the many national differences that exist throughout the EU: the defence of external cause is not available in several member states, whereas in others it is. Contributory negligence and assumption of risk of the injured party are most commonly used as defences. In light of such defences, recording equipment in the autonomous vehicle might provide electronic evidence of the accident.³³²

³²⁹ See *supra*, section 1.1.

³³⁰ As is common, also in the PLD and the *Francovich* state liability for EU-violations.

³³¹ See *supra*, section 3.2.

³³² Duffy and Hopkins, 2014, p. 122.

7.4.3 Pros and cons of imposing liability on the owner or operator

Substantively, there are indeed voices that propose to allocate the risk that autonomous vehicles may introduce to the owner and/or the operator of the vehicle.³³³ An argument that has been used in favour of this solution model is that it confronts the owner and operator with the financial risk of accidents that will still be present, either in the form of being held personally liable for damages or through carrying liability insurance. This will help them to '*properly value the expected cost of accidents*', and may even be taken into account in their purchasing decisions.³³⁴

A second argument is that this would offer equal protection to injured parties within the community. In Chapter 3, it was seen that a number of EU member states have risk-based liability for motor vehicles whereas other member states currently merely rely on fault-based liability. It was argued, that the risk-based systems generally give injured parties a much better legal position to receive compensation in cases involving autonomous vehicles than fault-based systems. By washing away these national differences through harmonisation or unification, European citizens would have a (more) similar position in the exercise of their right of free movement.

A third argument to harmonise traffic liability for motor vehicles is that this may '*help protect innovation and encourage manufacturers to push the adoption of this technology forward*'.³³⁵ The idea behind this is that the differences between the national regimes on traffic liability also have an effect on the role that is left to play for product liability (and the legal pressure on producers): injured parties are much more likely to prefer the risk-based liability for motor vehicles over product liability claims.³³⁶ In the member states that have a fault-based (thus less 'plaintiff friendly') traffic liability for motor vehicles, injured parties must, on the contrary, resort to product liability. The argument for harmonisation or unification is that such differences between national liability rules may hamper the conditions of competition. To the extent that the EU aims to 'level the playing field' for producers through the harmonisation of national laws, liability for motor vehicles must also be included in this.

All this is further supported by the presence of liability insurance for motor vehicles; the owner/keeper already carry conventional liability motor insurance, although it has also been suggested '*insurance specifically designed for autonomous cars could be created*'.³³⁷ The increased safety that autonomous vehicles are expected to bring, creates an argument to assume that the cost of liability insurance would be modest.³³⁸

However, there are also strong arguments against the imposition of strict liability on the owners or keepers of autonomous vehicles. For one, it could be argued that consumer confidence in autonomous vehicles will be undermined by imposing risk-based liability on consumers, in the sense that buying these vehicles would make them liable for risks that they cannot control in the same fashion as they are for conventional motor vehicles. The difference with conventional vehicles is that the higher the level of autonomy is that autonomous vehicles introduce, the lower the *level of control* of the owner and of the user will be. The more technically complicated the vehicle becomes, the less the owner and the user will be able to take safety measures and to prevent accidents himself. Also from a deterrence point of view, we could imagine that allocating

³³³ A.o. Duffy and Hopkins, 2014.

³³⁴ Rapaczynski, 2016. A similar point was critically discussed in the previous section.

³³⁵ Duffy and Hopkins, 2014, p. 119.

³³⁶ Recourse claims by the insurers of injured parties *vis-à-vis* the producer may also not be effectuated, both for the fact that the PLD offers limited protection and procedural reasons.

³³⁷ Duffy and Hopkins, 2014, p. 121.

³³⁸ See Duffy and Hopkins, 2014, p. 118.

the costs to the latter at all times, even in situations where the operator has no or little control, will not be efficient. On the other hand, the owner and operator have a role to play in terms of the vehicle's maintenance, performing updates of its software and instructing it to move in certain places under certain conditions, allowing or enabling others to use it, *etcetera*. If they know *ex ante* that breaching these duties will potentially make him liable, that might give them an (extra) incentive to conform to these duties. This will depend, *inter alia*, on the conditions of the insurance policy (*bonus-malus*).

7.4.4 Regulatory challenges

But the question, more than anything, is whether harmonising or even unifying the national regimes on traffic liability within the community is, currently or in the near future, politically achievable. To date there is a large number of EU regulatory acts in various policy areas related to motor vehicles. Some of these acts are concerned with matters of civil law, more particularly with compulsory third-party (liability) insurance. However, there has not yet been a substantive law on traffic liability at EU-level, although initiatives have been explored and taken in the past. Taking regulatory action at EU-level to that effect will change the national liability rules for motorised traffic. As seen in Chapter 3, several EU member states do not (yet) have a risk-based liability for motor vehicles in their national law system. In some of these countries, the existing fault-based liability is quite similar to risk-based liability because of the high standard of care applicable for car drivers, but for SAE-level 5 vehicles³³⁹ personal conduct of the user will be almost irrelevant. In countries with an exclusively fault-based traffic liability law, such as currently the UK and Malta, this solution model might thus implicate a serious reform of the law as it stands. This may not be politically achievable nor may it be considered feasible in these countries. Introducing one single, EU-wide liability for motor vehicles even seems inconceivable, given the high level of protection offered to victims of motorised traffic in some countries (Sweden, France, Belgium, and the Netherlands).

7.4.5 Conclusion

The national regimes of traffic liability are not easily harmonised, particularly in the immediate future. Traffic victims will continue to have an unequal legal position within the community. Indirectly, this also frustrates the level playing field for producers of autonomous vehicles: it can be expected that in member states with a high level of protection of traffic victims through substantive and procedural law, producers will face less claims than in member states in which traffic liability is exclusively fault-based.

7.5 Model 3: No-fault insurance

7.5.1 Basic model

In the third solution model, the entitlement to compensation is directly derived from the injured party's own insurance. Generally,³⁴⁰ this is different from *liability* insurance for motor vehicles. Liability insurance can in principle not be the injured party's own insurance, but stands for an

³³⁹ See *supra*, section 1.3 for an explanation of the SAE-levels.

³⁴⁰ With the exception of the Swedish no-fault model for motor traffic accidents, where a distinction is made between personal liability of the owner or driver of the motor vehicle and objective, no-fault liability of its liability insurer.

insurance taken out by the potential wrongdoer. No-fault insurance could either be taken out by the owner or operator of the autonomous vehicle or by its producer but it does not rely on any liability: the risk that persons suffer damage caused by the motor vehicle is *directly* insured. This last point may be more theoretical than of practical value, since injured parties within the EU have a direct action against motor liability insurers (and are also in other ways protected by law as if it were their own, direct insurance). But the fact that no-fault insurance does *not* depend on civil liability lies at the core of the no-fault model and *does* have meaning: it does not present an adversarial compensation scheme (as third-party liability insurance does); the mere risk that the motor vehicle was involved in an accident is the object of insurance. In this respect, it is more similar to private health insurance; with the difference being that the latter in principle covers the general risk of medical costs of persons as specified when the insurance was taken out. No-fault insurance will typically rest on the vehicle and the list of insured persons is not necessarily limited to concrete individuals known or specified *ex ante*. The insured risk under health insurance includes (in principle) all health-related damage regardless of its precise cause, whereas no-fault insurance may be limited to damage caused by traffic accidents.

7.5.2 Finance, assessment of damage, role left for civil liability

The no-fault model seeks to replace the adversarial model of civil liability law by a system of direct insurance: the policyholder, appointed by law, takes out an insurance package that covers the risk of damage of all persons inside the vehicle and possibly of other traffic members. These are all directly insured, regardless of any civil liability. The policyholder will most likely be the owner or possessor of the autonomous vehicle or its producer (and/or the producer of its software). If the producer would take out no-fault insurance for potential victims, then it could or could not still be for the owner, keeper or user to, separately, take out insurance for other risks related to the vehicle, for example for the risks of car theft, vandalism, fire, or extreme weather conditions, *etcetera*.

There are various degrees in which civil liability could be replaced or complemented by no-fault insurance and different technical ways in which to do it. It would go beyond the scope of the research that led to this report to discuss them all, but the main issues will highlighted.

Policyholder and premium payments. The most likely parties to fall under the statutory obligation to take out the no-fault insurance for autonomous vehicles would be the owner/operator, the producer (and/or the software producer) or both. As far as the premium payments are concerned, a variable part of the premiums could be considered, paid by individual owners/operators, and a fixed part (albeit with risk differentiation) to be paid by the industry. See below, section 7.5.3.

Mandatory? Different from the United States, in Europe, there are only few and specific forms of no-fault insurance but these mostly rely on a voluntary basis. For example, the (additional) insurance coverage that owners of motor vehicles can take out for the financial risk of damage of drivers or passengers. In the no-fault model for autonomous vehicles, as envisaged in this report, the motor insurance would be mandatory. Some examples of mandatory no-fault policies exist in the US;³⁴¹ these have been criticised in the past, mainly because they were associated with

³⁴¹ See Rapaczynski, 2016, nt. 63 who mentions that '[n]o-fault insurance laws are currently in force in twelve states', referring to <http://www.iii.org/issue-update/no-fault-auto-insurance>.

increased medical costs.³⁴² However, that appears to regard specifically the American market for health services. Further, the no-fault insurance, as envisaged here, would complement the injured party's entitlement to social security benefits.

Insured risk. No-fault insurance would typically cover both the risk of damage of the persons inside the motor vehicle, including its operator, and the risk of damage of non-motorised persons outside the autonomous vehicle. The insured risk could be limited to the specific risks generated by this new technology. But it could also be as wide as to cover all of the vehicle's software and hardware and other risks attached to the vehicle, such as non-functioning airbags and alike.

The coverage could further be narrowed down in various other ways. One way would be to require that the autonomous vehicle or its software was 'defective', but as was argued in section 7.3.2 above, this criterion creates many hurdles for successful claims as it requires significant expertise. It would appear to be most efficient, if the no-fault insurance would cover all risks produced by the CAV, including how the vehicle was used. Policy makers could investigate these (and perhaps other) options in close consultation with experts and representatives of insurers, the industry, traffic victim/consumer associations and possible other stake holders throughout the community to explore how workable and feasible these really are.

Role left for liability. Another issue to consider is what role civil liability should and could play in the no-fault model. One possibility is that all parties that would risk liability but for the insurance model, still carry that risk to the extent that the damage caused by them exceeds the maximum insured sum. Another possibility is that the no-fault insurance model leaves civil liability law untouched. In the latter case, the national differences with regard to traffic (and product) liability will remain. However, in the Swedish experience most victims will not pursue a claim for compensation based on civil liability as the no-fault claim requires less of them in terms of proof, *etcetera*. The no-fault insurer could be granted the right to seek reimbursement (repayment) *vis-à-vis* the liable party for the insurance payments paid to the injured party. To the extent that the damage is not covered by the no-fault insurance, the injured party could maintain his right to claim compensation from the liable party.

7.5.3 Pros & Cons of the no-fault insurance model

As was outlined in section, there is currently a legislative proposal pending in the UK to introduce an insurance model, albeit formally based on objective liability similar to Belgium, but with a wide no-fault scope of protection. There are several proponents that advocate a true no-fault compensation scheme, both in the US³⁴³ and in Europe, particularly in the Dutch legal doctrine and amongst certain Dutch insurers.³⁴⁴ One main advantage is that, compared to the liability system, the no-fault model promises to reduce the litigation rate and that payments can be made quicker than in the adversarial model that liability insurance encompasses.³⁴⁵ The injured party will claim payment from his own insurance company. The latter will possibly negotiate any reimbursement with the faulty party's insurance, but reimbursement claims of insurers typically do not lead to a lot of litigation.³⁴⁶

³⁴² Rand report, 2010.

³⁴³ Funkhouser, 2013.

³⁴⁴ Association of Insurers, 2015 and Van Wees, 2015.

³⁴⁵ Cf. Albert, 2008, p. 108 (referring to Scandinavian no-fault systems).

³⁴⁶ Albert, 2008, p. 317.

It must be considered to maintain a co-existing role for liability law, either through the injured party's free choice to opt for a liability claim instead of claiming payment from the no-fault insurance or through reimbursement claims from the no-fault insurer *vis-à-vis* the producer. This has important advantages. First, it is not yet clear what the near future holds, but different future scenarios for (connected and) autonomous vehicles are currently thought of.³⁴⁷ Most of these scenarios are based on the idea that autonomous vehicles will not, in the near future, be used in cities or city centres, but rather be used on public highways and alike. Having a dual compensation system would allow policymakers and insurers to gradually, with time, shift its internal focus from primarily resting on civil liability insurance (covering fault) to the insurance that rests on a no-fault basis, in accordance with the increased level of automation. Liability insurance would initially be the main insurance but with time, as the roads will be filled more and more with autonomous vehicles, and as their technology will be used all around, it would make place for no-fault insurance (*e.g.* for failures of technology), as the main mechanism for compensation.

But there are also (possible) disadvantages and (potentially) negative consequences. The first to mention is that if the victim's entitlement to insurance payments merely rests on the CAV's involvement and not on personal liability, possibly capped by a fixed level of payment and/or maximum insured sums, it may expose insurers to a potentially high risk of claims, compared to the cost of claims paid under liability law. The strength of this argument requires further research, but a few remarks can be made here:

- a. The cost of no-fault insurance cannot be based on the current accident rates for conventional motor vehicles given the fact that a serious reduction of accidents is expected of the use of autonomous vehicles in the long run.
- b. Secondly, the no-fault insurance for the European market would complement the social security entitlements of the insured victims. This means that it has a secondary role, similar to the limited role that liability law currently plays for accidents caused by conventional motor vehicles.
- c. The supposition that the amount of claims paid under no-fault insurance will be higher than the amount of claims paid under liability insurance, may be counterbalanced, to some extent, by reduced legal transaction costs under no-fault insurance.
- d. There are ways to narrow down the exact scope of the no-fault insurance.

The second, somewhat related disadvantage of the no-fault model could be that it might attract 'false positives' or even false insurance claims altogether. This argument gains strength from the idea that insurance claims and their assessment (to examine whether the requirements are met) will be less regulated, less demanding and less detailed than those for claims under the rules of civil liability law. At the same time this reveals an advantage of insurance over the legal model, *viz.* that it replaces judicial determination by an insurer's investigation of the claim. But so as to ensure equal treatment of insured parties and possible anomalies that private markets may induce, a system of public law regulation and control would be in place here. That means that even though litigation costs will be reduced, the costs of public regulation and enforcement must not be overlooked in this model.

The third point to consider is the lack of incentives that the insurance model would introduce, both for the industry and consumers. To date, there is no empirical proof that no-fault insurance

³⁴⁷ See *e.g.* the English reading report of the KiM, 2015.

reduces the level of care or has negative effects for the behaviour of insured parties.³⁴⁸ However, we would imagine that a differentiation of the insurance premiums for consumers could be possible, based on which premiums would consist of a fixed and a variable part. The fixed part would then, for example, be borne by the producer whereas the variable part would be borne by the consumer, *inter alia* based on the individual's annual mileage, his type of car and its safety devices and his age.

A fourth point concerns the modest level of compensation. Under no-fault policies, this will generally be lower than under civil liability law, for example in the sense that non pecuniary damage is not (or to a smaller extent) covered and that the payments for the monetary damage (medical costs, income loss, *etc.*) are modest, compared to the generous level of compensation that national liability laws tend to offer.³⁴⁹ The question for policymakers to consider here would be whether limited standardised insurance awards for relatively many injured parties and fast payment under no-fault insurance is to be preferred over full compensation in restricted cases that involve lengthy, costly liability litigation.

7.5.4 Regulatory challenges

Technically there may be various ways and grounds to introduce a no-fault insurance model for autonomous vehicles (or for all motor vehicles) within the community. But the regulatory challenge is, aside from the points to consider as were mentioned above, particularly, that this would force EU member states to impose on their citizens (or on producers) the duty to take out such insurance. Acceptance by the public at large and/or the industry is imperative. Further, no-fault insurance is only expected to properly function if the market for this insurance product would be sufficiently competitive. Whether and how this can be achieved within the community, may require further, more detailed research as to the technical possibilities and market conditions as well as a scientific inquiry and analysis as to the feasibility and the demand for such an insurance.

7.5.5 Conclusion

The new social and technological reality of connected and autonomous vehicles calls for the development of an EU-wide insurance remedy. Given the rapid developments in the market for autonomous vehicles, a special no-fault insurance, complementary to the injured party's entitlement to social security benefits, replacing civil liability claims for damages, may provide for a flexible and satisfactory solution. Both in terms of legal certainty, its potentially wide scope of protection and efficient claim handling, it appears to outweigh the adversarial options under the PLD and the national traffic liability laws. Further investigation would be necessary to develop the details of a comprehensive insurance in close cooperation with representatives of the private insurance market and industry. The ultimate choice for solutions must be left to politics. It involves the choice as to what is socially, economically, politically *etcetera* the 'right' balance to be struck between the interests of the parties involved – the industry, potential victims/consumers, distributors, insurers – and society at large.

³⁴⁸ See the Rand report, 2010, p. and the analysis of Van Dam, 2008, p. 341ff with a similar conclusion on p. 356.

³⁴⁹ Cf. Albert, 2008, p. 108 (referring to Scandinavian no-fault models).

8. Conclusions

8.1 General remarks

The introduction of autonomous vehicles on the internal market will inevitably give a new impetus to the policy for the protection of safety of their operators. But with all the advantages that new technologies of autonomous (and connected) vehicles bring, these can and will also be responsible for casualties on our roads. Although producers claim that some of the technology is still in a public *beta* phase, that itself does not indicate which party legally must bear the damage that results from such casualties.

8.2 Conclusions regarding the current regulatory framework

Below, our conclusions will be presented in numerical form in respect of the current legal framework for product liability, traffic liability and a few remaining rules on (and grounds for) liability.

8.2.1 Legal implications of the current product liability rules

1. The current legal framework for producers' liability has been harmonised at EU-level but this only concerns cases in which damage was caused by a particular 'defect' in the product. This means that traffic accidents in which autonomous vehicles are implicated are generally not covered to the extent that they are caused by the vehicle's wear and tear, bad repair, the way it was used (in the absence of information defects), the road situation, weather conditions or by other traffic members, *etcetera*.

