GECKO

GOVERNANCE FOR NEW MOBILITY SOLUTIONS

Analysis of regulatory responses and governance models

REPORT COVERING THE FINDINGS OF THE ANALYSIS OF REGULATORY RESPONSES AND GOVERNANCE MODELS

14/10/2019

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824273.

SUMMARY SHEET

Deliverable No.	2.1
Project Acronym	GECKO
Full Title	Governance principles and mEthods enabling deCision maKers to manage and regulate the changing mObility systems
Grant Agreement No.	824273
Responsible Author(s)	Anne Reynaud, IRU
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External Review	Matthew W. Daus, Windels Marx
Quality Assurance Committee Review	Yannick Bousse, UITP Mauro Giorgetti, FIT
Date	09/10/2019
Status	Final
Dissemination level	Public
Abstract	This document presents a first mapping of the regulatory responses and governance models for new mobility solutions in the EU and other key countries.
Version	1
Work package No.	WP2
Work package Title	Regulatory and Governance framework
Programme	Horizon 2020
Coordinator	UITP – The International Association of Public Transport

Website	www.h2020-gecko.eu
Starting date	December 2018
Number of months	30

CONTRIBUTING PARTNERS

Organisation	Country	Abbreviation
IRU Projects ASBL	Belgium	IRU
Union Internationale des transports publics	Belgium	UITP
Promotion of Operational Links with Integrated services, Association Internationale	Belgium	POLIS
Capital High Tech SARL	France	CHT
Abo Akademi	Finland	AA
Confederation of Organisations in Road Transport Enforcement AISBL	Belgium	CORTE
Universita Commerciale Luigi Bocconi	Italy	UB

DOCUMENT HISTORY

Version	Date	Organisation	Main area of changes	Comments
0.1	06.05.2019	IRU		First draft for review
0.2	10.07.2019	IRU	Table of content Include External review comments by Matthew Daus	Revised draft
0.3	19.07.2019	UITP	Review of deliverable	
0.4	22.07.2019	IRU	Insert UITP review comments	
1	09.10.2019	UITP	Final review and submission	

LIST OF ACRONYMS

ADAS – Advanced driver assistance system

AGTC – Agreement on Important International Combined Transport Lines and Related Installations

AGN – The European Agreement on Main Inland Waterways of International Importance

APIs – Application Programming Interface

ARTS – Automated Road Transport System

DG – Directorate general

BEV – Battery Electric vehicles

CAV – Connected, automated vehicles

CEF – Connecting Europe Facility

C- ITS – Cooperative, Intelligent Transport System

ECJ – European Court of Justice

ECOSOC – Economic and Social Council

EFSI – European Fund Strategic Investment

EGNOS – European Geostationary Navigation Overlay Service

ETS – Emission trading

EU – European Union

EV – Electric Vehicles

FCEV – Fuel Cell Electric Vehicle

GDPR – General Data Protection Privacy

GLOSA – Green Light Optimal Speed Advice

GNSS – Global Navigation Satellite Systems

GPS – Global Positioning system

GRSG – Working party on General Safety

GSM – Global System for Mobile communications

HEV – Hybrid Electric vehicles

IAE – International Energy Agency

INPI – Institute for the protection of Intellectual property

IoT – Internet of Things

ITC – Inland Transport Committee

ITF – The International transport forum

ITS – Intelligence Transport system

LEZ – Low Emission Zone

LPG – Liquefied Petroleum Gas

MoU – Memorandum of Understanding

NHS – National Health Service

NREAP – National Renewable Energy Action Plan of Sweden

OECD – Organisation for Economic Co-operation and Development

OEM –Original Equipment Manufacturer

PHEV – Plug-in hybrid electric vehicle

SDG – Sustainable Development Goals

SUMP – Sustainable Urban Mobility Plans

STRIA – Strategic Transport Innovation Agenda

TFL – Transport for London

TM – Traffic Management

TRAN – Transport and Tourism committee

UN – United Nations

UNECE – United Nations Economic Commission for Europe

WLAN – Wireless Local Area Network

WP – Work Package

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1. EXECUTIVE SUMMARY

The goal of the GECKO project is to support authorities with tools and recommendations for the development of new regulatory frameworks that will accompany the new mobility era. An important part of the goal is to build evidence via research regarding existing regulatory responses and governance models related to disruptive innovation for mobility. This document aims at presenting the first mapping of the regulatory responses and governance models in the EU and other key countries.

In this document, and in the whole GECKO project, regulation is defined according the OECD definition as "any instrument by which governments, their subsidiary bodies, and supranational bodies set requirements on citizens and businesses that have legal force1".

In the scope of this research, disruptive innovation is defined according to the commonly accepted definition by Clayton Christensen2 that states that a disruptive innovation is a "process by which a product or service initially takes root in simple applications at the bottom of a market, typically by being less expensive and more accessible, and then relentlessly moves upmarket, eventually displacing established competitors3". Three elements have to be identified for an innovation to be qualified as disruptive:

1. Enabling technology: an invention that makes a product more affordable and accessible to a wider population.
2. Innovative business models: a business model that targets non-consumers, new customers who previously did not buy the product, did not use the service in the given market or the least profitable customers.
3. Coherent value network: a network in which suppliers, partners, distributors, and customers are each better off when the disruptive technology prospers.

[1] "The term may thus encompass a wide range of instruments: from primary laws and secondary regulations to implement primary laws, subordinate rules, administrative formalities and decisions that give effect to higher-level regulations and standards. Regulations may also emanate from non-governmental or self-regulatory bodies to which governments have delegated regulatory powers. Regulations do not only address the activities of the private sector, but often include the rules and procedures that target the internal operation of public authorities, including ministries and government agencies. So-called 'soft law' is increasingly important. This means that, for example, administrative guidance and circulars which are not intended to have legal force, may acquire legal force in practice. Most countries have a well-established hierarchy of regulations, starting with their constitution. They usually require that lower-level regulations must not conflict with higher-level regulations, and that the former must derive their legitimacy from the latter"

[2] Harvard business institute, what is disruptive innovation?

[3] See supra.

The first part of this research presents the challenges related to the regulation and governance of mobility considering the development of disruptive innovations. The existing regulations at the international, EU, national and city level play an important role.

There are many different regulatory elements that have to be considered in the development of a suitable regulatory framework at the EU level such as taxation, competition, market organisation models, environmental regulation, and social standards and data protection. The question of governance is also considered as to why a national government would intervene in the governance of mobility, for example to define the level and standards of public services and to communicate with the public regarding taxation which has to match the level of public services. This research will also present the particular governance models of London, Amsterdam and Lyon. London, for example, has a governance structure characterised by single management of most public transport and a transport strategy integrated with other policy areas such as health. How platform and shared economy tend to be regulated is also presented in this document, as these structures are considered an important enabler of several disruptive innovations such as Blablacar for example.

The second part of this research presents several case studies divided into four categories:

- Cooperative, connected and automated vehicles;
- Infrastructure, Network and traffic management;
- MaaS and Platforms;
- Shared/on demand mobility.

With the help of the case studies we highlight general patterns that are common to several types of disruptive innovations across different countries. There is, for example, the important use of soft law, or the use of scientific research framework to proceed with testing. But there is also the work on the last mile issue or even the question of access to tender processes for example. The fact that the services provided by a majority of these innovations mostly differ from traditional mobility by their business models and their way to reach customers is also important to highlight.

This work will support further research in the GECKO project. More precisely the GECKO project aim to develop policy guidelines either to support the elaboration of a European regulatory framework around disruptive innovation related to mobility, or to adapt existing regulation if necessary. These guidelines should address the greater principles to be followed and applied at the national level, and city level.

2. INTRODUCTION

"Why dinosaurs will keep ruling the auto-industry?"[4], "How can regulation keep up as technological innovation races ahead?[5]", "How disruptive technologies are disrupting regulators[6]", "Policy makers, face challenges in designing the appropriate legal and regulatory framework so that new technologies are used properly and for the benefit of society[7]". As we can see from these newspaper titles, designing the correct regulatory frameworks around innovation is an overwhelming challenge for regulators and decision makers. The GECKO project arises from this unanimous observation.

The goal of the GECKO project is to support authorities with tools and recommendations for the development of new regulatory frameworks to accompany to the new mobility era. To reach this goal a strong stakeholder engagement and consultation process will be organised and evidence-based research will be done on topics such as existing regulatory responses, economic, social and political effects of the new services and technologies for passenger and freight, and also the question of public private partnerships.

This document presents the first analysis of the regulatory responses and governance models in the European Union and in other key countries. This research will cover freight and passenger transport with a focus on road transport in urban areas.

Regulation plays a key role in supporting innovation and keeping a fair balance between innovation and regulation is not always easy. Regulators have to keep up with the pace of innovation, which proves challenging when it comes to disruptive innovations[8].

Disruptive innovation can be briefly defined by two criteria:

- The disruptive innovation should have the "potential to drastically alter markets and their functioning"[9]
- The innovation should not only "involve a new product or process, but should also involve the emergence of a new business model"[10].

[4] Why dinosaurs will keep ruling the auto-industry, John Paul MacDuffie, and Takahiro Fujimoto, Harvard Business Review.
[5] Finance Monthly, How can regulation keep up as technological innovation races ahead?
[6] Keep calm and regulate: How disruptive technologies are disrupting regulators, Conventus law.
[7] Briefing, European parliamentary research service.
[8] EPSC Strategic note, Toward an Innovation Principle Endorsed by Better Regulation.
[9] OECD, Key points of the hearing on dispute innovation, 16-18 June 2015
[10] See supra.

A good example of the challenge for policy makers to keep up with the pace of innovation is the introduction of the LED street lighting[11]. As the EU regulatory framework around street lighting was based on traditional technology, it took two years to adapt the regulatory framework allowing the introduction of the LED street lighting. This is an example of how a regulatory framework instead of supporting and enabling innovation is becoming a barrier: by being behind. This is why following the pace of innovation from a regulatory perspective is of key importance. The regulators have to find the right balance between the necessary predictability of the regulatory environment and adaptability to technological and scientific progress. A regulatory framework can also be considered a barrier to innovation by being too strict or too rigid.

According to several authors[12] the sector of mobility and transport is facing a change comparable to the mass adoption of automobile vehicle, the 'automobile transition' of the 20th century. If we are no longer at the stage of the 'automobile transition', we could be entering 'the smart transition'. We can now talk about the notion of the so-called Smart Mobility[13], defined by a transition from ownership to usership on a background of urbanisation and connectivity[14]. But 'Smart Mobility' can also be defined as "a way to move people and goods using new technology that is faster, cleaner, more accessible and less expensive than traditional options"[15]. This research will tend to present a mapping of the current regulatory responses and governance models shaping a regulatory framework around the disruptive innovation shaping the "smart-mobility".

In order to present these existing regulatory responses and governance models we will present the two key notions of regulation and governance in relation with disruptive innovation linked to smart mobility. Then, the notion of disruptive innovation will be presented in general and in relation to the question of mobility. The last part of this research will present a variety of case studies and concrete examples of disruptive innovations and the regulatory environment developed around it.

[11] See 1.

[12] Iain Doherty, Greg Mardsen and Jillian Anable in "The governance of Smart Mobility".

[13] The Governance of Smart Mobility, transportation research part A, Elsevier.

[14] Future of Personal Mobility- life with or without ownership of cars, Forbes.

[15] Daniel Lyons, Director, TMT Advisory, EY, Smart mobility: How tech is transforming transport.

3. REGULATION AND GOVERNANCE

The term **regulation** can be defined in several ways. In GECKO the chosen definition is the one from OECD. In this document and in the whole project, regulation is defined as "any instrument by which governments, their subsidiary bodies, and supranational bodies set requirements on citizens and businesses that have legal force[16]".

Another term that is important to present is the notion of '**soft law'**, defined by OECD as "Co-operation based on instruments that are not legally binding, or whose binding force is somewhat "weaker" than that of traditional law, such as codes of conduct, guidelines, roadmaps, peer reviews."[17] This term is important to present, as according to several authors[18] the use of soft laws seems to be the preferred regulatory approach to disruptive innovation. Soft law instruments are used to regulate autonomous vehicles, for example in the US where the Department of Transportation released several sets of guidelines around the topic[19]. In Europe, we can take the example of the Memorandum of Understanding (MoU) signed in 2016 between the Latvian ministry of Economics, Uber, and Taxify[20]. Or again at a different level, last year, AXA signed a MoU with Uber to set up standards of protection for drivers[21]. The reasons why soft law tools appeared to be the preferred regulatory tools around innovation is because they respond adequately to the regulatory challenges faced by regulators when it comes to develop the right ecosystem for innovations. These challenges are numerous but can be briefly summarized as speed, blurring edges and diversity[22]. As previously mentioned the pace, the speed of development of these innovations is one of the main challenges for regulators. Disruptive innovations and new business models have blurry edges and play with the limits developed by existing regulations. Is Uber a taxi company if they do not own cars? And finally, diversity, the wide range of new innovations and

[16] "The term may thus encompass a wide range of instruments: from primary laws and secondary regulations to implement primary laws, subordinate rules, administrative formalities and decisions that give effect to higher-level regulations and standards. Regulations may emanate from non-governmental or self-regulatory bodies to which governments have delegated regulatory powers. Regulations do not only address the activities of the private sector. They include the rules and procedures that frame the internal operation of public authorities, including ministries and government agencies. So-called 'soft law' is increasingly important. This means that, for example, administrative guidance and circulars which are not intended to have legal force, may acquire legal force in practice. Most countries have a well-established hierarchy of regulations, starting with their Constitution. They usually require that lower-level regulations must not conflict with higher-level regulations, and that the former must derive their legitimacy from the latter"

[17] OECD, regulatory policies, soft law.

[18] Ryan Hagemann, Jennifer Huddleston Skees, Adam Thierer, 'soft Law' is eating the World, George Mason university, the bridge.

[19] Preparing for the future of transportation, U.S. Department of Transportation.

[20] Ministry of Economics, Latvia, The memorandum of Understanding with Uber and Taxify has been signed.

[21] International Finance, Uber and AXA to set a new standard for protection of independent drivers and couriers.

[22] Collaboration, Innovation … Regulation? The disruptive shifts taking our economy by storm, Deloitte.

new business models makes it difficult for regulators to develop an adapted regulatory framework for all of them.

Along with this notion of regulation, the term **governance** is also key in this research. Governance is defined by the OECD as "the exercise of political, economic and administrative authority necessary to manage a nation's affairs[23]." The definition can be broadened for the purpose of this research and translated at the European and international levels and not be limited at the national level. Questions linked to the concept of governance are, who has a voice in the decision process? How are the decisions made? And who is accountable once a decision has been made? [24].

Another key notion to present is the notion of **good governance**, which can be characterised by "participation, transparency, accountability rule of law, effectiveness, and equity etc. [25]."

In this section the key challenging regulatory aspects around the question of disruptive innovation and mobility will be listed. Then, the existing governance models and reasons to regulate smart mobility will be analysed. Finally, the various regulatory levels collaborating in the development of this regulatory framework around disruptive innovations in relation to mobility will be presented.

3.1. Regulatory Levels

This section presents the existing regulatory frameworks at both the international and EU level. This implies presenting and discussing the key regulatory bodies and texts. The role played by the national and local authorities regarding the development will also be raised.

3.1.1. International

At the international level the first regulatory body to mention is the Economic and Social Council (ECOSOC) of the United Nations (UN).

- *Key regulatory bodies*

It was established in 1945 as one of the six main organs of the UN. ECOSOC can be described as "central platform for fostering debate and innovative thinking, forging consensus on ways forward, and coordinating efforts to achieve internationally agreed goals.[26]" In 1947 ECOSOC

[23] OECD Glossary of statistical terms.
[24] Institute of governance, defining, governance.
[25] OECD Glossary of Statistical term.
[26] ECOSOC, United nations Economic and Social Council.

created the United Nations Economic commission for Europe (UNECE), composed of 56 members from Europe, North-Africa and Asia, with its major aim to promote economic integration[27]. The highest policy making body of the UNECE in the field of transport is the Inland Transport Committee (ITC). Within this intergovernmental forum UNECE members and other UN members work together to develop tools for economic cooperation and also adopt international legal instruments regarding inland transport. Within ITC there are several Working Parties (WP).

- *Key regulatory texts*

At the international level the Vienna convention on road traffic is the most relevant text to this research and is key for the development of the regulatory framework for disruptive innovation in mobility. The Vienna convention is an international treaty agreed upon at the ECOSOC Conference on Road Traffic in 1968 and concluded in Vienna on 8 November 1968. The aim of this treaty is to facilitate international road traffic and to increase road safety by establishing standard traffic rules among the 78 countries which ratified this convention. The international level of regulation and policy makers play an important role especially regarding the questions of environment, customs, harmonization and standardization.

3.1.2. European Union

Key regulatory bodies

- The European Parliament and its committee on transport and tourism (TRAN Committee);
- The European Commission is also playing a key role as a regulatory body at the EU level;
- The European Court of Justice;
- The Council of the European Union.
- Road transport is heavily regulated and the following texts or regulated areas are relevant to be mentioned.

Key regulatory texts

- The business to platform directive: the proposal[28] for an EU regulation was put forward in April 2018 by the EC to promote fairness and transparency for business users of online intermediation services. This proposal is mainly directed at online intermediary service providers, regarding the payment of the service on the platform and the contractual

[27] UNECE, info, about UNECE, mission

[28] Regulation on promoting fairness and transparency for business users of online intermediation services

relationship. Airbnb, Uber, Facebook, and Amazon among others would be affected by this directive[29].

- Regulation on taxi and private hired vehicles: this regulation coming from the European parliament or from the European Commission is particularly relevant regarding the question of access to the profession, access to the market, and rest time rules.
- Regulatory texts regarding the questions of subcontracting and liability[30].
- General Data Protection Privacy- regulation 2016/679: on the protection of natural persons with regard to processing of personal data and on free movement of such data. It was approved in April 2016. GDPR is the most important change in data privacy regulations in 20 years. The goals of GDPR:
- To harmonize data privacy laws across Europe,
- To protect and empower all EU citizens' data privacy,
- To reshape the way organizations across the region approach data privacy.
- The regulation around taxation at the level of the European Union is also important to mention in the scope of this research. The EU has created a framework to encourage Member States to use taxation and infrastructure charging in the most effective and fair manner in order to promote the 'user pays' and 'polluter pays' principles.
- Directive 2011/76/EU amending Directive 1999/62/EC on charging heavy goods vehicles for the use of certain infrastructures,
- The Energy Taxation Directive.
- Regulation linked to competition, with antitrust regulation and the questions regarding state aid in relation with road transport and infrastructure. The Council of the EU sets out general antitrust procedural framework which applies to transport by road in the council regulation N°1/2003 along with the council regulation N°1017/68 presenting the applying rules of competition to transport by road, but not only. Regarding competition, it is also important to mention relevant regulations and guidelines on state aid, and transport infrastructure.
- Public procurement with the public procurement directive.
- The public transport regulatory framework.
- The Regulation n°1370/2007 on public transport services by rail and by road[31].

[29] A proposed EU regulation for online platform-to-business relationships

[30] Study for the JURI committee, liability in subcontracting chains : National Rules and the Need for a European framework

[31] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007R1370&from=EN

At the EU level the policy makers play a key role especially regarding the questions of safety, environment, funding, social protection, standardization, and competition.

3.1.3. National and local

At the national level within the EU Member States the relevant regulatory bodies and texts for the scope of this research vary from a country to another and depend on the governance models. The key areas where national regulatory framework and authority play a key a role are taxation, subsidies, funding, licensing, and access for example to infrastructure.

At the local level, once again the texts and bodies vary from a local authority to another, according to the chosen governance model amongst other elements. The key areas where national regulatory framework and authority play a key a role are licensing, subsidies, the use of public space and public infrastructure, the public procurement, funding and granting access to the city.

3.2. Policy and regulatory aspects

This section highlights relevant policy and regulatory aspects that are key to consider in the development of the regulatory frameworks. Policy and regulatory aspects which are a key challenge related to the development of the regulatory framework around disruptive innovation in mobility:

- The use of data. The question of data is a recurrent one when it comes to the development and the implementation of disruptive innovation as Smart mobility just like smart cities are by definition huge processors of data[32].
- The issue of personal protection. The question of protection of personal data is to find the right balance to define and then protect so called personal data, without preventing business and innovation that need data to develop and operate. How to guarantee the right protection of my geolocalisation and bank data when using Uber, Whim or Lime? How to guarantee the protection of personal data without slowing down the race in the development of autonomous vehicles?
- The governance of data. In the current operating transition towards Smart Mobility data is the most valuable asset. There is a need for the governing authority (government at the national level, governing bodies at the European level) to exert some sort of control over

[32] Data protection in a smart city bike system: the example of Turku. Vera Fovet.

these data, first not to lose its authority but also to avoid anti-competitive practices or any other kind of potential negative externalities[33].

- Environmental issues. Smart mobility with a stronger use of public transportation, the development of e-mobility or the use of automated vehicles is meant to have a strong positive impact on the environmental issue.
- The social challenges. Social protection of workers and more specifically drivers. Uber has faced many legal procedures on the ground of employment rights and the drivers' contracts in Europe[34]. There are also issues regarding the number of hours worked by Uber drivers and the regulation around it, some authors[35] are even talking about a legal loophole about this issue. Social inclusion with the notion of inclusivity, equity and diversity to be taken into account.
- Taxation. The complexity of tax structures deployed in the new business models thanks to disruptive innovation in transport, besides for example Airbnb, Amazon and Uber. Avoiding taxes is also creating unfair competition. The key role of a governing body is to avoid the loopholes enabling tax avoidance. But also, subsidies and taxes are powerful tools and can be used as an incentive to support for example the development of electric or low CO^2 emission vehicles in most of the member states[36]. For example, in The Netherlands the registration tax is calculated based on the emission of CO_2 [37]. The same logic can be applied to disruptive innovation with for example subsidies for the upkeep for infrastructure supporting disruptive innovations[38].
- Competition and the importance of working towards the prevention of the development of anti-competitive behaviour by correcting or constraining the acquisition of dominant power[39]. Uber[40] and Amazon[41] are good examples to illustrate this problematic.
- Liability: the fact for someone to be legally responsible for something[42]. Regarding shared mobility we can take the example of Blablacar, a platform of ridesharing, which accepts no liability for rideshares[43]. Regarding autonomous vehicles the question is to know if a driver can still be held liable in case of an accident[44].

