AVENUE

Autonomous Vehicles to Evolve to a New Urban Experience

D2.12 Final Report on regulatory requirements and compliance plan

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Acronyms

ADS	*Automated Driving Systems*
AI	*Artificial Intelligence*
API	*Application Protocol Interface*
AV	*Automated Vehicle*
BMM	*Business Modelling Manager*
CAV	*Connected and Automated Vehicles*
CB	*Consortium Body*
DSES	*Department of Security and Economy Traffic Police*
EAB	*External Advisory Board*
EC	*European Commission*
EU	*European Union*
EUCAD	*European Conference on Connected and Automated Driving*
GDPR	*General Data Protection Regulation*
GNSS	*Global Navigation Satellite System*
IPR	*Intellectual Property Rights*
IT	*Information Technology*
ITU	*International Telecommunications Union*
NMT	*non-motorised transport*
OCT	*General Transport Directorate of the Canton of Geneva*
ODD	*Operational Domain Design*
OEDR	*Object And Event Detection And Response*
PC	*Project Coordinator*
PCU	*Passenger Car Unit PCU*
PEB	*Project Executive Board*
PGA	*Project General Assembly*
PRM	*Persons with Reduced Mobility*
PTO	*Public Transport Operator*
PTS	*Public Transportation Services*
QRM	*Quality and Risk Manager*
QRMB	*Quality and Risk Management Board*
SA	*Scientific Advisor*
SAE Level	*Society of Automotive Engineers Level (Vehicle Autonomy Level)*
SMB	*Site Management Board*
SoA	*State of the Art*
TDM	*Transportation Demand management*
TM	*Technical Manager*
UITP	*Union Internationale des Transports Publics*
WP	*Work Package*
WPL	*Work Package Leader*

Executive Summary

In order to identify and map regulatory and legislative requirements and procedures (concerning actual and under development policies), we have collected data, for the French, Swiss, Luxembourg and Danish situation, at national, regional and local levels on the three following aspects:
- policy decision making organization, i.e., competencies,
- laws and legal documents in the field of urban planning, transportation and mobility,
- reports, white books and national programs.

After this first step, we have interviewed partners of the AVENUE project to investigate the issues they encountered and/or still face and how they overcame any problems. We aimed at identifying potential bottle necks, expectations in terms of regulation evolutions or stakeholders' contribution and give decision-makers tools to assess regulatory impact on the deployment of autonmated public transport as well as to anticipate regulatory evolution in orfer to implement complianbce plans.

Section 1 presents the framework of automated mobility and of the AVENUE project.

Section 2 identifies and maps regulatory and legislative requirements and procedures for the deployment of automated public transport. After providing a general overview on the international and European organizations involved in regulatory statements and the branches of law framing regulation for public transport, we propose a tool to evaluate the level of regulation framework openness to automated mobility, the ROAD© index (the Regulation Openness for Automated Driving index). Considering regulations and policy making process, we distinguished a set of four variables to measure the level of national or local readiness for the implementation of automated collective vehicles on open roads. ROAD© index helps to evaluate regulation as facilitator or barrier to automated mobility and to understand in which way decision makers can leverage on regulation to make it build a favourable framework for mobility innovation.

Section 3 proposes a methodology and a set of tools to implement a regulatory intelligence that allow to anticipate changes and implement compliance plans. The report presents a wide range of the tools available on the web now make it possible to easily collect "white information" as well as "grey information" which is more difficult to access and requires greater technical resources.

1 Introduction

AVENUE aims to design and carry out full-scale demonstrations of urban transport automation by deploying, for the first time worldwide, fleets of autonomous minibuses in low to medium demand areas of 4 European demonstrator cities (Geneva, Lyon, Copenhagen and Luxembourg) and 2 to 3 replicator cities. The AVENUE vision for future public transport in urban and suburban areas, is that autonomous vehicles will ensure safe, rapid, economic, sustainable and personalised transport of passengers. AVENUE introduces disruptive public transportation paradigms on the basis of on-demand, door-to-door services, aiming to set up a new model of public transportation, by revisiting the offered public transportation services, and aiming to suppress prescheduled fixed bus itineraries.

Vehicle services that substantially enhance the passenger experience as well as the overall quality and value of the service will be introduced, also targeting elderly people, people with disabilities and vulnerable users. Road behaviour, security of the autonomous vehicles and passengers' safety are central points of the AVENUE project.

At the end of the AVENUE project four-year period the mission is to have demonstrated that autonomous vehicles will become the future solution for public transport. The AVENUE project will demonstrate the economic, environmental and social potential of autonomous vehicles for both companies and public commuters while assessing the vehicle road behaviour safety.