2. Concretely, risk-based liability is imposed on automotive manufacturers and others, such as: developers that put their name or brand on the vehicle, component makers (producers of sensors, software, *etc.*), importers and distributors. They can avoid liability by arguing they have not put their product into circulation. And component makers, if traceable, will also be excused if they can argue that the defect in the vehicle concerns its design or the (lack of) information as provided by its producer. Car-dealers are not liable on this risk-basis if they inform the claimant within reasonable time of the identity of the producer or the person who supplied them with the vehicle.

3. 'The' industry includes several parties that will not incur this risk-based liability for the vehicle's defectiveness. These include mainly rental companies and other service providers, pure developers of the operating technology, testing companies and public bodies that allow and regulate autonomous vehicles to be on the road. These parties incur fault-based liability (and in some countries particular other grounds for risk-based liability, such as for dangerous movables or of motor vehicles).

4. The autonomous vehicle (or its component part) will be defective 'if it does not offer the safety that a person is reasonably entitled to expect'. This calls for a multifactor test,³⁵⁰ and is therefore not easily predicted or applied in concrete cases. Generally, the least of problems can be expected for manufacturing defects; consumers may not expect the vehicle to be 100 percent free of other defects. 'Information defects' may also consist of unclear warnings, warnings that give the user too little time to respond to them, not adequately repeating information, not displaying it on the dashboard and even credible advertisements that make it appear as if no caution of the user is needed any longer.

³⁵⁰ See *supra*, section 2.2.4.

5. The analysis pointed to three factors that make the requirement of a 'defect' challenging or difficult: this not only requires technological knowledge, but also there is normative (legal) uncertainty as to what the required safety standard is for the technology, other than that it must equal 'the perfect driver'. Defect free software is an illusion, but to what extent may users expect the software to be free of vulnerabilities? Thirdly, without interventions this requirement will be applied and interpreted differently by national courts and practises throughout the EU.

6. Autonomous vehicles will inevitably introduce new risks: risks unknown at the time of production. The so-called compliance defence and development risks defences lead to the effect that risks unforeseen by the legislator and risks that could not be detected by the industry, are carried by the injured party. That may not be perceived as reasonable, and might negatively impact consumers' confidence.

7. The PLD does not include compensation for damage to the defective product (the vehicle), nor for goods intended for professional use or property 'in the public domain' (e.g. lamp posts), nor for property damage below 500 Euro. The damage related to personal injuries or death may, at the discretion of the member states, be limited to maximum amounts. Any additional liability must rest on a fault basis as the PLD involves 'maximum' (total) harmonisation.

8. Procedurally, the PLD does not offer any specifications, which means that private individuals may await long and costly legal proceedings. The legal procedure may also be burdened by fault-elements of the PLD, for example if the producer raises a contributory negligence defence (see *infra*, at 10).

9. The six scenarios showed highly uncertain outcomes and were illustrative for the limited practical relevance of the PLD. The sensor missing a lane closure and software malfunctioning could be seen as defects for which the producer is liable, unless the latter shows that the defect must have appeared after the vehicle was put in circulation, through normal 'wear and tear' or other parties' interventions (vandalism, bad repair). It would not be realistic to expect producers to be able to produce material completely incapable of degradation. Nevertheless, in the latter cases there is no compensation under the PLD. The same can be said, at least to some extent, for hacking and network problems: if these were caused by 'bugs', vulnerabilities or other risks that could not be detected, the PLD offers no remedy. Finally, it will not offer full protection if the user neglects instructions, unless there was an information defect.

10. Lastly, it was argued that legal uncertainty is a barrier that must be taken seriously as it increases the legal cost and predictability of (cross-border) claim handling and it may be a barrier to innovation. Uncertainty can be found with regard to the legal standards to determine 'defectiveness', but also as to the standards of care that apply to users (in terms of a lack of experience using an autonomous vehicle) and to producers (in terms of the levels of safety and back-up systems that producers must adhere to in order to avoid liability).

8.2.2 Legal implications of the current traffic liability laws

1. The aforementioned gaps and constraints (*supra*, in section 8.2.1), will be an argument for a number of injured parties to primarily direct their claim for damages towards the party who was involved in the traffic accident, rather than to claim compensation from the manufacturer. It may come 'naturally' to sue the traffic member who was physically involved and be more practical too: the motor vehicles based in the EU and EEA are covered by mandatory liability insurance,

for minimum insurance sums, and the injured party is protected by various 'claimant friendly' rules.³⁵¹

2. Yet, the substantive rules on traffic liability have *not* been harmonised and vary strongly between very protective risk-based liability for motor vehicles and fault-based liability. This means that the insured risk of civil liability will be different around the EU. The claimant's preference will, ultimately, depend on the member state's rules on traffic liability (and other sources of compensation, such as voluntary private insurance for the driver and/or passengers).

3. The requirement of personal fault will present more difficulties as vehicles become more autonomous and connected and the objective possibility that human behaviour contributes to the accident will generally decrease. Consequently, fault liability of the operator (driver) may play a much less significant role than fault liability for conventional drivers.

4. Fault liability will mostly remain relevant for autonomous vehicles at SAE-levels 1 to 4.³⁵² At levels 5 and 6, there *can* still be fault liability of the operator of the vehicle, but this will be rather exceptional.³⁵³ This is not only relevant for true fault-based systems, as currently in the UK and Malta. In most EU member states, the driver only incurs *personal* liability on a fault-basis if he causes damage.

5. Fault liability raises several legal issues and uncertainties. A crucial question is to what extent operators of autonomous vehicles may rely on their hardware and software technology if national liability rules are to be applied. And: how strict must the fault requirement be applied to the use of autonomous vehicles? For example, in many countries case-law expects the driver of a motor vehicle to be experienced, but this seems out of place if operators, on a large scale, are not familiar with the new technology and streams of information. The current duties of care will hardly be relevant; new duties of care must be created by case-law, which means there will be a considerable period of legal uncertainty, resulting in (extra) transaction costs and a lack of adequate victim protection.

6. One particular gap must be considered for countries that have a risk-based liability for motor vehicles. These generally (with the exception of Sweden and the UK's 'Vehicle Technology and Aviation Bill', currently pending) exclude or limit the recovery of the driver-victim or the owner of the motor vehicle. Motorised victims are thus less protected than other traffic members, for the reason that using a motor vehicle creates danger. This reason can no longer be maintained if the accidents rate is seriously decreased by their vehicle and if the owner and user of autonomous vehicles are 'risk minimisers'.

7. From the comparative overview, there appears to be another possible challenge for countries with risk-based motor liability. This relates to the fact that their rules vary greatly as to the requirements for risk-based liability, the legal defences, the scope of protection, the recoverable heads of damage, the assessment of damage and the level of compensation. The implications of this may be visible if the cost of liability is off-set in the price of autonomous vehicles or in other

³⁵¹ See *supra*, section 3.1.

³⁵² See *supra*, section 1.3 for an explanation of the SAE-levels.

³⁵³ *Supra*, section 3.2.1 (with examples).

ways passed onto the consumer. Currently, legal diversity exists for conventional motor vehicles and motor insurance, but it has less impact because of the underlying fault-based rules.

8. Different from the principle of *personal* liability, upheld in other countries within the EU, the Swedish Traffic Damage Act equally protects motorised and non-motorised victims. Both have a direct right to compensation against the insurer: the insurer's liability, not the insured's personal (human) liability is the basis of the claim for compensation. This is based on the social believe that the parties involved are not each other's adversary and that the driver is as much in need of insurance protection as anyone else injured by motor traffic. The latter is shared by the UK's proposed Vehicle Technology and Aviation Bill. Both in Sweden and in this proposed bill (but different from other, liability-based systems in the rest of the EU), drivers are even entitled to compensation if theirs was the only motor vehicle involved in the accident.

9. The six scenarios illustrate the significant differences that exist between the national regimes of traffic liability in the EU. It appeared that the fault-based systems would not offer compensation in half of these hypotheticals, possible exceptions were scenario 4, as it concerns the user's fault and scenarios 3 and 5, involving a network interruption (then the claim is directed against the telecom provider) and hacking (claim against the hacker). The current rules on risk-based liability that exist in a number of member states, protect non-motorised victims and passengers.³⁵⁴ The owner, possessor or keeper is generally liable for any technical defects of the vehicle or errors of the person using it. But in most of these systems (with the exception of Sweden, France and Belgium) he may raise the defence of external cause in scenarios 3 and 5 (and avoid liability). The driver/operator who sustains personal injuries or property damage may carry voluntary insurance, but is generally (except in Sweden and, more limited, in France) not protected. Property damage is in most national regimes of strict liability for motor vehicles excluded or treated less favourable than personal injuries.

10. Lastly, central in the national systems of traffic liability are the concepts of 'driver' and, at least in some systems, 'owner' (or 'possessor' or 'keeper'). Both of these concepts call for close reconsideration once autonomous vehicles will be launched or more integrated in society, dependent on how these vehicles will be owned and shared and which parties are in control of and benefiting from these vehicles.

8.2.3 Legal implications of the current fault liability rules; hacking and privacy issues

Fault liability will remain necessary with the coming of autonomous vehicles; this can easily be underrated. In (at least) five ways fault liability will remain highly relevant.

1. Firstly, to give legal meaning to the operator's ('driver's') availability, monitoring and alertness to signals that he should regain control over his vehicle if needed and not use devices that could be hacked or could disturb the vehicle's connectivity. Further, fault liability could protect

³⁵⁴ In the Netherlands injured passengers are, strictly spoken, excluded from risk-based liability that is imposed on the owner/keeper of a motor vehicle. But per 1 January 2017 the Association of Insurers has declared that liability motor insurers shall compensate injured passengers of the insured motor vehicle on a no-fault basis.

potential victims if the operator uses the vehicle in circumstances in which one could foresee that it might cause damage, such as extreme weather conditions or driving in crowded places.

2. Secondly, this can also be said for the owner's responsibility (if there will be) to update the vehicle's control system and to take care of the maintenance of the vehicle, to prevent its use under the special circumstances as aforementioned, or to prevent that the vehicle becomes more vulnerable to hacking.

3. Thirdly, fault liability may be used to claim damages from local authorities or other policymakers and/or supervisory bodies, for example for the damage that is caused while autonomous vehicles are tested on public roads or operated by a control room. Or for traffic signals that are ill-fitted for connected vehicles.

4. Fourthly, it can be used against producers (e.g. for property damage below the threshold of 500 Euro) and not-producers outside the scope of the PLD (e.g. testers and mere developers).

5. Five, fault liability will be used for other parties that may be more remotely involved, such as telecom network providers, but also hackers, and this is not harmonised in the EU. Under the national liability rules in all of the member states, a hacker may be held liable for the damage caused after hacking into autonomous vehicles. But hackers may be difficult to identify and locate. Liability may also befall 'peripheral' parties, such as the producer (for autonomous vehicles' software that is defective because it contains bugs that could have been avoided, and which enabled the hacking thereof) and the owner or user of the vehicle.

6. Producers risk liability under the DPD and also the GRDP, that will likely gain force in 2018, by then replacing the former directive, only if they are 'controllers' or 'processors' of personal data: in both qualities, producers can be held liable for material and immaterial damage resulting from their infringement. Illustrative are cases in which a controller or processor fails to take appropriate technical and organisational measures to protect the data from being hacked into; or fails to notify the supervisory authority and/or people whose data have been revealed by a hack.

7. The question whether or not *drivers/operators (users)* of autonomous vehicles have the obligation to install software (security) updates, and whether they can be held liable for the damage caused by a hack when they did not comply with this obligation, is governed by national law. It was argued that hacking is likely to be covered by risk-based liability for motor vehicle, but that fault-based liability demands that the operator has personally breached his duty of care by not taking measures to prevent hacking.

8. Autonomous vehicles equipped with event data recorders, and/or communicating through tracing technology may relieve the parties involved in the liability process. Logged vehicle and driving behaviour data could be used to determine the exact cause of accidents, who was at fault, and who may be held responsible. Moreover, V2X communication could even prevent accidents from happening by sharing real-time information on the whereabouts of other autonomous vehicles on the roads. When TT-data are personal data in the sense of European regulatory framework on data protection, these must be stored and processed in conformity with current (strict) rules from *inter alia* the DPD. Even stricter rules will be applicable in the EU after the GDPR has come into force. Most technical data (such as motor behaviour, fuel use- and actuator data) fall outside the scope of the privacy rules, while other forms qualify as personal data (describing the behaviour of the driver). Most types of user introduced data will be personal data in the sense of the DPD and GDPR. Location data, indicating whereabouts of the vehicle and its passengers,

can be personal data. These do not directly represent a natural person. However, it can be construed that when data from different sources are combined, these can identify the owner of a vehicle and where he lives and works, which are personal data. The same applies to location data of a rental, which reveal the identity of the renter if combined with the rental company's customer administration.

9. The DPD and the GDPR provide a non-limitative indication of appropriate protection measures that controllers must take, but they also leave room for self-regulation in order to further fill in *inter alia* which protection measures are appropriate. Considering the probable length of CAV data processing chains and the number of actors involved, all individual controllers and processors should be stimulated to actively participate in the drafting process codes of conduct and certification mechanisms that comply with the GDPR. The current data protection principles endorsed by European car producers yet available need to be made more concretely, but may provide a good starting point.

10. If persons who suffer damage from an infringement of the GDPR claim damages, liability rests primarily with the controller. The processor can only be held liable for infringements that are specifically directed to processors, or when they have acted '*outside or contrary to lawful instructions of the controller*'. A regulatory answer may be sought to the question whether or not a producer of CAV TT could be held liable if a data breach occurs due to insufficient security measures taken by him, while he is *not* a controller or a processor. The PLD may be invoked, but its limited scope of protection may not be satisfactory.

8.3 Conclusions regarding European added value

1. The European Added Value of regulatory action at EU-level was assessed through a multi-factor approach, as advocated by the EC and common practice in other assessment reports. This approach is consistent with the aim to find the balance between technological innovation and respecting and protecting safety of traffic victims.

2. The added value in the current context results from three factors. Firstly, regulatory action at EU-level seems imperative to promote legal certainty within the Community, which in its turn could reduce transaction costs related to dealing with different national liability laws for damage caused with autonomous vehicles. This will support the competitive gains of the EU in autonomous vehicle technology. Secondly, EU-action is imperative to further increase the effectiveness of consumer protection, given the serious legal gaps and challenges that product liability law will prove to have after the roll-out of autonomous vehicles. As the PLD is community law and entails 'total harmonisation', it cannot be left to the discretion of the member states to solve these legal issues. Regulatory action to alter national traffic liability laws and particularly to include the victim-driver in the scope of protection, cannot be left to the member states as some have yet announced that their national laws will suffice, whereas the UK is considering a bill that will offer automatic compensation to the victim-driver. That would mean that the driver's legal position will be entirely different under some law systems than under others. Related to this is, thirdly, the added value argument that regulatory action at EU-level is necessary to create a level playing field for automotive producers and member states to facilitate the distribution of this means of transport as one of the driving forces of the internal market.

3. Legislative interventions from the EU in order to harmonise private law rules come in the shape of directives. In fields of community intervention where a uniform implementation of the chosen

policy is necessary, regulations are in place. Which instrument to opt for thus depends on the legal solution chosen.

8.4 Conclusions regarding the legal solution models

8.4.1 Three legal solution models

Three models must be considered in which different solutions can be found: the model that stands for modifications or revisions in product liability law (product liability reform), the model that stands for modifications in the national traffic liability laws (traffic liability reform), and the model that presents insurance solutions (no-fault insurance). These are each obvious directions in which various solutions can be found, that can also be combined.

8.4.2 Solution model 1: product liability reform

1. The first point here, would be to submit a proposal to include the software used in autonomous vehicles or better yet, software as such, in the concept of 'product' under the PLD.
2. It can be considered to also replace the 'reasonable expectations'-test that constitutes 'defectiveness' by a stricter criterion (or to abandon this test), at least for design-defects.
3. An improvement from the consumer's perspective would be to include in the protective scope of the PLD technological vulnerabilities, software bugs, design risks, and alike, not scientifically known or detectable at the time of production.
4. This would be a drastic change of the concept of defectiveness (indirectly also affecting the reasonable expectations-test) and implicates abandoning the current development risks defence (sub *e*). Embedding risks scientifically unknown or identifiable means to let go of a fault element in the PLD, that expects no more of producers than to comply with the state-of-the-art.
5. However, even if these excluded risks *would* be brought under the producer's liability, the practical relevance of the PLD will be limited. The reason for that is that product liability will always, to some degree 'compete' with the applicable national liability rules for motor vehicles, if these are risk-based.
6. This divergence of national laws within the EU may frustrate the 'level playing field' of producers in the market for autonomous vehicles: in some countries their liability risk will be high (*viz.* in countries in which traffic liability for motor vehicles relies solely on fault) and in other countries producers may hardly face claims due to the strict liability for motor vehicles imposed on the owner or keeper of the vehicle (*viz.* in countries with risk-based liability for motor vehicles that is close to a 'guarantee' to receive compensation, such as France, Belgium and Sweden).
7. It follows, that if the regulator wishes to canalise liability to the industry (the producer), he must consider both substantive and procedural improvements within the regulatory framework for product liability, that make the claimant's legal position closer to the benefits that conventional traffic victims are given in the aforementioned systems of strict liability for motor vehicles and liability motor insurance directives.

8. However, in its last evaluation report concerning the PLD, in 2011, the European Commission did not demonstrate the desire to modify the Directive in respect of the development risks defence.

9. Moreover, canalisation of liability to producers could have adverse effects, such as 'chilling' effects on innovation and producers offsetting the cost of their risk of liability through liability insurance or through the price of their vehicles, with negative consequences for the competitive edge of the EU.

10. The conclusion must be that the current product liability law has room for improvements, but from a consumer protection perspective other compensation mechanisms must be considered and prioritised.

8.4.3 Solution model 2: traffic liability reform

1. The second solution model concerns the harmonisation or unification of national traffic liability rules, or, ultimately, the imposition of risk-based liability on owners or keepers of autonomous vehicles for damage caused by their vehicle, regardless of fault.