[33] Transportation research part A: The governance of mobility. Iain Docherty, Greg Marsden, Jillian Anable.
[34] The guardian, Uber loses appeal over driver employment rights.
[35] Diane Kruzman, Some Uber drivers works dangerously long shifts, USA Today.
[36] CO^2 Based motors vehicle taxes in the EU, ACEA.
[37] See supra
[38] The governance of Smart mobility, Elsevier.
[39] Ian Forrester, Disruptive innovation and implications for competition policy, European University Institute.
[40] Damien Gerardin, Should Uber be allowed to compete in Europe? And if so how? Competition Policy International.
[41] Lina M.Khan, Amazon's antitrust paradox, The Yale law journal.
[42] Cambridge Dictionnary
[43] European Comission, Exploratory study of consumer issues in online peer-to-peer platform markets, case study of Blablacar.
[44] Katie Chandler, Driverless cars and product liability.

- Safety, as many of the disruptive innovations in smart mobility promote themselves as "safer" than traditional mobility[45]. The question of safety is also at the heart of the regulatory framework when you talk about road safety regarding autonomous vehicles[46] , or regarding electric vehicles but also, simply regarding the Lime electric scooter[47].
- Security and cyber security. These aspects are of particularly important for autonomous vehicles[48].
- Standards and standardization is a horizontal aspect touching upon most of the other aspect presented. Standards can concern data protection, testing of autonomous vehicles, or even about communication protocols for multi-brand platooning[49].
- The question of access to the cities and the regulatory element linked to it are also to be taken into account in the frame of this research. Many cities and towns in the EU are regulating around the question of access to the city (Urban Access Regulations - UVAR). UVAR are where certain types of vehicles are restricted from entering a part of an urban area with the aims to resolve issues such as air pollution, congestion, road safety and noise while supporting the attractiveness of cities. There are three main identified schemes adopted by the cities to regulate around access to the city. Low Emission Zone (LEZ), defined areas where the most polluting vehicles are regulated. Usually this means that vehicles with higher emissions cannot enter the area[50]. A LEZ scheme has already been adopted in Germany, The Netherlands, France, Belgium and England amongst other European countries. Urban Road Tolls, where entry to an area is subject to payment. In most cities this money is usually spent on improving transport in and around the city[51]. The most well-known examples of urban road tolls are London[52] and Stockholm[53]. Urban Access Regulation, is the case where access is regulated by other requirements, for example when a permit is required to enter an area, or access allowed at certain times of the day[54].

3.3. Governance models

[45] Iain Docherty, Greg Masden, Jillian Anable, The governance of smart mobility.
[46] European Commission, on the road to automated mobility: An EU Strategy for mobility of the future.
[47] Lime Scooter welcome, but speed limit essential, PressReader.
[48] Caleb Kennedy, New threats to Vehicle Safety: How cybersecurity Policy will shape the future of Autonomous vehicles, Michigan Telecommunications and Technology law review.
[49] See footnote 35.
[50] Urban Access Regulation in Europe, Low Emission Zone.
[51] Urban Access Regulation in Europe, Urban Road Tolls.
[52] Urban Access Regulation in Europe, Urban Road Tolls, London.
[53] Urban Access Regulation in Europe, Urban Road Tolls, Stockholm.
[54] Urban Access Regulation in Europe.

3.3.1. International Governance

Regarding the notion of governance two concepts seem important to be introduced: Sustainable development Goals (SDG's) and Sustainable Urban Mobility Plans (SUMP).

The SDGs were adopted in 2015 by all UN Member States and aim at becoming a shared plan for peace and prosperity for people and the planet, now and into the future. There are 17 components of the SDG's and several are linked with the question of governance of transport and the transition of smart mobility. The main one on sustainable cities and communities is SDG 11, but it is considered that all the 17 SDG's are somehow linked with the question of mobility[55]. The Inland Transport Committee, supported by the Sustainable Transport Division of UNECE, carries out a number of activities which have a direct impact on the achievement of the 2030 Sustainable Development Agenda[56]. These legal instruments are considered indispensable for developing efficient, harmonized and integrated, safe and sustainable inland transport systems[57].

The SUMP Concept[58] is coming from the 2013 Urban Mobility Package[59] through a broad exchange between stakeholders and planning experts across the EU. The concept describes the main features of a modern and sustainable urban mobility and transport plan[60]. One of the main goals of the SUMP concept is to improve the accessibility of urban areas and to provide high-quality and sustainable mobility and transport to, through and within urban areas.

The next paragraphs aim to present the reasons for a national government[61] to get involved in the governance of transport. Some of these can also apply to the EU level or the local level. It is important to note that the intervention of the state tends to vary based on the culture of the country. For example, in continental Europe, where the culture of the welfare state is important, the state will tend to intervene in the governance of transport[62] more than in the countries with a more neo-liberal market tradition[63]such as the US and the UK.

3.3.2. Challenges of governance

There are many challenges to overcome for a government at the national level but also at the local or EU level in governance of mobility.

[55] SDGs and the UN Transport Conventions
[56] Transport and the Sustainable Development Goals
[57] Inland Transport Committee
[58] The SUMP Concept
[59] The Urban Mobility Package
[60] A Concept For Sustainable Urban Mobility Plans
[61] Iain Docherty, Greg Masden, Jillian Anable, The governance of smart mobility.
[62] Constanzo Ranci, Competitiveness and Social Cohesion in Western European Cities
[63] Jamie Peck, Neoliberalizing states: thin policies/hard outcomes.

- Timing: considering the pace of development of innovation in mobility the window for states to take over the governance from private actors might be really short[64]. This would also be the way to prevent self-governance.
- The regulation of data[65]. Smart mobility innovations are huge processors of data, data will be the most valuable asset, for several authors "data is the knowledge upon which the power to control the marketplace is built"[66]. The risk to which governments are exposed is that disruptors will have the control of knowledge and the control of the power coming from it.
- The distributional impact: equity and non-discrimination which are part of a national government role. This problematic can be illustrated with for example the Uber algorithm that offers a better service to certain neighbourhoods in Washington by means of surge pricing[67].
- Financing the development of disruptive innovations[68]. The problematic about taxes and subsidies is closely linked to governance, how to balance, taxes, subsidies, use of infrastructure and public interest. The problematic of taxation of smart mobility needs to be addressed by governments[69].

According to some authors[70] for the governance of Smart mobility there is a need "to create the conditions of a continuous learning process". Indeed, the new role played by citizens is to be taken into account regarding the question of governance of transport. New role of the citizens in Smart Mobility is now a source of information with the data they are providing to smart mobility actors, but also by providing information and services when it comes to peer to peer sharing. It seems important to raise awareness about the importance of data protection and to work on 'digital empowerment' of citizens. At the European level, in the frame of the digital education action plan[71], the campaign #SaferInternet4EU[72] was launched in May 18 as one the 11th action to be taken in the frame of the action plan[73].

3.3.3. European city examples

[64] G. Capoccia, D. Kelemen, the Study of Critical Junctures: Theory, Narrative, and Counterfactuals in Historical Institutionalism.
[65] V. Buscher, L. Doody, M. Webb, C. AounUrban Mobility in the Smart City Age
[66] Iain Docherty, Greg Masden, Jillian Anable, The governance of smart mobility.
[67] The Washington post, Uber seems to offer better service in areas with more white people. That raises some tough questions.
[68] Lindberg Gunnar, Fridstrøm Lasse, Working Paper, Policy strategies for vehicle electrification
[69] Iain Docherty, Greg Masden, Jillian Anable, The governance of smart mobility.
[70] Enrica Papa, Dirk Lauwers, Mobility Governance in Smart Cities of the Future.
[71] Digital Education Action Plan - Action 7 Cybersecurity in Education
[72] Launch of the #SaferInternet4EU initiatives on Safer Internet Day
[73] Digital education Action Plan

London, Amsterdam and Lyon are three examples to present how governance of transport can work at a city level in different countries in Europe.

- London

London with the extensive role played by Transport of London (TfL). TfL is a public organisation responsible for transportation in London[74]. London and TfL are often presented as a model in terms of governance of transport because of the high usage of public transport and lower carbon emission compared to the rest of the UK. This achievement can be linked to the convenience of the Oyster card, an integrated ticketing system whereby a single card can be used on all transport services across London. The TfL model is characterised by four main features:

- First, there is the control over the provision of bus services such as setting the bus routes before tendering them individually to private sector operators.
- Then there is the ability to negotiate for long-term funding settlements, and the ability to raise local funds.
- There is also, a governance structure characterised by the single management of most public transport.
- And finally, a transport strategy that is integrated with other policy areas. The transport strategy for London is coordinated and integrated within the wider economic strategy for the city, which allows TfL to consider the impact of transport investment on other areas of public provision. Health can be used as an example[75]: TfL produced the world's first transport action plan for health which sets out plans to promote walking and cycling, improve health and reduce costs for the National Health Service (NHS) in London.

- Amsterdam

Amsterdam metropolitan area is organised in two governance arrangements: a smaller scale partnership which includes 16 municipalities and a larger structure called Amsterdam Metropolitan Area (MRA) including 36 municipalities and 2 provinces. The MRA fosters co-operation in three main policy fields: transport, economic development and spatial planning. Each policy field has its own platform. For the question of transport first there is the platform for the Accessibility of the Amsterdam Metropolitan Area (PBM), which meets on average six times a year and co-ordinates all activities related to traffic and transport projects. For economic development there is the platform for the Regional Economic Structure (PRES). Finally, for spatial planning there the platform for Planning (PRO). This last platform meets approximately four times a year and pays a special attention to the issues of sustainability, metropolitan landscape and urbanisation[76] [77].

[74] TfL is a model for transport investment and management in other UK cities.
[75] Hendy P. (2014), Improving the health of Londoners, Transport action plan, London: Transport for London.
[76] Overview of metropolitan governance paper for the parliamentary committee on state building, regional policy and local self-government, Ukraine
[77] Government of The Netherlands, Mobility, public transport and road safety.

- Lyon

Since 1 January 2015, in Lyon, the urban community of the so called “Grand Lyon” became the “Métropole de Lyon”. This new metropolitan authority combines the competences of Grand Lyon and those of the department of the Rhône on its perimeter. It is administered by a Metropolitan Council, whose chairman is the Mayor of Lyon. “Métropole de Lyon” covers the creation and management of cultural facilities, construction and maintenance of hot and cold networks and broadband networks, concession of electricity and gas distribution, management of aquatic areas and flood prevention, prevention of delinquency, access to rights, participation in the governance of train stations, co-leading competitiveness poles, housing, creation and maintenance of services for electric vehicles, external defence against fires, hygiene and health. The budget of the “Métropole de Lyon” comes from three main sources of revenues: 65% from tax revenues, 25% from central government transfers and 10% from other sources. “Métropole de Lyon” includes several participatory and consultative bodies: the Development Council; the Consultative Commission for Local Public Services; and the Inter-municipal Commission for accessibility for the disabled[78].

[78] Overview of metropolitan governance paper for the parliamentary committee on state building, regional policy and local self-government, Ukraine

4. DISRUPTIVE INNOVATION IN URBAN MOBILITY

4.1. Definition of disruptive innovation

According to the Christensen Institute[79] disruptive innovations have the potential to be an incredibly positive force in the world. If there is no uniformly accepted definition of disruptive innovation, at least some criteria to qualify an innovation as a disruptive one can be identified. It is important to start by presenting what disruptive innovations are not[80]: disruptive innovations are not new technologies that make good products better[81].

The commonly accepted definition of disruptive innovation is the definition from Clayton Christensen[82] according to which disruptive innovation is a "process by which a product or service initially takes root in simple applications at the bottom of a market, typically by being less expensive and more accessible, and then relentlessly moves upmarket, eventually displacing established competitors[83]." According to this conception the first car developed by Carl Benz in 1886 would not be qualified as a disruptive innovation because the vehicle was targeting exclusive consumers, a training was required to learn how to use it, and it included high-end features, while the Ford model T from 1908 is considered disruptive because it was affordable, easy to use and included only basic features. According to the Christensen institute there are three elements to qualify innovation as disruptive:

- First there must be an enabling technology, an invention that makes a product more affordable and accessible to a wider population. The smart phone or the internet are key examples of enabling technology.
- The second element is an innovative business model which according to this definition targets non consumers, new customers who previously did not buy a product, did not use a service in a given market or were the least profitable customers.
- The third element is a coherent value network, so a network in which suppliers, partners, distributors, and customers are each better off when the disruptive technology prospers. These criteria can also be aligned with the one from the OECD definition previously mentioned[84].

[79] Christensen institute
[80] Harvard business school online, 4 keys to understanding Clayton Christensen's theory of disruptive innovation, Chris Larson.
[81] Disruptive innovations, Clayton Christensen institute.
[82] Harvard business institute, what is disruptive innovation?
[83] See supra.
[84] OECD, key points of the hearing on dispute innovation, 16-18 June 2015

4.2. Platform and shared economy

Two other relevant terms have to be defined: **platform economy** and the complementary concept of **shared economy**.

Platform economy can be defined as a medium which lets others connect to it[85] and **shared economy** is an economic system based on people sharing possessions and services, either for free or for payment, usually using the internet or more often a platform to organize it[86].

These two terms a closely interrelated as platform economy is an enabler of shared economy while using it at the same time. These economic models are enabled by the technological advancement of internet combined with democratisation of use and ownership of smartphones. The interconnection of these two is so strong that the European Commission (EC) actually uses the term "collaborative economy" and defines it as "business models where activities are facilitated by collaborative platforms that create an open marketplace for the temporary usage of goods or services often provided by private individuals"[87].

These global trends lead to regulatory challenges. According to the platforms themselves these only offer matchmaking services, whereas in according to some authors these act as a classic employer ('platform paradox'[88]). In the logic of this platform paradox the platforms are not doing a passive matchmaking, but instead rely on rating systems and algorithmic control to ensure that each aspect of the worker's task is completed in compliance with company policy and customer instructions.

This paradox plays a crucial role for purposes of EU law and the most relevant example is the Case C-434/15 *Asóciacion Professional Elite Taxi v Uber Systems Spain SL*[89]. In the frame of this judgement, Uber, a strong example of platform and collaborative economy, suggested that its platform was an 'information society service' so the rules of the EU's electronic commerce directive were to be applied. The European Court of Justice (ECJ) disagreed with the suggested reasoning given the tight control exercised by Uber over drivers. The company offers more than an intermediation service and offers also urban transport services via its platform. Several other important regulatory challenges around platforms remain: there is the question of labour law and the problematic of disguised self-employment, but also the question of taxation as they are dematerialised and the question of data protection.

There are many relevant examples to illustrate the new trends of platforms and shared economy-based companies such as Amazon or Booking.com. One of the most famous examples of the

[85] What is Platform Economy? Quora.
[86] Cambridge Dictionnary, Sharing economy.
[87] Communication from the European Commission, a European Agenda for the Collaborative economy.
[88] European Confederation of Trade Union, Collective voice in the platform economy: challenges, opportunities, solutions.
[89] Case C-434/15 Asóciacion Profesional Elite Taxi v Uber Systems Spain SL.

platform and shared economy is Airbnb, currently present in over 190 countries[90], which connects travellers and local property owners. Its business model works as in one side of the platform people list their housing properties and receive an income as a rent. On the other side Airbnb provides the opportunity for travellers to book these available spaces from local hosts for lower price compared to hotels. The problem caused by Airbnb is that its support short term rentals of accommodations in tourist and central areas of the city. These areas are at the same time facing a shortage of housing[91]. To counter this problem several cities imposed taxes on Airbnb rentals and limited the amount of nights per year the property can be rented.

4.3. Urban mobility

As we saw in the precedent section with the example of Uber, the transport sector is far from being excluded from the trend of platform and shared economy. The development of this trend in transport as in all the other sectors is supported by the Internet, widespread availability of smartphones and also by the geolocalisation. Another impacting element is the parallel trend of less of vehicle ownership to more usership of the transportation means previously mentioned.

Amazon is relevant example of platform economy that might disrupt the transportation sector. According to some authors[92] Amazon's entry into directly managing the distribution of its products has led to massive changes in the trucking and freight transportation industries and will likely lead to more over time. Its ultimate goal seems to be a complete, door-to-door delivery service that no longer needs to rely on any specific providers for last-mile delivery, along with increased internal freight capacity. Among its recent major developments, Amazon moved from relying heavily on third-party services for delivery to amassing its own fleet of semi-trailers, building a network of independent contractors and working on development of drones that could, eventually, someday in the future, handle last-mile delivery. This move will force the other players to either compete or partner with Amazon.

Uber, as already mentioned is one of the most famous example of platform, shared economy coming as a disruption to the transport industry. Uber relies on its smartphone application to connect passengers with drivers. The customers download the Uber application and use it when they need a ride. With the application you also have the possibility to track the car. Drivers are using own cars and anyone with a car can become an Uber driver. Uber set the prices for rides, the payment is made by credit card via the application, which results in safe and secure transactions. Uber keeps a percentage of the price of the ride for itself as a revenue. In certain locations or periods when the competition is stronger, such as Lyft, Uber tends to reduce the price of the ride. Uber operates a low cost model and does not own the cars, but it still has to invest in

[90] Collaborative services Network, Case Study of Uber and Airbnb.
[91] Airbnb contre villes : où en est le bras de fer ?
[92] Sean Maharaj, Opinion: Amazon Innovations Force Supply Chain Change, Transport Topics.

technology and in research in order to grow. The Uber's business model[93] just described is a typical example of the platform economy business models'.

Another relevant example from this transition from ownership to usership and platform economy in transport are the e-scooter services such as Tier, Flash Lime. Thanks to these applications you can find an available e-scooter near you, unlock it via the application and pay accordingly to the distance or time travelled. E-scooters are causing several issues in cities. For example, in Madrid the local authorities ordered the removal of electric scooters within 72 hours in December 2018 following an accident with a pedestrian[94]. In Paris, e-scooters have been banned from circulating on the footpath and will be included in the *Loi d'orientation des Mobilités* for the e-scooter to benefit from a regulatory framework[95].

Flixbus is another interesting example of innovation in transport, disrupting European long-distance travel. The company provides convenient, affordable, and safe intercity bus travel to 1,000 destinations in 20 countries across Europe. This company works with more than 250 independent bus partners to offer a comprehensive network in Germany, France, Italy, Austria, and the Netherlands, as well as cross-border services to countries including Scandinavia, Spain, and the UK. The Flixbus e-commerce and technology platform aims at providing a high-quality customer experience, and enables the company to work effectively with its independent bus partners who operate the network while Flixbus focuses on network and capacity planning, quality management, and sales and marketing. Flixbus offers paperless travel, booking and delay management on its mobile app, data driven network development, and dynamic pricing similar to airlines[96].

[93] Collaborative services Network, Case Study of Uber and Airbnb.
[94] The Telegraph, Madrid orders removal of electric scooters within 72 hours.
[95] The Local, Riding an electric scooter on the pavement will soon be illegal in France.
[96] Disrupting travel : Flixbus

5. CASE STUDIES

In this section of the research relevant case studies are presented. These case studies are divided into four categories. The first category of this section is about cooperative, connected and automated mobility,

5.1. Cooperative, connected and automated mobility

5.1.1. Connected and Automated Vehicles

Introduction
Connected vehicles are defined as a motor vehicle "that connect to other vehicles and or devices, networks and services outside the car including the internet, other cars, home, office or infrastructure"[97]. An autonomous vehicle is defined as "a fully automated vehicle equipped with the technologies capable to perform all driving functions without any human intervention[98]." Automated Vehicles is defined as "a motor vehicle which has technology available to assist the driver so that elements of the driving task can be transferred to a computer system[99]." There are meant to be several advantages linked to the deployment of vehicle automation: • Road safety. As the human error is estimated to be a factor of 90% of the road accidents[100], then the deployment of automated, connected and cooperative vehicles will improve road safety. • Reducing congestion. By helping to reduce congestion and making traffic more fluid in general the deployment of automated, connected and cooperative vehicles will have a positive environmental impact. • Improve social inclusion by ensuring mobility for all, including elderly and impaired users.

[97] Gowling WLG, Are you data Driven?
[98] European Parliament, Briefing January 2016, Automated Vehicles in the EU.
[99] European Parliament, Briefing January 2016, Automated Vehicles in the EU.
[100] European Commission, Road Mobility and Transport.

- Bringing comfort to people. By allowing people to do other activities instead of driving and easing access to city centres are also expected advantages.[101]

But the disruption can also bring negative impact if not correctly framed especially from a regulatory point of view, for example job shift resulting in job losses.

International Regulation

At the international level several regulatory texts and regulatory bodies are important to highlight.

- The Geneva Convention on road traffic (1949)[102] that aims at promoting the development and safety of international road traffic by establishing certain uniform rules.
- The Vienna Convention on Road Traffic (1968) that aims to increase road safety. It has been ratified by 75 countries including all EU member states except Spain[103]. This convention is stricter than the Geneva Convention regarding the obligations of the driver. The US have not ratified the Vienna convention, which makes it easier for them to allow autonomous vehicle. One of the main elements of the Vienna convention linked to the question of automated vehicle is the article 8[104]. It states that "Every moving vehicle or combination of vehicle shall have a driver" and that "Every driver shall at all times be able to control his vehicles". This restrictive definition can be slowing down the deployment of cooperative, connected and automated vehicles. The Working Party on Road Traffic Safety in March 2014, thus supported the amendment of the convention and the terminology "system which influence the way the vehicles are driven" and other systems "which can be overridden or switched off by the driver" are in accordance with the article 8 of the Vienna Convention and can thus be qualified as vehicles. With this amendment the definition of vehicles became broader and more flexible. This amendment was approved by the Working Party on Road Safety. On December 13, 2016, an act implementing an amendment to the Vienna Convention on Road Traffic entered into force in Germany. The amendment allows the transfer of driving tasks to the vehicle itself, provided that the technologies used are in conformity with the United Nations vehicle regulations or can be overridden or switched off by the driver[105]. It is also important to highlight the fact this question is now a priority of the World Forum for Harmonization of vehicle Regulations (WP 29)[106].