1.1 On-demand Mobility

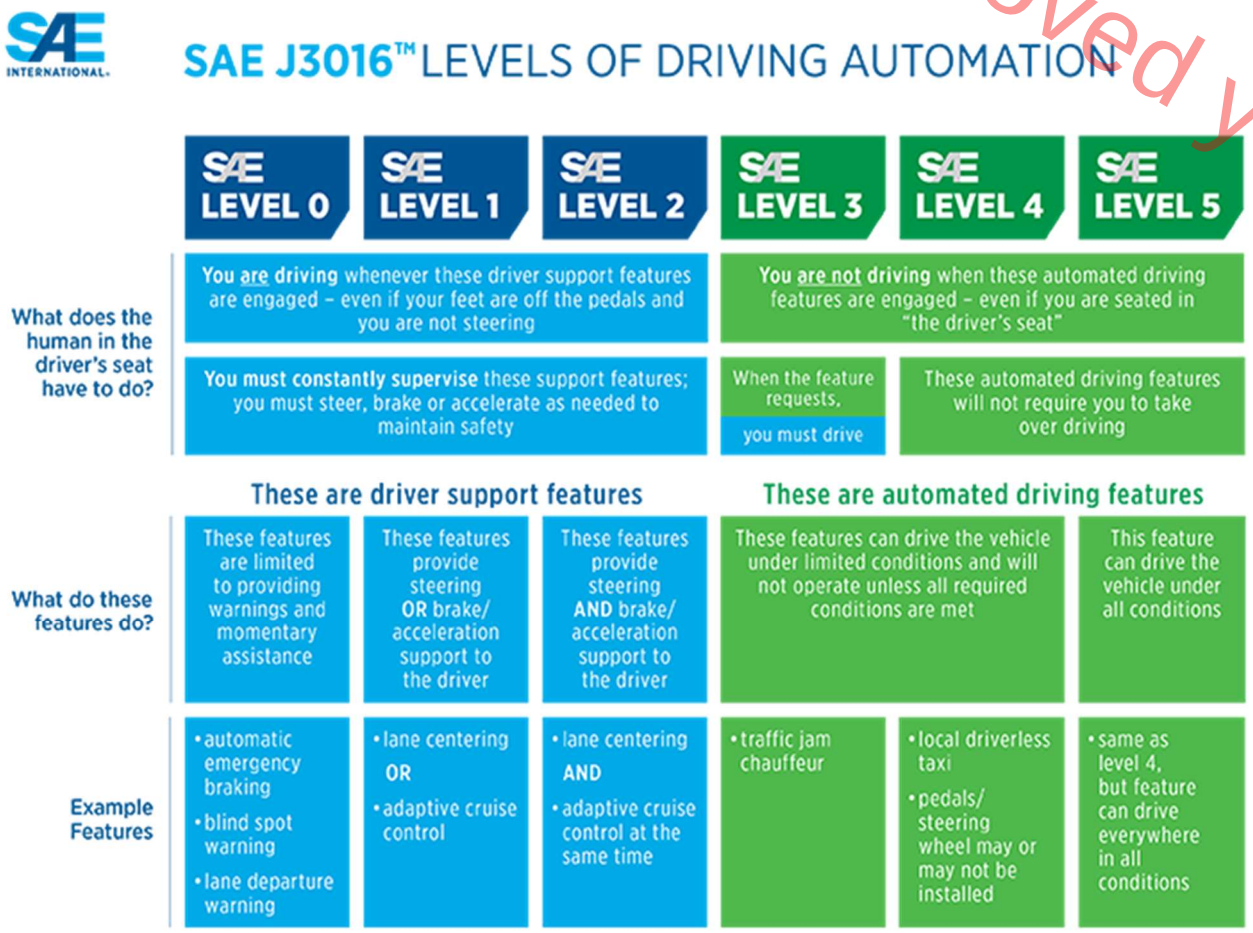
Public transportation is a key element of a region's economic development and the quality of life of its citizens.
Governments around the world are defining strategies for the development of efficient public transport based on different criteria of importance to their regions, such as topography, citizens' needs, social and economic barriers, environmental concerns and historical development. However, new technologies, modes of transport and services are appearing, which seem very promising to the support of regional strategies for the development of public transport.
On-demand transport is a public transport service that only works when a reservation has been recorded and will be a relevant solution where the demand for transport is diffuse and regular transport is inefficient.
On-demand transport differs from other public transport services in that vehicles do not follow a fixed route and do not use a predefined timetable. Unlike taxis, on-demand public transport is usually also not individual. An operator or an automated system takes care of the booking, planning and organization.
It is recognized that the use and integration of on-demand autonomous vehicles has the potential to significantly improve services and provide solutions to many of the problems encountered today in the development of sustainable and efficient public transport.

1.2 Autonomous Vehicles

A self-driving car, referred in the AVENUE project as **an Autonomous Vehicle** (**AV**) is a vehicle that is capable of sensing its environment and moving safely with no human input. The choice of Autonomous vs Automated was made in AVENUE since, in the current literature, most of the vehicle concepts have a person in the driver's seat, utilize a communication connection to the Cloud or other vehicles, and do not independently select either destinations or routes for reaching them, thus being "automated". The automated vehicles are considered to provide assistance (at various levels) to the driver. In AVENUE there will be no driver (so no assistance will be needed), while the route and destinations will be defined autonomously (by the fleet management system). The target is to reach a

system comprising of vehicles and services that independently select and optimize their destination and routes, based on the passenger demands.

In relation to the SAE levels, the AVENUE project will operate SAE Level 4 vehicles.



1.2.1 Autonomous vehicle operation overview

We distinguish in AVENUE two levels of control of the AV: micro-navigation and macro-navigation. Micro navigation is fully integrated in the vehicle and implements the road behaviour of the vehicle, while macro-navigation is controlled by the operator running the vehicle and defines the destination and path of the vehicle, as defined the higher view of the overall fleet management.

For micro-navigation Autonomous Vehicles combine a variety of sensors to perceive their surroundings, such as 3D video, lidar, sonar, GNSS, odometry and other types sensors. Control software and systems, integrated in the vehicle, fusion and interpret the sensor information to identify the current position of the vehicle, detecting obstacles in the surround environment, and choosing the most appropriate reaction of the vehicle, ranging from stopping to bypassing the obstacle, reducing its speed, making a turn etc.