2. Given the much expressed need for clarity of the law, soft law instruments seem more theoretically relevant than they are of practical value.

3. Regulatory intervention could involve exclusively autonomous vehicles by imposing on the member states the duty to introduce a risk-based liability for these vehicles only, or go as far as to introduce risk-based liability for *all* motor vehicles, both conventional and autonomous (and all of the automation variants in between).

4. One might consider an EU wide risk-based liability that would canalise the damage caused by autonomous vehicles to the owner and keeper of the vehicle. Causation and the available defences could partly be made optional, to create scope for the many national differences that currently exist throughout the EU.

5. The creation of an EU risk-based liability for motor vehicles would provide more of a level playing field for producers, preventing victims in member states with less favourable traffic liability rules to resort to product liability.

6. However, it could be argued that consumer confidence in autonomous vehicles will be undermined by imposing risk-based liability on consumers, particularly because, dependent on the exact level of autonomy, they may be much less in control of the vehicle than they are in conventional motor vehicles.

7. But the question, more than anything, is whether harmonising or even unifying the national regimes on traffic liability within the community is, currently or in the near future, politically achievable.

8. For SAE-level 5 vehicles,³⁵⁵ personal conduct of the user will be almost irrelevant. In countries with a fault-based traffic liability law, such as currently in the UK and in Malta, this solution

³⁵⁵ See para. 1.3 for the SAE-levels.

model might thus implicate a serious reform of the law as it stands. This may not be politically achievable nor may it be considered feasible in these countries.

9. 'Full-fledged' harmonisation in the sense of introducing one single, EU-wide liability for motor vehicles in fact seems inconceivable, given the high level of protection offered to victims of motorised traffic in some countries (Sweden, France, Belgium, and the Netherlands).

10. Our conclusion is that the current national regimes of traffic liability are not likely to be harmonised, whereas harmonising them would promote an equal legal position of traffic victims within the community and could provide a level playing field for producers (who, in member states that impose risk-based liability on car owners, will be faced with less claims than in member states in which traffic liability is exclusively fault-based).

8.4.4 Solution model 3: no-fault insurance

It was indicated that the most plausible solution would be to introduce no-fault insurance. The conclusions in that regard were as follows.

1. No-fault insurance could be taken out by the owner or operator of the autonomous vehicle or by its producer, but it is characterised by the fact that it does not rely on any liability.

2. Its value is not so much that the risk that persons suffer damage caused by the motor vehicle is *directly* insured, as it is that it does not present an adversarial compensation scheme (as third-party liability insurance does).

3. The statutory obligation to take out the no-fault insurance for autonomous vehicles would befall the owner/operator, the producer (and/or the software producer) or both. As far as the premium payments are concerned, a variable part of the premiums could be paid by individual owners/operators, *inter alia* based on the individual's annual mileage, his type of car and age, and a fixed part (albeit with risk differentiation) to be paid by the industry.

4. This could take the form of a compulsory private insurance, for the part of the damage that is not covered by social security, thus complementing the injured party's entitlement to social security benefits.

5. If the producer would take out no-fault insurance for potential victims, then it might still be for the owner, keeper or user to, separately, take out insurance for other risks related to the vehicle, such as car theft, vandalism and fire.

6. Although the insured risk could be limited to the specific risks generated by this new technology, we would suspect it would be most efficient if the no-fault insurance would cover all risks produced by the car, including how it was used.

7. Policy makers could investigate how workable and feasible these options are, in close consultation with experts and representatives of insurers, the industry, consumer associations and other stake holders throughout the community.

8. A complementing role of liability law could be maintained, either through the injured party's choice to opt for a liability claim instead of claiming payment from the no-fault insurance and/or

through reimbursement claims from the no-fault insurer. The argument against a litigation mode in terms of its extra transaction cost seems limited: injured parties will use direct insurance instead of pursuing a liability claim; reimbursement claims of their insurers are limited and settled out-of-court. Keeping a residual role for liability law has the practical advantage that it would facilitate a more gradual shift from liability claims towards no-fault insurance throughout time, as the market transforms from conventional and semi-autonomous motor vehicles at present towards, ultimately, fully autonomous vehicles.

9. No-fault insurance replaces judicial determination by an insurer's investigation of the claim. It can only function well if the insurance market for this product is sufficiently competitive. To ensure equal treatment of insured parties and possible anomalies that private markets may induce, a system of public law regulation and control would be in place here. That also means that even though litigation costs will be reduced, the costs of public regulation and enforcement must possibly not be overlooked in this model.

10. It must be concluded that, given the rapid developments in the market for autonomous vehicles, a special no-fault insurance, complementary to the injured party's entitlement to social security benefits, may provide for a flexible, satisfactory solution. However, the conditions within the insurance market and public regulation (as aforementioned) as well as acceptance by the public at large and/or the industry are imperative and require further investigation.

8.4.5 Over-all conclusions

Over-all, it is highly recommended that the details of a no-fault insurance for autonomous vehicles are investigated, in close cooperation with representatives of the private insurance market and industry. This would rest on a statutory obligation and would see to the part of the damage not covered by the injured party's entitlement to domestic social security benefits. A directive that imposes on member states the duty to introduce a no-fault insurance to cover the damage caused by autonomous vehicles would probably be most fit to achieve the goals as aforementioned (and not exceed them).

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ANNEX II

Socio-economic analysis of the EU Common approach on liability rules and insurance related to connected and autonomous vehicles

**Research paper
by RAND Europe**

Abstract

This study provides an evidence-based assessment of the possible added value of developments of EU rules on liability and insurance related to the testing, deployment and use of connected and autonomous vehicles in the European Union. The research focuses on the liability and social and economic impacts of fully autonomous or self-driving vehicles. It also focuses on the Product Liability Directive. We adopt a mixed method approach for assessment. First, we undertake qualitative interviews with key stakeholders (including car manufacturers, insurers, those from connected industries, those who provide services or supervise compliance, as well as consumer agencies) to explore the appropriateness of the existing liability regulation as well as amendments to European liability law on the deployment and take-up of connected and autonomous vehicles. Second, we conduct quantitative (economic) analysis of the possible added value of these legislative changes on deployment. We find that while product liability legislation is seen to be of critical importance for producers in developing and bringing new technologies to market, pre-emptive legislation of the Product Liability Directive (PLD) to account for connected and autonomous vehicles is not required at this time.

AUTHOR

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Abbreviations

ACEA	European Automobile Manufacturers Association
CBA	Cost-benefit analysis
DfT	Department for Transport
EC	European Commission
EU	European Union
FAVs	Fully Autonomous Vehicles
GHG	Greenhouse gas
MID	Motor Insurance Directive
MS	Member State(s)
NHTSA	US National Highway Traffic Safety Administration
OECD	Organisation for Economic Co-operation and Development
PLD	Product Liability Directive
SAE	Society of Automotive Engineers
VKT	Vehicle Kilometres Travelled
VOT	Value of Time

Executive summary

The objective of this research paper is to provide an evidence-based assessment of the possible added value of development of EU rules on liability and insurance related to the testing, deployment and use of connected and autonomous vehicles in the European Union.

The research focuses on the liability and social and economic impacts of fully autonomous or self-driving vehicles (referred to as FAVs).

It also focuses on the Product Liability Directive (PLD). The PLD Directive, as interpreted by the Court of Justice of the European Union, sets rules for the liability of producers and rights of consumers. This framework is based on a moderately strict liability regime, and is applicable to car manufacturers.

We adopt a mixed method approach for the analysis, using both qualitative and quantitative approaches. First we undertake qualitative interviews with key stakeholders (including car manufacturers, insurers, those from connected industries, those who provide services or supervise compliance, as well as consumer agencies) to explore how the appropriateness of existing liability regulation as well as amendments to European liability law on the deployment and take-up of connected and autonomous vehicles might be influenced by amendments to European liability laws. Second we conduct quantitative (economic) analysis of the possible added value of these legislative changes on deployment.

We find that while product liability legislation is seen to be of critical importance for producers when considering whether to bring new technologies to market, pre-emptive legislation of the Product Liability Directive (PLD) to encourage deployment of connected and autonomous vehicles is not required at this time.

While there is a preference for harmonisation, or minimisation of variation, of national liability laws between manufacturers, insurers and those in connected industries, it was felt that such harmonisation would not have a manifest impact on the roll-out of connected and autonomous vehicles, given the substantial market pressure to roll out these vehicles. Moreover, manufacturers will be planning to roll out FAVS in a number of countries, inside and outside the EU, with differing liability laws.

Moreover, the quantitative analysis indicates that even if amendments to the PLD were able to bring forward or speed up roll-out of FAVs, given the size of likely impacts, the social and economic benefits to society are relatively small (noting that the quantitative analysis is sensitive to assumptions regarding traveller productivity and sharing of vehicles, with higher levels of productivity and sharing leading to higher societal benefits). It is noteworthy that the quantitative analysis uses quite optimistic values for traveller productivity and even with higher levels of vehicle sharing the societal benefits are still relatively small.

Further, the qualitative research with stakeholders found that most stakeholders felt that the existing legislation was appropriate for connected and autonomous vehicles, particularly if existing legislation and international treaties were interpreted in an open-minded way. Many felt that it was simply too early in the innovation process and that it was important to learn what may happen before introducing new legislation that could be detrimental to the roll-out and use of these vehicles. There was also a view that it was not feasible to foresee and legislate for every

possible outcome, and that policymakers should not be afraid of the judicial process to determine benchmarks.

Thus, we recommend no amendment to the PLD at this time.

However, there was near-unanimous agreement on the need for the PLD to work alongside other Member States' regimes to ensure timely compensation for road accident victims.

Moreover, there are areas that could require legislation, particularly with regard to the use of connected and autonomous vehicles, for example whether young children could travel independently in these vehicles, as well as clarification of interpretation of specific issues, for example whether the concept of 'a driver' in the Vienna Convention could encompass autonomous driving, or whether individuals could be charged with criminal negligence if in an accident in an autonomous vehicle they were not driving.

There will also be new risks, such as cyberattacks, hacking, etc., which will need to be taken into account in assessment of liability.

During the research, stakeholders identified a number of areas where intervention would be useful to improve the effectiveness of connected and fully autonomous vehicles. The first of these, mentioned by nearly all interviewees, was in terms of access to accident and driving data to enable accurate and timely liability judgements, including such areas as data standards, sharing, and storage, as well as in terms of data privacy and protection. Such access may be required by manufacturers, insurers, public authorities and travellers themselves. The second was in the area of setting of vehicle standards more generally.

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Transport for London

Uber

Volvo Group

Chapter 1 Introduction

| -Background

The EU has a population of 501 million, who own some 252 million passenger cars. According to the European Automobile Manufacturers Association (ACEA), there are 2.2 million people directly employed in automotive manufacturing in Europe and a further 5.1 million jobs depend on the related manufacturing, sales, maintenance and services sectors.³⁵⁶ In addition, there were 2.3 million people working in high-tech manufacturing, and, for the EU28, the value of high-tech exports represented 15.6 % of all exports in 2014.³⁵⁷ According to some studies, 30 to 40 per cent of the value in the automotive supply chain will pass through digital platforms in the near future (EC, 2016). With the EU28 accounting for 21 % of global passenger car production and almost 75 % of inland freight transported by road in Europe, the deployment of connected and autonomous vehicles is likely to have a significant impact on the European economy. The deployment of connected and autonomous vehicles is also expected to save lives as over 90 % of road accidents are a result of human error. A recent study has estimated that the overall future economic and social benefits of connected and autonomous vehicles in the UK (only) could be in the region of EUR 67 billion per year by 2030, generating 320,000 new jobs and saving over 2,500 lives.³⁵⁸

Motor vehicles and road transport are already fairly heavily regulated, with the European Union alone responsible for 1,776 regulatory acts related to 'motor vehicles'. In terms of civil liability and insurance, the major area of interest for the Committee of Legal Affairs and this study, there are two main pieces of EU legislation covering liability rules relating to motor vehicles. The first of these, Directive 2009/103/EC (Motor Insurance Directive), is an EU framework establishing third-party liability insurance cover for victims of road traffic accidents. This works alongside national traffic accident rules on liability and the calculation of damages for victims, which vary across Member States. The second, Product Liability Directive (85/374/EEC), is based on the highly harmonised EU framework on liability of a producer of a defective product. Under this Directive, the producer of a defective product must compensate personal injuries and damage to private property irrespective of the negligence of an individual.

While some regulatory frameworks are being developed to cover road testing of autonomous vehicles, there is little co-ordination between jurisdictions, and no evidence of anticipatory legislative regimes for large-scale deployment.³⁵⁹ For example, the UK Department for Transport (DfT) has drawn up an action plan that includes a review of the existing set-up as regards liability, vehicle use and safety that will also be informed by real-world testing.³⁶⁰ It has also published a Code of Practice for the testing of automated vehicle technologies. The European Commission's GEAR discussion paper reports that it is now time to gain experience of real traffic conditions with large-scale testing on EU roads and that, although currently no legal obstacles are foreseen, for higher levels of automation, changes in EU legislation concerning the liability framework may be needed.³⁶¹ There is concern that this lack of co-ordination could lead to unnecessary barriers

³⁵⁶ University of Buckingham Business School. 2014. The used car market report 2014. A report for BCA.

³⁵⁷ Eurostat (http://ec.europa.eu/eurostat/statistics-explained/index.php/High-tech_statistics)

³⁵⁸ KPMG. 2015. Connected and Autonomous Vehicles – the UK Economic Opportunity.

³⁵⁹ OECD. 2015. Automated and Autonomous Driving: Regulation under uncertainty.

³⁶⁰ DfT. 2015. The Pathway to Driverless Cars: Summary report and action plan.

³⁶¹ European Commission. 2016. GEAR 2030 Discussion Paper, Roadmap on Highly Automated Vehicles.

for the development and deployment of new technical solutions. Further, there is concern that liability legislation may be a significant barrier for manufacturers and designers of autonomous vehicles.³⁶²

1. Definitions and context

According to an Organisation for Economic Co-operation and Development (OECD) study,³⁶³ automated driving encompasses a wide range of technologies and infrastructures, capabilities and contexts, use cases and business cases, and products and services. Many cars sold today are already fitted with some degree of automation technology, while the deployment of fully autonomous vehicles will depend on continued development of technical innovations and policy choices. The OECD and KPMG (2015) reports both use the Society of Automotive Engineers' (SAE) definition of automation, with six levels of automation (L0-L5), L5 being fully automated with no driver required. Anderson et al (2014)³⁶⁴ use a similar five-point classification scale from the US National Highway Traffic Safety Administration (NHTSA); in this case the car can drive itself without a human driver at Level 4. None of these scales makes a distinction between connected and autonomous vehicles, because whether a vehicle is connected or not is only roughly correlated with its level of automation.

An EPRS (2016)³⁶⁵ briefing document on automated vehicles distinguishes between connected vehicles on the one hand – for which communication between vehicles and infrastructure is made via the internet – and cooperative Intelligent Transport Systems (ITS) on the other – which enable direct communication between vehicles and infrastructure. Hence, while a vehicle may be capable of driving without a human driver (i.e. travel autonomously), the method by which this is enabled, i.e. whether it is not at all connected, or connected to other vehicles and/or infrastructure, may have quite different implications for liability. Vehicles that connect with the infrastructure will involve different actors than those that sense the environment around them; they may also have different safety characteristics.

In this study we focus on the liability and social and economic impacts of SAE L5 fully autonomous vehicles or self-driving vehicles (referred to as FAVs throughout this document).³⁶⁶ We do not distinguish between the different options for how the automation is enabled, insofar as the social or economic benefits; although we will examine the role of the suppliers of subsidiary or component parts that enable the automation in the consideration of liability.

³⁶² DfT, 2015. OECD, 2015.

³⁶³ OECD, 2015.

³⁶⁴ Anderson, James M., Nidhi Kalra, Karlyn D. Stanley, Paul Sorensen, Constantine Samaras & Oluwatobi A. Oluwatola. 2016. *Autonomous Vehicle Technology: A Guide for Policymakers*. Santa Monica, Calif.: RAND Corporation. RR-443-2.

³⁶⁵ European Parliament. 2016. Briefing. Automated vehicles in the EU.

³⁶⁶ This paper therefore does not deal with 'semi-autonomous vehicles' or with issues arising specifically out of the testing phase for the technology. It is assumed that although some Member States consider that they will face legal difficulties in testing FAVs, for example arising out of the Vienna Convention on Road Traffic of 1968 (see next section), since five Member States are not bound by that Convention, testing of FAVs will be permitted within the EU and the liability issues that arise are matters solely for those Member States.

Table 1: SAE and NHTSA levels of automation

SAE level	Definition	NHTSA level	Definition
Zero – no automation	The full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems.	Zero – no automation	The driver is 'in complete and sole control of the primary vehicle controls (brake, steering, throttle and motive power) at all times and is solely responsible for monitoring the roadway and for safe operation of all vehicle controls'.
One – driver assistance	The driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving tasks.	One – function-specific	The vehicle is able to 'assist or augment the driver in operating one of the primary controls – either steering or braking/throttle controls (but not both)'.
Two – partial automation	The driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task.	Two – combined function	The vehicle is able to coordinate two or more 'primary functions' simultaneously, but a driver remains in overall control.
Three – conditional automation	The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene.	Three – limited self-driving	The vehicle is able to control all 'safety-critical functions under certain traffic or environmental conditions', but would need to relinquish control to a driver on occasion to deal with more complex driving scenarios.
Four – high automation	The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene.	Four – full self-driving	'[V]ehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip'. The vehicle may be occupied or unoccupied, and is solely responsible for safe operation.
Five – full automation	The full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions.		

Sources: based on OECD (2015), adapted from SAE Standard J3016 (SAE, 2014) and NHTSA, 2013, 4–5.