[101] ERTRAC, Automated Driving Road Map, 2015.
[102] Convention on Road Traffic Geneva, 19 September 1949
[103] Convention on Road traffic.
[104] The Vienna Convention, the convention on Road Traffic of 1968.
[105] Germany: road transport regulation amended to allow autonomous vehicles
[106] Consolidated and updated provisional agenda for the first session of the working party on automated/autonomous and connected vehicles.

- The International Transport Forum (ITF) at OECD is an intergovernmental organisation with 59 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers.

The UNECE with the adoption in October 2018 of the resolution on the deployment of highly and fully automated vehicles in road traffic that offers recommendations to ensure a safe interaction between automated vehicles, other vehicles and more generally all road users[107], and stresses the key role of human beings, be they drivers, occupants or other road users[108].

European Regulation

After the international level it is interesting to take a look at the key regulatory texts and at the European level. The questions of data is a recurrent challenge when it comes to the development and the implementation of disruptive innovation as Smart mobility just like smart cities are by definition huge processors of data. Different element imposed by the GDPR[109] link to the development, utilisation au Connected, automated vehicles (CAVs). Constructors of CAVs will have to define very precisely the exact data they need to process. This question of data protection regarding the development of CAV's raises concerns such as ethical issues, safety, security and consequently user trust.

- The declaration of Amsterdam (14th April 2016)[110] is another key component of the existing EU level regulatory framework the European Commission and private sector have agreed on with joint goals and actions to facilitate the introduction of connected and automated driving on EU roads and prevent a patchwork of rules and regulations arising within the EU, which would be an obstacle to both manufacturers and road users[111].
- The question of liability and insurance at the EU level is another important aspect. The Motor vehicles liability insurance Directive 72/166/CEE[112] does not really deal with the question of responsibility, the only obligation is to be insured. There is no major change related to automation. Next, according to Directive 85/374/EEC on product liability[113], the producer will be liable if its product is considered defective (it does not provide the safety level the consumer is entitled to expect). In the frame of this directive insurer and manufacturer will share the responsibility, and there is no major change when it comes to CAV's. The only consequence is a stricter responsibility on the victim who has to prove that the accident was caused by an error of the vehicle and not from a negligence. This

[107] Report of the global forum for road traffic safety on its seventy-seventh session
[108] UNECE adopts resolution on the deployment of highly and fully automated vehicles in road traffic – 9th October 2018.
[109] EUGDPR.
[110] The Declaration of Amsterdam.
[111] Government of the Netherlands, the declaration of Amsterdam.
[112] Motor Vehicle liability insurance
[113] Directive 85/374/EEC, product liability.

becomes problematic with autonomous vehicles as there is a need to access the black box, which has to be given by the manufacturer.

- The directive 2007/46/EC[114] on type-approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, is also relevant to mention as it provides with a common set of rules. It makes type-approval compulsory for all categories of whole vehicles, including those built in several stages. It lays down: a harmonised framework with general technical requirements for the type approval of new vehicles and of systems, components and technical units designed for such vehicles, so as to facilitate their registration, sale and entry into service in the EU; rules regarding the sale and entry into service of vehicle parts and equipment.
- The questions of standardization and type-approval are key when it comes to the current regulatory framework on the development of cooperative, connected and autonomous vehicle. A relevant element is also Directive 2007/46/EC[115] as any new motor vehicle has to comply with the administrative procedures and the technical requirements defined in the pre-mentioned directive. Next, there is the declaration of Transport Minister of the G7[116] according to which the EU commissioner for transport shall work coordinating research, promoting international standardisation within an international regulatory framework, evolving technical regulations and ensuring data protection and cyber security. As previously mentioned the development of automated vehicle at the European level is closely linked with the performance of infrastructure.

The Horizon 2020 is an also an important element as several project are financed by the EU to work on this topic (e.g. Ensemble[117] project).

Another key element are the guidelines published by DG Grow on the 26th of October 2018. The EC announced its intention to work with EU countries in 2018 on guidelines to ensure a harmonised approach for exemption procedure for the type- approval of automated vehicles[118]. The main goals of the guidelines are to promote new technologies, to harmonize the practice on Article 20 of Directive 2007/46/EC and to ensure fair competition and transparency.

As part of the 2001 White Paper on Transport, the EC adopted on 16/12/2008 the ITS Action Plan, which led to the adoption on the 7/07/2010 of the "ITS Directive" 2010/40/EU.

- Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems (ITS) in the field of road transport and for interfaces with other modes of transport: ITS Directive

[114] Directive 2007/46/EC.
[115] Directive 2007/46/EC
[116] The declaration of Transport Minister of the G7
[117] Ensemble, European Project, Horizon 2020
[118] DG, Grow guidelines, publication.

- Regulation 886/2013 on road safety traffic information
- Regulation 2015/962 on EU-wide real-time traffic information Services (see Annex I for more details)
- Regulation 2017/1926 on MultiModal Travel Information Services (MMTIS)
- Draft Delegated Act on Cooperative Intelligent Transport Systems (C-ITS) that will amend and supplement the ITS Directive.
- Standardisation programme for ITS // Implementing Decision (EU) No 2016/209
- C-ITS Security Description of the CPOC Protocol in the EU C-ITS Security Credential Management System (EU CCMS) - Study
- C-ITS Security - Certificate Policy for Deployment and Operation of European Cooperative Intelligent Transport Systems (C-ITS)
- C-ITS Security - Security Policy & Governance Framework for Deployment and Operation of European Cooperative Intelligent Transport Systems (C-ITS)
- C-ITS Platform Phase II final report of September 2017; Annexes to the C-ITS Platform Phase II final report of September 2017;
- UN Regulation on AVs

The Third Mobility Package includes an integrated policy for the future of road safety with measures for vehicle and infrastructure safety; the first ever CO2 standards for heavy-duty vehicles; and a strategic Action Plan for the development and manufacturing of batteries in Europe.

Regarding digital affairs, it also includes the following Communications:

- Europe on the move: Sustainable Mobility for Europe: safe, connected, and clean
- On the road to automated mobility: An EU strategy for mobility of the future.

Also related to the European Commission's communication, MEP Van de Camp's own-initiative report on autonomous driving in European transport was adopted during the plenary session on 15th January 2019.

Digital Single Market

- Communication from the Commission to the European Parliament, the European Council, the Council, the European economic and social Committee and the Committee of the Regions: "Artificial Intelligence for Europe"
- Communication on Building Trust in Human-Centric Artificial Intelligence following the work of the high-level group on the Ethics Guidelines for Trustworthy AI
- Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications
- Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union: NIS Directive

- Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013: Cybersecurity Act
- Communication on 5G for Europe: An Action Plan

National Regulation

France published in May 2018[119], a strategic framework on French government's policy actions dedicated to the development of automated or driverless vehicles, covering modes of use and local expectations, safety, acceptance, competitiveness and employment, and EU and international cooperation[120].

In **Germany** is also relevant, as it has established a growing number of test beds for technologies, systems and vehicles. Currently 15 exist, allowing the testing and validation of automated driving functions and intelligent infrastructures on a variety of different road categories in real traffic situations and under real-life conditions[121].

In the **UK**, in 2015 the government founded the Centre for Connected and Autonomous Vehicles (CCAV30) to secure the UK's position at the forefront of this change, focussing on the safe development, production, deployment and use of CAVs and their related technologies[122]. In Austria, in autumn 2018 the Action Programme on Automated Mobility covering the period 2019-22 was released. Additional 65 million Euro of public funding have been dedicated to follow-up actions on automated and connected mobility[123].

In **Finland** as well several measures are being adopted to support the development of the automated, connected and cooperative vehicles. For example, the 75 km Aurora test section with a specifically equipped 10 km instrumented section along E8 in Northern Finland is in active use and automated public transport shuttles and buses as well as MaaS solutions are being evaluated in several cities to assess and improve their technical performance, impacts, benefits and costs[124].

Greece has decided to allow the circulation of fully automated driverless vehicles in urban areas and on public roads for research/pilot implementations. The framework requires a thorough analysis of the proposed routes, a certification process for the vehicles, a proper training for the operators (remote or on-board), a supervision by appropriate specialized research or academic bodies and an active support by local authorities. Greece is in the process

[119] National Strategy for the Development of Autonomous Vehicles
[120] ERTRAC, Automated Driving Road Map, 2019.
[121] ERTRAC, Automated Driving Road Map, 2019.
[122] ERTRAC, Automated Driving Road Map, 2019.
[123] ERTRAC, Automated Driving Road Map, 2019.
[124] ERTRAC, Automated Driving Road Map, 2019.

of further adaptation of its legal framework to support and facilitate the permanent circulation of autonomous vehicles[125].

Examples

Stockholm autonomous shuttles

Nobina is a private company operating autonomous buses in Stockholm, starting three years ago a pilot in closed areas. The test in open road allowed Nobina technology to collect inputs good and bad from the public following the text in public road, to learn how the vehicle actually acts in traffic. After the 20 000 passengers being driven by the autonomous shuttles during the year, the new aim is now to take it to the next level which is today three vehicles integrated in the public transport. The level of automation of these autonomous shuttles is somewhere in between level 3 and 4, so the drivers has to take control over the vehicle from time to time. They have a line number, users can use it and pay for it with their public transport ticket and it is also possible to change from an autonomous to a non-autonomous. So far, these buses are small buses which transport people to other bigger buses, working on the last miles. Around June this year hopefully six autonomous buses will be deployed in Stockholm. These buses were also deployed in Norway last summer and three vehicles are about to be launched in Copenhagen.

Regulatory wise there were no pre-existing processes on the approval of testing autonomous vehicles on public roads, they started from a blank page. A lot of dialogue with the Swedish transport agency, the government, and other relevant stakeholders was necessary. They were all working towards consensus because the goal is environmental and better transport for public users. They achieved the goal of defining a regulatory framework to allow autonomous buses to be tested on public roads so now there is an existing process to approve testing on public roads. The approval was given for a fixed route in the first place but then approved for an area so the buses gained in flexibility. One of the first challenges was to overcome the definition of vehicle from the Vienna convention because the autonomous buses from Nobina technology do not fulfil the Vienna convention criteria: no driver seat, no dashboard, and no instrument cluster. But still it was approved, and the buses are qualified as vehicles despite the criteria from the Vienna convention.

The second step in the conversation around the adaptation of the regulatory framework was: how to act in public traffic?

They went through all the regulation to see how an autonomous vehicle will act in the road situation areas which were tricky for example the policeman sign. If a policeman stands in front of you and stops you then you have to follow. The autonomous bus struggles to turn right if the policeman asks to turn right. To develop the communication on how to act in traffic, they went through all of these kinds of situations that could be considered as a barrier to overcome for the bus in open roads. As another example, if a person jumps in front of the vehicle, the signal

[125] ERTRAC, Automated Driving Road Map, 2019.

comes from a camera or other sensors, and that signal send information to the breaking system. It is like with a driver and his eyes.

Then test drive was organized in collaboration with the Swedish transport agency, just like when you take your driver's licence, they passed the test and got the final approval to have the autonomous buses on the road.

Regarding the key question of liability, the driver/person on board will be held responsible, but the final person responsible is the executive director of Nobina. The company backs up the person in the bus. This way they fulfil all regulatory demands with the transport agency. Insurance works like for a normal bus. When they remove the driver, which is the next step, the insurance will be on the vehicle and the responsibility will be on Nobina and the person supervising the vehicle. There are also existing contracts between manufacturers and Nobina to ensure all the relationships are clear legally wise.

Some other limitations are framing the implementation of these autonomous shuttles. For safety reasons the speed limit is 20km/h, as required to obtain the approval for road testing. The speed will be increased in steps up to 40km/h. Regulatory wise the vehicle is defined as a bus so it will benefit from the same access to bus stops and bus lanes. All these buses are electric and benefit from separate electric charging stations provided by the government as part of the Swedish electrification policy.

Luxembourg

Here the development is part of an EU project called the Avenue project[126]. Avenue aims to design and carry out full-scale demonstrations of urban transport automation by deploying, for the first time worldwide, fleets of autonomous mini-buses in low to medium demand areas of four European demonstrator cities: Geneva, Lyon, Copenhagen and Luxembourg, and later on to three replicator cities. The Luxembourg Ministry of Transport gave a temporary permit to operate a fully autonomous shuttle strictly on dedicated roads under the existing Luxembourg regulation called '*essai scientifique*' (scientific testing). This allows the shuttles to operate a vehicle, which as such, is not in 100% conformity with the current regulation, e.g. the shuttle does not have a steering wheel, no brake pedal, no driver seat, no rear-view mirrors, lights are not in full accordance with legislation, etc. The autorisation under '*essai scientifique*' has many limitations and requirements to fulfil. In order to drive on Luxembourgish roads, you have to prove that all parts of the vehicle are EU homologated. Nonetheless this rule can be adapted if you are using a vehicle that is used to do development or research for new technologies, like it is the case for our autonomous shuttles. In this case not all parts have to be homologated in order to get the permission to drive on the roads of Luxembourg if you obtain an individual permission by the Luxembourgish Ministry of Transportation for driving under '*essai scientifique*'.

[126] H2020 Avenue Project.

The following rules apply:

- The maximum speed is 25km/h (the maximum speed for vehicles driving under '*essai scientifique*' is not always 25km/h, it will be decided individually for autonomous shuttles like the one in this example, it is 25km/h)
- An operator with a bus driving license (permit D1) has to be on-board at all times, and being able to drive manually (with a gaming console in this case). The shuttles are being driven/operated by operators who were drivers on regular buses.
- A sign on the front and rear side of the vehicle saying '*essai scientifique*' has to be placed.
- The shuttles are only allowed to drive within Luxembourg, they are not allowed to cross the border.

There are two autonomous shuttles operating in the city of Luxembourg. These electric shuttles are level 3 of automation, driving by itself, but the driver will be taking over when there is an obstacle but shuttle can pass a static object. The buses are allowed to drive on the road with other vehicles and road users. In Luxembourg the autonomous shuttles aim at connecting the train station to the city centre of Luxembourg, they aim to work on the last miles issues. The shuttles have access to the bus stops and there are no bus lines in Luxembourg but if there were any the autonomous shuttles would have access to. It is important to note that Luxembourg is not willing to set up own rules for full autonomous vehicles. They will adopt the rules that the EU will set up in the future. Luxembourg is applying the traffic rules that are mentioned in the Vienna Convention on road traffic.

The autonomous shuttles are included in the AXA insurance of the whole fleet and are treated as any other vehicle of the same category (>3,5t, 15 passengers). The public liability insurance covers for material damages as well as for physical injuries of third parties. The insurance for the autonomous vehicles works like for any other vehicle: in case of an accident, an investigation has to find out who caused the accident. If the investigation shows that a malfunction of a system caused the accident, the manufacturer of the system will be responsible. If the investigations show that a part of the autonomous system wasn't working during/before the accident, the manufacturer of the autonomous system will be responsible. Currently the autonomous shuttles are not equipped with a black-box. So after an accident it is not possible to analyse the data before or leading to the accident. The insurance knows this and they know as well that without a black-box the risk for them is higher not to find out who or what caused an accident. For the time being, insurance companies have no idea how to calculate their risk when insuring an autonomous vehicle as they do not have the experience and cannot set up an algorithm to calculate the risk. If they wouldn't have had a fleet insurance contract with AXA for their 550 vehicles, AXA probably wouldn't have agreed to insure their 4 autonomous vehicles because the risk for them would have been too high.

Port of Rotterdam

The port of Rotterdam is the largest port of Europe, 385,000 people work in and for Rotterdam's port and industrial area. The Port of Rotterdam has an extensive network of intermodal transport connections: rail, inland shipping, road and pipelines[127]. This port is pioneer regarding the development of automation, it was the first port in the world with automated guided vehicles (AGVs), and the first with automated terminals[128]. The Port of Rotterdam is also using IBM's internet of things (IoT) and artificial intelligence (AI) technologies as part of its digital transformation that will eventually enable it to host autonomous ships by 2025[129]. The port of Rotterdam is administrated by the Port of Rotterdam authority.

But automation in the harbour also has risks, in 2016, Dock workers at the Port of Rotterdam, recently went on strike over increasing automation and the need for job security. Employees fear that automation at the docks in the coming years will put hundreds out of work[130].

The development of automation in the port of Rotterdam is part of the work done for the development of automation the Netherlands more broadly speaking. In the Netherlands, regarding the regulation, there is a strict separation between public road and non-public roads. Within the Port of Rotterdam the automated cargo chassis can run freely because:

- They are not on public roads;
- Not publicly accessible.

The automated container chassis operating in the Port of Rotterdam are not submit to the regular legislation as it is in a close area with no access to public roads.

On public roads there is a national regulation which tend to frame testing of autonomous vehicles. In 2015, the regulation was modified to allow testing on public roads for automatic vehicles with the driver inside. In 2018 an amendment of the Road traffic Act of 1994 was voted, this amendment will become effective this year, it will allow testing of automated vehicle without driver inside but with an operator who can be outside of the vehicle. Testing is of key importance as the outcomes of the experiments around automated vehicles will provide inputs for the regulation. Before being allow to experiment on public road, there is a strict system of control and evaluation, for example a permit from the ministry is required, and there is also an evaluation of the vehicle, of the driver and of the infrastructure.

Insurance is mandatory for any vehicle included autonomous vehicles and is required for testing of autonomous vehicles. The experiment in itself should be insured. The testing company need adequate insurance for everything that goes wrong. The insurance is checked by the ministry and the National Vehicle Authority.

[127] Port of Rotterdam, Intermodal transportation.
[128] New standard in container terminals and services.
[129] Dutch port readies itself for autonomous ships.
[130] Automated Ports Have Dockworkers in the Netherlands Threatening Strikes.

In the Netherlands, liability is built on jurisprudence: traditionally the driver is held liable. Then it is possible to differ the liability if the driver proves that he is responsible. As testing without drivers inside the vehicles are going to be allowed this year, the supervisor, who might be outside the vehicle will be consider as the driver.

5.1.2. Passenger urban air mobility

Introduction
Urban air mobility can contribute positively to a multimodal transport system.[131] It refers to the use of aerial autonomous vehicles or vertical take-off and land (VToL) vehicles to transport people living in populated urban areas.
European Regulation
Mobility Packages: • Mobility Package n°1: clean, competitive and connected mobility. An agenda for a socially fair transition towards lean, competitive & connect mobility for all is mentioned in the communication. • Mobility Package n°2: clean mobility. The Clean Vehicles Directive contains elements on new CO2 standards and a review of Regulation 1073/2009 aimed at liberalizing road passenger transport services across the EU. • However, there are no mentions on any initiatives related to digital affairs. **Digital Single Market:** • Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications. • Communication from the Commission to the European Parliament, the European Council, the Council, the European economic and social Committee and the Committee of the Regions: "Artificial Intelligence for Europe" • Communication on Building Trust in Human-centric Artificial Intelligence following the work of the high-level group on the Ethics Guidelines for Trustworthy AI.
Examples

[131] Airbus Urban Mobility

Uber is one of the leading players in the air mobility race. It established UberAIR, which is a platform that offers a drone hailing service for individuals. UberAIR will work in a similar way as UberX and UberBLACK. Uber will use the big data collected from their existing ride hailing app to determine the hub locations, platform size, and minimum ground time. This service is expected to be launched in Tokyo, Osaka, Mumbai, Delhi, Bangalore, Melbourne, Sydney, Rio de Janeiro and Paris. There are other urban air mobility services are developed now, such as Airbus urban mobility, SkyGrid, and Aeromobil.

5.1.3. Drone last mile delivery

Introduction

Drones rely on several sophisticated technologies, but many of these still have to be improved so that drone delivery becomes a common practice:

- Autonomous flight: even if some drones are already able to fly without the support of a user who controls his route, this technology is not yet consolidated. Currently the most mature unmanned-aerial systems (UAS) applications involve short-range surveillance and associated photographs or videos. All drones that travel further the operator visual line of sight require unmanned traffic management (UTM)[132]. Recently the Federal Aviation Administration (FAA) and UAS stakeholders created the Low Altitude Authorization and Notification Capability program, which provides UAS with access to controlled airspace near airports by processing airspace authorizations at low altitudes in near real time[133].
- Battery performance: the energy density of lithium-ion batteries is growing by 5 to 8% every year and their lifespan is expected to double by 2025. This improvement will allow delivery drones to fly for more than an hour without recharging.
- Detect-and-avoid technologies: these systems, which help drones avoid collisions and obstacles, are not yet mature; drones currently available have such systems but are still unsophisticated. Strong solutions are expected to emerge by 2025.

132 a system of radar, beacons, flight-management services, communication systems, and servers that coordinate, organize, and manage all UAS traffic in the airspace

133 Air-mobility solutions: What they'll need to take off (McKinsey&Company), 2019

Location technologies: drones must be able to identify their position even in areas where GPS signals are limited, such as densely built cities and remote locations. The widespread rollout of a GPS alternative is more than ten years in the future.
European Regulation
MOBILITY PACKAGE N°1: Clean, competitive and connected mobility Communication: An agenda for a socially fair transition towards clean, competitive & connected mobility for all. Clean Vehicles Directive, new CO2 standards and a review of Regulation 1073/2009 aimed at liberalising road passenger transport services across the EU… It does not, however, contain any initiatives related to digital affairs. **Digital Single Market** Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications Communication from the Commission to the European Parliament, the European Council, the Council, the European economic and social Committee and the Committee of the Regions: "Artificial Intelligence for Europe" Communication on Building Trust in Human-Centric Artificial Intelligence following the work of the high-level group on the Ethics Guidelines for Trustworthy AI
Examples
An interesting application of drone delivery is that of Reykjavik In August 2017 AHA a supplier which delivers on behalf of restaurants and shops in Iceland's capital, in collaboration with Flytrex, an Israeli drone-service company, started a drone delivery service across Elliðárvogur, an inlet that divides Reykjavik from its eastern suburbs. The flight took four minutes instead of the 20 or more required to drive around Elliðárvogur. Iceland's transport authorities authorized them to run 12 other routes across Reykjavik, including journeys over land. Currently, if weather conditions are favourable, customers (who must first obtain permission from neighbours for flights to pass overhead) can order goods using the online app and be served by a drone: the drone is loaded by a company employee, who dispatches the craft after entering the destination using a hand-held device. The customer gets a message to say the drone is on its way, and can use the app to follow its progress on a map. When it arrives, the customer enters a pin into the app to accept delivery and the drone lowers its package on a line.