For the Macro-navigation, that is the destination to reach, the Autonomous Vehicle receives the information from either the in-vehicle operator (in the current configuration with a fixed path route), or from the remote control service via a dedicated 4/5G communication channel, for a fleet-managed operation. The fleet management system takes into account all available vehicles in the services area, the passenger request, the operator policies, the street conditions (closed streets) and send route and stop information to the vehicle (route to follow and destination to reach).

1.2.2 Autonomous vehicle capabilities in AVENUE

The autonomous vehicles employed in AVENUE fully and autonomously manage the above defined, micro-navigation and road behaviour, in an open street environment. The vehicles are autonomously capable to recognise obstacles (and identify some of them), identify moving and stationary objects, and autonomously decide to bypass them or wait behind them, based on the defined policies. For example with small changes in its route the AVENUE shuttle is able to bypass a parked car, while it will slow down and follow behind a slowly moving car. The AVENUE vehicles are able to handle different complex road situations, like entering and exiting round-about in the presence of other fast running cars, stop in zebra crossings, communicate with infrastructure via V2X interfaces (ex. red light control). The shuttles used in the AVENUE project technically can achieve speeds of more than 60Km/h. However this speed cannot be used in the project demonstrators for several reasons, ranging from regulatory to safety. Under current regulations the maximum authorised speed is 25 or 30 Km/h (depending on the site). In the current demonstrators the speed does not exceed 23 Km/h, with an operational speed of 14 to 18 Km/h. Another, more important reason for limiting the vehicle speed is safety for passengers and pedestrians. Due to the fact that the current LIDAR has a range of 100m and the obstacle identification is done for objects no further than 40 meters, and considering that the vehicle must safely stop in case of an obstacle on the road (which will be “seen” at less than 40 meters distance) we cannot guarantee a safe braking if the speed is more than 25 Km/h. Note that technically the vehicle can make harsh break and stop with 40 meters in high speeds (40 -50 Km/h) but then the break would too harsh putting in risk the vehicle passengers. The project is working in finding an optimal point between passenger and pedestrian safety.

1.3 Preamble

WP2 aims to define in detail the use cases of each demonstrator, the scenarios for each implementation phase and the value added services required for the success of the demonstrators. A human-centred design approach for the design of the use cases will be followed. The required data to be collected for the impact analysis will also be defined. Existing knowhow and best practices will be surveyed, assessed and analysed. The work of the tasks of WP2 is iterative and as the provided demonstrators and services become more sophisticated, new iterations of the work of the different tasks will be contacted.”

AVENUE will identify and map regulatory and legislative requirements and procedures (concerning actual and under development policies), as well as barriers/ obstacles for the full deployment of THE AVENUE vision and demonstrations. The identification will focus on the city demonstrators (in depth – exhaustive analysis) and up to 10 additional cities (non-exhaustive analysis). From the latter, an in-depth analysis will be performed for those to be selected as replicators. Based on the results of the analysis a plan for regulatory compliance will be elaborated per demonstrator and replicator city.

The present document is one of the deliverables of WP2. It proposes a large scan of the regulatory current situation for automated mobility and two tools to follow regulatory evolution and to implement a regulatory intelligence that will allow relevant compliance plans.

Firstly, we propose an index to assess the regulatory openness for automated mobility that helps to assess the level of barriers in a given urban context: the ROAD index. This index is built with a couple of criteria that are indicative of the degree of legal and political leverage to the implementation of automated mobility.

Secondly, we propose a methodology to implement a regulatory intelligence and relevant compliance plan. Indeed, regulation is in constant evolution and to comply organisation need not only to follow but to anticipate this evolution.

In this report, after a short introduction in section 1, section 2 provides a general overview of current regulation status and an index to asses wether a local regulatory context is a barrier or a facilitator for automated mobility. Section 3 proposes de methodology to implement a regulatory intelligence.

2 Regulatory requirements

2.1 Regulatory framework and evolution

Since the first project aimed at smart mobility and services launched in 2010 on a European scale – the CATS project (City Alternative Transport System), a three-year project (2010-2012) – European and national governments have been considering urban transport disruption, targeting more specifically collective transport regarding the potential for robotization i.e. the integration of buses operating without a driver, automated or automated buses.

From there, national and regional regulators have authorized many experimentations of automated mobility in order to study the feasibility of setting up a transport network integrating automated buses. From a worldwide benchmark conducted in 2019, Antonialli (2020) listed no less than 176 experimentations worldwide, of which 104 were already finished, 57 were currently running and 15 were still yet to start. These 176 projects unfold in 142 cities spread over 32 countries around the world enabled by 20 different automated shuttles manufacturers. As stated by Antonialli (2021), the stake is to offer city travellers automated buses as part of their public transport network. This implies that regulation should allow driverless buses to operate on mixed roads along trucks, cars, bicycles, pedestrians...

As of today, all experimentations have been introduced with low legal requirements, the testing of automated vehicles being permitted as long as the test organization got the permit approved, most often under the condition that a driver (or on-site operator) is present in the vehicle and can, at any time, disable automated driving and take control of the vehicle.

In France, the French National Assembly passed the Mobility Orientation Law in December 2019 (Loi d'orientation des mobilités, LOM) and the ministry of transport declared that a shared use of automated vehicles of various sizes, integrated into local mobility network, seems more promising than an individual use claiming that for goods logistics should further enrich the use cases with new players.