2. Key liability and insurance issues

The large-scale adoption of autonomous vehicles would in practice transform the basis of liability for road traffic accidents. At present, liability focuses on the individual driver or owner of the vehicle.³⁶⁷ The applicable rule varies from Member State to Member State. In some, the traditional

³⁶⁷ Note that the current state of the law on these topics is dealt with in extensive detail in the following paper, commissioned at the same time as this study:

E.F.D. Engelhard and R.W. de Bruin, EU Common Approach on the liability rules and insurance related to Connected and Autonomous Vehicles: Legal Analysis, Annex I in Evas, T., *European Added Value Assessment: EU Common Approach on the Liability Rules and Insurance related to Connected and Autonomous Vehicles*, European Parliament Research Service, Brussels, 2016. We provide only a summary here.

rule that there is no liability without fault still applies (e.g. UK, Ireland and Cyprus). In many other Member States, fault has been replaced by strict liability,³⁶⁸ but with significant variations in its application (for example, in some Member States fault on the part of the victim is irrelevant whereas in others it results in a reduction in the compensation awarded). In others still, although the underlying rule might be strict liability, in practice losses arising out of injuries from road accidents are dealt with by the social security system. EU law does not require any approximation of these regimes, in the sense that the substance of the law is changed, but it does require Member States to establish compulsory insurance against whatever form of liability is locally in force. In addition, the Rome II regulation governs cross-border accidents, guiding the choice of legal regime to apply when accidents occur outside the habitual residence of the participants. Some Member States, however, continue to apply instead the older Hague Conventions.³⁶⁹

One issue of *international* law will, however, need to be dealt with before FAVs can be deployed in many parts of Europe. Twenty-three out of 28 Member States are bound by the Vienna Convention on Road Traffic of 1968, which is widely (though not necessarily correctly) interpreted as imposing a requirement that all road vehicles must have a human 'driver'. That requirement would rule out FAVs in those countries. Even the amendment to the Convention proposed by Austria, Belgium, France, Germany and Italy in 2014 that it should be sufficient that a 'driver' can override or switch off the autonomous system would pose problems for full level 5 autonomy, which is usually understood as removing human intervention even as a back-up system. The possible solutions include: further amendment of the Convention to allow full autonomy; reinterpretation of the term 'driver' under the Convention to include remote control by a non-human driver (for example a service company); and inclusion in all FAV vehicles of an 'off-switch'. The third solution is not only technically unsatisfactory – the sudden turning off of the system is likely in many situations to be more dangerous than leaving it on – but also likely to give rise to domestic legal problems. Could non-use of the off-switch count as negligence in states operating a fault system? Would all occupants of a FAV within reach of the off-switch count as having 'control' of the vehicle in Member States imposing strict liability on that basis? In Member States that impose liability on 'holders' of vehicles, would the existence of an off-switch render any of the occupants of the vehicle potentially liable? The other solutions would be preferable. Such issues, however, are not discussed in this research paper, which focuses on EU liability rules.

The widespread use of autonomous vehicles would shift attention to the liability not of the owner of the vehicle (or its 'driver', a concept that loses its engineering if not its legal meaning in a fully autonomous vehicle) but to the liability of the manufacturer of the vehicle. Accidents might be attributable to the design of the vehicle, or its manufacture, or to the design or manufacture of its component parts, including the software it uses. That is the world of product liability, which is governed by existing law at the European level requiring Member States to adopt essentially the

³⁶⁸ In law, strict liability is a standard for liability which may exist in either a criminal or civil context. A rule specifying strict liability makes a person legally responsible for the damage and loss caused by his/her acts and omissions regardless of culpability. Under strict liability, there is no requirement to prove fault, negligence or intention.

³⁶⁹ See the following for a discussion of the Rome II regulation and Hague convention: <http://www.europarl.europa.eu/document/activities/cont/201212/20121219ATT58306/20121219ATT58306EN.pdf>
http://www.biicl.org/files/5200_graziano_27-09-10_biicl_1.pdf

same system of strict liability for personal injury and damage to personal property caused by 'defective' products.

In Member States currently operating regimes based on fault for road traffic accidents, the liability of owners or drivers will become very difficult to prove since the owner or driver would have done no more than a passenger on a train or an aeroplane to affect the way the vehicle operates. In those states, the principal recourse of victims will be against manufacturers in product liability. An additional possible defendant would be commercial suppliers of FAV services who hire the services of their vehicles out to individuals. Those suppliers are also potentially liable in product liability, but they might also be liable under general Member State civil responsibility regimes (again often fault-based) or consumer protection regimes. In Member States operating strict liability regimes, victims might still be able to sue owners (or 'keepers' or 'holders' or 'users') of motor vehicles, although that might depend on precisely how the strict liability regime works. One can, for example, imagine that regimes, such as the French, which are based on concepts of 'control', might conclude that the owner of an autonomous vehicle is not in 'control' of it in any relevant way and that the relevant 'controller' is the manufacturer or designer of the vehicle or the commercial supplier of FAV services. But even where strict liability regimes continue to hold owners of vehicles liable, and the ultimate private customers for FAVs rather than the service providers continue to own their vehicles (a scenario that might be thought unlikely), those owners, or their insurers, would seek to join manufacturers or suppliers as defendants using product liability or the local civil liability regime, thereby reducing their own exposure. In both sorts of regime one would therefore expect insurance premiums for private customers of FAV vehicles to fall, perhaps radically.

The main issue to consider is whether the Union's product liability regime (under the Product Liability Directive) is appropriate for autonomous vehicles.

The Product Liability Directive (PLD) establishes a framework for liability regime for producers that, *inter alia*, is applicable to car manufacturers.³⁷⁰ The PLD Directive, as interpreted by the Court of Justice of the European Union, set rules for the liability of producers and rights of consumers. This framework is based on a moderately strict liability regime.³⁷¹ A producer of a defective product must compensate personal injuries and damage to private property irrespective of the negligence of any individual. Defectiveness is defined as failing to provide the degree of safety persons generally are entitled to expect. The rights of consumers to claim damages under provisions of the PLD cannot be limited by the contractual clauses included by the producer.³⁷² The PLD, however, provides a limited list of defences in Article 7 PLD, including the development risks defence that there is no liability if 'the state of scientific and technical knowledge at the time when he put the product into circulation was not such as to enable the existence of the defect to be discovered'. Another defence may arise under Article 8(2), which permits Member States to provide for contributory fault on the part of victims to reduce or disallow liability. In addition, some national rules on civil liability still apply, for example on non-material damage in personal injury, and how liability is apportioned among multiple defendants.

³⁷⁰ For review of the application in the MS, see Fourth report on the application of Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, amended by Directive 1999/34/EC of the European Parliament and of the Council of 10 May 1999.

³⁷¹ Article 1, PLD

³⁷² Preamble and Article 13, PLD.

Road accidents will remain 'bilateral' in the sense that the behaviour of both injurers and victims will continue to contribute to the risks that accidents will happen. For example, inattention by pedestrians, and the extent to which other road users choose to travel, will still be positively correlated with the accident rate. But since the PLD includes a contributory negligence defence, the legal regime would continue to take the bilateral nature of road accidents into account. The only practical difference would be that contributory negligence on the part of other drivers would no longer be relevant, for the simple reason that FAVs have no drivers.³⁷³

Strict liability has both advantages and disadvantages. Unlike fault regimes, it provides incentives for potential causers of accidents to control, in a cost-justified way, the extent to which they engage in risky activities overall, and not just to comply with legal standards on the occasions they happen to engage in the activity. On the other hand, even when combined with a rule reducing or eliminating compensation in cases of contributory negligence, strict liability does not provide incentives for potential accident victims to set their own activity levels at cost-justified levels.³⁷⁴ The extent to which this gap matters in practice, however, depends on the degree to which potential victims already limit their exposure to risk regardless of the legal liability regime, for the obvious reason that they want to avoid pain, injury and death.

Another alleged advantage of strict liability over fault is that it tends to reduce process costs and thus overall transaction costs. The argument is that fault requires victims to establish precisely who did what – in the case of a FAV, for example, who made which mistake in producing the software or the hardware of the vehicle – whereas in strict liability the victim has no need to discover these details. It is not clear, however, that this amounts to a very big advantage. Even in strict liability the victim has to prove causation, which is not necessarily cheap to establish. In addition, the claims processing industry in fault-based jurisdictions has been able to standardise claims and so benefit from economies of scale.

Among strict liability's other disadvantages is that in its pure form it does not allow a court to take into account the positive externalities³⁷⁵ a product might engender. In extreme cases, for example liability for damage caused by vaccines, strict liability can prevent a socially beneficial product from reaching the market. Extending this to FAV technology, potential defendants (in this case manufacturers) will react to liability rules according to the prospective private costs to them, not the net social benefits of their activity, so a situation could possibly arise in which the private costs of the manufacturer would be greater than their prospective profits from the activity

³⁷³ In some jurisdictions the effect of shifting to the PLD will paradoxically be to bring back contributory negligence. In France, for example, road accidents are currently governed by a strict liability rule that does not include a contributory negligence rule. France's implementation of the PLD, however, does include contributory negligence (see Cc 1245-12 (previously 1386-12)). France will thus move from a regime that assumes road accidents are unilateral to one that assumes they are bilateral. From an economic point of view this change might result in a small improvement in efficiency, although probably only with respect to property damage.

³⁷⁴ R. Cooter and T. Ulen, *Law and Economics* 6th edition (Boston: Addison-Wesley, 2012) Table 6.2 at p. 204

³⁷⁵ Externalities arise when an actor does not take into account the impact of his actions on others. In the case of conventional motor vehicles, each vehicle on the road increases the risk of accidents for all vehicles; this is a negative externality. Adding AVs to the network, on the other hand, does not increase the risk of accidents and in fact can be thought of as decreasing the risk for conventional road users – a positive externality.

even where the social benefits would have outweighed the social costs. On the other hand, many commentaries on the current regime stress that it is not a pure form of strict liability, which would mean holding defendants liable for any damage caused by their product, but in a modified form requiring the claimant to show above all that the damage was caused by a 'defect' in the product, where 'defective' means that the product did not provide the degree of safety that persons generally are entitled to expect. It is not, however, entirely clear whether the social benefits of the product are to be taken into account. At least one judge has said that, at least in some kinds of case, they are not to be taken into account.³⁷⁶ It might be that the only necessary reform would be to ensure that 'defective' is interpreted so that its application must take into account a product's social benefits.

Current product liability law is not entirely clear on a number of other issues. The small number of claims based on it, especially in comparison to the number of road traffic accident claims, means that questions have remained unanswered for thirty years. Among these is the highly relevant question of whether software itself, as a component separate from the physical product which it operates, counts as a product, an issue that divides experts.³⁷⁷ In addition, some of the rules established in 1985 are arguably inappropriate for a world of autonomous vehicles, for example a long-stop limitation period of ten years since the product was put into circulation. In a Member State operating a fault regime for road traffic accidents, the effect of a ten year limitation period would be that there might be no liability at all for accidents involving old autonomous vehicles. A related issue is the extent to which repairs or updates can cut off liability – the rule that no liability attaches to a product where 'the defect which caused the damage did not exist at the time when the product was put into circulation by him or that this defect came into being afterward' (Directive 85/374/EEC art 7) might need to be reconsidered. A related issue is the question of the liability of intermediate suppliers, such as the commercial suppliers of FAV services. Currently they can entirely escape liability under the Directive if they identify who supplied the product to them, a process that continues back either to the manufacturer or the first importer of the product into the EU (Directive 85/374/EEC art 3(3)).

Another set of issues arises out of the regulation of cross-border accidents. Both Rome II and the Hague Conventions treat products liability and road traffic accident cases differently. This difference will not have mattered when the two types of case were mutually exclusive, but will come to matter when all road traffic accident cases are also potentially product liability cases.

|| -Objectives and scope of this paper

³⁷⁶ Burton J. In *A v National Blood Authority (Hepatitis C Litigation)* no 1 [2001] 3 All E.R. 289. See M. Jones et al *Clerk and Lindsell on Torts* 21st edition (London: Sweet and Maxwell, 2015) 11.60 (commenting that Burton J.'s view might not be correct in other circumstances). See also e.g. C. Johnston, 'A personal (and selective) introduction to product liability law' (2012) 1 *Journal of Personal Injury Law* 1-17, agreeing with C.J. Miller and R. Goldberg, *Product Liability*, 2nd edition (Oxford: OUP, 2004) para.10.86 p.385 that Burton J.'s view is 'controversial'.

³⁷⁷ See generally the discussion in S. Saxby (ed.) *Encyclopedia of Information Technology Law* (London: Sweet and Maxwell, 2016) 7.132. For the view that software is not a 'product' see e.g. C. Walton et al, *Charlesworth and Percy On Negligence* 13th edition (London: Sweet and Maxwell, 2015) 15.14-15.15. For the view that software supplied on a physical medium counts as a 'product' but not software downloaded from the Internet, see e.g. M. Jones et al *Clerk and Lindsell on Torts* 21st edition (London: Sweet and Maxwell, 2015) 11.51.

The objective of this research paper is to provide an evidence-based assessment of the possible added value that development of EU rules on the liability and insurance related to the testing, deployment and use of connected and autonomous vehicles in the European Union can bring. Specifically, the research paper identifies potential opportunities and gaps of the current EU legislative framework on liability and insurance related to motor vehicles and provide estimates on the possible benefits and costs of failure to take a common EU approach considering technological developments in the area of connected and autonomous vehicles.

We adopt a mixed method approach for the analysis, using both qualitative and quantitative approaches. First, we undertake qualitative interviews with key stakeholders, including car manufacturers, insurers, those from connected industries and those who provide services or supervise compliance, to explore the appropriateness of existing liability regulation as well as how deployment of connected and autonomous vehicles might be influenced by amendments to European liability laws. Second, we undertake quantitative (economic) analysis of the possible added value due to changes in deployment as a result of legislative changes. The research paper discusses policy options that the EU could possibly adopt in the area of connected and driverless cars, and the benefits and challenges that each option would entail.

III -Structure of the paper

This research paper is structured as follows:

- Chapter 2 sets out the proposed legislative policy options and the findings from in-depth interviews with stakeholders.
- Chapter 3 sets out the cost-benefit analysis (CBA) to quantify the social and economic costs and benefits of the legislative options.
- Chapter 4 assesses the legislative policy options and provides recommendations.

Each chapter of the report commences with a non-technical summary of the research activities, describes the methodologies and highlights the key findings relevant to the chapter (where relevant at this stage of the research).

Chapter 2 Stakeholders' views of amendments to the Product Liability Directive

Summary and key findings

Research activities: This chapter sets stakeholders' views of potential amendments to the Product Liability Directive (PLD). The findings are derived from in-depth interviews with 13 key stakeholders including vehicle manufacturers, insurers, those from connected industries and those who provide services or supervise compliance, exploring the appropriateness of existing liability regulation as well as how deployment of connected and autonomous vehicles might be influenced by amendments to European liability laws.

In the interviews we discussed four legislative policy options (summarised below). These allow quantification of a common approach to legislation at EU level (Baseline-Divergence), as well as the introduction of further legislation to pre-empt variation by Member States:

- Option 1 (Baseline): The law as it is, with no adaptations for FAVs.
- Option 2 (Divergence): The law at EU level as it is, but with significant new variations introduced by Member States.
- Option 3 (Pro-industry harmonisation): EU legislation to pre-empt variation by Member States, with the changes favouring the producers and suppliers of autonomous vehicles.
- Option 4 (Pro-victim harmonisation): EU legislation to pre-empt variation by Member States, with the changes favouring road accident victims.

Key findings:

Below we summarise the key findings from the interviews:

- Product liability legislation is of critical importance for producers when considering whether to bring new technologies to market, but the PLD is good enough as it is.
- However, the PLD needs to work alongside other Member State regimes to ensure timely compensation for road accident victims.
- Harmonisation of liability laws across Member States is preferable, but divergence would not have a substantial impact on roll-out of autonomous and connected vehicles.
- Pre-emptive amendments to the PLD are not required, but if amendments are made they need to ensure fair treatment of producers and victims.
- Policymakers should not rush to provide new liability legislation: it is too early in the innovation process, and the risk of suboptimal legislation, potentially locking in unintended consequences, is a danger. However, legislation might be required in areas of use of connected and autonomous vehicles, clarification of interpretation of specific issues, e.g. whether the concept of 'a driver' in the Vienna Convention could encompass autonomous driving, and whether individuals could be charged with criminal negligence if in an accident in an autonomous vehicle they were not driving. Finally, there will be new risks, such as cyberattacks, hacking, etc., which will need to be taken into account in assessment of liability.
- Interventions may be required: (i) to ensure access to accident and driving data to enable accurate and timely liability judgements, including in areas such as setting of data standards, sharing and storage, as well as in terms of data privacy and protection; and (ii) to set vehicle standards.

I - Proposed legislative policy options

In this study we aim to explore whether and how changes to the PLD might influence deployment of connected and autonomous vehicles. We do this by exploring the impacts of four legislative options, as described below. These have been purposefully specified to be relatively straightforward to allow discussion within an interview context, across a range of stakeholders. They have also been purposefully defined to reflect legislative extremes to give us the opportunity to identify impacts.

The first option is a baseline, no change, which will set out the basis for comparison. Option 2 assumes increased divergence of legislation across Member States, which allows quantification of the value of coordination, relative to the baseline. Options 3 and 4 set out possibilities for further harmonisation, with Option 3 introducing further legislation supporting industry and Option 4 introducing further legislation supporting victims.

Option 1 (Baseline): The law as it is, with no adaptations for FAVs

The applicable law for fully autonomous vehicles will consist mainly of a rule (under EU law) of strict liability for producers for damage caused by defective products, defective being defined as 'not as safe as people generally are entitled to expect'. Liability is only for death or personal injury, or damage to personal property worth more than €500. Producers, which includes manufacturers, component makers and first importers into the EU, are able to defend themselves on the basis of a 'development risks' defence – that the state of scientific and technical knowledge at the time the product was put into circulation was not such as to enable the existence of the defect to be discovered. In addition, producers are not liable for defects that arise after they put the product into circulation. Producers can also reduce their liability if those injured were at fault. Victims have three years from the date of their injury to sue and the possibility of liability runs out entirely ten years after the product was put into circulation. Unlike drivers of conventional cars, producers of autonomous vehicles are not subject to an obligation to take out insurance.