5.2. Infrastructure, Network and Traffic Management

5.2.1. Infrastructure

Introduction
For the scope of this research this category of infrastructure can be defined as innovations in infrastructure management, pricing, taxation and finance, digitalization and integration (Syncromodality, Intermodality, interoperability and integration of transport systems) and life cycle optimisation. Intermodality, interoperability and integration of transport systems have been high on the EU policy for several decades. Since the concept appeared in the 1980s the idea of integration of transport systems evolved from the integration of physical networks, to the integration among multiple modes of transport and the integration of transport systems[134]. Intermodality refers to the seamless transportation of freight or passengers through multiple modes of transport under a single form of organisation and/or billing. Interoperability is the (technical) ability of a passenger, transport operator, vehicle or other means of transport to operate seamlessly on multiple networks or parts of networks that could be physical, digital or financial. Integration of transport systems refers to the overall process of treating transport modes in terms of infrastructure, coordination, information sharing, billing, accessibility etc. as one[135]. The main challenge for the infrastructure is harmonization and standardization at the EU and international level. Road infrastructure, regulations, and driving customs vary from country to country, even city to city, and are overseen by a multiplicity of bodies. It's not clear which institutions have the power and reach to regulate and standardize the driving environment[136]. Transport infrastructure are one of the key priority of the Strategic Transport Innovation Agenda (STRIA)[137]. According to the STRIA Roadmap the EU transport infrastructure key challenges with regard to governance network are pricing, taxation and finance; syncromodality, intermodality, interoperability and integration of transport systems; life cycle optimisation; and infrastructure operation[138]. Regarding the question of infrastructure it is important to present the C-ITS, "Cooperative Intelligent Transport Systems (C-ITS), technologies that allow road vehicles to communicate with other vehicles, with traffic signals and roadside infrastructure as well as with other road users. The systems are also known as vehicle-to-vehicle communications, or vehicle-to-infrastructure communications[139]."

[134] Transport Infrastructure Expert Group.
[135] Transport Infrastructure Expert Group.
[136] Harvard Business review, To Make Self-Driving Cars Safe, We Also Need Better Roads and Infrastructure.
[137] Strategic Transport Innovation Agenda.
[138] STRIA, Infrastructure Roadmap.
[139] C-ITS Platform, final report, January 2016.

International Regulation
At the international level the UNECE is working on the question of the transport infrastructure development140. Its International Transport Infrastructure Observatory141 aims to enhance cooperation among different transport infrastructure initiatives in Europe and Asia and to create economies of scale and maximize efficiency by helping governments and organizations to achieve more by spending less. The key main agreements from the UNECE are: • The European Agreement on Main International Traffic Arteries (AGR, 1975)142, provides UNECE Governments with the international legal framework for the construction and development of a coherent international road network with a view to the development of international road transport and traffic throughout the UNECE region. • The European Agreement on Main International Railway Lines (AGC, 1985)143, provides a legal and technical framework for the development of a coherent international rail network in the region. • The European Agreement on Important International Combined Transport Lines and Related Installations (AGTC, 1991)144 provides the technical and legal framework for the development of efficient international combined road/rail transport infrastructure and services. Combined road/rail transport comprises the transport of containers, swap bodies and entire trucks on railway wagons to and from especially equipped terminals. • The European Agreement on Main Inland Waterways of International Importance (AGN, 1996)145, establishes the internationally agreed European network of inland waterways and ports as well as the uniform infrastructure and operational parameters to which they should conform. It focuses on building a strong Europe-wide network146.
European Regulation
At the EU level there are several relevant elements: • Connecting Europe facility (CEF), key EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at European level. It supports the development of high performing, sustainable and efficiently

[140] UNECE, transport infrastructure Development.
[141] The international Transport Infrastructure Observatory background document, ECE/TRANS/2018/4.
[142] The European Agreement on Main International Traffic Arteries.
[143] The European Agreement on Main International Railway Lines.
[144] The European Agreement on Important International Combined Transport Lines and Related Installations.
[145] The European Agreement on Main Inland Waterways of International Importance.
[146] Infrastructure - TEN-T - Connecting Europe.

interconnected trans-European networks in the fields of transport, energy and digital services. CEF investments fill the missing links in Europe's energy, transport and digital backbone[147].

- European Fund Strategic Investment (EFSI) for transport, a central pillar of the Investment Plan, or so-called Juncker Plan[148].
- ITS directive, (2010/40/EU)[149], adopted on 7 July 2010 to accelerate the deployment of these innovative transport technologies across Europe. The Directive is an important instrument for the coordinated implementation of ITS in Europe. It aims to establish interoperable and seamless ITS services while leaving Member States the freedom to decide which systems to invest in[150]. Relevant regulations are for instance regulation 886/2013 on road safety traffic information, regulation 2015/962 on EU-wide real-time traffic information Services (see Annex I for more details) and regulation 2017/1926 on MultiModal Travel Information Services (MMTIS)
- The STRIA roadmap[151] previously mentioned. One of the pillar of this road map is transport infrastructure.
- The TEN-T Policy. This policy works on the question of harmonization of transport infrastructure in the member States of the European Union. It promotes and strengthens seamless transport chains for passenger and freight, while keeping up with the latest technological trends[152].
- The GDPR, regarding the question of data protection link to connected infrastructure.
- The Road Infrastructure Safety Management Directive, Directive 2008/96/EC[153].
- The DIRECTIVE 2014/94/EU on the deployment of alternative fuels infrastructure[154].
- The INSPIRE directive (2007/2/EC) of the European Parliament and of the Council establishes an infrastructure for Spatial Information in the European Community. Several texts have been produced to support the INSPIRE objectives, such as the technical Guidance for the implementation of INSPIRE dataset and service metadata based on ISO/TS 19139:2007 (02/03/2017). ISO/TS 19139:2007 defines Geographic MetaData XML (gmd)1 encoding, an XML Schema implementation derived from ISO 19115; Commission Regulation (EU) No 1311/2014 of 10/12/2014 amending Regulation

[147] The Connecting Europe Facility.
[148] The European Fund Strategic Investment.
[149] Directive 2010/40/EU
[150] ITS, Action Plan and Directive.
[151] STRIA Roadmap.
[152] The pillars of the Ten-T policy.
[153] Directive 2008/96/EC
[154] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0094&from=en

(EC) No 976/2009 as regards the definition of an INSPIRE metadata element and the INSPIRE Metadata Implementing Rules: Technical Guidelines based on EN ISO 19115 and EN ISO 19119 (2008, 2013).

- The Mobility Package n°1 with the proposal for a Directive on the Interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees in the Union (recast); communication material on an agenda for a socially fair transition towards clean, competitive & connected mobility for all.
- The Second Mobility Package, the Clean Vehicles Directive, includes new CO2 standards and a review of Regulation 1073/2009 aimed at liberalising road passenger transport services across the EU.
- The Third Mobility Package includes an integrated policy for the future of road safety with measures for vehicle and infrastructure safety; the first ever CO2 standards for heavy-duty vehicles; and a strategic Action Plan for the development and manufacturing of batteries in Europe.

Digital Single Market:

- Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications
- Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union: NIS Directive
- Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013: Cybersecurity Act
- Communication on 5G for Europe: An Action Plan.
- Communication from the Commission to the European Parliament, the European Council, the Council, the European economic and social Committee and the Committee of the Regions: “Artificial Intelligence for Europe”
- Communication on Building Trust in Human-Centric Artificial Intelligence following the work of the high-level group on the Ethics Guidelines for Trustworthy AI

National Regulation

Transport infrastructure is closely linked with the deployment of autonomous vehicles and E-mobility innovations. But as you cannot invest in everything at once, the question for Member States is to decide what they want to invest in first infrastructure or the development of

autonomous, connected vehicles[155]. But infrastructure is a key element as is linked to security and automation. Member States are making different decisions regarding this question. For example, in January 2018 the UK Government announced that it will boost its digital infrastructure with over £1 billion of public investment[156].

Examples

Spacetrain

Spacetrain is a start-up specialized in research and development in robotic systems[157].Its freestanding shuttle powered by air cushions on an inverted "T" monorail, is capable of carrying up to 250 passengers. This new means of transportation aims to significantly reduce the time and cost of travel between two territories.

The main regulatory problematics faced in the implementation and development of Spacetrain are:

- Hydrogen and the security measures linked to it.

The main issue is storage (security and logistic)[158], and the problematic of testing in transport as there is no existing regulation on testing of hydrogen transport of passengers.

- The tender processes are too restricted and not open to innovation.

Because Spacetrain doesn't belong to an already known and defined transportation category, they cannot participate in tender processes. The tender processes are too restrictive, as for example they are only for rail which excludes guided transport and when the tender process is for guided transport this is not adapted to Spacetrain either as the targets are tram and metro.

- The regulatory framework of guided transport.

Spacetrain has been classified in guided transport but it is not fitting. The Spacetrain fits in this regulatory framework because they use a rail but it does not fit considering the speed Spacetrain can achieve (up to 720km/h). The fact that the trains are six –meter higher on the road is not taken into consideration, for example regarding security questions, pedestrians, there is no danger with pedestrians crossing considering the height of the train.

- Testing.

The Spacetrain team is currently trying to regain the right to use an old testing line from the old technology which inspired Spacetrain. The mobility law allows some flexibility when it

[155] WSP, Adapting Infrastructure for a Driverless Future.
[156] Reshaping infrastructure for autonomous vehicles the road to nowhere?
[157] Spacetrain.
[158] Spacetrain - La production et le stockage : deux variables essentielles pour une filière hydrogène en plein développement.

comes to testing, nevertheless the authorisation to use the old line is still on hold because there is no regulation around this technology. Spacetrain is operating in a "grey zone" regulatory wise.

There are several positive elements in the French regulatory framework which are supporting the development of Spacetrain and innovation in general. The main is on financing innovation. With for example the Financial support provided by the public institute for the protection of Intellectual property (INPI) which provides financial support for innovation projects[159]. Or there is also the innovation tax credit which is a tax measure reserved for SMEs. The latter can benefit from a tax credit of 20% of the expenses necessary for the design and / or the realization of prototypes or pilot installations of a new product, within the meaning of the tax definition[160].

The Important regulatory, policy texts which composed the regulatory framework in France and which are relevant to Spacetrain are:

- Mobility law from April 2nd 2019. Key measures a 40% increase in investments to improve everyday transport, alternative solutions to the car on the whole territory and also, priority to the rehabilitation of our road and rail networks.
- "*Plan climat*", a national plan presented on the 6th of July 2017 that aims at accelerating the energy and climate transition and the implementation of the Paris Agreement within 5 years.

Regarding the question of governance of transport in France, the regions are the regulatory authority, but as the central government is the main financial provider there is no real autonomy.

Zeleros

Zeleros in Spain, which is a Hyperloop, a new mean of ground transportation that can carry passengers and cargo at speeds over 1000 km/h inside low-pressure tubes[161]. The use of the tube is the main difference between Zeleros Hyperloop and Spacetrain. In this case study the disruption comes from the use infrastructure, the vehicle in itself, the use of space and the definition of distance. After 6 years of research, there are 6 companies in the world working on the Hyperloop technology. China and Korea have their own Hyperloop development projects coordinated at a national level.

Interoperability is one of the key element for the technology to be used and to work. No failure in the railway can be tolerated. Zeleros started reaching out to different company working on the development of Hyperloops. Poland, Canada, Netherlands and Spain with Zeleros are working together since July 2018. An agreement was signed to cooperate on a common

[159] INPI
[160] Direction générale des Entreprises, le crédit d'impôt innovation.
[161] Zeleros – Hyperloop

standardized approach. The four countries started talking with the European Commission (EC) to work together on harmonization and interoperability of the infrastructure. The EC suggested to start with being granted national support before acting. In Spain, Zeleros received support from the Ministry of science and Infrastructure. Following this the EC consulted the Member States to see the interest in the project.

At European level, DGs MOVE, GROW and RESEARCH are collaborating with the world's main Hyperloop developers. In Spain there is a strong focus on technological development. The Ministries of science and infrastructure are the key actors working on the development of a suitable regulatory framework for Hyperloop technology. Regional and city governments are also providing support to this project, led by Zeleros. The region of Valencia has provided authorisation to use a 2km test track to be built in 2019. Following that, Zeleros will be able to suggest a large-scale test track at the EU level. From a regulatory perspective, this test rack is classed as a research facility. This framework is helpful. But it is also very far from being allowed to carry people or goods. Zeleros needs to collaborate with universities to obtain authorisation to proceed with the testing. Architects and expert wills collaborate on the development of the track, working primarily on the issue of safety. After testing, the national agency for railway safety will be in charge of coordinating permit issuance to allow the project to scale up. So far, the only test track in the world is in the US and is 500m long. Which is too small to test all the parameters. Testing focuses on levitation and propulsion. In Spain Hyperloops do not yet have a legal status. At the moment there is nothing yet on insurance and liability. The call is to create an authority responsible for Hyperloop at EU level (a regulatory unit) and control units at national level.

5.2.2. Network and traffic management

Introduction
"Traffic management provides guidance to the European traveller and haulier on the condition of the road network. It detects incidents and emergencies, implements response strategies to ensure safe and efficient use of the road network and optimises the existing infrastructure, including across borders. Incidents can be unforeseeable or planned: accidents, road works, adverse weather conditions, strikes, demonstrations, major public events, holiday traffic peaks or other capacity overload."[162]
Since the 60s, many initiatives have been setup in order to deal with traffic management (TM)[163], from the first guidance highway programmes in the beginning of the 70s which led to the first

[162] https://ec.europa.eu/transport/themes/its/road/application_areas/traffic_management_en
[163] http://www.panorama-ifpen.fr/systeme-de-transport-intelligent-mobilite-3-0-definition-enjeux-acteurs/

Traffic Management Centers, to the current innovations brought by the development of Intelligent Transport Systems (ITS) due to the digitization of market sectors. In this section, we will review the disruptive technologies that are developed for the traffic management, but also the associated risks and challenges from an economic, social, environmental and safety points of view. This will lead to the governance and regulation trends in order to address these key features which will be illustrated by three relevant case studies.

Regarding Traffic Management Systems, the data integration and processing is challenging in order to adopt a data-driven approach, as they are miscellaneous and coming from many sensors[164]. Data need to be standardized, synchronized, and exploited properly (with new traffic models) in order to bring valuable information and improve traffic information quality, in order to give appropriate alternative route guidance[164]. To achieve this goal, as we will see for the TM2.0 case study, a new architecture must be defined in order to adopt a Cooperative, Connected and Automated Mobility, through the development of Cooperative Traffic Management Services. In addition, the use of personal data must be managed in agreement with policies. The end-users will be an important actor of the traffic management system, exchanging data with traffic management centres and service providers.

The high-performant traffic management system that will be developed should contribute to sustainable mobility, through:

- Road safety improvement, through a better understanding of the current status which can prevent accidents and a better management of emergencies;
- Congestion decrease, by setting up dynamic guidance strategies, thus decreasing emission rates from vehicles;
- Commuting time reduction;
- Better cooperation between public and private parties regarding traffic management through the establishment of synergies;
- Emergence of new business models to answer end-users' demands.

Risks must be identified in order to have the best exploitation of this disruptive paradigm, by adopting the appropriate measures:

- IoT involve people and objects tracking through mobile data, bringing security and privacy issues to overcome;

[164] Traffic Management Systems: A classification, review, challenges and future perspectives, A. M. de Souza & al., *International Journal of Distributed Sensor Networks* 2017, Vol 13(4).

- The lack of data interoperability issue must be addressed to exploit properly the data, and exchange them within the stakeholders (service providers, traffic management centres and end-users);
- The development of cooperative traffic management services needs to have a legal framework in order to solve the upcoming liability issues (data ownership and reliability);
- A good cooperation framework between public and private parties is required to have all the data required to achieve better traffic management performances.

Regarding traffic management governance, the traffic management plans are elaborated by the road authorities, relying on information given by service providers, but not in collaboration with them. However, this management is changing, going towards transport open data and collaboration between public and private stakeholders. In the framework of the TM2.0 project, ERTICO has displayed the current usual architecture on operational structure and the relations between stakeholders for the establishment of Traffic Management Plans[165,166]:

International Regulation

The UNECE was one of the pioneer organizations that set up traffic management initiatives[167], initially through the working group on the prevention of road accidents in 1950. In 2017 Global Forum for Road Traffic Safety, an intergovernmental body was established. This commission generated harmonized international agreements and conventions regarding traffic through the 20th century, such as:

- Convention on Road Traffic (September 1949 and November 1968)
- Convention on Road signs and signals (September 1949 and November 1968)
- Agreement on minimum requirements for the issue and validity of driving permits (April 1975)

There is also another working group, the Working Party on Road Transport that aims at harmonizing and simplifying the rules and requirements at transports, through the management and update of international instruments[168].

European Regulation

EU is currently setting up directives in order to deploy Intelligent Transport Systems (ITS). Among these directives, we can quote 2010/40/EU[169], which is a first step towards the

[165] TM2.0: TF8: The exchange of Traffic Management Plans in TM2.0
[166] TM2.0 TF10 : Contractual Agreement
[167] http://www.unece.org/trans/roadsafe/rsabout.html
[168] http://www.unece.org/trans/main/sc1/sc1_about.html
[169] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32010L0040&from=EN

interoperability and standardization of the data regarding traffic. Regulation 886/2013 on road safety traffic information followed the ITS directive.

In 2014 was also adopted the Commission Delegated Regulation (EU) 2015/962 on EU-wide real-traffic information services[170], detailing requirements in order "to ensure the accessibility, exchange, re-use and update of road and traffic data by road authorities, road operators and service providers for the provision of EU-wide real-time traffic information services". Datex II was adopted as a standard for the traffic data. The next year, the delegated regulation 2015/962 (EU) ensures that road authorities and operators provide static road data in a standardized format.

These initiatives were followed by a communication note from European Parliament on 2016 (COM (2016) 766) that listed the required actions in order to setup C-ITS platforms by 2019, such as:

- EU will support Member States and Industries for the deployment of ITS and provide funding for R&D projects regarding this topic, promoting international cooperation.
- EU will work on "a common security and certificate policy"[171] for deployment and operation of C-ITS. Regarding privacy protection, the General Data Protection Regulation was setup on May 2018.
- EU will ensure the data interoperability, with a hybrid communication approach, through a procurement framework and will define C-ITS telecommunication frequency
- EU will setup a compliance assessment process in order to ensure security.

In 2017, the Commission proposed the regulation 2017/1926 on MultiModal Travel Information Services (MMTIS) as part of its first Mobility Package. Draft delegated Act on Cooperative Intelligent Transport Systems will amend and supplement the ITS Directive.

Recently, on March, 13th, 2019 a delegated regulation supplementing 2010/40/EU directive (C/2019/1789) was published. A list of priority services was established, involving Vehicle-to-vehicle service of Infrastructure-to-vehicle service[172], for which requirements regarding data that have to be collected and triggering conditions and message parameters were specified.

Moreover, a certificate policy was setup in order to define an EU C-ITS trust model, with the establishment of root Cas (Certification Authorities) and conformity assessment procedures, relying on existing norms, such as ISO 27001 (security management of information technologies). At the same time as these regulations are being established, EU has already started the implementation of the traffic management policy through the financing of several

[170] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32015R0962&from=EN
[171] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016DC0766&from=EN
[172] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=PI_COM:C(2019)1789&from=FR

national/international projects in the framework of the deployment of the National Traffic Management System on the TEN-T network[173] such as:

- CROCODILE: setup of a data exchange infrastructure (Austria, Cyprus, Czech Republic, Germany, Greece, Hungary, Italy, Poland, Romania, Slovenia)
- Next-ITS: real-traffic information and road safety related traffic information on the Nordic section of the Scandinavian-Mediterranean Corridor (Denmark, Finland, Germany, Sweden)
- MedTIS: development of interoperability services to inform travellers on traffic and driving conditions (Spain, France, Italy, Portugal)
- Scoop@F: development of C-ITS (France, also partners in Spain, Portugal, Austria)[174]

The INSPIRE Directive (2007/2/EC) of the European Parliament and of the Council establishing an Infrastructure for Spatial Information in the European Community also defines MetaData. More information in 6.2.1.

The Third Mobility Package includes an integrated policy for the future of road safety with measures for vehicle and infrastructure safety; the first ever CO2 standards for heavy-duty vehicles; and a strategic Action Plan for the development and manufacturing of batteries in Europe.

Digital Single Market:

- Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications
- Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union: NIS Directive
- Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013: Cybersecurity Act
- Communication on 5G for Europe: An Action Plan.