However, worldwide, transport operators and manufacturers are still waiting for the establishment of their own national framework for the validation of automated public transport systems and, at the European and international level (UNECE), a technical regulation and approval framework specific to the automated vehicle.

Indeed, regulation appears clearly double-sided since regulatory compliance can either restrict or facilitate transition towards a new urban mobility. Regulatory authorities may either create obstacles for the release of automated vehicles or shape a uniform set of laws that promotes automated mobility as the best solution for the renewal of public transport (Brodsky, 2016).

Regulation can be interpreted broadly, as a social mechanism of control, or, more specifically as a set of authoritative rules, accompanied by some administrative agency, for monitoring and enforcing compliance (Jordana and Levi-Faur, 2003).

Automated vehicles indeed raise new challenges to which the law must now bring adapted responses in view of new risks and liabilities. New risks concern, on the one hand, General Data Protection Regulation and cybersecurity, and, on the other hand, driving task delegation from human to machine. Regulation for automated mobility represent a complex issue lying at the crossroads of three main legal fields: civil, criminal and administrative laws. The question of liability is the corner stone of any regulatory modification.

For a decade now, regulation on the deployment of automated vehicles for public transport have undergone profound changes and regulators are still working on it. Therefore, the objective to give an image of current regulatory in 2020 would be useless because this picture would quickly become obsolete.

More important than the knowledge of the complete regulatory spectrum, which is rapidly changing, the challenge for automated mobility stakeholders is to anticipate and balance the governance of risks

associated with the regulation process and evaluated the impact on the deployment of the new technology.
Therefore, the report aims to provide an overview of the regulatory framework and proposes a methodology to assess, on a national or a regional level, to which extend regulation may be considered as facilitator or barrier for the deployment of automated mobility. The methodology is based on the assessment of a specific index: the ROAD© index, Regulation Openness for Automated Driving index. The index was designed by Sylvie Mira-Bonnardel and Elizabeth Couzineau and published in 2021[1].
The ROAD© index provides a metric to access the impact of regulation on the deployment of mobility innovations, such as automated mobility. The ROAD© Index has been designed by mixing research articles, documentary reviews and experts' interviews.
This index is the main contribution of D2.12. Actually there was no existing tool providing this type of support and evaluation. So Sylvie Mira-Bonnardel and Elizabeth Couzineau created the ROAD index as an aggregated indicator. The construction and validation of ROAD has been made on Peer-review iterative process, in order to guarantee scientific relevance and constituency. Meanwhile it has been presented to city professionals to ensure its applicability and usefulness. If needed, we can provide the various feedbacks.
We think that the understanding of the regulation design process and of the implied organizations undoubtedly helps to anticipate legislative evolutions.

There are various instances playing a role in legislation changes and these instances vary according to the country. Nevertheless, here are some insights of their levels.
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	European level and higher	National level	Regional level	Local level
Vehicle safety test	X			
ITS interoperability	X			
Liability		X		
Energy consumption	X	X		
Data protection	X	X		
Typology on automation	X			
Circulation on public space			X	X
Driving license	X			
Speed		X		
Parking regulation				X

The following sections present each level.

2.1.1 The international regulatory frameworks

Current regulation concerning road and driving are clearly in conflict with automated vehicles development (Beland, 2005; Mordue, Yeung, Wu, 2020). Automated mobility induces a transfer of responsibility from humans to robots which is the very reason of this conflict because existing international laws are based on the concept of responsibility that is very difficult to adapt to robots (Li, Sui, Xiao, Chahine, 2019).
Regulatory and legal issues are one of the main concerns for the introduction of highly automated driving systems. The responsibility and liability of all stakeholders needs to be clear, manufacturers,

[1] Mira-Bonnardel, S., Couzineau, E., (2021), How to assess Regulation Openness for Autonomous Driving in public transport? The ROAD Index ; . In: Mira-Bonnardel, S., Antonialli, F., Attias, D. (2021). The Robomobility Revolution of Urban Public Transport: A Social Sciences Perspective. Springer International: Gewerberstr (Switzerland).

service providers, government and transport operators need to be aware of their rights and obligations related to the use of automated vehicles.
In that purpose, legislators are discussing the evolution of the Vienna Convention on road Traffic of 1968, as well as the Geneva Convention on road Traffic of 1949, which are both fundamental elements governing the obligations of the driver at the international level. The objective is to design a common regulatory framework that facilitates automated mobility deployment. Since traffic does not stop with national frontiers and interoperability is crucial, discussions are conducted at two main levels: the international level and the European level.