Suppliers of the services of autonomous vehicles are potentially liable under these rules, but they can escape liability simply by revealing who supplied the vehicles to them, a process that can continue until responsibility is pinned on the manufacturer or the first importer into the EU.

The existing law is uncertain in some respects: e.g. it is not clear whether software counts as a 'product' or whether the social benefits of a product can be taken into account in deciding whether it is 'defective'.

Other liability rules might also be relevant in some circumstances. For example, companies that supply the services of autonomous vehicles to consumers might be sued on the basis of other legal rules providing for compensation to accident victims. These rules vary across Member States of the EU. In the UK for example, accident victims other than the person who paid for the services of an FAV would have to prove that the service provider was at fault in the way they had behaved in relation to the FAV, but in France such victims would have only to prove that the service supplier had control over the behaviour of the FAV.

Option 2 (Divergence): The law at EU level as it is but with significant new variations introduced by Member States

One way in which the law might develop is that different Member States of the EU might introduce their own national regimes dealing with FAVs, taking advantage of the ambiguities and gaps in existing EU law. For example, some might declare that software is not a product and others that it is a product. Some might declare that if victims are at fault in an accident involving an FAV they lose all rights to compensation, while others might declare that they lose none of their compensation. Some might restrict the application of the development risks defence in cases involving autonomous vehicles and some might allow it to apply to its maximum effect.

The different additional national rules relevant to the liability of suppliers of the services of FAV vehicles might also come to diverge more. For example, some Member States might carve out regimes for FAV service providers protecting them from any additional liability but others might take the opposite view and make them liable without proof of fault, regardless of the position in product liability law. This divergence might particularly happen with regard to accidents involving pedestrians. For example, in some Member States pedestrians might lose their right to sue if they failed to cross the road at authorised points (the equivalent of the US 'jaywalking' laws) but in others the change in the law might be in the opposite direction, allowing them to claim full compensation even if they were at fault.

Option 3 (Pro-industry harmonisation): EU legislation to pre-empt variation by Member States, with the changes favouring the producers and suppliers of autonomous vehicles

Another way the law might develop is for the EU to pass legislation that precludes Member States making different rules, and resolving the current legal issues in ways that favour the producers and suppliers of autonomous vehicles. For example, it might ensure that software does not count as a product, that the social benefits of autonomous vehicles should be taken into account in judging whether a vehicle was defective, and that any fault on the part of victims removes their right to compensation entirely.

The EU might also establish that FAV service providers cannot be sued except as 'suppliers' under the EU PLD, meaning that they would escape all liability, including liabilities under additional national law, if they inform victims about who supplied the vehicles to them.

Option 4 (Pro-victim harmonisation): EU legislation to pre-empt variation by Member States, with the changes favouring road accident victims

The final way the law might develop is that the EU might pass legislation that precludes Member States making different rules but resolving the issues in favour of road accident victims, for example declaring software to be a product, excluding social benefits from the issue of defectiveness, removing any defence based on the fault of the victim and requiring all producers to take out insurance.

On the liability of FAV service providers, the EU might make them liable as producers in their own right, regardless of what information they gave to victims, and might require them to carry insurance to cover that liability.

|| -Stakeholders' views on the legislative options

In June and July 2016, in-depth interviews were held with 13 stakeholders:

- 2 Manufacturers
- 4 Insurers
- 3 Connected industries
- 3 Service providers or those who supervise compliance
- 1 Consumer agency.

All interviews were undertaken by telephone and took between 45 minutes and an hour. Interview participants came from a number of EU countries, including France, Germany, Italy, The Netherlands, Sweden and the UK. Consent for interviews was obtained from all interview participants prior to conducting the interview. All participants were also instructed that their participation in the interview was voluntary and that the interview could be concluded at any time (no interview was concluded early).

The interviews used a semi-structured format. Prior to the interview, participants were sent a 1-page information sheet (see Appendix A) setting out the aims of the study and the four legislative policy options.

Below we set out the key themes emerging from the interviews.

The PLD is good enough as it is

While stakeholders felt that product liability legislation is of critical importance for producers when considering whether to bring new technologies to market, there was near-unanimous agreement that the PLD did not need amendment to cover roll-out of connected and autonomous vehicles. For most, the PLD was judged to be 'good enough as it is', providing balance between industry and consumer protection. The small numbers who disagreed did not say that the PLD was not good enough, but rather that there was currently no evidence that it was not working (as opposed to full agreement that it was working). A small number of interviewees felt they needed to check the details of the PLD in more detail.

Many interviewees felt that the existing ambiguities identified in the PLD (and highlighted in the scenarios) were not an issue. Specifically, nearly all felt that software would be covered under the PLD, and that 'reasonableness' and social benefits are taken into account when assigning liability.

Further, most participants felt that legislators should not rush to provide new legislation as it was too early in the innovation process and carried risks of suboptimal legislation, potentially locking in unintended consequences.

But the PLD needs to continue to work alongside other Member State regimes to ensure timely compensation for road accident victims

There was a very strong view, amongst insurers but also other stakeholders, that there was also a need for personal automobile insurance, even for FAVs where the driver would not have responsibility for the driving task but would be responsible for decisions about vehicle use, for

example in terms of who is using it, whether the conditions are appropriate, etc.. The key role of such insurance would be to ensure timely compensation for victims of accidents, but it would also cover cross-border incidents, non-driving accidents (for example if someone opens a door, injuring a cyclist), theft and damage, as well as accidents with non-autonomous vehicles (referred to as 'traditional' vehicles hereafter), which would remain a substantial component of the vehicle fleet.³⁷⁸

The Motor Insurance Directive (MID) was seen by many (6 of the 13 interviewees, including a mix of those representing manufacturers, insurers and consumers) as an efficient legislative vehicle for managing such insurance. Some argued that there may be benefits in future, with increasing take-up of FAVs, to moving towards harmonisation with a strict liability insurance system on the basis that driver fault would become immaterial. Behind the MID, insurers would pursue liability claims with the manufacturer or producer through the PLD, as they do now. This would probably happen more frequently in the case of FAVs, compared to now.

Others felt less strongly that insurance through the MID was needed, with a move of liability to manufacturers or to new providers who may provide cover for all travel, regardless of mode; but they also felt strongly that, whatever final system emerged, it needed to ensure that victims are compensated in a fair and timely manner.

A number of interviewees thought that insurance may change substantially, with insurance premiums being much more personalised to people's travel choices and risks, and that such products are bound to be developed, with increasing data on travel.

Harmonised liability laws across Member States are preferable, but divergence would not have a substantial impact on roll-out of autonomous and connected vehicles

In Option 2 we explored an option of increased divergence of laws across Member States. Nearly all participants felt that harmonised liability laws across Member States were preferable to an option with increasing divergence. For example, some felt there may be benefits in limiting variation between national liability laws between Member States.³⁷⁹ It was felt that such divergence would, however, not impact roll-out of connected and autonomous vehicles, given the substantial market pressure to roll out these vehicles, and that manufacturers will be rolling them out in numbers of countries, inside and outside the EU, with differing liability laws. For producers and manufacturers, having to operate across a number of countries with different laws may increase their costs, but these costs would ultimately be passed on to consumers. In terms of insurance, many felt that insurance was largely a 'local business' and that premiums already vary substantially across countries, taking account of differences in risks, system efficiency, etc.

A small number of respondents (2 out of 13) felt that divergence (and experimentation) would be beneficial in terms of providing valuable evidence on the effectiveness of different approaches.

³⁷⁸ Although it is undoubtedly true that Member State regimes designed to ensure the rapid payment of compensation to victims will need to be amended to ensure that liability grounded in the PLD is included, the need for users of FAVs, who are essentially all passengers in the vehicle, to have liability insurance is far from clear. Passengers in cars and taxis are not currently required to carry liability insurance for the simple reason that they are hardly ever liable for anything. There is real risk here of insurance being mis-sold.

³⁷⁹ The PLD allows variation only in limited areas (for example in national laws on non-material damage, extending time limits for actions and rights of recourse), but other variations beyond the scope of the Directive itself might be attempted, for example with regard to compulsory insurance for product liability.

No one felt that these variations would be important enough to impact deployment or take-up of FAVs.

Some interviewees felt that there may be benefits in harmonisation of motor insurance laws to ensure victims are compensated in a timely manner, and that there may be benefits in moving to a system assuming strict liability with roll-out of FAVs.

Pre-emptive amendments to the PLD are not required, but if amendments are made they need to ensure fair treatment of producers and victims

When exploring options 3 and 4, again most interviewees were of the view that no pre-emptive amendments to the PLD were required. But if amendments were made they should reflect a balance between the producer and the victim: a balance between options 3 and 4, leaning towards Option 4. Many interviewees emphasised that if legislative changes were made, these needed to protect victims, because the reputation of autonomous vehicles and social acceptance was ultimately important for market acceptance.

Many interpreted the example amendments as already being part of the PLD, for example, inclusion of software (Option 4), including social benefits of FAVs in judging effectiveness (Option 3). Many expected that 'reasonableness' would prevail in terms of assigning fault and liability, in terms of fault of victims.

Again, most felt that unless draconian changes were made, such changes were unlikely to have an impact on roll-out of autonomous and connected vehicles, although some interviewees thought they could have some impact (increasing take-up between 5-10%).

Do not legislate too early

Overall, there was a view that policymakers should not legislate too early. There was a view that existing legislation was appropriate for connected and autonomous vehicles, particularly if existing legislation and international treaties were interpreted in an open-minded way. Further, many felt that it was simply too early in the innovation process and that it was important to learn what may happen before introducing new legislation that could be detrimental to roll-out and use of these vehicles. There was also a view that it was not feasible to foresee and legislate for every possible outcome, and that we should not be afraid of the judicial process to determine benchmarks.

Areas that could require legislation would be on issues of use of connected and autonomous vehicles, for example whether young children could travel independently in these vehicles. A few interviewees noted that it may be useful for the European Commission to provide clarity on specific issues, for example whether interpretation of 'drivers' in the Vienna Convention could encompass autonomous driving. A few interviewees mentioned concerns regarding criminal liability legislation, specifically whether a person could be charged with criminal negligence while in an autonomous vehicle even if they were not driving. Others noted that there will be new risks, such as cyberattacks, hacking, etc., which will need to be taken into account in assessment of liability.

One interviewee asked whether it was time for new international legislation on road safety more generally.

Key areas where intervention would be valuable

Interviewees noted a number of areas where intervention would be useful to improve the effectiveness of connected and fully autonomous vehicles.

The first of these, mentioned by nearly all interviewees, was in terms of access to accident and driving data to enable accurate and timely liability judgements, including such areas as data standards, sharing, and storage, as well as in terms of data privacy and protection. Such access may be required by manufacturers, insurers, public authorities and travellers themselves. The second was in the area of setting of vehicle standards more generally.

Chapter 3 Quantifying the socio-economic costs and benefits of the legislative options

Summary

Research activities: This chapter responds to the research objective to quantify the additional value from an EU common approach on liability and insurance related to connected and driverless cars compared to what could be achieved by Member States at national or international levels without EU action.

Methodologies: We undertake cost-benefit analysis (CBA) to quantify the socio-economic costs and benefits of changes to the rate of roll-out and take-up of FAVs as a result of different legislative options. We use a Net Present Value approach, including the following potential benefits as a result of FAVs:

- Reductions in journey travel time due to more efficient use of road capacity
- Increased productivity of travellers (reductions in travellers' values of time)
- Reductions of driver costs for freight vehicles
- Possible increases in the amount of travel, as a result of increased ease of travel
- Reductions in vehicle accidents
- Reduction in air pollution, due to more efficient driving
- Changes in insurance costs due to a combination of reduced accident risk and liability regime
- Potential loss of revenue for public transport providers
- Potential loss in tax revenue (indirect taxation, e.g. on insurance)
- Wider economic impacts from transport on productivity and competitiveness.

The CBA explores costs and benefits for different stakeholders, including:

- Travellers
- Non-travellers, more widely
- Transport service providers/operators
- Producers, e.g. automobile manufacturers, insurance and components providers
- The rest of the economy
- Governments (Member State governments and EU institutions).

The data underpinning the impact on roll-out rates of FAVs come from interviews with key stakeholders, including car manufacturers, insurers, connected industries and those who provide public provision of services and supervise compliance. All other data are based on values and estimates from the literature.

Key findings:

- The societal benefits of earlier (5 years earlier) or faster deployment are relatively small. The key benefit of earlier or faster deployment is through reduced 'costs' of travel for FAV users because FAVs are assumed to drive more efficiently and users are able to be productive while travelling. Increases in travel efficiency also lead to benefits for drivers of normal vehicles, as a result of reductions in congestion.
- Assumptions regarding insurance costs, specifically whether insurance would be required for FAV users or whether liability insurance costs would be passed on directly from manufacturers or suppliers to users, are that these would also be small.
- The analysis is sensitive to assumptions regarding traveller productivity and assumptions regarding sharing of vehicles, with higher levels of productivity and sharing leading to higher societal benefits.

I -Background

In the interviews conducted with experts (discussed in Chapter 2), we found near-unanimous agreement that the PLD did not need amendment to cover roll-out of connected and autonomous vehicles and that although harmonised liability laws across Member States were preferable to further divergence, this would not have a substantial impact on the roll-out of autonomous and connected vehicles. In this chapter we explore the size of social and economic benefits of faster roll-out and take-up of connected and autonomous vehicles to put into context the potential size of societal benefits, even of small changes in roll-out and take-up. In addition, we examine the effect of the two different insurance regimes. In the first of these, we assume that FAV users do not need insurance and, in the second, that the insurance fully internalises the external accident costs.³⁸⁰ Finally, we undertake sensitivity analysis to show the importance of different assumptions and parameters on the size of the calculated benefits; these include the value of time for FAV users, the proportion of FAVs that are shared, and the level of accident risk for all road vehicles.

II - Framework for quantifying the socio-economic costs and benefits

1. Cost-benefit methodology

We quantify social and economic costs and benefits of different legislative options through cost-benefit analysis (CBA). CBA has been proposed as an evaluation tool in a wide range of settings; for example, the European Commission (EC) has a published guide on the economic appraisal of investment projects³⁸¹ and in the UK, HM Treasury's Green Book provides a framework for appraisal or evaluation of a policy, project or programme.³⁸² A study for the EC Secretariat General, on the assessment of the costs and benefits of EU regulation, also recommends and presents guidance on the use of CBA.³⁸³

With respect to the transport sector in particular, models that have been applied to study the impact of policy options at the EU scale also provide a welfare analysis of this type.³⁸⁴ These quantify the impact of changes in travel costs on travel demand at a range of spatial levels and for different stakeholders, depending on the policies of interest. In all cases, parameterisation and calibration is required. European guidance has been published on values that could be used to monetise impacts for use in CBA.³⁸⁵ In some countries, there is a long tradition of CBA in appraisal of transport projects that has in some cases been formalised.³⁸⁶ WebTAG is the UK Department for Transport's online transport appraisal tool, providing both framework and parameters for the analysis. Together with the European guidance, this forms a useful starting point for our assessment.

³⁸⁰ These can roughly be equated to options 3 and 4 from Chapter 2.

³⁸¹ DG-Regio (2014): Guide to Cost-Benefit Analysis of Investment Projects. European Commission.

³⁸² HM Treasury (2011): The Green Book - Appraisal and Evaluation in Central Government. London TSO.

³⁸³ CEPS (2013): Assessing the Costs and Benefits of Regulation. European Commission

³⁸⁴ Proost S, Dunkerley F, Van der Loo, S, Adler N, Bröcker J, Korzhenevych A (2013): Do the selected trans European transport investments pass the cost benefit test? *Transportation*, 41, 107-132. REMOVE and PRIMES models are further examples used in EU 2050.

³⁸⁵ Ricardo-AEA (2014) Update of the Handbook on External Costs of Transport. European Commission.

³⁸⁶ For example, the UK, the Netherlands (Onderzoeksprogramma Economische Effecten Infrastructuur) and France (*le calcul économique*)

CBA can be defined as a simplified welfare economic assessment based on a (partial) model of the economy. A particular project is therefore assessed through its impacts on a limited number of relevant markets and not the economy as a whole. A traditional transport CBA involves the calculation of travel time savings and other benefits to transport users (relative to a baseline of not having the project), which are then compared with the costs of the project. The spill-over effects on other transport markets, the environment and the rest of the economy also need to be taken into account, particularly where there are market distortions; labour market taxation is a particular example here. Underpinning the CBA approach is the fact that in a perfectly competitive economy, the direct transport benefits are equal to the final economic system benefits. These primary benefits affect accessibility to activities and consequently economic activity. Recently CBA has been expanded to account for market imperfections, particularly in relation to regional growth (agglomeration³⁸⁷), productivity, competition and labour market effects, which may give rise to additional, wider economic impacts not covered in the standard CBA. These impacts can be calculated as add-ons to the standard CBA, following an approach such as the one presented in the DfT WebTAG guidance.³⁸⁸ The alternative would be a comprehensive general equilibrium modelling approach, which has its own operational limitations and is far beyond the scope of this study.³⁸⁹

In this study we do not use a formal model to determine the impact of EU and government policy on demand for FAV and other transport markets and non-transport markets in Europe. Instead we rely on published data and data from expert interviews. Given the uncertainty associated with the advent of driverless technology on the roads, we also have to make a number of assumptions (see Appendix B). While we note the clear limitations of this approach, it allows us to assess the impact on transport and other markets in a consistent way within the project constraints. Although a more sophisticated model may offer some advantages, it would also need to rely on assumptions to determine the demand for FAV and its impact on other markets.

2. Establishing the baseline and scenarios

The objective of the CBA exercise is to quantify how the benefits arising from the deployment of FAVs may change under different liability regimes. We look at the benefits and costs of different liability regimes for the FAV market **from a European perspective**. Some liability regimes may result in transfers of producer profits and consumer benefits within the economy from one Member State (MS) to another; the manufacturing sector in one country may benefit at the expense of another, for example. Quantification of these effects is beyond the scope of this study. Only overall impacts for the EU are calculated.