[173] Complete list can be found in the following list: https://ec.europa.eu/transport/sites/transport/files/themes/its/road/doc/2013_its_ten_t_projects.pdf

[174] http://www.scoop.developpement-durable.gouv.fr/presentation-du-projet-scoop-a29.html (French)

- Communication from the Commission to the European Parliament, the European Council, the Council, the European economic and social Committee and the Committee of the Regions: "Artificial Intelligence for Europe"
- Communication on Building Trust in Human-Centric Artificial Intelligence following the work of the high-level group on the Ethics Guidelines for Trustworthy AI

National Regulation

On the national level, EU member states transposed the European policy (directive 2010/40/EU) on the deployment of traffic management ITS. Public progress reports are available on the EC website[175] .Several regulatory texts were implemented, as well as subsidies regarding:

- Road infrastructure, devices for traffic monitoring or traffic management centers (e.g. PEREX 4.0 in Belgium, the Automatic Traffic Monitoring Center CANARD[176] in Poland);
- National projects: for instance, C-Roads (France, Czech Republic…), "Paso del Estrecho" Special Traffic Operation (Spain)

At the local level, the European cities define the mobility policy they want to implement in their cities, and are often responsible of road traffic management (for instance, Traffic Management Act in UK[177]). In the framework of National/European projects, some European cities were volunteers for being pilots for the implementation of intelligent traffic management systems, such as, for instance, Bordeaux and Helmond (C-The Difference European project[178]), Portsmouth (implementation of a Cloud based traffic management system[179]), etc.

Examples

Traffic management 2.0

Traffic management 2.0 (TM2.0) is an innovative platform created in 2014 by ERTICO, an organization aiming at promoting and accelerating the Intelligent Transport Systems in Europe. Its objective is to create a Collaborative and Interactive Traffic Management System, by developing synergies between the public authorities, the private service providers and the drivers. The TM 2.0 concept is based on:

- Provision of individual communication channels between TMCs and road users/service providers;

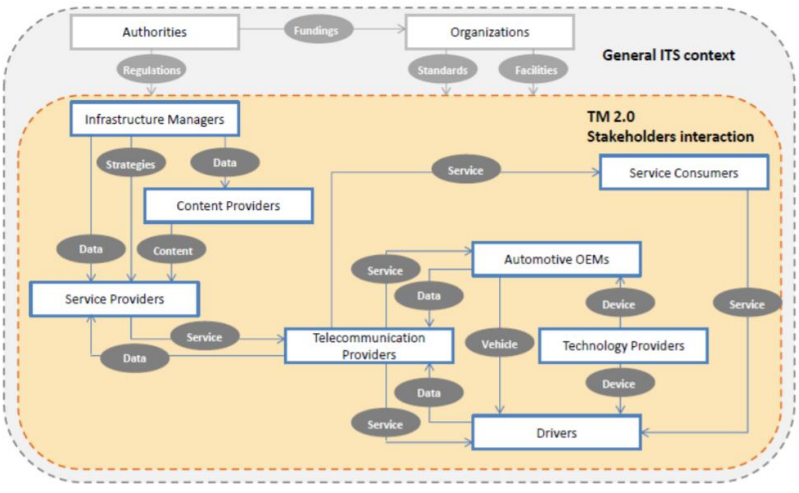
[175] https://ec.europa.eu/transport/themes/its/road/action_plan/its_national_reports_en
[176] Centrum Automatycznego Nadzoru nad Ruchem Drogowym
[177] https://www.gov.uk/government/publications/traffic-management-act-2004-summary/traffic-management-act-2004-summary
[178] See GLOSA case study
[179] https://ec.europa.eu/transport/sites/transport/files/2018_uk_its_progress_report_2017.pdf

- Development of a new interface for data exchange between TMCs and service providers, necessary for individual and collective traffic information and signage;
- Cooperation and information exchange with other transport modalities;
- Development of (new) business cases with benefit to all stakeholders.

This project managed to gather all the stakeholders that are involved in traffic management:

- Public authorities from several European Countries: Austria, Switzerland, Germany, Italy, Norway, Macedonia, Belgium, Netherlands, Spain, Romania, Finland;
- Vehicle manufacturers, such as BMW and Mini;
- Research institutes;
- Service providers;
- Suppliers;
- Traffic and Traveller Information companies.

In the framework of this project, ERTICO tackled interoperability issues by selecting the data formats, and the services that have to be proposed in order to get advanced navigation services, adaptive and dynamic traffic control, traffic status and event detection[180], that are missing in the current definition of the traffic management plans. Moreover, ERTICO worked on the way that Traffic Management Plans can be exchanged between different regions and countries, through an innovative integrated loop architecture, benchmarking the current separate one[165,166]:



[180] TM2.0 TF3 Report: Principles of Data

Figure 1: Traffic Management (TM) 2.0 architecture

Regarding regulations challenges, ERTICO also highlighted some legal barriers that have to be overcome by EU regulations, such as data reliability and security[181]: liability problems in case of wrong data provision, unspecified ownership of data, and lack of security infrastructure for cooperative vehicle data. ERTICO is currently pushing the cooperation between private and public parties and proposing innovative schemes and architectures, thus being a strong actor involved in the deployment of intelligent traffic management systems.

For the next steps, relying on already performed work, interactive and cooperative traffic management system will be tested in pilot cities in the framework of the EU project SOCRATES$^{2.0}$ with pilots at Amsterdam, Copenhagen, Munich, and Antwerp[182]. These cities were chosen because this project can be part of programmes that are being implemented (Amsterdam Practical Trial programme), or can fit with the city's mobility vision (ITS action plan "Better mobility in Copenhagen"), or thanks to singular governance model (one-way communication from road authority to service providers in Munich, without intermediary role, or international framework such as the Flemish traffic centre which manages the whole of the motorway network in Flanders).

Green Light Optimal Speed Advice

GLOSA, for Green Light Optimal Speed Advice, is one of the innovative products developed by the French company NeoGLS. This service aims at calculating the adequate vehicle speed to adopt in order to avoid red traffic lights, in the framework of C-The Difference European project[183].

The expected impacts fulfilling the sustainability mobility are the following:

- Reduce energetic costs
- Reduce environmental cost
- Improve road safety
- Earn time
- Improving traffic in an innovative way.

This service is already setup in Bordeaux, thanks to the collaborations with:

- GERTRUDE company, which deals data regarding the management of traffic lights in this city;
- Qucit company, which provides predictive analytics regarding park & ride;

[181] TM2.0 TF2: Barriers and Enablers
[182] https://socrates2.org/
[183] http://c-thedifference.eu/

- Public authorities (Bordeaux Métropole).

This service was also tested in Helmond (Netherlands) and demonstrate GLOSA interoperability. The implementation of the service is being developed in the framework of three EU projects aiming at providing C-ITS in order to provide guidance to the drivers: Compass4D (focusing on freight, 2013-2016), C-The Difference (2016-2018), and the ongoing C-Mobile project (2017-2020). These projects aim at providing C-ITS regarding traffic management, developing the technologies and ensuring their interoperability and large use among the drivers. In the framework of these projects, other valuable guidance information, beyond GLOSA, are provided to the drivers:

Services	Bordeaux	Helmond
Emergency vehicle approaching	✓	✓
Road hazard warning	✓	X
Road works warning	✓	✓
Park and Ride information	✓	X
Signal violation, intersection safety	✓	✓

Table 1: Technologies tested in Bordeaux and in Helmond

This service is disruptive in the way that this system provides guidance to the drivers, relying on 3G/4G detection systems instead of former detection units.

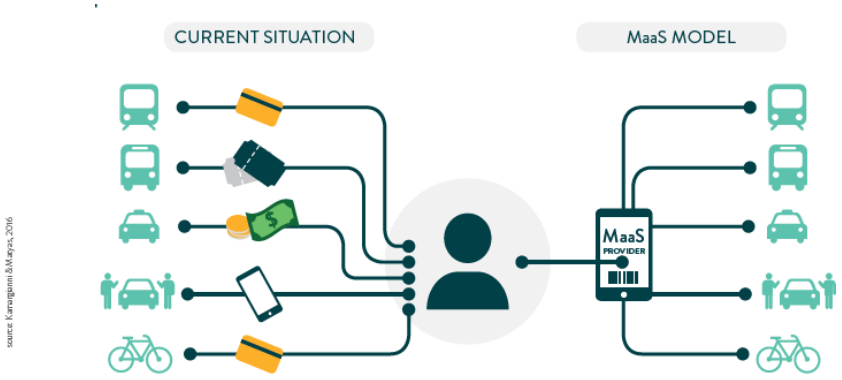
In Bordeaux, regarding regulatory challenges, the data and source codes own by Gertrude and collected through the existing network of detection systems are given to the local authority Bordeaux Métropole via an operating permit. Then, the data are used by NeoGLS, in agreement with the local authority, in order to setup GLOSA.

5.3. Mobility-as-a-Service (MaaS) and Platforms

5.3.1. MaaS

Introduction

MaaS is the integration of, and access to, different transport services (such as public transport, ride-sharing, car-sharing, bike-sharing, scooter-sharing, taxi, car rental, ride-hailing and so on) in one single digital mobility offer with active mobility and an efficient public transport system as its basis. This tailor-made service suggests the most suitable solutions based on the user's travel needs. MaaS is available anytime and offers integrated planning, booking and payment, as well as, en route information to provide easy mobility and enable life without having to own a car.



With the development of MaaS new players are offering a multitude of new services to move around cities yet for the traveler confronted to all these options finding the best way to move around can be quite challenging. This is where the MaaS concept steps in: MaaS is about taking away the hassle of finding the most suitable mobility option.

From a city authority perspective, the main objective is to change citizens' travel behaviour towards more sustainable modes, offer better service and affordable mobility to reduce car ownership through a mobility solution, while offering the same flexibility and convenience as a car for all citizens.

From the user perspective, they are looking for reliable and accessible urban mobility from door to door, enjoying total freedom of mobility without having to pay for, maintain and park a car is the main purpose. Once people realise the improved service through MaaS they will reconsider car ownership and be more inclined to change their mobility habits towards more sustainable modes.

From a transport operator perspective, MaaS is therefore also about offering its travellers a better service with a wider range of options that will attract more customers. It is clear that any business actor in the MaaS ecosystem will pursue the goal to grow his business[184].

European Regulation

A concern is pricing and revenue sharing, e.g. similar to the situation with hotels (e.g. booking.com). The EU is addressing such issues with regulation promoting fairness and transparency for business users of online intermediation services[185] [186].

The EC also commissioned a study on the remaining challenges for EU-wide integrated ticketing and payment systems[187] [188].

The INSPIRE Directive (2007/2/EC) of the European Parliament and of the Council establishing an Infrastructure for Spatial Information in the European Community also defines MetaData. More information in 6.2.1.

Mobility Package n°1

- Communication: An agenda for a socially fair transition towards clean, competitive & connected mobility for all.

Mobility Package n°2

- Clean Vehicles Directive, new CO2 standards and a review of Regulation 1073/2009 aimed at liberalising road passenger transport services across the EU… It does not, however, contain any initiatives related to digital affairs.

Digital Single Market

- Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications

National Regulation

The institutional fragmentation with different authorities in charge of the mobility services available in a city can be a barrier for the quality of the MaaS solutions. Indeed, different regulations for the diverse transport modes are often the source of missing coordination. The setup of mobility agencies or multimodal transport authorities in charge of all urban mobility

[184] UITP Mobility as a Service Report, 2019.
[185] Proposal for a regulation promoting fairness and transparency for business users of online intermediation services.
[186] Platform-to-business trading practices.
[187] Remaining challenges for EU-wide integrated ticketing and payment systems.
[188] Study on remaining challenges for Eu-wide integrated ticketing and payment systems results

services would facilitate a coordinated organisation of mobility services also in regard to urban space allocation and street design.

Finland

In 2018, The Act on Transport Services in Finland brought together legislation on transport markets. The aim of the legislative reform is to provide the users with better transport services and to increase freedom of choice in the transport market. Part of this act ensures that regardless of the mode of transport, a provider of passenger mobility services shall ensure that essential, up-to-date data on its services is freely available from an information system (open interface). The data should be provided in a standard, easy to edit, and computer readable format. At minimum, this essential data shall include information on routes, stops, timetables, prices, availability, accessibility as well as access to the sales interface of their ticket and payment systems - at least for single tickets[189].

The Netherlands

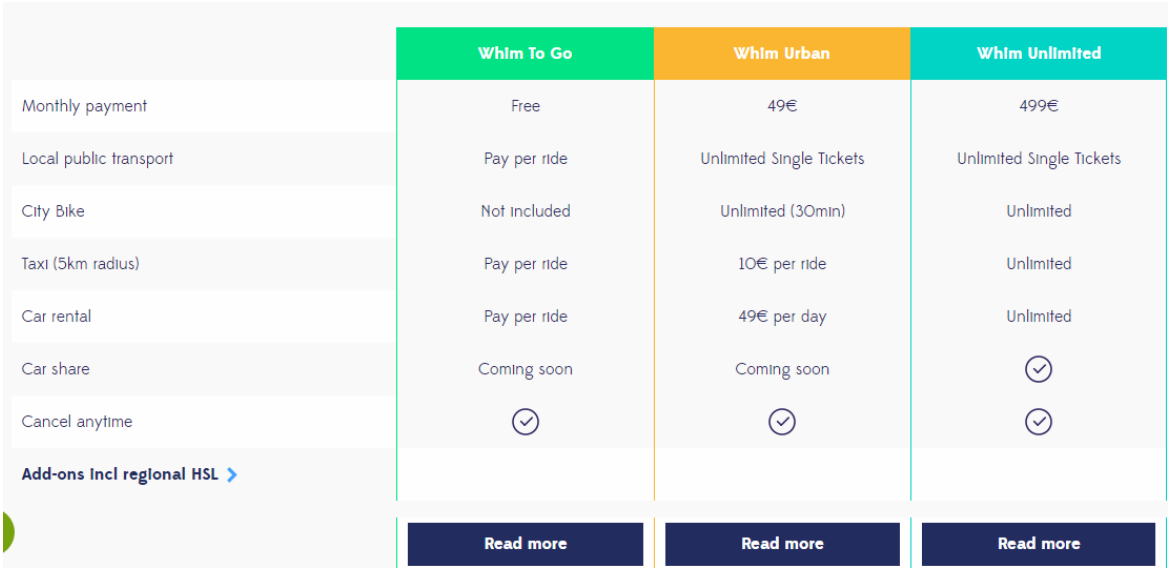
Within the Netherlands, 41 parties have registered for the umbrella framework agreement for MaaS that was organised by the Ministry of Infrastructure and Water Management. After the assessment 24 parties were admitted, who registered for regional pilots? The Ministry of Infrastructure and Water Management then chosen seven MaaS pilots to be rolled out nationally and gain insight into the effects and functioning. The pilots will start in the regions: Amsterdam, Utrecht-Leidsche Rijn, Twente, Rotterdam-The Hague, Eindhoven, Groningen-Drenthe and Limburg. The incentive grant of a total of 20 million euros is valid for 2 to 3 years. The co-financing of the central government and the region is intended to give the private companies a boost in the development of apps.

Examples

Helsinki

In Helsinki, the company MaaS Global launched its service under the brand Whim in 2017, offering both pay-as-you-go solutions and subscription/monthly packages. The large majority of clients so far adopted the *Whim To Go* and Whim Urban offers.

[189] Finish Ministry of Transport and Communications.



	Whim To Go	Whim Urban	Whim Unlimited
Monthly payment	Free	49€	499€
Local public transport	Pay per ride	Unlimited Single Tickets	Unlimited Single Tickets
City Bike	Not included	Unlimited (30min)	Unlimited
Taxi (5km radius)	Pay per ride	10€ per ride	Unlimited
Car rental	Pay per ride	49€ per day	Unlimited
Car share	Coming soon	Coming soon	✓
Cancel anytime	✓	✓	✓
Add-ons incl regional HSL >			
	Read more	Read more	Read more

Figure 2: Current commercial offering of Whim MaaS in Finland

Madrid

Launched in July 2018, MaaS Madrid is travel consolidation platform that works towards optimising travel organisation and developing a smoother mobility infrastructure specifically in the Madrid area of Spain. By providing not only travel bookings but raising awareness towards new types of alternative travel methods MaaS Madrid becomes one of the many leaders in adapting and revolutionising Spanish Mobility[190]. Madrid City Council's Air Quality and Climate Change Plan was the catalyst behind the shared mobility app, MaaS Madrid. Launched by The Municipal Transport Company (EMT) of Madrid it combines public transport data and other transport service providers into a single app in a bid to drive both shared mobility and public transport use. Plan A is the Madrid City Council's air quality and climate change plan of. It is Plan A because it targets the 'Air' we breathe and because there is no Plan B if we wish to build a sustainable city which assures the health of its inhabitants by meeting the challenge of pollution, and if we wish to protect the city against the impacts of climate change[191].

Antwerp

In 2017, the Belgian city of Antwerp has announced plans to pilot MaaS, which brings public transport, taxis, bike hire, and car sharing together in a single subscription-based service to provide a convenient alternative to the private car. This initiative is led by the Mayor of the city of Antwerp and more precisely it is the responsibility of the vice mayor of the city Koen Kennis, in charge of mobility.

The applications available in Antwerp:

- Smart ways to Antwerp
- Whim

5.3.2. Maas Platforms

Introduction
The MaaS Platform(s) is the IT structure that is used by the MaaS Operator(s) to provide the final service of mobility to the end-users. The MaaS Platform is split into two elements: the front-end and the back-end, all of which are made up of components developed by the IT Providers.[192] This platform manages all the data and functionalities needed for MaaS operators to offer services.[193] The MaaS platforms can be developed by MaaS operators or IT providers.
European Regulation
Intelligent Transport Systems Directive and Delegated Acts: • Regulation 2017/1926 on MultiModal Travel Information Services (MMTIS) • Standardisation programme for ITS // Implementing Decision (EU) No 2016/209 **Mobility Packages** • Proposal for a Directive on the Interoperability of electronic road toll systems and facilitating cross-border exchange of information on the failure to pay road fees in the Union (recast); • Communication: An agenda for a socially fair transition towards clean, competitive & connected mobility for all. • Clean Vehicles Directive, new CO2 standards and a review of Regulation 1073/2009 aimed at liberalising road passenger transport services across the EU… It does not, however, contain any initiatives related to digital affairs. **Digital Single Market** • Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications • Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union: NIS Directive

[190] Mobility as a Service Companies to Watch in Spain.
[191] Madrid City Council's Air Quality and Climate Change Plan.
[192] MaaS Dictionary
[193] Mobility as a Service (MaaS) and Sustainable Urban Mobility Planning (SUMP)

- Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013: Cybersecurity Act
- Regulation (EU) 2019/1150 of the European Parliament and of the Council of 20 June 2019 on promoting fairness and transparency for business users of online intermediation services (Text with EEA relevance): P2B Regulation
- Communication from the Commission to the European Parliament, the European Council, the Council, the European economic and social Committee and the Committee of the Regions: "Artificial Intelligence for Europe"

  Communication on Building Trust in Human-Centric Artificial Intelligence following the work of the high-level group on the Ethics Guidelines for Trustworthy AI
- Communication from the Commission to the European Parliament, the European Council, the Council, the European economic and social Committee and the Committee of the Regions "Towards a common European data space": B2B Data Sharing
- Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information: PSI Directive
- Commission study on "Remaining challenges for EU-wide integrated ticketing and payment systems": preliminary results as well as executive summary were published in February 2019

Examples

FluidHub is the platform technology for building MaaS offerings in cities and regions. FluidHub offers a comprehensive toolset for MaaS operators to develop and operate their intermodal mobility apps. Public authorities can also use FluidHub to orchestrate their B2B MaaS ecosystem.

5.4. Shared and on-demand mobility

In the cases described below, the main issue remains in adapting the existing regulations to accommodate the challenges brought by the disruptive transport technologies and services.

Shared mobility and on-demand mobility are two trends emerged as a response to the change in traveller need for cheaper transport (e.g. sharing the cost of travel) and the need for easy access to a transport (service) at a given moment.

Shared mobility can be defined as usage of shared resources, in this case vehicles, which are made available to registered users at various locations in the city.

On-demand mobility, on the other hand, is service provided 'on-demand', when requested by the customer, and not based on a fixed schedule.

5.4.1. Car-sharing

Introduction
The service of using cars available in public spaces and shared among different users for the desired amount of time, is a concept that was in the EU first widely deployed in Paris in December 2011. It is a model of car rental where users are able to rent cars for short periods of time, by the hour or minute. The price of rental includes fuel, maintenance, insurance, parking, and the costs are paid on a per-use basis, without subscription. As a private car is in actual use only a fraction of the time, and is otherwise occupying a parking space, it was estimated that a single shared car can replace between 5 to 15 private cars[194]. Such systems are usually made available in one of the following forms: • Station-based • Free-floating • Peer-to-peer With station-based services the user can book a vehicle and collect it at a specifically designated parking space. After the use, the vehicle needs to be returned to the same location. Peer-to-peer systems allow on one side citizens to make their car available to others while they do not use it, and on the other side the citizens without a car can get access to one in the neighbourhood, and for a reasonable price. Examples of such services are Turo, drivy and iCarsclub. The commercial car sharing services make use of the roads and public parking spaces (e.g. station-based systems use especially designated parking spaces), and therefore needs to get an approval by the city authorities. This also enables the city to exercise control over the deployment of car-sharing in order to help them mitigate congestion, use of public space, pollution and coexistence with other (public) means of transportation. OEMs, such as Daimler, BMW, Ford and many others, are increasingly investing in car sharing systems, since this is likely to become a large market for car sales in the future and they want to control it. At the same time the direct presence in the market provides them the grounds to deploy advanced technologies, such as EV and autonomous driving[195].
European Regulation

[194] Does sharing cars really reduce car use?