International work on regulation is still making some progress mainly within the United Nations Economic Commission for Europe (UNECE), one of five United Nations regional commissions administered by the Economic and Social Council (ECOSOC). UNECE was established in 1947 to encourage economic integration and cooperation among its member countries. Among various sectorial division, the UNECE Sustainable Transport Division works to facilitate the international movement of people and goods by inland transport modes. It aims to improve competitiveness, safety, energy efficiency and security in the transport sector.
The Inland Transport Committee (ITC) is the highest policy-making body of the UNECE in the field of transport. Together with its subsidiary bodies, the ITC has provided a pan-European inter-governmental forum, where UNECE member countries come together to discuss tools for economic cooperation, to negotiate and to adopt international legal instruments on inland transport.
UNECE is at the center of the legal and regulatory work needed to realize the vision of new sustainable mobility and support the mass introduction of automated vehicles on the roads. It started dedicated works on this issue back in 2014. Since 2014, the UNECE's Sustainable Transport Division has provided a multilateral platform for the negotiation of international legal instruments.
In this framework, two milestones were reached in 2016: firstly, the 1968 Vienna Convention on road traffic was amended to open the door to automated vehicles in traffic; secondly, the 10 km/h limitation for automated systems was removed from UN Regulation No. 79.
The World Forum for Harmonization of Vehicle Regulations, hosted by UNECE, is the intergovernmental platform that defines the technical requirements applied by the automotive sector worldwide. Today, automation is the priority of the Forum's work. (UNECE, 2019a). Within UNECE there are efforts to enable traffic of automated vehicles at higher levels (UNECE, 2019b). So far, however, the organization still requires a driver in each vehicle on the road.
One of the most important critical ambition of the World Forum for Harmonization of Vehicle Regulations is to consolidate the international harmonization of vehicle regulations (WP.29).
At the forum February 2020 session (178th session), the group proposed a framework to provide guidance for harmonization by identifying key principles for the safety and security of automated vehicles of levels 3 and higher. This document has been prepared by the representatives of China, European Union, Japan and the United States of America and has been endorsed by the Inland Transport Committee of UNECE.
Issues currently covered by the framework are threefold:
Safety, concerning people as well inside the vehicle as around, and the safe integration of automated vehicles in road traffic, connectivity, cyber security and data protection regarding personal data protection as well as liability and responsibility in case of injuries.

Safety and integration in road traffic

According to the framework the level of safety to be ensured by automated vehicles implies that an automated vehicle shall not cause any non-tolerable risk, meaning that automated/automated vehicle systems, under their full automated self-driving mode, shall not cause any traffic accidents resulting in injury or death that are reasonably foreseeable and preventable. Based on this principle, this framework sets out a series of vehicle safety topics to be considered to ensure safety.

- System Safety: When in the automated self-driving mode, the vehicle should be free of unreasonable safety risks to the driver and other road users (pedestrians, bicycles, cars, … and ensure compliance with road traffic regulation.
- Failsafe Response: a system or plan that comes into operation in the event of something going wrong or that is in place to prevent such an occurrence.
- Fail-detection: If something is fail-safe, it has been designed so that if one part of it does not work, the whole thing does not become dangerous.
- Human Machine Interface: the system should include driver engagement monitoring and request the driver to hand over the driving tasks in any case the driver needs to regain a proper control of the vehicle. In case of a driverless vehicle, the system should allow interaction with an external supervisor.

The evolution of Regulation 79 on safety

"Over the past decades, developments in vehicle safety have contributed significantly to the overall reduction in the number of road fatalities and severe injuries. However, 25 300 people died in 2017 on Union roads, a figure that has stagnated in the last four years. Moreover, 135 000 people are seriously injured in collisions every year. The Union shall do its utmost to reduce these figures drastically aiming at the Vision Zero goal of "no fatalities".
In addition to the safety measures to protect vehicle occupants, the implementation of specific measures to prevent fatalities and injuries of vulnerable road users, such as cyclists and pedestrians, is needed to protect users outside of the vehicle. Without new initiatives on general road safety, the safety effects of the current approach will no longer be able to off-set the effects of increasing traffic volumes. Therefore, the safety performance of vehicles needs to be further improved as part of an integrated road safety approach and in order to protect vulnerable road users better." (Regulation (EU) 2019/2144).
The United Nations Regulation No. 79 provides Uniform provisions concerning the approval of vehicles with regard to steering equipment, the first version has been issued in 1988.
To see the whole regulation and its evolution, the following links are useful:
https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XI-B-16-79&chapter=11&clang=_en

Automated vehicles may be able to make a huge contribution in reducing road fatalities since more than 90 per cent of road accidents are estimated to result from some level of human error. As computer-driven vehicles will gradually be taking over tasks of a driver, harmonized rules and technical requirements for automated vehicle systems should be adopted at UNO level and promoted at international level in the framework WP9 of the United Nations Economic Commission for Europe.
For example, advanced emergency braking or emergency lane-keeping systems might not be fully operational in some cases, in particular due to shortcomings in the road infrastructure. In those cases, the systems should deactivate themselves and give information about the deactivation to the driver. If they do not deactivate automatically, it should be possible to switch them off manually. Such deactivation should be temporary and last for a period when the system is not fully operational only. Drivers may also need to override advanced emergency braking systems or emergency lane keeping systems, where the functioning of the system could lead to greater risk or harm. This ensures that the vehicles are always under the driver´s control. Nevertheless, the systems could also recognize instances where the driver is incapacitated and therefore intervention by the system is needed in order to prevent the worsening of an accident.
Safe integration of automated vehicles in road traffic is allowed using two tools: Object Event Detection and Response (OEDR), Validation for System Safety (VSS).
OEDR aims to detect and respond to object/events that may be reasonably expected in the cases portfolio.

VSS obliges vehicle manufacturers to demonstrate a robust design and validation process based on a systems-engineering approach with the goal of designing automated driving systems free of unreasonable safety risks and ensuring compliance with road traffic regulation.