We assume that FAVs will be introduced, but the rate at which this happens depends on the liability regime.³⁹⁰ For the baseline, we assume that the existing law remains as it is, with no particular adaptation for FAVs (see Chapter 2, Option 1). We then develop a number of scenarios

³⁸⁷ Agglomeration refers to the 'economic mass' accessible to firms (Graham and van Dender, 2009). Reducing transport costs can reduce interaction costs in the spatial economy leading to agglomeration externalities, such as labour market pooling, more efficient knowledge sharing and industry specialisation.

³⁸⁸ WebTAG Unit A2.1

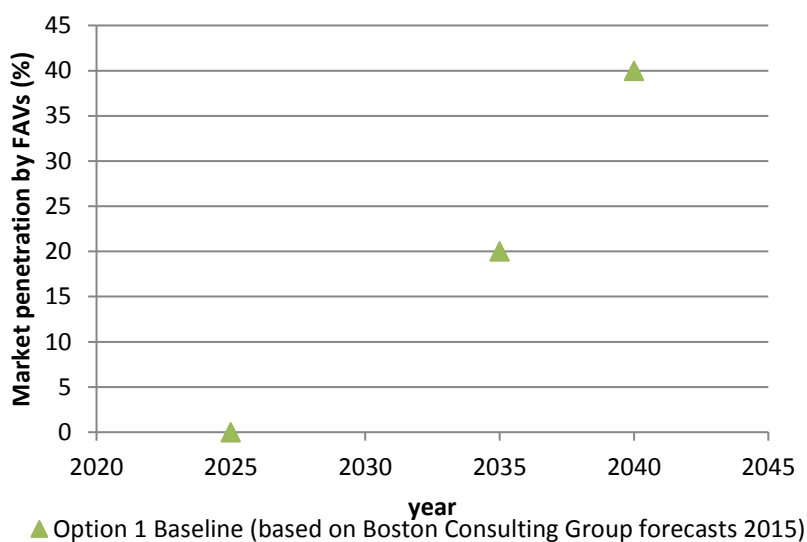
³⁸⁹ See OECD (2011), *Improving the Practice of Transport Project Appraisal*, ITF Round Tables, No. 149 and Proost et al, 2013 for further discussion of these issues.

³⁹⁰ Hence we do not compare the impact of FAVS with a baseline without these vehicles.

to represent the impact of different liability regimes on the roll-out and take-up of connected and autonomous vehicles. The change in benefits relative to the baseline is then quantified for each scenario.

The baseline forecast demand for FAVs was presented in the interviews discussed in Chapter 2 (shown in Figure 5). The selection was somewhat arbitrary but was largely based on a scenario developed by the Boston Consulting Group (BCG), which assumes that some governments would pass regulations on FAVs after about eight years. The BCG forecast was considered an appropriate starting point for assessing the effects of wider European legislation on FAV deployment. Moreover, most of the interviewees felt that the BCG predictions were as good as any other as a starting point.

Figure 5 – Baseline market penetration rates for FAVS



Source: Own calculation, presented in Appendix B, based on Exhibit 11, BCG (2015)

In addition to the demand, the baseline scenario (S0) requires a large amount of data and assumptions relating to the relevant transport markets and wider economy. Full details of these are provided in Appendix B. The assumptions that are particularly relevant for the analysis are:

- The FAV forecast reflects the percentage of new car sales that are FAVs. This is converted into the percentage of FAVs in the total fleet, using a simplified stock model. A fixed annual mileage per vehicle type is then assumed to determine vehicle-kilometres travelled (VKT), the unit of demand in the model. Additionally there is some assumed new (induced) demand.³⁹¹
- Forecasts of demand for car, bus, rail, cycling and walking³⁹² are exogenous and include future expected changes (see Capros et al. 2013). An adjustment is made to allow for assumed modal shift from these to FAVs, if the out-of-pocket or time costs of travel are reduced (and switches from FAVs to other modes in the opposite case).
- The costs for travelling in FAVs (per VKT) in the model are based on those currently available in the literature³⁹³, adjusted for income, growth and inflation. Unless otherwise specified, values for FAVs are assumed to be the same as for private cars.
- The purchase price for FAVs is initially higher than an equivalent standard car.³⁹⁴
- The time costs of travelling, measured considering the value of time (VOT), for FAV users is assumed to be half (50%) that for normal car users, on the basis that driving will become a less onerous task and drivers will be able to participate in other activities; also it is assumed that FAVs drive more efficiently. We also assume that the effective capacity of the road infrastructure increases with the proportion of FAVs, allowing more throughput on roads and reducing congestion.
- Insurance costs are assumed to depend on accident risk. Accident risk has been declining and it is assumed it will be half its 2010 value by 2025, due to increasing levels of automation more generally. FAVs are assumed to be 50% less risky than 'normal' cars. A fixed proportion of total accident costs are covered by insurance premiums. In the baseline we assume this proportion is the same for FAVs and 'normal' cars, and we test the impact of different assumptions in scenario tests.
- We assume that 10% of FAVs are shared vehicles and shared vehicles cover five times more distance than privately owned vehicles. It is assumed that no 'normal' cars are shared.
- We assume that FAVs cause less air pollution (local and greenhouse gas (GHG) emissions) because they are driven more efficiently. This is reflected in a 25% reduction in the pollution costs per VKT of FAVs compared with 'normal' cars.

We consider the following scenarios:³⁹⁵

- S1: **Earlier Deployment**, deployment of FAVs takes place at the same rate as in the baseline but deployment starts five years earlier.

³⁹¹ A fixed parameter is used but it reflects changes in generalised price and effective capacity expected, based on elasticities.

³⁹² Cycling and walking are taken together as a slow mode.

³⁹³ Mainly EU Handbook of External Costs, DfT WebTAG, TREMOVE.

³⁹⁴ Based on BCG analysis.

³⁹⁵ Only the parameters discussed for each of the scenarios are changed in that scenario; all other parameters remain unchanged from their baseline values.

- **S2 Slower Deployment Rate**, deployment of FAVs starts at the same time as the baseline forecast but occurs at a slower rate, so that in 2035 and 2040, new car market penetration is half that of the baseline.
- **S3: No Insurance Costs**, no insurance is required for FAV users. (This corresponds approximately to Option 3 from Chapter 2.)
- **S4: Fully Internalised Costs**, all accident costs for FAVs are fully internalised in the insurance market and this is reflected in the insurance premium to consumers. (This corresponds approximately to Option 4 from Chapter 2.)
- **S5: Lower Productivity**, the VOT for FAV users is 50% higher than assumed in the baseline, reflecting lower levels of productivity in FAVs.
- **S6: Higher Accident Rate**, the accident rate for all vehicles has reduced more slowly and is 50% higher than assumed in the baseline by 2025.
- **S7: Increased FAV safety**, FAVs are safer than assumed in the baseline and reduce the accident risk by 90% (baseline 50%).
- **S8: 50% of FAVs are shared**, compared with 10% in the baseline. Shared vehicles cover five times more vehicle-kilometres than privately owned vehicles.

Scenarios S1 to S4 explore impacts that could be influenced by the liability and insurance regimes that could be in place across Europe. Scenarios S5 to S8 provide sensitivity analysis. They examine the importance of other factors, not related to insurance or liability but which could affect the magnitude of the benefits attributed to the roll-out of FAVs in any setting. The baseline roll-out into the new vehicle fleet differs from the baseline (shown in Figure 1) in scenarios S1 and S2 only. In the remaining scenarios, the baseline roll-out is unchanged but there may be different modal shift and induced demand responses resulting from changes in other parameters.

Sensitivity analysis is an important aspect of this study, to which our approach is well suited. Given the uncertainty associated in making an assessment of the impact of technology yet to be deployed, under legislative regimes yet to be enacted or tested, it is important to establish how sensitive the various impacts included in the CBA are to the parameters used to calculate them.

2.1 Assessing the impacts

The transport markets we are primarily interested in are private cars in terms of vehicle kilometres travelled (VKT), by users in the EU. The introduction of FAVs into this market could have a number of impacts, which we incorporate in the CBA. These are summarised in the following table and discussed in further detail below.

Table 15 – Summary of impacts by stakeholder group included in the CBA

Stakeholder group	Impacts
Travellers	Travel times may decrease because FAVs may be able to make more efficient use of road space. This could be countered by more people travelling by FAVs. Moreover, because people can be more productive while travelling, the perceived cost of travelling time in a FAV will be less. ³⁹⁶

³⁹⁶ By generalised cost we mean the monetary costs associated with a journey (fuel, vehicle ownership and maintenance) as well as time costs, monetised using the value of time.

	There will be changes in the costs of travelling by FAVs, because the costs of insurance and ownership will change. Moreover, FAVs may be driven more efficiently, which will reduce the per kilometre cost of travelling. Reductions in out-of-pocket costs may have a secondary impact on the amount of travel. There may be health costs of increased travel by FAVs if people switch from modes which incorporate higher levels of walking.
Population more widely	If FAVs have fewer accidents, there will be lower numbers of injuries and deaths due to road accidents. If FAVs drive more efficiently, there will be fewer greenhouse gas emissions and air pollution.
Transport service providers/operators	If FAVs are more attractive compared to other modes of travel, for example public transport services, people may switch more journeys to FAVs, resulting in lower revenues from public transport services.
Producers on other markets (vehicle, insurance, components)	Vehicle producers, other component providers, vehicle repair services and insurers may see changes to revenues and costs as a result of the introduction of FAVs.
Rest of economy (Wider impacts)	Improvements in transport efficiency facilitated by take-up of FAVs will lead to wider economic impacts. These take account of agglomeration effects, labour market inefficiencies and product differentiation.
EU (MS governments and EU institutions)	The introduction of FAVs may lead to lower tax revenues for governments from insurance.

These impacts are quantified for all the options and can be negative or positive in value. We are only interested in how these effects differ from the baseline. Quantifying these provides a quantitative measure of the added value of faster roll-out and take-up of connected and autonomous vehicles and, additionally, of the impact of different insurance regimes. All of these impacts are counted as user and producer benefits in CBA terminology.

The above analysis relies on some additional assumptions. We assume that the proportion of FAV vehicle technology types will not be significantly different from the existing fleet. In particular, given the uncertainty in the data pertaining to FAVs, we do not include any impacts from the introduction of FAVs that would arise from them being electric; for example on noise, the environment (tailpipe emissions) or infrastructure wear and tear. If the use of electric vehicles is encouraged as a result of FAVs, this could add substantially to the benefits. We have also excluded freight from our analysis. Here, the impact of platooning is clearly important. However, given the difficulty of quantifying the demand for freight FAVs and the effect of liability and insurance regimes on this sector, we have focused on passenger transport.

There are, in addition, a number of potential impacts on other markets that we return to in the next section:

- Manufacturers (producers) of standard cars, trucks and lorries may lose new car sales to FAVs. Over time second-hand sales may be affected.
- Component suppliers may provide more components to FAVs than they do to normal vehicles.

- Changes in accident risk may affect revenues in the insurance industry.

However, we do not account for the following.

- Independent suppliers in aftersales markets may be impacted as repairs and spares may be tied to producer-preferred suppliers.
- Impact of liability regimes on costs of manufacturers and the insurance industry.
- Impact of direct changes to labour market for private cars, noting that implications for structural unemployment are beyond the scope of this study.

The costs that are of interest for this study are those to the EU of implementing liability legislation and those arising to consumers and business for compliance with legislation and litigation.

Detailed calculation of additional administrative costs to the EU (and MS) of drawing up and enforcing legislation for the different scenarios is beyond the scope of this study³⁹⁷. Moreover, given the findings in subsequent sections that the benefits are relatively small for legislative amendments, there is less reason to quantify the costs of making such amendments.

The costs arising to consumers and business from compliance with legislation are accounted for, not on the cost side, but with the benefits to these groups. Compliance costs, including both administrative costs and changes in liability costs, should be reflected in the impact on the deployment of FAVs. However, our interview findings indicated that the different liability regimes would not significantly affect roll-out. One explanation for this is that, for producers, these compliance costs would be negligible compared to other costs associated with FAVs. In this analysis, we make a number of simplifying assumptions as to how costs are transferred between consumers, producers and insurers when the liability regime differs from the baseline. Firstly, for the scenario (S3) where there are no insurance costs for the FAV user, the existing producer insurance is considered sufficient to cover any liability arising under the PLD. Secondly, when the accident costs from FAVs are fully covered, these costs are passed on to the consumers either directly in their motor insurance or in the purchase price, if the producer takes on the liability.³⁹⁸ We assume there are no additional transaction costs to the insurance industry for insuring FAVs, either through producer insurance (S3) or motor insurance for users (S4).³⁹⁹ Finally, for all other scenarios, the same insurance rules are assumed to apply to both 'normal' cars and FAVs. These assumptions allow us to isolate the impact of the parameter of interest in a particular scenario.

As for litigation costs, it is unclear what the impact of FAVs will be. If the litigation rate per accident remains constant, total litigation costs will indeed follow the accident rate downwards. Initially, however, the litigation rate might rise as parties seek to clarify any uncertain aspects of the law. In the longer term the litigation rate per accident might even fall below pre-FAV levels

³⁹⁷ The costs and benefits of EU regulation are discussed in Renda et al. (2013). The costs of implementation and compliance have also been the subject of detailed studies in other areas, such as environment and data protection. See for example London Economics (2015), Farmer et al. (2013).

³⁹⁸ In the case where EU law has been harmonised in favour of accident victims (Option 4, Chapter 2), costs may be passed on to the user either directly through motor insurance or indirectly by producers through the purchase price. Alternatively, producers may choose to absorb the costs, as at least one producer has signalled they would under certain conditions. In our analysis, to avoid ambiguity, we assume that costs are passed on but discuss the implications of this.

³⁹⁹ Or these are not passed on to the consumer.

because the number of potential parties might fall – instead of every driver being a potential defendant, only service providers and manufacturers will come into that category and so it will become easier to systematise the treatment of claims.

An alleged advantage of strict liability (brought about through a move to the PLD) over fault is that it tends to reduce process costs and thus overall transaction costs. The argument is that fault requires victims to establish precisely who did what – in the case of a FAV, for example, who made which mistake in producing the software or the hardware of the vehicle – whereas in strict liability the victim has no need to discover these details. It is not clear, however, that this amounts to a very big advantage. Even in strict liability the victim has to prove causation, which is not necessarily cheap to establish. In addition, the claims-processing industry in fault-based jurisdictions has been able to standardise claims and so benefit from economies of scale.

Finally, we assume that the costs associated with providing the infrastructure for FAV deployment to EU MS will not differ between the baseline and other scenarios.

There are a number of outcome measures that are commonly used in CBA: Benefit Cost Ratio (BCR), Net Present Value (NPV) and Internal Rate of Return (IRR). The choice of measure depends to a large extent on the type of project to be assessed.

For this study, the analysis period is 2025-2040. Most studies do not predict much deployment of FAVs before 2025.⁴⁰⁰ The chosen period balances the need to measure the impact of FAV deployment against increasing uncertainty of future predictions. We expect that the main effect of the different options will be to change the rate of market penetration by FAVs. For each option, the benefits for each year relative to the baseline are calculated (noting that these may be negative). As we also expect that the legislative costs to the EU of the different options will be small (and possibly not even quantifiable) relative to the benefits, the NPV is the preferred measure as this uses differences rather than ratios.

The NPV is defined as the sum of the difference between the benefits (B_t) and costs (C_t) over each year (t) of the analysis period (n), discounted to today's value, such that

$$NPV = \sum_0^n \frac{B_t - C_t}{(1+r)^t}, \text{ where } r \text{ is the discount rate}$$

DG-Regio (2014), recommends a discount rate of 4%.

||| -Findings from the cost-benefit analysis

In this section we present the results of the CBA for the eight scenarios. The monetised impacts represent the value of the differences in each scenario relative to the baseline.

⁴⁰⁰ KPMG (2015), Jiang et al (2015): Self-Driving Cars: Disruptive or Incremental? Applied Innovation Review.

The demand for FAVs as a proportion of all new cars and the total car fleet is presented in Table 16. While the proportion of new car sales that are FAV may be relatively high in the baseline, it takes some time for this to work its way into the fleet as a whole. There are marked changes in demand for FAVs in S1 and S2, as expected. Small changes also occur in the other scenarios due to assumptions regarding induced demand and modal shift as prices change.

Table 16 – Proportion of new cars and all cars that are FAVs, by scenario (%)

Year		2025	2030	2035	2040
New cars (%)	Baseline	0.0	6.4	19.6	39.8
	Baseline	0.0	1.4	5.3	12.8
All cars (%)	S1 – Earlier Deployment	1.4	5.3	12.8	23.7
	S2 – Slower Deployment Rate	0.0	0.9	2.8	6.7
	S3 – No Insurance Costs	0.0	1.4	5.4	12.9
	S4 – Fully Internalised Costs	0.0	1.4	5.3	12.8
	S5 – Lower Productivity	1.4	1.3	5.1	12.5
	S6 – Higher Accident Rate	0.0	1.4	5.3	12.8
	S7 – Increased FAV Safety	0.0	1.4	5.4	12.9
	S8 – 50% Shared FAVs	0.0	1.7	5.8	13.6

The results of the CBA for each scenario are presented in Table 17.

The main benefit of increased deployment of FAVs is through a reduction in the generalised costs of transport for FAV users due to increased productivity (lower VOT) and more efficient driving. More efficient driving also benefits normal car users through reduced congestion costs and leads to reduced environmental impacts. The calculation of wider economic impacts from agglomeration benefits is also a result of reductions in congestion. Tax revenues are reduced because there is less tax from lower insurance premiums and, since 10% of FAVs are shared, fewer vehicles are needed to supply demand, although this is offset by reduced subsidies for public transport operators. In our analysis, health impacts are negatively affected by increased demand for FAVs, as a result of a modal shift away from active modes (cycling and walking, including as part of public transport use). Bringing forward deployment of FAVs has a larger impact than changing the rate of deployment as more benefits accrue over the analysis period. However, the impacts of both are relatively small. To put the magnitude of these effects in context, the increase in benefits of approximately €150bn from earlier deployment of FAVs represents less than 0.1% of European GDP over the same period. The turnover of the EU automotive industry represents about 6.5% of GDP. This suggests that a regulatory regime that slows or speeds up the rate of deployment of FAVs does not significantly change the benefits arising from FAV technology, which may themselves be large⁴⁰¹.