[195] Business models, National variations and Upcoming Disruptions

On EU-level there is no specific regulation addressing such type of a service (apart from regulations on online platforms, GDPR and data sharing). The recent merger of two largest market players, car2go and DriveNow, owned by Daimler AG and BMW Group, required an intervention of European Commission, which approved the merger in November 2018[196] under certain conditions. Since the merger would likely provide the two services a monopolistic position on several markets (cities): Berlin, Cologne, Düsseldorf, Hamburg, Munich and Vienna. Several other companies, for example car rental and OEMs had intentions to enter the mentioned markets, where these two services operate and would thus pose a substantial barrier for the new entrants. In addition, Daimler owns Moovel, a platform and app for integrated mobility, which would after the merger have the incentive to offer only own services and disabling other integrated app providers to offer the two merged car sharing services. As a remedy, the Commission granted the merger with a condition that the interface (API) to the new merged car sharing service is made available to other potential integrators, and that other car sharing providers are granted presence on the Moovel app. The implementation of the decided measure is still ongoing.
National Regulation
There are substantial differences on how Member States, regions and cities regulate car sharing. For example, in Sweden the regulation emphasises sustainability and thus sets the plan for EV to represent more than 50% share in car sharing fleets. In France the rules are strict: all free floating vehicles need to be electric, and these also get easy access to parkings. In April 2017 Germany adopted a 'Car-Sharing Law' regulating allocation of parking spaces specifically for car sharing nationwide[197]. Public parking spaces are allocated to fixed location based services individually, whereas parkings are shared for free floating services.
Examples
Car2go is currently the largest carsharing operator in the world, with a presence in nine countries and nearly 30 cities. It operates as a one-way instant access carsharing system within a pre-defined urban zone. Members can find an unoccupied parked vehicle, access it immediately, and use it to meet their local travel needs. As long as the vehicle is parked within the operating zone, users only pay for the time that they drive.[198]

5.4.2. Car-pooling

[196] Commission clears the creation of six joint ventures by Daimler and BMW, subject to conditions

[197] Germany enacts car-sharing law

[198] Impacts of Car2Go on vehicle ownership, modal shift, vehicle miles traveled, and greenhouse gas emissions: An analysis of five North American cities

Introduction
Ride-sharing or carpooling is the sharing of car journeys so that more than one person travels in a car. Ride Sharing happens mostly spontaneous, however technology is used to connect people to share their rides.
European Regulation
Mobility Packages • Communication: An agenda for a socially fair transition towards clean, competitive & connected mobility for all. • Clean Vehicles Directive, new CO2 standards and a review of Regulation 1073/2009 aimed at liberalising road passenger transport services across the EU… It does not, however, contain any initiatives related to digital affairs. **Digital Single Market** • Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications • Commission study on "Remaining challenges for EU-wide integrated ticketing and payment systems": preliminary results as well as executive summary were published in February 2019
National Regulation
The proposals on new measures, its implementation and monitoring are often done through city's 'mobility agencies', which are responsible for traffic, parking and also public transport. In Brussels there is *Bruxelles Mobilité*[199], in Rome there is *Roma Mobilità*[200], and in London there is TfL[201].
Examples
In Brussels, Taxistop provides carpooling services assisting customer find carpool partners. Matching preferences, route frequencies and itineraries, it allows to formulate very precise requests and to find appropriate matches. In addition to the traditional carpooling services, it also offers companies the possibility of organizing the service tailored to their employees raising their awareness on alternatives to individual cars. Furthermore it provides some additional services such as a benefits calculator, a list of carpool parkings, information on

[199] Bruxelles Mobilité
[200] Roma Mobilità
[201] Transport for London

user's fiscal benefit and "Real Time" service which enables users to find partners at the last minute.

5.4.3. Bike sharing

Introduction
Shared bicycles are not a new concept, but shared dock less bicycles that do not need to be returned to a specific location are a relatively new phenomenon that hit the majority of European cities in the second half of 2018 and is growing even faster especially since the beginning of 2019. These bicycles are powered by an electric motor, can be located using a dedicated app, unlocked, used, and left anywhere in the predefined area.
European Regulation
Intelligent Transport Systems Directive and Delegated Acts • Regulation 2017/1926 on MultiModal Travel Information Services (MMTIS) **Mobility Packages** • Communication: An agenda for a socially fair transition towards clean, competitive & connected mobility for all. • Clean Vehicles Directive, new CO2 standards and a review of Regulation 1073/2009 aimed at liberalising road passenger transport services across the EU… It does not, however, contain any initiatives related to digital affairs. **Digital Single Market** • Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications Commission study on "Remaining challenges for EU-wide integrated ticketing and payment systems": preliminary results as well as executive summary were published in February 2019
National Regulation
Operators in **Singapore** are now obliged by the Ministry of Transport to hold a license, and ban users who continually refuse to park in designated spaces. The number of bicycles they can deploy has also been restricted. Those who do not comply face a heavy fine or risk having their license revoked. Dockless bike sharing was first introduced in **Beijing** in August 2016 as one of the earliest adopters. ofo and Mobike are the two largest players, although a range of emerging companies, such as Bluegogo, Hello, Youon, and Xiaoming, among others, have also emerged in recent

months. With the city experiencing clogged public spaces and blocked sidewalks due to the number of dockless bikes, the Ministry of Transportation at the national level published, in August 2017, the first country-wide regulatory framework as a means to resolve some of its issues. Beijing's municipal government also has issued regulations that relate to the parking challenge as the number of bikes continues to rise. To limit the oversupply of bikes, which is leading to parking and public space disturbances, Beijing has requested that companies agree to a cap on the number of bikes, and has established parking regulations by way of geo-fence technology. Furthermore, operators now must provide user insurance for each trip, as well as ensure that no child under the age of 12 uses the service. Other regulations in place include the protection of user safety deposits made through independent financial institutions that oversee operator accounts. Additional standards at the city level include the following:

- GPS and bicycle safety standards
- Fleet-size control/restriction
- Security deposit surveillance and refund
- Proper operation parameters
- Information and data sharing
- Insurance provision
- Defined parking areas and public space requirements
- Bike maintenance and repair[202]

Examples

Different operators target one or more cities in one or more countries:

- Free-floating: Gobee.bike, Ofo, Bluegogo, Bicycle, Mobike, O'bike (discontinued due to damage and theft), Pony, etc.
- Semi free-floating: Titibike, Uber Jump, Oribiky, Indigo Weel, etc.

With stations: Vélib'2 (Paris), etc. More examples here.

5.4.4. E-scooter sharing/ micromobility

Introduction

E-scooters are the fastest growing category and because of their number, being parked on the sidewalks or being driven along other vehicles on the streets, can be seen as the most disruptive modern means of transportation in the city. Their business model is rather simple: vehicles are available for rent to anyone who registers with a credit card (also used for the payment of the service), usually are priced at 1 EUR for unlocking and the first minute + 0.15 EUR/minute. Initial

[202] The Evolution of Bike Sharing: 10 Questions on the Emergence of New Technologies, Opportunities, and Risks

investment is quite considerable, since the company needs to purchase a substantial number of vehicles to make the service attractive, and at the same time it needs to engage in acquiring new customers. The e-scooters need to be charged (daily), so in addition some companies offer anyone to collect the e-scooters with low battery and charge them at their own expenses, for which they get paid.

These vehicles bring several advantages: although not particularly cheap, they are very convenient because of their solid availability, small, manageable size, the ability to leave it anywhere without the need to look for a designated parking. As such, they can be seen as an ideal first or last mile transport mode, when the user would usually need to walk or cycle to e.g. a metro station. E-scooters have proven to be especially useful in cities with more hilly terrain, where traditional bikes require too much effort.

At the same time, its speed (usually up to 30 km/h), no means to enforce safety equipment (e.g. helmet, gloves), no clear rules on where these can be driven (sidewalk, public roads) or parked, they also bring risks and challenges. First of all, road safety is at question, since no specific driving licence is required, and the maximum speed, combined with small wheels can pose an additional danger to its drivers. Also, often used on sidewalks, these vehicles can pose a danger also to pedestrians, not to mention the annoyances when these, while parked, are obstructing the sidewalks.

Due to recently emerged issues, e.g. road safety and use of public space and frequent vandalism, several cities have come with different measures addressing e-scooters.

European Regulation

Intelligent Transport Systems Directive and Delegated Acts

- Regulation 2017/1926 on MultiModal Travel Information Services (MMTIS)

Mobility Packages

- Communication: An agenda for a socially fair transition towards clean, competitive & connected mobility for all.
- Clean Vehicles Directive, new CO2 standards and a review of Regulation 1073/2009 aimed at liberalising road passenger transport services across the EU… It does not, however, contain any initiatives related to digital affairs.

Digital Single Market

- Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications
- Commission study on “Remaining challenges for EU-wide integrated ticketing and payment systems”: preliminary results as well as executive summary were published in February 2019

National Regulation

Paris was one of the first EU cities to experience the phenomena of e-scooters. Today, according to a study[203], 11% or a quarter of Parisians are already using e-scooters, only 8 months after the launch of Lime, the service with the largest share in the French capital. Also, 59% of the users reported the use of e-scooters as a replacement for existing personal motorised vehicles such as cars, taxis, rideshares and motorcycles. A large majority (85%) also claimed to use e-scooters as a compliment to other forms of transport, e.g. to access the public transport. Responders also estimate an average 11-minute reduction in travel time in work commuting. Nearly all claim to use bike lanes, where these are available. There are 10 different companies providing the service[204], operating around 15.000 vehicles, a number which is estimated to increase up to 40.000 by the end of 2019[205].

France only allows scooters on sidewalks if they have a maximum speed of 6 km/h. As typical e-scooters can achieve the speed of more than 25km/h, they are required to use bike lanes. The legislators are also considering a new law, which will require the A1 type of driving licence to operate the faster e-scooters. Today, the rules[206] do not allow the e-scooters to be used on sidewalks, the maximum speed is limited to 25km/h, and driving on, for instance, bus lanes, requires the user to respect road traffic rules. Helmet is not mandatory, but highly recommended. Fines for not respecting the rules are set in the new regulation. Driving on a sidewalk can be fined by 135 EUR, the operators can face a fine of 50 – 65 EUR for not respecting the published guidelines. The rules apply also to 'hoverboards' and electric skateboards. The most recent development is the city authority's proposal for a taxation of free-floating e-scooters and other shared vehicles[207]. According to the proposal, e-scooters would be taxed at 50 EUR/year.

There are currently between 3000 and 3500 free-floating e-scooters and bicycles in Brussels[208], mainly provided by Troty, Lime, Dott, Flash, Tier, Bird, Billy and Scooty. These vehicles are gaining traction especially because of the hilly nature of Brussels. The city has already received complaints about the incorrectly parked e-scooters and has committed to monitor the issue, also concerning road safety.

The city recently (1st February 2019) adopted a new regulation that requires e-scooter providers to acquire a licence to operate[209] in order to ensure a level playing field for companies

[203] Nearly 1/4 Million Parisians Are Using Dockless Electric Scooters, Study Finds

[204] Paris : qui sont les 10 opérateurs de trottinettes électriques en libre-service de la capitale ?

[205] Trottinette électrique sur le trottoir : 135 € d'amende à paris

[206] Paris : quelles sont les consignes à respecter pour circuler en trottinette électrique dans la capitale ?

[207] Paris va taxer les vélos et les trottinettes en libre-service

[208] How cities deal with shared micro-mobility (case study Brussels)

[209] Les trottinettes électriques partagées à Bruxelles

and to impose rules, e.g. prohibition on internal combustion engines. In addition, there are rules on parking. E-scooters cannot be parked on narrow pedestrian spaces – to counter this measure the city will help designate drop-off zones. Also, at certain locations the number of parked vehicles will be limited, and at certain locations parking will not be allowed. Helmets are not mandatory, but the speed is limited to 18km/h on roads and 5km/h on sidewalks, although the scooters can go up to 30km/h in case of a descent. Fines for users speeding are set to 58 EUR. On the other hand, with the new law, service providers risk a 50 to 300 EUR fine for incorrectly parked e-scooters 24h after a warning, resulting in potential suspension of the licence in extreme circumstances. The city also set a limit on the number of available licences.

In July 2018 the city banned the use of e-scooters (and similar vehicles) on sidewalks. In December 2018 the city of Madrid revoked licenses for all three e-scooter operators (Lime, Wind, and VOI) following a change in the law concerning where these can operate and their maximum speed. At the beginning of 2019 the city adopted new rules that allow circulation for up to 8600 vehicles from 18 different providers (of the total 25 that applied for the permit to operate). These vehicles were also classified into different categories.

Características	A	B	C0	C1	C2
Velocidad máx.	20 km/h	30 km/h	45 km/h	45 km/h	
Masa	≤ 25 kg	≤ 50 kg	≤ 300 kg	≤ 300 kg	
Capacidad máx. (pers.)	1	1	1	3	
Ancho máx.	0,6 m	0,8 m	1,5 m	1,5 m	
Radio giro máx.	1 m	2 m	2 m	2 m	
Peligrosidad superficie frontal	1	3	3	3	
Altura máx.	2,1 m	2,1 m	2,1 m	2,1 m	
Longitud máx.	1 m	1,9 m	1,9 m	1,9 m	
Timbre	NO	SÍ	SÍ	SÍ	
Frenada	NO	SÍ	SÍ	SÍ	
DUM (distribución urbana mercancías)	NO	NO	NO	NO	SÍ
Transporte viajeros mediante pago de un precio	NO	NO	NO	SI	NO

Los VMP se clasifican en función de la altura y de los ángulos peligrosos que puedan provocar daños a una persona en un atropello. Se definen como ángulos peligrosos aquellos inferiores a 110° orientados en sentido de avance del VMP, o verso el conductor o pasajeros.

Figure 3: Rules that apply to different types of personal mobility services[210]

Madrid allows these to circulate only on bike lanes and not on the public roads if the user is younger than 16 (helmet is required), and their speed on sidewalks is limited to 5km/h. Minimum user age is 15 and maximus vehicle speed is 20km/h[211].

Examples

Different operators target one or more cities in one or more countries. For example, there are 12 of them in Paris: Bolt, Wind, Hive, Ufo, Tier and Voi stopped for several days (early July 2019); Lime, Bird, Dott, Circ (formerly Flash), Jump (Uber subsidiary) and B-Mobility (sponsored by Usain Bolt).

210 Todo sobre la normativa y legislación de patinetes eléctricos de Madrid

5.4.5. Ride-hailing and TNC

Introduction
Technological developments and innovations in recent years have widely facilitated the access to services by online matching apps and smartphone solutions. It follows the concept of the sharing economy, a lifestyle where individuals benefit from usage rather than ownership of products. First of all, to clarify the terminology, what we refer to here as „Transactional platforms for the ride-selling“ or “ride-selling” are mobile applications that match customer demand for a ride with private drivers or drivers of vehicles for hire through GPS tracking. Other terms used in the literature are „ride-sharing apps“, „Transportation Network Companies“(TNC) or applications for „ride sourcing“. The best known example of such platforms is Uber, which launched its service in 2009 and which is now available on all continents in many cities worldwide. Since Uber's launch, several other companies have copied its business model with its main competitor being Lyft founded in 2012, and like Uber based in San Francisco. There are also initiatives elsewhere around the world as in India (Ola Cabs), China (Didi), Dubai (Careem), Russia (Yandex), Brazil (99 now part of DiDi) or Europe (as Haxi in Norway for example). These emerging platforms in the mobility market evolved from the concept of car pooling , which as such exists already since a longer time in the form of online platforms such as Blablacar for example. The main difference is that ride-hailing apps offer transport on demand, meaning that the ride is not planned in advance. The ride is requested and only driven because of this request. Most of the time, destinations are not shared between the riders, making the trip more individualized than with car-pooling. With carpooling the ride would have been done anyways but not with ride-selling. Some resemblance to taxi services can be identified, by offering a ride in exchange for a fare. For ride hailing platforms though, anyone with a driving license and a private car and fulfilling the specific criteria set up by the company, can sign up as a driver to chauffeur persons around, meaning the companies behind the ride-selling application do not own a fleet of cars. This allows these companies to expand rapidly.[212]
European Regulation
Across the EU, an on-demand transport service, such as Uber, is now defined as "chauffeur-driven car hire" (or private-hire vehicles related services), intermediated via collaborative (online) platforms. As concluded in the judgement of the European Court of Justice in

[212] UITP Combined Mobility Toolbox

December 2017[213], following several litigations across the EU, and specifically a litigation between Elite Taxi (Barcelona) and Uber, there is a distinction between the transport service provided by the driver and the intermediation service provided by the intermediation platform. There are other EU-wide initiatives that are affecting the on-demand and shared mobility, especially because these operate as online platforms. EC in June 2016 provided guidance on how EU laws apply to collaborative economy[214]. The regulation is addressing access to the market, as the collaborative economy-based businesses enter markets served by traditional players and proposes tools such as licensing, quality standards requirements and measures to ensure fair conditions.

In April 2018, the EC proposed a regulation on promoting fairness and transparency for business users of online intermediation services[215], which was adopted in February 2019. The regulation sets the rules that will help avoid unilateral trading practices that are harmful especially to small businesses that provide their service through online platforms, which have a much larger bargaining power. For example, an online platform with a substantial market power can set and change conditions and terminate collaboration with a business, and so far there were no laws preventing them to act in such way.

Intelligent Transport Systems Directive and Delegated Acts

- Regulation 2017/1926 on MultiModal Travel Information Services (MMTIS)

Mobility Packages

- Communication: An agenda for a socially fair transition towards clean, competitive & connected mobility for all.
- Clean Vehicles Directive, new CO2 standards and a review of Regulation 1073/2009 aimed at liberalising road passenger transport services across the EU… It does not, however, contain any initiatives related to digital affairs.

Digital Single Market

- Proposal for a Regulation of the European Parliament and of the Council concerning the respect for private life and the protection of personal data in electronic communications and repealing Directive 2002/58/EC: Regulation on Privacy and Electronic Communications

[213] The judgment of the European Court of Justice in Case C-434/15 Asociacion Profesional Elite Taxi did not concern services of 'chauffeur-driven car hire', but the intermediation service offered by an online platform.

[214] Communication of the Commission « European Agenda for collaborative economy » COM(2016)356 final.

[215] Platform-to-business trading practices

- Commission study on "Remaining challenges for EU-wide integrated ticketing and payment systems": preliminary results as well as executive summary were published in February 2019

National Regulation

In **Germany**, local laws require taxi drivers to hold commercial licenses in order to pick up passengers and adhere to a set fare structure. There is no separate regulation, so on demand transport services need to comply with existing taxi laws. **French** authorities earlier imposed the rule forcing car services to wait for 15 minutes between reservation and pick up. The government has merged "Collective Transport Permit" with "Chauffeurs License" to make it difficult to obtain license. In **Spain**, on demand transport services companies can only work with drivers who carry a valid professional VTC license, as required by all professional drivers. In **Belgium**, on demand transport service is banned in the country for using private cars. Only license taxis service is allowed, for example Uber drivers may be fined 10000 Euro for any pickup. **Denmark** has introduced new taxi laws in February 2017 that includes requirements such as mandatory fare meters, video-surveillance and seat occupancy detectors to activate the airbags. The **Italian** government has deferred the introduction of norms to control car hire and car-share services till the end of 2017. The ride hailing companies buy licenses in smaller towns where it cost less and use them to work in cities. A taxi license in Rome is worth EUR 150,000 but the NCC (cars rented with a driver) license just one tenth.

It is left to the cities to decide on how the service can operate, set the conditions to gain access to the public parking. As a result, there are substantial differences on how these services are regulated on national, regional and city level. For example, in Amsterdam the holders of the premium taxi licence are allowed to use tram and bus lanes, Brussels is running a training program for new drivers, in Warsaw occasional transport do not need to comply with the maximum allowed prices. In Stockholm the taxi service has been deregulated, same in Helsinki. In some cities on-demand transport services are banned, and in some cities, these are allowed as they also complement the existing public transport offer.

Examples

UBER

Uber is a platform that matches passengers with a need of transport with drivers who can provide the service with (own) vehicle. Besides its basic functionality of a match-making platform, Uber is also particular in the way it started its operation – instead of limiting the service supply to professional drivers, it enabled anyone with a vehicle (car) to offer through its platform to transport the passengers demanding a service. Its service is very similar to a taxi service and the cost of using is based on distance and time, nevertheless, there are two major differences: the cost is estimated beforehand, and the final price (for the customer) and payment for the provided driving service depends on current supply and demand. Such dynamic pricing can also act as a barrier in rural areas and at night, since low interest in

providing the transport service results in the platform incentivising potential drivers by raising the price for the passengers. The portfolio of available features and services is expanding, potentially allowing Uber to compete also with other means of transportation.

Uber is available in several cities globally, but with a restricted offer and even banned in certain cities. At the end of 2018, the service was available in more than 600 cities across 65 countries[216]. Each day, more than 15 million trips are completed, and so far, more than 5 billion trips have been completed worldwide. In total, there are 3 million drivers actively providing transport services for Uber's 75 million passengers. In the USA alone, Uber's market share in the ride-hailing market is estimated at between 69% and 74%. Dynamic pricing, based on current demand and available supply, enables the platform to incentivise both sides of the platform. In cases of high demand, the prices are increased, more so if there is not enough supply at the given moment. At the same time, higher earnings are offered to drivers that are willing to provide their service in times of high demand and low supply. Such mechanism – surge pricing - helps to ensure the balance of demand and supply and therefore more reliable service functioning. The growth of Uber is also reflected in the number of licences in those cities.

As an online platform, Uber is facing challenges also on data privacy and security. In September 2018 is was fined USD148m for failing to report a data breach in 2016[217].

After long history of taxi drivers' strikes and litigations between the taxi companies and Uber, the city of Barcelona in January 2019 adopted new rules on how such services can operate. The new rules require a vehicle to be booked at least 15 minutes in advance, and this pushed Uber and Cabify, another ride-hailing app, to cease their operations in Barcelona[218], as the booking requests are almost always made instantly. In order to push the local authorities in a similar direction, taxi drivers in Madrid have been engaged in several strikes[219], once even for 12 days, but have so far not achieved their objectives. Regular taxi licences cost between 135.000 – 160.000 EUR, whereas private hire vehicle cost much less and have softer rules.

In Brussels Uber was banned in April 2014[220]. In October 2015, Uber suspended its UberPOP service and continued to operate its UberX service, which uses licensed drivers. The service is still available in the city today, although the commercial court of Brussels banned its activities in January 2019. The ban became only valid for the 19 communes of Brussels, and does not apply to customers who use Uber to travel to the airports that are located outside the communes' territory.

[216] Uber Revenue and Usage Statistics (2018)

[217] Uber to cough up $148 million for hiding a data breach in 2016

[218] Uber, Cabify announce they are pulling their services out of Barcelona

[219] Madrid taxi drivers call off strike without achieving their objectives

[220] Uber to continue in Brussels despite ban by court

The ruling was published in Dutch, created substantial confusion on interpretation, and the French ruling that followed established that UberX service can legally operate in the region of Brussels[221].