Cybersecurity and personal data protection

Cybersecurity issues go along with anonymity and personal data protection hardening as well as system's hacking.
Automated vehicles should be protected against cyberattacks in accordance with established best practices for cyber vehicle physical systems. Vehicle manufacturers should ensure that system updates occur as needed in a safe and secured way and provide for after-market repairs and modifications as needed.
The French Data Protection Authority (CNIL) worked to encourage innovation ecosystems while ensuring the protection of car users' personal data and proposed in 2018 a compliance plan linked with the European General Data Protection Regulation for connected vehicle. For further information https://www.cnil.fr/en/home
The CNIL examined 3 scenarios.
Scenario #1 - IN => IN: collected data stay in the vehicle and are treated by the system for appropriate responses.
Scenario #2 - IN => OUT: collected data are transmitted to a third part and are saved and treated outside the vehicle.
Scenario #3 « IN => OUT => IN: data are collected in the vehicle and transmitted externally to trigger an automatic action in the vehicle.

Data concern the vehicle user (name, civil status, e-mail address, biometric data etc.), the vehicle (serial number, plate number, …), the geolocation, the state of the vehicle and its parts, the use of the vehicle by the occupants.
Data Processing of such data shall only involve information that is relevant, adequate, and not excessive with regard to the purpose of the file, i.e., its objective.
In that regard, the General Data Protection Regulation refers to the principle of "data minimization" (article 6-3 of the French Data Protection Act, and article 5-1 of the EU General Data Protection Regulation). The objective is to regulate remote access to car data needed for the deployment of mobility services. Meanwhile, service providers have to make people aware why they are asked to give their data for.

Liability attribution

Liability issue is linked with data collection and protection. It is treated with the event data recorder (EDR) and the Data Storage System for Automated Driving vehicles (DSSAD). These tools are built to establish the cause and the responsibility in case of crash.
EDR collects and records the necessary data to understand what or who was controlling the driving in case of a crash.
DSSAD collects and records the necessary data to reconstruct the las moment before a crash and identify the status of the driving system.

According to Guilbot (2017), the law seems sufficient to address conflictual situations involving an automated vehicle, but measures need to be implemented to identify causality and liability. Data collection is part of that, but practices must comply with all legislation, particularly European legislation, regarding the personal data protection and the privacy of users.
Yet, many questions related to liability attributing remain open. Indeed, in the absence of specific legislation, vehicles owners, i.e., transport operators, will remain liable in the first instance for incidents caused by their automated vehicles. However, if an accident occurs in an automated bus as a result of

an error or shortcoming in the system as opposed to resulting from carelessness on the part of the owner, in some cases it might be considered unfair to attribute the incidents to the vehicle owner.
Several complicated liability questions arise in relation to incidents involving automated vehicles. For example, what if the vehicle had made a choice that a driver would never have chosen: should the transport operator be responsible? Who should be responsible for incidents caused by defects in the software? The car manufacturer? The manufacturer of the software that failed to prevent the accident. Who should be held liable in the case of a cyber-attack on vehicles? Should the software manufacturer be strictly liable for defective software security that allowed third parties to hack into the car? Or should the transport operator be liable if, for example, they had failed to download software security updates? Should network providers be held liable if accidents are a result of a defect in connectivity causing the incident? (Fagnant & Kockelman, 2015).
With the increase in event data recorders (also known as insurance black boxes) in vehicles, it should become easier to determine exactly what the the cause of an accident was (subject to privacy implications). However, fault for the accident will still need to be attributed. Additionally, there is the question of who should insure the vehicle. Should all relevant parties contribute to the insurance? Will car owners still be required to have third party liability insurance? Will car manufacturers be legally required to have product liability insurance? Will accidents in automated vehicles fall under the product liability regulations preventing any limitation on the bringing of claims against the manufacturer? Or if a network provider is liable, will telecoms liability limitations apply?
In the UK, 11 major insurers, including Aviva and Direct Line, have been working together to provide a framework for insuring automated vehicles (House of Lords, 2016). One option being considered is expanding compulsory insurance to cover product liability, another one is the manufacturer takes all responsibility for its products.

2.1.2 The European framework

On the European level, a road map has started in 2016 with the creation of Europe's first Automotive-Telecom Alliance. The Alliance includes 6 leading sectorial associations, as well as 37 companies, including telecom operators, vendors, vehicle manufacturers and suppliers for both cars and trucks. The main goal of this Alliance is to promote the wider deployment of connected and automated driving in Europe. The first concrete step is the advancement of a "Pre-Deployment Project" aimed at testing major use-case categories. These tests aimed to identify and address both technological and regulatory issues, interoperability issues as well as infrastructure investment to address connectivity needs, safety and security (ACEA, 2016).
In Europe the regulatory framework is defined by European Union directives, regulations and standards. However, European countries may promote their own specific regulatory framework using the United Nations Economic Commission of Europe (UNECE) regulation requirements as a base.
All European Parliament legislative initiative reports (INI) must automatically be accompanied by a detailed European added value assessment (EAVA). The purpose of the European added value assessment is to support a legislative initiative of the European Parliament by providing a scientifically based evaluation and assessment of the potential added value of taking legislative action at EU level. In 2018, the EAVA suggested that it was necessary to revise the current legislative EU framework for liability rules and insurance for connected and automated vehicles.
Not only would revision ensure legal coherence and better safeguarding of consumers rights but it would also be likely to generate economic added value. The report argues that accelerating the adoption curve of driverless or automated vehicles by five years has the economic potential to generate European added value worth approximately €148 billion (Evas, 2018).
In 2017, 29 European countries, Members of the European Union and of the European Economic Area, signed a Letter of Intent to intensify cooperation on testing of automated road transport in cross border test sites. EU objective is that all member countries profit from the artificial intelligence for mobility, AI being considered as a common good.
In 2018, the European Commission presented a document titled: "On the road to Automated Mobility: An EU strategy for Mobility of the Future" (EU, 2018). That document proposes "a comprehensive EU

approach towards connected and automated mobility, setting out a clear, forward looking and ambitious European agenda" in order to "ensure that EU legal and policy frameworks are ready to support the deployment of safe connected and automated mobility" (EU, 2018). In addition, the Commission published guidelines EU approval of automated vehicles (EU, 2019). Hence, the EU strives to harmonize legislation on the automation of vehicles among its member states.