Reducing the liability of FAVs for accidents for users (S3) appears to have an overall positive impact. Lower insurance reduces the cost of travel, leading to positive transport user impacts. These outweigh the additional burden to society of accident costs involving FAVs, which are no longer covered by insurance. These are small as FAVs have a lower accident risk than other

⁴⁰¹ It is important to emphasise that these scenarios are intended to show how different liability regimes might affect the roll-out of FAVs, given that this technology is expected to be introduced anyway. The benefits of introducing AV technology relative to not doing so is a different comparison. Based on our own indicative NPV calculations using data from KPMG, 2015, the benefits in this case would be of the order of 2% of GDP over the period 2015-2030.

vehicles. On the other hand, making FAV users fully liable has a negative impact (S3). In this case where the additional liability costs are fully internalised and passed on to drivers⁴⁰², there is a reduction in transport user benefits, because of the increase in travel costs and this more than offsets the benefit in terms of external accident cost impacts.

However, both these effects are small relative to the benefits of earlier or faster deployment.

It is noteworthy that the analysis is more sensitive to changes in parameters unrelated to insurance and liability as it relates to FAVs. While reducing the accident risk of FAVs to 10% of that for normal cars clearly provides societal benefits, these will not be significant until a sufficient level of deployment is reached. However, if FAV users are assumed to value travel time differently than forecast, or if accident rates for all vehicles change because of improvements in non-FAV technology in the fleet, they will have a significant impact on the calculated benefits. Similarly, assumptions on vehicle sharing are important because they impact user costs. In our analysis we have restricted this business model to FAVs; shared normal cars could increase user benefits further.

In the above results we focus on the impacts from the passenger transport market. There are, in addition, a number of potential impacts on other markets. Manufacturers (producers) of standard cars may lose new car sales to those selling FAVs (of course, the same suppliers may sell both standard vehicles and FAVs). Over time, second hand sales may be affected. Compliance with new legislation may also have an impact on manufacturer's costs. The standard assumption is that, in the long run, FAV and standard car manufacturers will operate in perfectly competitive markets and price at marginal cost. Revenues across the industry are then mainly affected by the sharing model, assumed for FAVs in our analysis, as fewer vehicles are needed to supply the expected travel demand. For example, we estimate a decrease in revenues of around €90bn if FAVs are introduced more quickly than in the baseline. However, if components in FAVs constitute a larger proportion of the vehicle value than for other vehicles⁴⁰³, suppliers may generate additional profits. Independent suppliers in aftersales markets, on the other hand, may be negatively impacted as repairs and spares may be tied to producer-preferred suppliers. We have neither explored nor quantified these effects.

In terms of the impact on the insurance industry, we have only included the impact of changes in insurance premiums in the transport market, assuming that there are no additional transaction costs associated with a change in liability regime. We have assumed that the pricing model for the insurance industry covers the accident costs internalised by each mode. Revenues are expected to decrease with the introduction of FAVs as they have a lower accident risk. However, insurance industry revenues are likely to be most affected by a reduced risk of accidents in the overall car fleet, which could result from the continued introduction of technology into non-automated vehicles, as well as other road safety measures. Finally, we do not consider the impact of direct changes to the labour market for private cars, noting that implications for structural unemployment are beyond the scope of this study.

⁴⁰² As noted earlier, we assume that the liability is passed to users either directly through motor insurance or, if producers are liable, indirectly through the purchase price. If producers do not pass on the accident costs, then the loss of benefits will accrue to producer and not consumer. In general this will not be a direct transfer as more consumers will continue to travel at the lower cost.

⁴⁰³ Estimated in one study to increase from 33.3 to 40 % of vehicle value (KPMG, 2015)

1.1 What the CBA means for legislative policy

Our analysis indicates that the relative benefits of earlier (5 years earlier) or changing the rate of deployment leads to relatively small societal benefits, relative to the baseline. Further, impacts as a result of differing assumptions regarding insurance costs, specifically whether no insurance would be required for FAV users or whether the liability insurance costs would be passed on directly from manufacturers or supplier to users, are also small.

The analysis is sensitive to assumptions regarding traveller productivity and assumptions regarding sharing of vehicles, with higher levels of productivity and sharing leading to higher societal benefits.

Table 17 – Summary CBA impacts of scenarios for the EU (€bn in 2015 prices)

	Insurance / Liability Scenarios				Sensitivity Tests			
Consumer Impacts (€bn in 2015 prices)	S1:Earlier Deployment	S2:Slower Deployment Rate	S3:No Insurance Costs	S4:Fully Internalised Costs	S5:Lower Productivity	S6:Higher Accident Rate	S7: Increased FAV safety	S8:50% shared FAVs
Transport user impacts	116.53	-35.58	35.22	-23.95	-188.14	-879.04	17.18	315.29
Health impacts	-1.99	0.00	-0.59	0.19	2.09	0.03	-0.36	-4.21
External accident cost impacts	2.34	-0.81	-22.12	6.92	0.05	-49.24	1.27	-0.10
External environmental cost impacts	8.60	-3.01	-0.20	0.06	0.71	-0.03	-0.12	-1.44
Tax revenue	6.57	0.82	-4.96	1.55	-2.67	130.85	-2.97	-26.81
Wider economic impacts	16.11	-5.55	0.75	-0.24	-226.30	-15.41	0.45	5.43
Total	148.15	-44.13	8.10	-15.47	-414.27	-812.85	15.46	288.17

1 All the impacts above are positive if they represent a benefit and negative if they represent a disbenefit relative to the baseline.

Chapter 4 Assessing the legislative policy options

Chapter summary and key findings

Research activities: Qualitative assessment of policy options set out in Chapter 1, taking account of stakeholder needs, social and economic benefits and EU value-added.

Key findings:

- Product liability legislation is of critical importance for producers when considering whether to bring new technologies to market, but pre-emptive legislation of the PLD is not required at this time.
 - While stakeholders felt that harmonisation of liability laws across Member States was preferable, divergence would not have a substantial impact on roll-out of autonomous and connected vehicles.
 - Moreover, the societal benefits of earlier (5 years earlier) or faster deployment are relatively small.
- But the PLD needs to work alongside other Member State regimes to ensure timely compensation for road accident victims.
- However, legislation might be required in areas of use of connected and autonomous vehicles, e.g. whether young children can travel independently in these vehicles; and clarification of interpretation of specific issues, e.g. whether the concept of 'driver' in the Vienna Convention could encompass autonomous driving, or whether individuals could be charged with criminal negligence if in an accident in an autonomous vehicle they were not driving.
- There will also be new risks, such as cyberattacks, hacking, etc., which will need to be taken into account in assessment of liability.
- Finally interventions may be required: (i) to ensure access to accident and driving data to enable accurate and timely liability judgements, including in areas such as setting of data standards, sharing, and storage, as well as in terms of data privacy and protection; and (ii) to set vehicle standards.

I -Analysis of policy options

In this chapter we provide a qualitative summary of the assessment of the four legislative policy options:

- Option 1 (Baseline): The law as it is, with no adaptations for FAVs.
- Option 2 (Divergence): The law at EU level as it is but with significant new variations introduced by Member States.
- Option 3 (Pro-industry harmonisation): EU legislation to pre-empt variation by Member States, with the changes favouring the producers and suppliers of autonomous vehicles.
- Option 4 (Pro-victim harmonisation): EU legislation to pre-empt variation by Member States, with the changes favouring road accident victims.

As noted in Chapter 1, the options have been specified in a relatively straightforward manner to allow discussion within an interview context, across a range of stakeholders. They have also been purposefully defined to reflect legislative extremes to give us the opportunity to identify impacts.

For each policy option, we consider the impact on stakeholders (discussed in detail in Chapter 1), the economic impact (from the CBA, discussed in Chapter 2), as well as further evaluation criteria relevant to EU legislative policy, specifically how the policy:

- Provides added value to the EU in terms of *effectiveness, efficiency, and synergy*.
- Contributes to stakeholders' needs (*utility and simplification*) and supplements other national or international policies (*complementarity*).
- Contributes to the *coherence* of the current framework regulating liability and insurance related to motor vehicles.

The European Commission Staff Working Document (SEC (2011) 867 final) recommended that the EU Added Value Test is performed on the basis of three criteria, as summarised in the box below.

BOX 1: EU VALUE ADDED TEST CRITERIA (SOURCE: EUROPEAN COMMISSION STAFF WORKING DOCUMENT (SEC (2011) 867 FINAL)

Effectiveness: where EU action is the only way to get results to create missing links, avoid fragmentation, and realise the potential of a border-free Europe.

Efficiency: where the EU offers better value for money, because externalities can be addressed and resources or expertise can be pooled, an action can be better coordinated.

Synergy: where EU action is necessary to complement, stimulate, and leverage action to reduce disparities, raise standards, and create synergies.

A common approach on liability and insurance related to connected and autonomous vehicles might arguably have such effects in the following ways:

- **Effectiveness:** harmonisation of liability laws across Member States may streamline and bring forward the roll-out of AVs across Member States, as well as reduce confusion over which laws apply for cross-border travel.
- **Efficiency:** coordination of liability laws reduces legislative requirements for Member States.
- **Synergy:** consistency of liability laws may raise standards and stimulate take-up of AVs across all Member States, reducing potential disparities.

As part of the qualitative interviews with stakeholders, questions were included to explore the impacts on effectiveness, efficiency and synergy of different policy options, if the policy impacted roll-out or take-up of FAVs. However, in nearly all of the interviews the respondents felt that the policy options would not impact roll-out, so the subsequent questions were irrelevant.

Similarly, questions were included in the interview protocol to explore the utility and simplification of the different legislative policy options in terms of stakeholders' needs. It was clear that the baseline scenario offered the best option to users, and that users felt that it was 'good enough as it is'. Other policy options were not seen to offer utility or simplification of the already good-enough PLD, at this time. Indeed, respondents feared that early attempts at legislation, albeit well-intentioned, could easily have unexpected and undesired deleterious effects.

The same is generally true for complementarity. The existing regimes on product liability and insurance provide beneficial complementarity to national liability regimes. The degree of benefit will rise automatically as the basis of liability for road traffic accidents shifts towards product liability. Some adjustment of the insurance regime might, however, be desirable to ensure that product liability is included as a form of liability relevant to road traffic accidents.

The position on coherence is similar. As the technology is rolled out, product liability will become more important as the source of liability for road traffic accidents. Since product liability is already a harmonised field (albeit in some respects imperfectly) we can expect an automatic increase in coherence of policy across Member States. Our assessment of our respondents, however, is that no need exists to attempt to create further coherence by legislative action at this time, at least not on the basis that further moves in the direction of harmonisation would encourage earlier deployment. In particular, although Option 2 might be seen as causing a loss of coherence, we have not found reasons, beyond creating coherence for coherence's sake, for taking counter-measures against it.

The impacts for each policy option are summarised in Table 18.

Table 18 - Assessment of legislative policy options

	Policy options			
	Option 1: The law as it is with no adaptations for FAVs (Baseline = PLD as now)	Option 2: The law at EU level as it is, but with significant new variations introduced by Member States	Option 3: EU legislation to pre-empt variation by MS, with changes favouring producers and suppliers of FAVs	Option 4: EU legislation to pre-empt variation by MS, with changes favouring road accident victims
Stakeholders' needs (Manufacturers, Insurers, Connected industries, Service providers, Consumer agencies)	Strongly preferred option 'The PLD is good enough as it is'.	Generally, harmonisation of laws is preferred; a small number felt that divergence and experimentation would be beneficial, but overall impact would be small.	Pre-emptive amendments not required, but if amendments are made they need to ensure fair treatment of producers and victims.	Pre-emptive amendments not required, but if amendments are made they need to ensure fair treatment of producers and victims.

Economic impact (from CBA)	Baseline for assessment.	Small impact, could be positive or negative.	Small impact, could be positive or negative.	Small impact, could be positive or negative.
Added value in terms of effectiveness, efficiency and synergy for EU Member States	Baseline for assessment.	Impact likely to be negative in terms of effectiveness, efficiency and synergy, but overall impact is small.	Small/negligible impact on effectiveness, efficiency and synergy.	Small/negligible impact on effectiveness, efficiency and synergy.
Utility and simplification for stakeholders	Baseline is preferred.	No discernible benefit from baseline in terms of utility and simplification to users.	No discernible benefit from baseline in terms of utility and simplification to users.	No discernible benefit from baseline in terms of utility and simplification to users.
Complementarity	Baseline is seen to work well by stakeholders. Inclusion of product liability in insurance regime might be desirable.	Complementarity of the PLD would still exist.	Would increase complementarity but legislative action not seen as required at this stage.	Would increase complementarity but legislative action not seen as required at this stage.
Coherence	Will increase automatically with deployment. No further action necessary.	Would result in some loss of coherence but preventive action not regarded as necessary at this time.	Would result in an increase in coherence but not regarded as necessary at this time.	Would result in an increase in coherence but not regarded as necessary at this time.

II -Recommendations

The conclusion from the qualitative analysis is that, while product liability legislation is seen to be of critical importance for producers when considering whether to bring new technologies to market, pre-emptive legislation of the PLD is not seen to provide benefits in terms of roll-out and take-up of FAVS, and is not required at this time.

While there was preference for harmonisation, or minimisation of variation, of national liability laws, by manufacturers, insurers and those in connected industries, it was felt that such harmonisation would not have a manifest impact on the roll-out of connected and autonomous vehicles, given the substantial market pressure to roll out these vehicles. Moreover, manufacturers will be planning to roll out FAVS in a number of countries, inside and outside the EU, with differing liability laws.

Moreover, the quantitative analysis indicates that even if amendments to the PLD were able to bring forward or speed up roll-out of FAVs, given the size of likely impacts the social and economic benefits to society are relatively small (noting that the quantitative analysis is sensitive to assumptions regarding traveller productivity and sharing of vehicles, with higher levels of productivity and sharing leading to higher societal benefits). It is noteworthy that the quantitative analysis uses quite optimistic values for traveller productivity and even with higher levels of vehicle sharing the societal benefits are still relatively small.

The qualitative research with stakeholders found that most felt that the existing legislation was appropriate for connected and autonomous vehicles, particularly if existing legislation and international treaties were interpreted in an open-minded way. Further, many felt that it was simply too early in the innovation process and that it was important to learn what may happen before introducing new legislation that could be detrimental to roll-out and use of these vehicles. There was also a view that it was not feasible to foresee and legislate for every possible outcome, and that we should not be afraid of the judicial process to determine benchmarks.

Thus, we recommend no amendment to the PLD at this time.

However, there was near unanimous agreement of the need for the PLD to work alongside other Member State regimes to ensure timely compensation for road accident victims.

Moreover, there are areas that could require legislation, particularly with regards to the use of connected and autonomous vehicles, for example whether young children could travel independently in these vehicles, as well as clarification of interpretation of specific issues, for example whether the concept of 'a driver' in the Vienna Convention could encompass autonomous driving, or whether individuals could be charged with criminal negligence if in an accident in an autonomous vehicle they were not driving.

There will also be new risks, such as cyberattacks, hacking, etc., which will need to be taken into account in assessment of liability.

Interviewees noted a number of areas where intervention would be useful to improve the effectiveness of connected and fully autonomous vehicles. The first of these, mentioned by nearly all interviewees, was in terms of access to accident and driving data to enable accurate and timely liability judgements, including such areas as data standards, sharing, and storage, as well as in terms of data privacy and protection. Such access may be required by manufacturers, insurers, public authorities and travellers themselves. The second was in the area of setting of vehicle standards more generally.

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Appendix A: Background information for interview participants

Appendix B: CBA Methodology, data and assumptions for quantitative assessment

Summary table of inputs and assumptions for the CBA

Parameter	Description	Value	Source	Notes
	discount rate (real) %	4	DG Regio (2014)	
	inflation rate (annual) %	1.18	IMF forecast	
Demand				
p_AV	Forecast AV market, penetration new car sales (%)		Own calculation based on BCG scenario used for baseline (BCG, 2015).	Changes over time.
V_C	Baseline demand car (10 ⁹ vkm)		Reference Scenario for transport demand for EU28 (Capros et al. 2013, Appendix 2, p91).	Changes over time.
V_PT	Baseline demand bus (10 ⁹ vkm)		As above.	Changes over time.
V_R	Baseline demand rail (10 ⁹ vkm)		As above.	Changes over time.
V_O	Baseline demand active modes (10 ⁹ vkm)		As above.	Changes over time.
p_NC	Proportion of car demand (car-km) by new cars	0.054	Based on Eurostat data for total cars in EU28 and ACEA new car registrations data.	Assumed fixed.
p_SH	Proportion of car demand by cars older than one year	0.946	As above.	Assumed fixed.
p_sh	Proportion of FAVs that are shared	0.1 (0.5 in S8)	Assumption. See section on Calculation of demand below.	Assumed fixed, except in scenario S8.

α_{sh}	Multiplying factor for shared vehicle km	5	Assumption. See section on Calculation of demand below.	Shared vehicles undertake five times more journeys than non-shared vehicles.
	Modal shift (cross) elasticities	0.01 (bus), 0.09 (rail)	Use values for public transport to car to apply to AVs (Balcombe et al., 2004).	Assume elasticity for slow modes is the same as bus.
k	Annual car mileage (km)	12,563	Calculated from vehicle stock and .vehicle demand	Assume fixed all years. See calculation of demand below.
β	Induced FAV demand multiplier	0.1	Assumption. See section on calculation of demand below.	Increased mileage per FAV over the baseline to account for access for non-drivers and the reduced cost of driving.
tL	Average lifetime of cars/FAVs	8 years		
Costs				
	Resource		TREMOVE v3.3.2, 2010 values. ⁴⁰⁴	This includes fuel and non-fuel costs for car travel. For rail and bus, also includes maintenance.
	Maintenance factor	0.5 cars, 0.8 FAVs	As above for cars. Assumption for FAVs.	Maintenance as a proportion of purchase price costs calculated for 2010 for EU as a whole and these proportions applied to future year costs. FAVs are more expensive to maintain than cars.
	Purchase premium FAVs		Own calculation based on cost and market share data from BCG, 2015.	Decreases with market penetration until same price as standard car (zero premium).