The litigations nevertheless continue between taxi operators and Uber on whether the more than 1000 Uber drivers should be considered staff or not and thus enjoy benefits such as holidays and sick leave.

As of June 2018, 3.6 million people in London regularly use the app, and around 45,000 drivers provide the service[222], making London one of the most important markets. Uber was banned in September 2017[223] as TfL, the entity regulating transport in the city raised concerns about public safety and security, which included a failure to report crimes or alleged crimes to the police, the way it obtained medical certificates and how it conducted proper background checks on drivers. In June 2018 Uber was granted a 15-month probationary licence, during which it will need to show that the concerns have been addressed properly and its operation will be monitored and enforced by TfL. It will have to provide TfL with the results of an independent review into procedure and safety every six months. As a result of the conditions imposed by London, the company changed the way it operates, on a global level. In addition to the new rules, Uber has also offered improved conditions for UK drivers, including limited insurance, limits on working hours and a 24-hour phone line for support. Its licence to operate in London will expire in September 2019[224]. Interesting initiative: as of January 2019, Uber is adding a 15p per mile 'clean air fee' with the objective to help drivers purchase more environmentally friendly vehicles, to operate a fully EV fleet by 2025[225].

[221] Uber peut bel et bien CONTINUER d'opérer à Bruxelles
[222] Sadiq Khan wants to restrict number of Uber drivers in London
[223] Uber lodges appeal over London ban
[224] Uber survives legal challenge brought by London cabbies
[225] London Uber fares go up after electric car charge

6. CONCLUSION

These new mobility trends, 'disruptive innovations', are leading the way towards so-called 'smart-mobility' which implies a pivot away from ownership of a means of transportation towards increased usership. These innovations aim to work on issues such as the last mile, congestion in busy roads or peak hours. However, there are several existing barriers, such as the lack of integration with traditional mobility and the lack of suitable regulation, impacting the development of these innovations.

Several regulatory initiatives are emerging from different countries in Europe at national level, but also at city level where there is significant use of soft law tools. For example, the City of Paris like many other European capitals was overwhelmed a year ago with the massive arrival of e-scooters, so the reaction of the mayor was to develop a code of conduct[226].

This transitional period with strong use of soft law tools highlight the need for a European framework on regulation of these disruptive innovations related to mobility. The role of this European framework will be to set the principles that support and guide national governments and local authorities in the development of their respective regulatory frameworks. This need is clearly illustrated with the example of automation in Luxembourg where there are pilot projects running, which means that the public is accepting these autonomous shuttles and as a means to help solve the issue of the last mile. Now, the government is waiting for a regulatory framework at European level to start development and implementation of autonomous bus shuttles in Luxembourg.

The need for harmonization at European level is especially strong regarding the testing of automation, but also infrastructure linked to automation or e-mobility. The question of safety is a European issue which needs a European response and, as highlighted in this research, the question of safety is inherent to several categories of innovation from electric cars and low noise to automation and e-scooters. Another element which requires harmonization is the question of access. First, access to cities, for example from an environmental perspective with the development of UVAR in almost all the European capital cities. This question of access also needs harmonization specifically regarding the use of bus stops and bus lines by autonomous bus or innovative taxi business models. Second, the question of access is also important when it comes to access to a profession with the question of the licensing of drivers, as recently seen with Uber. Another key point is the responsibility of platforms for the services they intermediate. Requirements regarding intermediaries vary significantly across the EU. Many European cities are

[226] Trottinettes électriques: Paris veut une réglementation.

all working on that issue and would need guidelines to harmonize it and ensure fair competition between the different players.

Another element where the question of harmonisation at the European level is of high importance is the governance of data in various respects. For example, this is relevant in respect of liability when it comes to automation, but also for driving and rest times for drivers or for e-scooters to understand the needs of the city in terms of mobility. This governance of data is of key importance and rather urgent to avoid self-governance. Moreover, data sharing and access to data are big questions, treated differently across EU Member States. These raise significant sensitivities amongst transport operators, both in terms of impact on their business of opening such data and in terms of costs associated with the data gathering and compatible data formats.

Harmonization at European level appears to be important. Pending such harmonization, it seems necessary to work towards clarifications in national regulation to ensure a level playing field between traditional actors and new players who are competing in the same market thus guaranteeing fair competition.

7. ANNEXES

7.1. Annexe 1: Alternative fuels and energy for transport

This category, for the scope of this research, deals with production, distribution and use of alternative fuels and energy for transport. These include vegetable oil, biodiesel, bioethanol, natural gas, liquefied petroleum gas, and hydrogen. Several alternative energy sources excluded from this section, including electricity.

In urban areas, the transportation sector is one of the principal sources of substantial energy consumption and carbon emission. Although diesel and gasoline are still the main energy sources used in urban transportation, alternative and transitional energy sources are being introduced. Alternative and transitional energy sources can be used to promote the development of sustainable transportation systems because these are renewable and have a lower environmental impact than diesel and gasoline. However, various technical, economic, and policy factors can prevent the successful application of alternative energy sources[227]. Policy, along with technology, are the two main obstacles to overcome for the deployment of alternative fuels and energy for transport.

There is an existing framework and several regulatory bodies are playing an important role in defining policies on the development, production, distribution and use of alternative fuels and energy for transport.

UN Regulation

At the International level UNECE is the key regulatory body defining guidelines and policy framework around the questions of the production, distribution and use of the alternative fuels and energy for transport. Its Group of Experts on Renewable Energy is exploring ways to enhance the uptake of renewable energy and to support the development of the renewable energy policies and the suitable frameworks on how to "do renewable energy right" from a systems perspective in the UNECE Member States.

To provide this support the UNECE developed a work plan for 2018-2019[228]. There are four pillars included in this work plan:

- To track of the progress made in the uptake of renewable energy sources
- To exchange know-how and best practices on how to help significantly increase the uptake of renewable energy;

[227] Linna Li, Becky Loo, Alternative and Transitional Energy sources for urban transportation.
[228] UNECE - Work Plan of the Group of Experts on Renewable Energy for 2018-2019

- Organizing the matchmaking activities to support renewable energy investments
- Cross-cutting cooperation to strengthen integration of renewable energy in future Sustainable Energy Systems.
- Along with the work plan there is the UNECE Renewable Energy Status Report[229], it represents a comprehensive overview of the renewable energy infrastructure, industry, policy, regulations, market development and potential growth rates in 17 selected countries of the UNECE region.
- At the International level there is also the work done by WP29 regarding alternative fuels. The World Forum WP.29 supported the establishment of new regulation for the use of alternative energy sources such as LPG (Regulation No. 67 in 1987), CNG (Regulation No. 110 in 2000), and specific LPG and CNG retrofit systems (Regulation No. 115 in 2003). In 2008 it amended the provisions of Regulation No. 83 on the emissions of pollutants of passenger cars to allow the use of biofuels and produced a draft of the principles, criteria indicators and definition of biofuels[230].
- The committee on sustainable energy is also part of the UNECE, its activities are conceived with a view to ensuring access to affordable and clean energy to all and to help reduce greenhouse gas emissions and the carbon footprint of the energy sector[231].

EU Initiatives

At the European level in 2013 the EU launched the Clean Fuel Strategy which contains measures regarding electricity, hydrogen, biofuels, LNG, CNG, and LPG.

In 2015 an expert group on alternative transport fuels was set up, under the lead of DG MOVE and DG CLIMA. Its goal was to support the EU in the deployment of alternative fuels infrastructure and to contribute to the EU energy and climate goals[232]. The same year, the EC published the Communication "A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy" setting a framework for achieving the 2030 EU climate and energy goals[233].

The "Research, innovation and competitiveness" dimension of the Communication foresees the launch of three initiatives.

- The integrated Strategic Energy Technology Plan (SET Plan), which aims to accelerate the development and deployment of low-carbon technologies. It seeks to improve new

[229] REN21 UNECE Renewable Energy Status Report
[230] UNECE, Global Warming and transport.
[231] UNECE, Committee on sustainable energy.
[232] Expert group on alternative transport fuels.
[233] European Commission, Communication on A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy, COM(2015) 080

technologies and bring down costs by coordinating national research efforts and helping to finance projects[234].

- The Strategic Transport Research and Innovation Agenda (STRIA) which will contribute to the realisation of the Energy Union vision by identifying the contribution the transport sector can make to the achievement of the climate and energy goals and providing input for research and innovation policy to maximise the impact of low-carbon technology solutions.
- The Global Technology and Innovation Leadership Initiative.

Another key element to mention as part of the existing regulatory framework at the EU level is the Mobility package 2, or Clean Mobility package. It includes new CO^2 standards, a clean vehicle directive, an action plan and investment solutions for the trans-European deployment of alternative fuels infrastructure, a revision of the Combined Transport Directive, a Regulation on Passenger Coach Services, and a battery initiative.

There are two main directives which compose the regulatory framework.

- The renewable energy directive and its revision proposal (submitted in 2018[235], final vote to be done during the first half of 2019). This directive presents the target of at least 32% of renewable energy by 2030, contributes to Europe's fight against climate change, aims to reduce air pollution, and to reduce dependence on energy imports and increases energy security.
- The second is the Directive 2017/94/EU[236] on deployment of alternative fuels infrastructure. In February 2019 a report was published on the Assessment of the Member States National Policy Frameworks for the development of the market as regards alternative fuels in the transport sector and the deployment of the relevant infrastructure pursuant to Article 10 (2) of Directive 2014/94/EU[237].

Another key element of the regulatory framework at the EU Level are the European Emission Standards, which aim to define the acceptable limits for exhaust emissions of new vehicles sold in the EU and EEA. The emission standards are defined in a series of EU directives staging the progressive introduction of increasingly stringent standards. The defined emission limits aim to reduce CO_2 for light-duty vehicles and heavy-duty vehicles[238].

National and local initiatives

[234] Strategic Energy Technology Plan.
[235] The revised renewable energy directive.
[236] Eur-Lex, Directive 2017/94/EU.
[237] Report was published on the Assessment of the Member States National Policy Frameworks for the development of the market as regards alternative fuels in the transport sector and the deployment of the relevant infrastructure pursuant to Article 10 (2) of Directive 2014/94/EU.
[238] European Commission, Emission in the automotive sector.

The role played at the national level and the city level are of significant importance to support the development and the use of alternative fuels and energy for transport. UVARs are a regulatory trend happening at the city level and are interesting to take into account especially when implemented with the creation of LEZ. As previously mentioned LEZ are areas where the most polluting vehicles are regulated. Usually this means that vehicles with higher emissions cannot enter the area. In some low emission zones, the more polluting vehicles have to pay more if they enter the zone[239]. The expansion of the number of these zones all over Europe can be considered as an indirect way to support the development, production, distribution and use of alternative fuels and energy for transport.

Zero and low emission buses

The role of the city is of particular importance as we can see in the case study of the buses in Brighton and Hove in the UK. In these cities the buses are public transport and managed as such. The particularity of these public buses is their contribution towards a cleaner environment, as the entire fleet runs on biodiesel. Biodiesel is fuel made from natural sources such as plant oils that can be used in diesel engines[240]. The company was one of the first in the industry to use low sulphur fuel as soon as it became available. They are the market leader in the fitment of specialist equipment to reduce pollution of exhaust gases from bus engines. All the modern vehicles have particulate traps fitted to their exhausts. Further research is being undertaken by the fuel suppliers to try to improve the biodiesel content currently being manufactured to meet the increasing environmental targets. They have several areas of known poor air quality and a low emission zone in Brighton City Centre which will soon require the fleet to be Euro 6 or better. Further ahead than that there is nothing in law to force Brighton & Hove Buses to do better than the Euro 6 standards, but some UK cities are looking at Clean Air Zones so it could certainly happen in the future. In terms of funding, with the cost of zero emission buses as high as it is, it is likely that operators will only be able to consider purchasing them with funding support which traditionally comes in annual rounds from UK Government. To receive funding from the UK government alternative fuels have to be sustainably sourced. Their hydrogen project actually has an element of EU funding as well through the European Project Fuels Cells and Hydrogen Joint Undertaking (FCH JU's Jive project). The FCH JU's Jive project[241] will deploy 152 fuel cell electric buses across 14 European cities throughout France, Germany, Iceland, Norway, Sweden, the Netherlands and the UK. This will expand the network of network of cities trialing fuel cell buses in Europe, demonstrating a growing appetite for the technology[242].

Biofuels in Sweden

[239] Urban Access Regulations in Europe – low Emission Zones
[240] Biodiesel definition, Collins English dictionary.
[241] FCH JU's Jive project
[242] FCH JU's project 2.

The second case study deals with the use of biofuels in Sweden. The main biofuels used by vehicles in Sweden are (in order), HVO (hydrotreated vegetable oil), FAME (fatty acid methyl ester), ethanol, and biogas[243]. In Sweden, the development of alternative fuels for the transport sector (including both fossil fuels, such as natural gas, and renewable fuels, such as biofuels) has been on the agenda since the 1970s, stimulated by the oil crises[244]. In 2011, the binding national target of 10% was met[245], and already in 2012 the share of renewable energy in Sweden surpassed the target for the EU Renewable Energy Directive (2009/28EC)[246] of 49%, as well as the Swedish parliament national overall renewable energy target of 50%[247].

Like the vast majority of the European Countries[248] Sweden has a National Renewable Energy Action Plan. The National Renewable Energy Action Plan of Sweden (NREAP, adopted in 2010) is one of the key elements of the policy on alternative fuels and defines the renewable energy targets per sector.

According to the country report compiled by the IEA Bioenergy[249], Sweden's policies on bioenergy have been rather stable for a long period of time. In 1991 a carbon tax was introduced and has since been raised multiple times, mainly in the heating and service sector, and lately also on industries that are not part of emission trading (ETS). Beside the carbon tax there are also variable energy taxes and fees on sulphur and nitrous oxide emissions. The most important incentives and tax measures were:

- 1970s to present: energy taxes to diversify energy use and decrease dependence on oil
- 1977: Law on municipal energy planning
- 1991: introduction of a carbon tax, high on heat, lower on industry.
- 1991 – 1995, 1997 – 2003: investment grants to build biomass fuelled CHPs.
- 2000 – 2004: green tax shift. The carbon tax was increased while labour taxes were lowered.
- 1998-2012 LIP & KLIMP: Local investment programmes for municipalities
- 2002: landfill ban for combustible waste
- 2003: Green certificate scheme to promote new renewable electricity production, • 2005: landfill ban for organic waste

[243] European Biofuels Technology Platform
[244] McCormick, Kes; Bomb, Christian; Deuwaarder, Ewout, "Governance of Biofuels for Transport in Europe: Lessons from Sweden and the UK", Lund University.
[245] Country report, IAE Bioenergy, Sweden – 2018 update.
[246] EU Renewable Energy Directive (2009/28EC)
[247] Country report, IAE Bioenergy, Sweden – 2018 update.
[248] National Action Plans.
[249] Country report, IAE Bioenergy, Sweden – 2018 update.

- 2007: Tax exemptions for biofuels for transport to be used to 2013. Annual prolongation since then with some major adjustments
- 2012: Electricity Certificates Act. Together with Norway, a common electricity certificate market was installed in order to increase the production of renewable electricity by 26.4 TWh by 2020. In 2016 the goal was raised to 30 TWh.
- 2016: Framework agreement on energy and climate: Net zero emissions to the atmosphere by 2045.

There are many actors contributing to the production, distribution and use of alternative fuels and energy for transport in Sweden.

- The Ministry of the environment, the Ministry of enterprises, and the Minstry of education and research.
- Organisations and agencies such as the Swedish Bioenergy Association[250] (Svebio),
- The Swedish Transport Administration[251] ,
- The biofuels industry and research stakeholders Göteborg Energi AB[252] or Swedish Biofuels[253].

Biofuels in France

The last case study of this section is about France and the development of the use of biofuels. At the national level the key actors in France are the Ministry of ecology and solidarity transition including the department in charge of transport within this Ministry. But it is also important to consider other related actors that are not ministries, such as the French Union of Petroleum Industries (UFIP), a car manufacturer or Engie, the French industry energy group for example. Engie is a large investor in renewable electricity production and also develops electric vehicles charging infrastructure, together with their partner EV BOX, a global manufacturer of electric vehicle charging stations and charging management software. Engie believes that while electrification will play a key role in the shift towards cleaner mobility, it also reaches its limits when it comes to long-haul heavy-duty transport. According to Engie, natural gas, in compressed or natural form, is a more credible and cost-effective alternative than electrification. ENGIE invests also in natural gas filling stations via our subsidiary GNVERT, offering their clients either Natural Gas or 100% biomethane solutions. ENGIE has also announced recently to mobilize 800 million EUR in the coming 5 years to develop green gas. ENGIE is involved in several projects including hydrogen for mobility, for example by developing the first hydrogen-powered bus line in France.

[250] Swedish Bioenergy Association
[251] Swedish transport Administration.
[252] Göteborg Energi AB.
[253] Swedish Biofuels.

ENGIE recommendation regarding the policy/regulatory framework:

- To provide visibility to investors in alternative fuel infrastructures, among others by stimulating the demand for cleaner vehicles and putting in place incentive programs, fiscal measures, etc.
- The "tailpipe approach" used to measure CO_2 emissions is inappropriate as it neglects greenhouse gas emissions from the production and transport of the fuel or electricity and the environmental impact of battery production. This approach is not technology neutral and creates a strong bias in favour of electrification. Electric vehicles, natural gas, biomethane, and renewable hydrogen will all be needed and should be supported in accordance with their environmental and social impact[254].

The key element of the regulatory framework in France dealing with the questions of the production, distribution and use of alternative fuels and energy for transport are the following ones:

- The application decree[255] of the Directive 2014/94/EU[256] on the deployment of alternative fuels infrastructure.
- The national action plan defining actions and measures to be implemented to promote alternative fuels in France[257]. In this national action plans, France is presenting how the obligation under the Renewable Energy Directive, including their legally binding 2020 targets will be met.
- The Law n°2015-992 about the energy transition for green growth[258].
- The decree of the 9th of April 1964 regulating the conditions of equipment, supervision and operation of compressed-gas fuel installations in motor vehicles.

7.2. Annexe 2: E-mobility

This category of disruptive technologies looks at electrification technologies and infrastructure for urban passenger and freight mobility, for example incentives for adoption, safety concerns and charging network. Electric mobility comes with a promise of better vehicle efficiency, low or zero emission, convenience and low production and maintenance costs. After several unsuccessful attempts to develop a usable, competitive and commercially viable and successful

[254] Making transport cleaner: Yes we can! Didier Holleaux, Executive Vice-President, ENGIE.
[255] Décret n° 2017-1673 du 8 décembre 2017 portant diverses mesures réglementaires de transposition de la directive 2014/94/UE du Parlement européen et du Conseil du 22 octobre 2014 sur le déploiement d'une infrastructure pour carburants alternatifs.
[256] Directive 2014/94/EU on the deployment of alternative fuels infrastructure.
[257] National Action Plan
[258] LOI n° 2015-992 du 17 août 2015 relative à la transition énergétique pour la croissance verte.

personal car, e.g. General Motors EV1[259] in 1996, the technological advances have accelerated only recently with the introduction of very performant Tesla's model S in 2012.

As of beginning of 2019 several car manufacturers are already refocusing their development plans and are planning to start manufacturing not only single electric car models, but also a wider range of models. Following the success of Toyota Prius[260], a hybrid powered car presented in 1997 and sold in more than 12 million, it is common today that a car manufacturer has a variety of electricity (co)powered vehicles in its portfolio:

- (Battery) Electric vehicles (BEV)
- Conventional Hybrids
- Plug-in hybrid electric vehicle (PHEV)
- Fuel Cell Electric Vehicles (FCEVs)

Traditional car manufacturers are now pouring substantial investments into the development of (fully) electric cars, battery development and manufacturing and charging infrastructure.

EV have advantages over the traditional, internal combustion engine powered cars. An EV itself does not have any (exhaust gas) emissions and noise levels are very low, making them ideal for densely populated urban areas fighting with air pollution and noise. Zero emissions are seen as their main selling point, nevertheless, the actual footprint of EV should consider also the production of electric energy, which still requires in most of the cases the use of thermal and nuclear power plants.

As several manufacturers keep introducing new and more attractive models, the sales numbers of EV keep growing and electric passenger cars represent today already 2.8% of the total. The production numbers are growing also in public transport (e.g. hybrid and electric buses in Europe[261], and electric buses in China), and several heavy-goods vehicles have already been presented and are slowly being deployed on European roads. One of the most awaited is Tesla's semi-trailer, which is promising a range of up to 800km[262].

Electric vehicles come with a wide array of advantages[263] that can be summarised as follows:

- Low/Zero pollution: depending on how the electric energy is produced
- Low noise: no exhaust, less moving parts
- Performance (constant torque, available from low speed) and convenience (e.g. no need to warm-up the engine)

[259] The Fascinating History of Tesla and the General Motors EV1
[260] The Toyota Prius is one of the most important cars of the past 20 years — here's a look at its impressive history
[261] Electric Bus Orders More Than Doubled Last Year In Europe
[262] Tesla Semi, all-electric trucks get scathing criticism from auto tech expert
[263] Benefits of electric vehicles

- Less moving parts and lower complexity of the propulsion, resulting in more efficient maintenance (in addition, remote diagnostics, software updates
- Lost cost of operation (depending on electric energy prices)

However, as any technology, these come also with some challenges in development, sales, deployment, operation and finally also recycling. The main ones are:

- Battery capacity and vehicle range
- Charging: time, infrastructure cost, availability and compatibility
- Electric energy production (managing trends, price)
- Battery R&D and production costs (component costs and availability)
- Battery lifecycle / recycling
- (High) vehicle development cost – hindering competition (small manufacturers)
- Whole vehicle (purchasing) cost
- Recycling used batteries

At the same time, there are also certain risks with EV. For example:

- Low noise: in urban areas EV can be dangerous to pedestrians since they are detected late
- Electric shock (high voltage) danger for mechanics and emergency responders[264]
- Battery fire in case of accident, high-voltage, dangerous and vehicle specific rescue operations
- High R&D costs might discourage small manufacturers (skewed competition)
- High infrastructure cost might result in slower uptake in certain areas
- Availability of electric energy
- Electric energy price

The way road vehicles are designed and operated on public roads is heavily regulated in order to ensure road safety, operation across borders, stimulate trade and competition, limit congestions and pollution.