By 31 January of each year, for the previous year, the Commission shall submit to the European Parliament and to the Council a report on the activities of the UNECE's World Forum for Harmonization of Vehicle Regulations (WP.29) as regards the progress made on the previous year, in the implementation of vehicle safety standards and as regards the position of the Union related to these matters.

Besides international and European levels, national governments are also taking over to transform regulatory requirements. For example, on September 5th, 2019, a new law on mobility was presented by the French government to the French parliament whose members discussed its application during fall. In order to improve the mobility for all residents, the French government has decided to deeply transform the mobility system, starting with the rail system in 2018, it targets in 2019 daily and short motilities, with a clear openness to innovation in product and services. €13,4 billion are targeted to investment to implement new motilities and help everyone to commute (Urban Mobility Company, 2020).
The French government wants to imply all stakeholders in the mobility plan, mainly companies and territorial authorities to provide alternative solutions to personal vehicles by means of automated shuttles, shared mobility, on-demand mobility, intermodal mobility services platform, all supported by digital technologies. The law also aims at improving mobility for disabled people like free mobility specific services for assistants, automated shuttles are expected to expand from 2020 onwards for urban mobility. A legal framework for free-floating is about to help transactions between delivery platforms, taxis, and drivers.

2.1.3 The regulatory design legal framework

The regulatory framework for automated mobility is shaped by the convergence of three main branches of law: the administrative law, the civil law and the criminal law.

The administrative law

The administrative law includes road traffic law in general and covers, among others issues, such as certification and licensing, technical controls, road traffic rules, …etc. It deals with stating technical norms as well. The most important legal challenges related to automated driving in the area of administrative law are in the field of user requirements as well as use requirements (Fagnant & Kockelman, 2015).

Some examples of user requirements and use requirements issues:

- Does automated driving require a special driving license?
- If so, shall it be national or international?
- Shall an automated vehicle driver ("user") be required to have a driving license at all?
- Which is the most appropriate terminology between "driver and "user" describing the person guiding the automated vehicle?
- Do we need any age requirement for automated vehicle users?
- Should we allow automated vehicles everywhere?
- Should it be mandatory on special roads or dedicated lanes?
- Does automated driving have to follow all traffic rules?
- If an automated vehicle violates a traffic rule, does it have to self-report to authorities?
- Should there be an external indicator on the vehicle when operated on automated mode?

The Civil Law

Civil law covers legal, the most significant being linked with civil liability: damage and/or injury (hence insurance issues) and product liability (defective product). Two different conceptual approaches could contribute to understand liability.

The first approach is based on a compulsory motor third party liability (MPTL) insurance under the regime of strict liability by mandating automated vehicle manufacturers to contribute a portion of the insurance for each individual vehicle. However, manufacturers would be exempted from product liability for injury and damage that is covered under the compulsory MPTL insurance regime and that was caused by a product defect affecting automated vehicle functionality, unless the defect is the result of gross negligence. This approach is rather theoretical than pragmatic due to possible administration difficulties.

The second approach suggests product liability to be further sharpened, the requirement of a product defect should be omitted. Instead, the manufacturer should be held liable for injury and damage caused by the way goods acted (i.e. the way of their actions and behaviour; their effect; and the failure of the goods to act or to behave in a particular way, or to have a particular effect). The main argument for this approach is the following: while automated vehicles will be much safer than conventional cars, the technology in the product is so complex that there is an uncontrollable residual risk of malfunctioning even when the product is free from defects. Hence, the legislation should introduce an irrefutable presumption of a defect in a highly or fully automated vehicle that causes an accident, unless the manufacturer can prove that the automated vehicle functionality was not the cause of the accident. The MTPL regime would, in this alternative, remain identical to the first approach, except that manufacturer would not be incorporated into the MTPL system (Ilkova & Ilka, 2017).

The criminal law

Automated driving-inspired legal challenges in the area of criminal law include especially the issue of criminal responsibility as well as protection against cybercrime and hackers. In general, research in this area is dealing with the following questions.

- What crimes may be committed with automated vehicles?
- Who should be held responsible in case, when using an automated vehicle, a crime is committed: the owner; the person who is sitting in the driver's seat (if there is any kind of it), the vehicle manufacturer, the software designer or another entity?
- Will the responsible subject change according to the circumstances and if so, how?
- How should the law react, if the criminally responsible subject is a legal entity?

As for the criminal responsibility for harm caused by an automated vehicle, according to most European states' criminal codes, the driver (or vehicle owner) may be charged with negligence even if the automated vehicle was in control (in automated mode). In case of no proved negligence, the criminally responsible entity is the manufacturer. Since in most cases, a vehicle manufacturer is a legal entity, it is highly important to consider the issue of corporate criminal responsibility. The European Union countries do not have an identical legislation in this area. Personal guilt is the basement of criminal codes in most countries; these codes would definitely need an amendment (Ilkova & Ilka, 2017).