⁴⁰⁴ Available from <http://www.tmleuven.com/home.htm>

	Insurance (eurocents/car km)	3.88	Own calculation for 2013 based on Insurance Europe Market report 2015 and demand data (Capros et al., 2013).	(A very similar value was also derived from TREMOVE 3.3.2 data). This baseline value for cars is multiplied by a risk factor to take account of increased safety expectations for both cars and FAVs in the study period. See section on accident costs below.
	Taxes		TREMOVE v3.3.2, 2010 values.	Taxes as a proportion of resource and insurance costs calculated for 2010 for EU as a whole and these proportions applied to future year costs.
Value of time (VOT)	Private time (eurocents/car km)		WebTAG v1.4, 2010 values.	Private time costs (euros/hour) were weighted by trip purpose, and converted to costs per car km assuming a fixed speed per road type.
α	Travel time factor	1 (car), 0.8 (FAVs) 1.5 (bus)	Assumptions See section on congestion below.	This takes account of relative average speed of vehicles. FAVS are assumed to drive more efficiently than normal cars.
	Increased in-vehicle productivity for FAV	0.5	Assumption.	This multiplies the VOT to reflect increased productivity in FAVs.
External costs				
	Congestion		See additional assumptions below. DfT, 2015.	Weighted by proportion of (equivalent) car km on different road types.

$\frac{\varepsilon_C}{V}$	Elasticity of effective capacity		Own calculation based on Schladover et al. (2012).	Reflects increase in effective capacity as proportion of FAVs increase, resulting in reductions in congestion.
	Accidents		Ricardo-AEA (2014).	Weighted by proportion of (equivalent) car km on different road types.
	Risk factor	0.5 cars, 0.25 FAVs	Based on own calculation for cars (see section on accident costs below). Assumption for FAVs in line with Fagnant & Kockelman (2015) that FAVs 50% safer at 10% market penetration.	Cars are 50% safer than now at start of calculation period and FAVs are 50% safer than normal cars. Both of these assumptions are tested in the sensitivity scenarios (S6, S7).
	Internalisation factor	0.76 (cars/FAVs), 0.16 (bus)	Ricardo-AEA (2014). See section on accident costs below.	Internalisation of external costs is examined in scenarios S3, S4.
	Risk elasticity	-0.25	Ricardo-AEA (2014). See section on accident costs below.	
	Air pollution (local air quality)		DfT, 2015.	
	Air pollution (GHG)		DfT, 2015.	
	Scale factor - FAV efficiency	0.75	Assumption.	More efficient driving in FAVs reduces emissions by 25% cf standard cars.
	Health (euros/passenger km)	2.18	Genter et al. (2008).	See additional assumptions below.

	Wider economic benefits (agglomeration)	0.25	DfT, 2014. PTEG, 2015. See additional assumptions below.	This factor multiplies congestion costs.
	Wider economic benefits (imperfect competition)	0.1	DfT, 2014.	This factor multiplies benefits derived from business travel (car/rail/FAV).

Additional assumptions

All values are presented for the 2015 baseline year and all calculation inputs have been converted accordingly. Where appropriate, units have been converted using occupancy factors from UK DfT guidance for cars, which allows for a change in car occupancy over time, and from TREMOVE for bus and rail. In terms of road capacity, we also assume that a bus is equivalent to two passenger cars. Prices are adjusted over the calculation period 2025 to 2040 for inflation and GDP.⁴⁰⁵ All costs and benefits are calculated in €billion at 2015 prices.

We note that detailed calculations or collection of data at the country level were beyond the scope of this project. It was also not part of our remit to consider methodological issues of aggregation of country level data to form EU average values, although we acknowledge their importance. EU aggregate level values were determined based on the data available in the literature. Where it was not possible to obtain or determine an EU value without detailed calculation, values were obtained from the UK DfT WebTAG guidance or other comparable sources. These have been used as the best data sources available, and although they cannot be considered to be representative of the EU as a whole, the majority of car-kilometres are driven in the wealthiest EU countries which could be expected to be similar to the UK.⁴⁰⁶

As far as possible, the Update of the Handbook on External Costs of Transport (RICARDO-AEA, 2014) was used to determine external costs. For congestion and private time costs, we used UK DfT WebTAG values directly and did not convert these to an EU average using a value transfer method based on relative GDP/capita (see Ricardo-AEA, 2014 for a method to do this). Using the value transfer method would require either that the relative GDP/capita of the UK to the EU average remained the same over the calculation period, as in the baseline, or that the change would be calculated based on forecasts of UK and EU GDP/capita over this period. To minimise the amount of uncertainty in the calculations we did not do this. For completeness, we note here that in 2010 (the WebTAG baseline), the ratio of UK GDP/capita to the EU average was approximately 1.2.

⁴⁰⁵ Source: Capros et al (2013).

⁴⁰⁶ From limited data available for 12 European countries in 2009, 98% of vehicle-km were travelled in France, Germany and the UK. (Source Eurostat [road_tf_road]).

In the analysis, we have not made any additional assumptions about parking costs. We did not explicitly include a parking charge element in the transport user costs. If we assume that a proportion of user costs are for parking, then when vehicles are shared, as in our model for FAV ownership, these costs are automatically reduced. However, there will be costs associated with parking FAVs, which will depend both on the ownership model and the infrastructure. If a FAV drives itself to a specially designated out-of-town parking place, there will be an extra trip cost and potentially a parking fee. It is not clear whether these costs would be larger or smaller than city centre parking costs. One study from North America indicates an annualised saving of \$2000 if parking spaces are moved out of the Central Business District (Litman, 2012). Shared ownership models could also mean a reduction in the need for off-street parking spaces at residential locations. However, it is not clear, given the time period of study (2025-2040) and that much parking in Europe is on-street, what this would mean for our analysis. Making additional assumptions to take account of these factors would add to the uncertainty in the calculations but would not provide additional insights into the impact in changes to liability legislation.

As far as we are aware, data on health impacts and wider economic impacts are not available at a European level. For health we used values for medium activity levels from the New Zealand Transport Agency (Genter et al., 2008) for combined slow (walk and bicycle) modes. To determine the contribution of travelling by public transport modes to active travel benefits, we then assume that walking or cycling accounts for 10% of a bus trip and 1% of a rail trip. Wider economic impacts arise from the fact that markets are not competitive and direct user impacts are amplified throughout the economy. According to UK DfT guidance (DfT, 2014), there are three main sources of wider impacts from transport: agglomeration; output changes on imperfectly competitive markets; and tax revenues from labour market impacts. We consider that agglomeration effects are relevant to this study as changes in transport costs can affect the accessibility of employment centres to workers and, as a consequence, the level of agglomeration. A detailed calculation is outside the scope of this study. A recent study on bus transport (PTEG, 2013) estimates that 90% of agglomeration impacts occur in urban areas and that these could represent 46 per cent of car congestion costs. We apply this approach of using a congestion cost multiplier but employ a lower value (0.25) to account for car kilometres outside metropolitan areas. The impact of imperfect competition on business travel is determined by multiplying the benefits accruing to business travellers by a factor of 0.1 (DfT, 2014).

Calculation of demand

We start from the forecast annual demand (v_{km}) for cars in year t and develop a simplified stock model:

$$V_{0t}^c = (\rho^N + \rho^S) k N_{0t}^c$$

where

$\rho^i, i = N, S$ are the proportions of demand driven by new and second hand cars, respectively.

N_{0t}^c is the number of cars in year t and k is the annual kilometres driven per car (referred to hereafter as mileage). We firstly assume that mileage k is fixed for all vehicle types for all years and that there is no car sharing, so that proportion of sales of different vehicle types corresponds to proportion of kilometres driven. (This is only really important for FAVs, as for others we use forecast demand directly).

For FAVs, we then have:

$$V_{0t}^{AV} = \rho^N \rho_t^{AV} V_{0t}^c + \rho^S \rho_{t-tL}^{AV} V_{0t}^c$$

where cars have a fixed average lifetime (tL) and we assume FAVs enter the second-hand market at the same penetration rate as for new cars. We expect the market penetration of FAVs to reflect the value placed on quality differences as well as cost differences between normal cars and FAVs.

There will also be induced demand, which is effectively increased mileage per FAV over the baseline. V_{lt}^{AV} is the induced demand for FAVs due to a) access for non-drivers, b) increased effective road capacity, and c) reduced cost per km of driving (part of this covered by effective capacity increase). Let

$$V_{lt}^{AV} = \beta V_{0t}^{AV} = \beta k N^{AV}$$

We assume a value for β and then check that this is consistent with values from the literature. In terms of access for non-drivers, Harper et al (2015) calculate the maximum additional demand from the elderly, non-drivers and those with medical conditions as being 12% of overall demand by comparison with existing trip-making behaviour of other sectors of the population. This would indicate that there may be considerable room for growth in the automated vehicle market to satisfy demand beyond the forecasts used in this study. The increase in capacity as a function of the proportion of FAVs has been estimated based on data in Schladover et al. (2012) relating the increase in effective highway capacity to the market penetration of vehicles with CACC.⁴⁰⁷ Using elasticities of demand with respect to capacity and travel cost (Hymel et al. (2010)), we can then calculate the expected increase in demand due to the expansion in effective capacity and lower costs resulting from FAVs. These calculations provide an order of magnitude estimate for induced demand, given that no data on FAVs are available. We note that the values from Hymel et al (2010) are lower than others in the literature but this is attributed to their use of longer time series and aggregated data, and that the effective capacity benefits from AVs are expected to increase strongly with market penetration. Our assumption for the increase in VKT for FAVs is also in line with other published estimates (Fagnant & Kockelman, 2015).

⁴⁰⁷ Fernandez and Nunez (2013) also provide some quantification of the capacity effects of platooning.

V_{Mt}^{AV} is the modal shift to FAV from other existing modes (excluding standard car)

$$V_t^{AV} = V_{0t}^{AV} + V_{It}^{AV} + V_{Mt}^{AV}$$

The modal shifts are calculated using cross-price elasticities of demand.

We assume no other changes to demand for other modes apart from the shift to FAVs. Then

$$V_t^c = \begin{cases} \left[\rho^N (1 - \rho_t^{AV}) + \rho^S \right] V_{0t}^c, t \leq tL \\ \left[\rho^N (1 - \rho_t^{AV}) + \rho^S (1 - \rho_{t-tL}^{AV}) \right] V_{0t}^c, t > tL \end{cases} \quad \text{for non-AV cars.}$$

$$V_t^m = V_{0t}^m - V_{mt}^{AV} \quad \text{for m=bus, active modes}$$

We assume that all non-FAV cars are privately owned as the demand data do not distinguish between privately owned vehicles and taxis or other shared, non-public transport, vehicles. If we then assume that a proportion of AVs ρ^{sh} are shared vehicles and they undertake proportionally more journeys $\alpha^{sh}k$ then

$$\begin{aligned} \bar{V}_t^{AV} &= \left[(1 - \rho^{sh}) + \alpha^{sh} \rho^{sh} \right] kN^{AV} \\ &= \left[(1 - \rho^{sh}) + \alpha^{sh} \rho^{sh} \right] V_{0t}^{AV} \end{aligned}$$

$$V_t^{AV} = \bar{V}_t^{AV} + V_{It}^{AV} + V_{Mt}^{AV}$$

The use of shared vehicles provides a second mechanism by which FAVs may increase vehicle kilometres travelled, over the baseline demand forecast by market penetration of new vehicle sales. We assume that 10% of vehicles are shared and that these travel five times the distance of a normal car. The proportion of shared vehicles and the distance travelled by shared vehicles is rather arbitrary and is therefore subject to sensitivity analysis. We note that Fagnant & Kockelman (2015) also assume 10% shared vehicles but ten times the demand for these in vkm travelled.

Congestion costs

Travel time cost per km by mode i is given by:

$TC_i^T = VOT_i T_i(V)$ where $V = \sum_i V^i$ for all modes above (subscript t dropped for convenience).

The travel time function (per km) consists of a free (uncongested) travel time and a congestion-related component, which depends on the ratio of volume to capacity. We can expect that lorries and buses effectively reduce capacity relative to cars because they travel more slowly. FAVs (both passenger and freight) on the other hand can be expected to effectively increase road capacity because they make better use of existing road capacity.

The simplest approach⁴⁰⁸ is to assume that the times taken to travel one km by the various mode are linearly related so that

$$TC_i^T = \alpha_i VOT_i T(V) \begin{cases} \alpha_{FAV} < 1 \\ \alpha_c = 1 \\ \alpha_F > 1 \end{cases}$$

Then

$$\begin{aligned} TTC^T &= \sum_i V_i VOT_i \alpha_i T(V) \\ \frac{dTTC^T}{dV_i} &= \frac{dT(V)}{dV_i} \sum_i V_i VOT_i \alpha_i + VOT_i \alpha_i T(V) \\ &= \sum_i V_i \left(\frac{dT(V)}{dV} VOT_i \alpha_i \right) + TC_i^T \end{aligned}$$

The first term on the LHS gives the marginal external congestion costs of adding a vkm of mode i to the network. (The second term is the private time costs of the additional km which are included in the generalised price to the user – the external costs are not.)

Hence we can use both the difference in the VOT for FAVs relative to cars, and the difference and the multiplicative factor α_{FAV} , to determine the effect of AVs on external congestions costs.

Note that $\frac{dT(V)}{dV_i} = \frac{dT(V)}{dV}$ assumes capacity is fixed. If AVs increase effective road capacity, then we have (approximately)

⁴⁰⁸ We follow the approach used in the TREMOVE model, TML (2007) in this regard.

$$\frac{dT(V)}{dV} = \frac{dT(V)}{dV} \Big|_c [1 - \varepsilon_{CV}]$$

where the elasticity ε_{CV} represents the effective percentage change in capacity for a 1% change in demand (of FAVs). This depends on the market penetration of FAVs.

Accident costs

For the calculation of accident costs we follow the methodology set out in Lindberg (2001), UNITE (2003) and Ricardo-AEA (2014). In the following we assume accident costs are averaged over different severities (fatal, serious, light) and that the cost calculation can be applied to different road types (urban, motorway, rural etc.). The total accident costs involving a vehicle of type j are then given by

$$TC_j^A = r_j(a + b + c)V_j$$

where $r_j = \frac{X_j}{V_j}$ is the accident risk, X_j is the number of accidents between mode j

and other modes and V_j represents demand for mode j .

The cost categories a , b and c are defined as follows (per km driven):

a - the willingness to pay (WTP) of road users to avoid an accident

b - the WTP of friends and relatives for the road user to avoid an accident

c - the pure economic costs (loss of output, medical, police etc).

In practice, b is considered to be negligible and c is about 10% of a . They are also averaged over accident severity for each road type.

Assuming further that A_j is the share of the accident costs that are borne by mode j and that the user internalises the perceived accident costs for his or her user type, the marginal external accident cost for mode j can then be derived as

$$\begin{aligned} MEC_j^A &= \frac{dTC_j^A}{dV_j} - A_j r_j(a + b) \\ &= r_j(a + b + c)(1 + E_j) - A_j r_j(a + b) \\ &= r_j(a + b + c)(1 - A_j + E_j) + A_j r_j c \end{aligned}$$

where $E_j = \frac{V_j}{r_j} \frac{dr_j}{dV_j}$ is the risk elasticity.

The marginal external accident cost includes the effect of an additional user of mode j on other users of that mode, on other modes and the external costs to society.

If we now assume that $c=0.1(a+b)$ then we obtain

$$\begin{aligned} MEC_j^A &= r_j(a+b+c)(1+E_j) - A_j r_j(a+b) \\ &= r_j(a+b+c) \left[(1+E_j) - 0.9A_j \right] \end{aligned}$$

In our calculations, we use data from Ricardo-AEA (2014). The most recent calculations of marginal external accident costs (per km) assume the following:

- $E=-0.25$ across all modes and accident severities and road types
- Value of a Statistical Life (VSL) = €1.7 million (2010 prices) – this gives a+b for fatal accidents; serious injuries are 13% of this, and light injuries 1%
- Shares A_j of cost internalised - 0.76 cars, 0.22 freight, 0.16 buses

In terms of the external costs per vkm provided (MEC_j^A), these are already aggregated over accident types. Information is not provided on the risk of different types of accidents, so the weight they are given in the aggregation is not known. We assume that these relative risks remain unchanged in our analysis and focus on the aggregate risk over all accident types for each vehicle type.

For the purposes of our calculations we need to adjust the existing MECs in two ways.

Firstly, we need to determine accident costs for standard cars during our calculation period 2025 to 2040. To do this we incorporate the decreasing trend in road accidents in the EU. Recently this seems to be about 8% per year.⁴⁰⁹ Assuming this continues, comparing with forecast travel demand, this suggests that the accident rate (risk) decreases by about 50% from its 2010 value and then remains fixed.

Secondly, we need to account for the safety benefits of FAVs over standard cars. Fagnant and Kockelman say that at 10% penetration, AVs are 50% safer. From EU data, 72% of accidents arise from human error (90% US)⁴¹⁰. So if we say AVs reduce the number of

⁴⁰⁹ Own calculations based on EU data. (source: http://ec.europa.eu/transport/road_safety/specialist/statistics/index_en.htm)

⁴¹⁰ Thomas et al. (2013), NHTSA (2008).

accidents by half for the same volume as normal cars, this implies the risk is half that of normal cars.

So since r_j scales external cost, we will rely on this parameter to adjust the costs for both normal road vehicles and AVs in terms of the decreasing trend in accident rates and the impact of AVs on accident risk.

The A_j can be used to adjust for how insurance costs may be applied.

We have no data to indicate how the risk elasticity may change over time. While a different value could be used for AVs, we do not do this.

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This assessment of European added value finds that revision of the EU's current legislative framework is necessary, notably as regards the regulation of civil liability and insurance. Quantitative assessment of added value, at the current stage of technological development, proved difficult and inconclusive. A qualitative analysis, however, provided evidence that action at EU level would (i) promote legal certainty; (ii) reduce the transaction costs for car manufacturers and public administrations arising from differences in national liability rules and systems for the determination and calculation of damages; and (iii) secure effective consumer protection.

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