International Regulatory framework

World Forum for Harmonization of Vehicle Regulations [265] (WP.29) of the UNECE has been active for more than 50 years on a global level. Open discussions on motor vehicle regulations are discussed by contracting partners that include United Nations country members and also

[264] Electric Vehicles Pose High-Voltage Risks For Technicians and Mechanics
[265] About The World Forum for Harmonization of Vehicle Regulations

governmental and non-governmental organisations in a consultative capacity. WP.29 has subsidiary working groups dealing for example with specific vehicle components or specific aspects, for example The Working Party on General Safety (GRSG)[266] .

Technical requirements for the assessment of safety and environmental performance of Electric Vehicles (EV), Hybrid Electric Vehicles (HEV) and Fuel Cells Vehicles (FCV) are also developed by WP.29. There are regulations [267]addressing the following safety aspects:

- UN Regulation No. 100 (Electric safety)
- UN Regulation No. 136 (Electric powered 2&3 wheelers)
- UN GTR No. 14 (Hydrogen and Fuel Cell Vehicle Safety)
- UN Regulation No. 134 (Hydrogen fuelled vehicles)
- Electromagnetic Compatibility (EMC) - UN Regulation No. 10
- Quietness of these vehicles at low speed especially for vulnerable road users

At the same time also, environmental issues are addressed through:

- Evaluation of the EV-mode range and its impact in the test cycle (NEDC, WLTC)
- The preconditioning of EV and HEV (NEDC, WLTC)
- Exemption for FCV
- Hardware in the Loop Simulation (HILS) for HEV trucks (in UN GTR No. 4)
- Phase II of WLTP (UN GTR No. 15)

The framework setup by the UNECE is instrumental for the introduction of innovative technologies to the market. It contains UN Regulations (provisions related to environment and safety), UN GTR (general technical requirements, dealing with performance-related requirements and test procedures) and UN Rules, which focus on periodical vehicle inspections. EV specific regulations are defined in Proposal for an Electric Vehicle Regulatory Reference Guide[268].

European Regulation

The European Commission often refers to the UNECE regulations in its regulation proposals in order to build upon already agreed rules, contribute with own developments and ultimately align with the rest of the world. The relevant acts[269] are:

- Commission Regulation (EU) 2019/543 of 3 April 2019 amending Annex IV to Regulation (EC) No 661/2009 of the European Parliament and of the Council and Annexes I, III and IV

[266] The Working Party on General Safety
[267] WP.29 contributes to mobility electrification
[268] Proposal for an Electric Vehicle Regulatory Reference Guide
[269] Directives and regulations on motor vehicles, their trailers, systems and components

to Directive 2007/46/EC of the European Parliament and of the Council as regards updating the references to and including certain Regulations of the United Nations Economic Commission for Europe on the type-approval of motor vehicles

- Commission Regulation (EU) No 630/2012 of 12 July 2012 amending Regulation (EC) No 692/2008, as regards type-approval requirements for motor vehicles fuelled by hydrogen and mixtures of hydrogen and natural gas with respect to emissions, and the inclusion of specific information regarding vehicles fitted with an electric power train in the information document for the purpose of EC type-approval

These rules are then applied by a Member State in a mostly seamless way. When it comes to incentives, however, the initiatives are created on a national and also on city level. For example, there are 167 Tesla model S at the Schiphol airport, purchased with the support of the incentives put in place[270].

In October 2017 The European Commission European together with German chemical group BASF, automakers Renault and Daimler and engineering firm Siemens created the European Battery Alliance[271], a consortium for battery production in Europe to compete with Asian and US manufacturers. There are also initiatives to support and incentivise the development of vehicles and charging infrastructure, as well a Directive (2006/66/EC) with the aim of minimising the negative impact of batteries on the environment and improving overall environmental performance[272].

In electric and hybrid vehicles there is a risk of fire when these are on-standby, being charged, while driving and especially in case of an accident[273] .The causes are usually short circuiting, overcharging, high temperatures and overheating. Besides the fire, there is also the danger of high-voltage (usually 200 – 800 V[274]) that can be a direct threat to human life. Batteries providing power to EV can burn for up to 24 hours[275], and the fire can start again even after it has been put out.

The main problem is how to extinguish such fires for various reasons. First of all, the location of the battery and electric wiring varies from model to model, and fire services need to be provided with special instructions on how to interrupt the electric current and how to deal with the fire. Locating the battery and wiring is one problem, but the other problem is also the nature of the fire that can result in toxic aerosols, dangerous to humans.

[270] Tesla taxis rolled out at Amsterdam Airport, to go with electric buses
[271] EU Battery Alliance – Strengthening Europe's economy
[272] Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators
[273] Safety Concerns with Li-ion
[274] A concept of a high-energy, low-voltage EV battery pack
[275] Smoking BMW i8 Dumped In Water By Firefighters

On several occasions fire services had to deal with EV catching fire after an accident[276]. For example, in October 2018 on an Austrian highway a Tesla Model S crashed into a concrete barrier[277]. It took 35 firefighters and five fire trucks to put down the fire.

Tesla, for example, publishes all the information relevant for first respondents on a dedicated page where emergency response guides with detailed schematics are shown. In addition, Tesla provides information on EV Safety training and on extrication.

Similar to Tesla, also Renault and several other OEMs provides emergency response sheets [278]for its hybrid and EV. Renault put in place an additional feature named 'firefighting access' that allows water to be applied directly to the battery if it catches fire. In addition, Renault is engaged in partnerships with firefighting services to which it offers specific trainings and provides the necessary materials for practicing. Unfortunately, there is no common approach on how this information is presented and made accessible.

Similar problems can be expected also for commercial vehicles, for example buses and trucks, which have batteries of even larger capacity and thus present an even bigger problem in case of fire[279].

The price of an EV is still significantly higher compared to traditional petrol-powered, limiting the number of citizens considering EV as a viable alternative. With the objectives to reduce emissions, several Member States provide subsidies and incentives for the purchase and operation of low or zero emission vehicles, such as EV, as the only means to stimulate the uptake. According to ACEA, the market share of electric vehicles is only substantial in those countries that offer extensive fiscal and non-fiscal incentives[280]. The data shows high market share in the Scandinavian countries, which have in place a variety of incentives. For example, Norway that has nearly 40% share of electric vehicles provides a purchase tax exemption for BEV and FCEV, a reduced purchase tax for PHEV up to 10.000 EUR and an exemption from VAT and import tax for BEV and FCEV. At 10% The Netherlands was the country with the largest share of new EV in 2017, which is reflected by the wide range of available incentives[281].

Poland, on the other hand, has an almost zero market share of electric vehicles, a consequence of not providing any incentives. Across the EU the differences in provided incentives are still extensive.

In general, the incentives are provided in the following forms[282]:

[276] Electrec: EV accidents
[277] Tesla Model S fire vs 35 firefighters
[278] Electric vehicles: Renault Group works hand in hand with fire services
[279] Bus Fire Safety: Safer battery systems in electric buses
[280] Interactive map: Electric vehicle incentives per country in Europe
[281] The impact of Electrically Chargeable Vehicles on the EU economy
[282] Overview of tax incentives for electric vehicles in the EU

- Purchase discounts
- Grants for switching from older diesel vehicles to BEV or PHEV
- Pollution tax exemption
- Registration tax exemptions and discounts (e.g. Denmark 65% in 2018, 90% in 2019 and 100% in 2020
- Road/circulation tax exemptions and discounts
- Company car tax exemptions and discounts
- VAT deductions

German OEMs, especially Volkswagen, are proposing a restructuring of the environmental bonus[283]. They propose higher incentives for smaller EV in order make them more attractive and thus help accelerate the adoption, and the opposite for larger, more luxurious vehicles. Furthermore, they propose free charging for EV that cost less than 20.000 EUR. While there is a wide presence of incentives for users, in the EU there are no incentives for manufacturers, whereas these are available for example in the US and China. Some countries also provide non-financial incentives, for instance access to restricted traffic zones and ability to use carpool lanes.

Availability, access and price of the charging network, as well as interoperability, are essential for a wide adoption of EV. Access to charging infrastructure and vehicle range remain the main reasons for new buyers being reluctant to choose purely electric vehicles. However, in Europe, associated with high installation cost, the progress on developing the charging infrastructure is proceeding with a slower pace. In 2016 only 11 countries had specific incentives in place to foster more charging facilities[284]. The Clean Power for Transport Directive is intended to support the development of national policy frameworks for the market development of alternative fuels and their infrastructure[285]. Some national governments are have announced very ambitious plans. Croatia plans to build 164 charging stations by 2020, which is equivalent to 1 every 50km.

Interoperability across different systems is however not guaranteed. While the majority of car manufacturers support the SAE J1772 charging connector, access to these facilities is often limited to specific brands, especially for premium locations and charging stations with higher capacity. At the same time the cost for recharging is not necessarily aligned and transparent. ISO 15118-1:2019[286] is a standard that defines the vehicle to grid communication interface which further improves charging and supports other use cases. The smart charging mechanism built into ISO 15118 makes it possible to perfectly match the grid's capacity with the energy demand for the growing number of EVs that connect to the electrical grid. ISO 15118 also enables

[283] VW wants EV subsidies revamped in Germany
[284] EU – high incentives, high market uptake
[285] Directive 2014/94/EU.
[286] ISO 15118-1:2019.

bidirectional energy transfer in order to realize vehicle-to-grid applications by feeding energy from the EV back to the grid when needed. Main benefit for the user is that no apps, QR-codes nor credit cards are needed to identify the user and process the payment. The driver doesn't need to do anything beyond plug the charging cable into the vehicle and the charging station (during wired charging) or park above a ground pad (during wireless charging). One of the first implementations was launched by EVgo [287](North America) for General Motors electric car-sharing service Maven. Systems based on the same technology have been also deployed in Europe[288].

On the commercial vehicles side, the city of Oslo in March 2019 announced the introduction of wireless charging for its electric taxi fleet[289]. The charging system will be installed under taxi parking spaces, at taxi stands, where cars would normally be idling for passengers. The deployment supports the country's goal of making all new cars electric by 2030.

7.3. Annexe 3 : Vehicle design & manufacturing

At the foundations of transport systems lies vehicle design and manufacturing (VD&M). Such relevance is also underlined by the drafting of an ad hoc EU-commissioned report[290] which identifies the VD&M -together with infrastructure and operational procedures[291]- as one of the three pillars of the transport system. Hence, advances in such field have been and will be crucial for EU mobility sector. Nonetheless, when it comes at policies and regulations related to VD&M, the mainly focus within and beyond the EU is on strategies for reduction of CO_2 emissions.

In this regard, all the major EU industrial sectors have faced changes and pursued technological advancements, and the advancements of interest are those which rend the vehicles both performants and environmental-friendly, namely the ones related to automation, energy storage, and powertrains[292]. Such advancements have different developments depending on the relevant transport sub-sector[293] (road transport, waterborne transport, aeronautics), and some of them are deemed to have exhausted their potential[294]. As for the specific regulations, several directives are relevant:

- The Directive 2000/53/EC, the "ELV Directive",

[287] EVgo is first North American EV Charging Network to Deploy Autocharge Technology, Enabling an Instant Start-Your-Charge Experience Without Apps or Cards

[288] Fastned gets ready for HPC & Autocharge in UK.

[289] Fortum and the City of Oslo are working on the world's first wireless fast-charging infrastructure for taxis.

[290] http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetailDoc&id=34594&no=1

[291] EU COMMISSION, "Vehicle Design & Manufacturing. Expert group report", p. 8: «Vehicle design and manufacturing (VD&M) is one of the three main pillars of the transport system – together with infrastructure and operational procedures».

[292] **EU COMMISSION**, "Vehicle Design & Manufacturing. Expert group report.

[293] **EU COMMISSION**, "Vehicle Design & Manufacturing. Expert group report".

[294] **EU COMMISSION**, "Vehicle Design & Manufacturing. Expert group report".

- The Directive 2005/64/EC. Directive 2000/53/EC regulates vehicles' End-of-Life, with the aim to rend dismantling and recycling environmentally friendly. Whereas the recovering's methods for traditional vehicles are well established, new challenges are related to the ones for electric vehicles[295].
- The Directive 2005/64/EC regulates the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability, obliging vehicles' manufacturers to design and produce vehicles without hazardous substances.
- As ELV Directive, Directive 2005/53/EC' rules are challenging when it comes at electric vehicles, since the used materials require new methods of recycling. It should be underlined that without these directives producers would not produce environmentally friendly vehicles, since there is not enough market-driven demand for such vehicles, especially in the automotive industry[296]. Indeed, European automotive was the most regulated industry even in 2006 according to CARS 21 high level group[297]. Obviously, these strict regulations affect the market and its competitiveness, especially when toward Asian manufacturers. Nonetheless, regulations could be both an impulse for disruptive technologies and a burden for manufacturers[298]. As a way of example, one possible challenge could be the one related to the use of IT solutions for the supply chain, allowing efficient exchange of data[299], as it would be explained in the third paragraph on Blockchain technology related to VD&M.

On the other hand, secularly, the EU institutions in the near future will improve strategies to rend regulations less demanding, as in the case of the Commission's new Better Regulation framework.

Beyond the EU framework, the focus is on safety. In such regard, within the UNECE the World Forum for Harmonization of Vehicle Regulations (WP. 29) sets regulatory instruments concerning motor vehicles and their equipment.

It operates in subsidiary groups focused on specific issues. To date, 6 subsidiaries groups have been formed, developing frameworks on lighting, passive and general safety, pollution, and also on connected and automated vehicles. Even though mostly the aim of these regulation is to set safety standards, the final goal is to facilitate cross-border trade. Besides safety standards, also WP29 has set some regulations on pollution. Some of the goals set in these regulations overlap with those indicated in UN 2030 Agenda for Sustainable Development. Finally, have given an overview on the regulatory framework, it goes without saying that VD&M is currently strictly related to environmental policies.

[295] **EU COMMISSION**, "Vehicle Design & Manufacturing. Expert group report".
[296] EU COMMISSION, "Vehicle Design & Manufacturing. Expert group report".
[297] CARS 21 A competitive automotive regulatory system for the 21st century.
[298] EU COMMISSION, "Vehicle Design & Manufacturing. Expert group report".
[299] EU COMMISSION, "Vehicle Design & Manufacturing. Expert group report", p. 29.

Blockchain

It is the case of the Blockchain technology used for the transport sector's supply chain: the resulting advancements are not related to the output of the VD&M (on its environmental friendliness) as in the case of the EU approach, but on its very process. A case study for VD&M is the one related to the use of Blockchain technology for the value chain of transport industries. The use of Blockchain could disrupt the transport sector[300] in the following years and is strictly connected to data protection compliancy problems.

Before analysing these issues, a preliminary introduction to Blockchain is necessary. It can be described as a digital distributed ledger, namely a network of ledgers/databases in which each computer represents a node, containing the same identical ledger. The reason of its entomology lies in the circumstance that the ledger is formed by a chronological chain of information (called blocks, thus "block-chain"). The main features of the Blockchain lie firstly in that for adding a new block (namely an information, usually related to a transaction), it is required the consensus of the node's majority, and secondly, in the circumstance that the chain is replicated identically for all the nodes. The sum of these two features implies that any node can control each transaction (becoming a new block).

When translated to the automotive global supply chain, the Blockchain nodes are represented by the former's stakeholder (i.e. manufactures, land transportation providers, warehouses, freight forwarders, custom brokers, governments, ports, ocean carriers and final customers). These nodes/stakeholders then contribute to form new nodes, representing different operative transactions[301]. As for its possible uses, one its traceability, namely the tracings history: every actor of the supply chain can control the good's status at each stage. Moreover, a unique database could improve the efficiency for different players in terms of documentation, databases implementation, and transactions[302]. As a backlash, the presence of a vast plethora of nodes can potentially lead to some basic cybersecurity problems[303] such as account's hacking.

Finally, more in general Blockchain produce challenges related to GDPR application. Currently, since the Blockchain has different uses and not so advanced, no specific law has been implemented at the European Level nor national level.

- Nonetheless, interesting solutions have been delivered by the French data protection authority (CNIL). According to CNIL, GDPR can be applied to Blockchain: indeed, miners are qualified as data controllers, and are so required to apply specific measures to ensure data protection[304]. As regulations are environmentally-focused, the production of electric vehicles has thrived. And indeed, the electricity is deemed to become the leading power

[300] EU COMMISSION, GERA 2030, October 2017.

[301] CATAPULT TRANSPORT SYSTEM, "Blockchain disruption in transport. Are you decentralised yet?" June 2018, p. 25.

[302] CATAPULT TRANSPORT SYSTEM, "Blockchain disruption in transport. Are you decentralised yet?"

[303] CATAPULT TRANSPORT SYSTEM, "Blockchain disruption in transport. Are you decentralised yet?"

[304] CNIL, "Blockchain. Solutions for a responsible use of the Blockchain in the context of personal data"

source for mobility in the near future.

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EV battery Production

Along the EV value chain, the crucial segment is battery production, currently controlled by EV original equipment manufacturers (OEMs). Among the latter, they are included well-known traditional automotive brands, as well as new EV-focused firms. The relevance of battery production is further testified by rumours on EU idea to allow aid for its production, with the aim to create a new hub competing with Asian and US giants[305], currently the major actors in the market. Since battery production is attractive toward new and traditional automotive manufacturers, its segment could become inflated. Indeed, it has been estimated that the production capacity of battery cell will exceed the market demand in 2021, creating new problems[306].

Beside the potential inflation, also the EV business model represents an obstacle for the battery production thriving. In such regard, the EV industry is facing a common situation among the new industries, e.g. related to the high initial costs. Moreover, these costs also increase because of the charging infrastructure need. In such regard, a possible solution for the development of a business model could be by developing partnerships along the value chain[307], especially for EV OEMs[308]. To have a complete overview on the industry, also relevant regulations need to be mentioned.

Within the EU, Directive 2006/66/EC ("Battery directive") indirectly applies for EV batteries as OMEs are included in Extended Producer Responsibility Schemes (EPR). Such schemes imply the producers' responsibility for the environmental impacts of their products until the latter end their life[309]. Together with the hard law indeed, in order to set down the regulatory barriers to innovation, the EC has promoted Innovation Deals[310] between stakeholders, namely EU institutions and authorities, national authorities and innovators. These Innovation Deals, which are voluntary agreements, will be than transposed into EU la and coordinated with the Battery Directive's review project.

[305] R. TOPLENSKY, EU to offer billions of funding for electric battery plants, Financial Times, October 15 2018

[306] D. KÜPPER , K. KUHLMANN , S. WOLF , C. PIEPER , G. XU , J. AHMAD, The Future of Battery Production for Electric Vehicles, The Boston Consulting Group, September 18 2018.

[307] EVUE, Electric Vehicles in Urban Europe.

[308] ACCENTURE, "The Electric Vehicle Challenge. Electric Vehicle Growth in an Evolving Market Dependent on Seven Success Factor", 2014.

[309] E. DRABIK, V. RIZOS, Prospects for electric vehicle batteries in a circular economy, July 2018.

[310] E. DRABIK, V. RIZOS, Prospects for electric vehicle batteries in a circular economy, July 2018.

Finally, any future regulation should also take into account that the traditional automotive brands will play a relevant role in EVs' batteries development. Indeed, since the main issues considered by these companies when developing technology and strategies are those related to their financial sustainability as well as those related to workforce organization[311], their financial sustainability has a strong influence on the development of EVs' batteries.

3D Printing

An interesting path in VD&M is the use of 3D printing technology in the automotive industry. More precisely, though, Additive Manufacturing (AM) is the official industry standard term for what is popularly recalled as 3D printing technology. For AM is intended a "process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies[312]".

AM technologies have been used in the automotive industry since the very early stage of their development, hence for a time period of 20 years. The current uses are mainly for prototyping or making specific tools and parts[313], as well as for rapid manufacturing[314]. Such uses bear efficiencies for the production as reducing lead times and decreasing costs[315]. An example of the lead time elimination is the use of AM for prototyping purposes. As 3D printers allow to scale up quickly from small prototypes to final deliverable, by a 3D prototyping process it is possible to test some functions on multiple forms and variety of prototypes, also at lower costs[316]. Since AM technologies are not meant for mass production, their (disruptive) effects are those to eliminate tooling, welding or other assembling line. Currently no standards have been developed for AM technologies. The main benefit for standardisation, together with quality consistency, is to have a widespread use of the relevant technology[317]. Indeed, since the automotive industry is highly regulated as for its manufacturing and product certification, the lack of standardisation could cause a delay in the adoption of Am technology[318].

[311] WORLD BANK, "Electric Mobility & Development. An Engagement Paper from the World Bank and the International Association of Public Transport", December 2018.

[312] https://www.wohlersassociates.com/additive-manufacturing.html

[313] https://www.ingwb.com/media/2088633/3d-printing-report-031017.pdf

[314] https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_The%20disruptive%20nature%20of%203D%20printing%20v1.pdf

[315] https://3dprintingindustry.com/news/3d-printing-automotive-industry-3-132584/

[316] file:///Users/federiconegrotti/Downloads/WP_DU_FiveWaysAuto.pdf

[317] https://amfg.ai/2018/10/19/developing-3d-printing-standards-where-are-we-today/

[318] https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_The%20disruptive%20nature%20of%203D%20printing%20v1.pdf

Finally, even though AM technologies have been in use for decades, currently no regulations, be hard law or soft law, have been adopted[319]. Hence, the main regulatory issues that will need to be assessed in future, together with those related to manufacturing rules for safety and environmentally friendliness, are those related to patents, copyrights and trademark.

[319] https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_3D%20Printing_20161028%20v1.pdf

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824273.