The regulatory framework has been constantly evolving for a decade and heavy changes are still to come. Currently, public transport operators (PTO) concern is to understand and anticipate forthcoming regulatory requirements. PTOs have to decide their investments upstream, years before regulation approval, and they need to consider whether regulation will help or restrict automated buses.

To cope with the uncertainty, eavesdropping on UE parliament's meetings may be an option, which limits anticipation. To be proactive, PTOs have to understand the regulatory design process, at national as well as local level.

Therefore, we propose a new methodology to assess whether the regulatory framework may facilitate or hinder the deployment of automated vehicles for public transport. This methodology is based on the ROAD© index; it is presented and applied to four cities in the next section.

2.2 Regulation Assessment: the ROAD© index

Apart from implementing a permanent scanning on all regulatory modifications, decision makers need to anticipate whether the current regulation they will have to comply to may facilitate or hinder automated driving for public transport. Therefore, they have to understand the framework of regulatory design as well as their political and organisational context.

Jordana and Levi-Faur (2003) bring forward four factors that need to be addressed in a regulatory process. Depending on how flexible these factors are, a regulation can be open more or less to innovation and new technological changes. The first factor is flexibility: a high adjustment flexibility allows a redesign of regulations in light of new technical innovations or new scientific findings. The second factor is issue definition: an effective regulatory design needs relevant information identifying the problems that are to be regulated distancing from industry interests for considering interest of the public at large. The third factor is adaption to the context whether at national, regional or local level. The fourth factor is the predictability of regulatory outcomes, which need relevant indicators (Jordana & Levi-Faur, 2003).

Experiments and innovations for public transport are authorized by certification bodies and local decision-making bodies, like municipalities. But the integration in public transport, meaning common transit pass for example, requires various authorizations.

Therefore, a city's openness to public transport innovation, like the introduction of automated vehicles, depends on the city/country decision process and the existence or not of an active governance organization. This organization is generally composed of city politicians and representative of the PTO. For instance, two cities, Geneva and Lyon have had, for many years, this governance organization. Copenhagen has this organization only since the beginning of 2019.

Since standardization from the European level will remain limited, the evaluation of regulatory as barriers or facilitators depends more on local decision process of a specific area like a city. Therefore, we propose a methodology to assess the local regulatory system though the scoring of the Regulatory Openness for Automated Driving (ROAD© Index)[2].

The prospective issues of the automated vehicle, and more precisely automated buses, have to be apprehended on several dimensions, the first being the distinction between the automated car and the automated bus, insofar as the uses are different, the related regulations are also different: to date, the cars are not intended to be considered as public transport, in the sense of a full integration into an urban transport network. This distinction could obviously evolve for example with robots-taxis, or on-demand collective transport.

Apart from the technical progress expected and the R & D efforts of the manufacturers, the conditions of development for automated buses are twofold: regulation and political will.

The regulatory issue of the vehicle itself, falls under the European and national level for approval, levels of security, global traffic permits on roads (open road, private site ...) and more generally its use of infrastructure.

The political will to implement an automated public transport service relies on three motivations: (1) revive, support and strengthen industrial policy, in particular the automotive industry and its derivatives; (2) revive, support and strengthen the country's competitiveness (in economic terms, but also in terms of attractiveness); (3) gain a pioneer position or become a model to copy.

At the local level, these three dimensions are combined with the objective of boosting the territory's attractiveness, whether in terms of inhabitants, business location or investors. The development of competitiveness clusters is an illustration of these motivations.

[2] The index analysis is published by Mira-Bonnardel and Couzineau (2021)

The manifestation of political will involves the definition and implementation of political and financial tools and the adaptation of the regulatory apparatus. Again, there are distinctions to be made between the national and local levels.
At the national level, some states are developing programs to fund experimental or demonstration projects with automated vehicles. The purpose of these projects is to be able to change the regulatory frameworks and to identify the obstacles and levers on which the state could intervene to favor the development of the sector (within an industrial policy framework) or to favor new uses for the development of a carbon-free mobility, for example.
At the local level, transport and mobility policies allow tests in situ of automated buses, local authorizations of experimentation granted but conditioned to their conformity with the national regulations.
The main issue surrounding the regulatory and political aspects of the deployment of automated buses concerns the confrontation and convergence of political will at national and local levels and the distance between the executive and the legislative bodies (short circuit vs. long circuit and intermediaries), which also refers to the complexity of the political systems of the various states composing Europe.
This issue can be addressed by analysing different variables contributing to policy making in the mobility ecosystem. Scoring these variables helps to understand the impact of regulation on mobility innovation. These variables are described in the next sub-section.

2.2.1 Variables scoring for the index.

We identified four variables that help to diagnose whether regulation can be considered as a facilitator or as a barrier to the development of automated mobility in a specific area such a city in a specific country. These variables are:

1. National Industrial policy,
2. National sustainable development policy and declination,
3. Local territories autonomy,
4. Governance and integration at local level.

Variable 1 - National Industrial policy strength

Industrial policy becomes a competitiveness-oriented policy defined by Michael Porter (1990) as a set of state interventions encompassing both business-environment interventions that are essential for promoting the development of the fabric of firms and improved competitiveness and direct interventions with targeted enterprises in small but well-identified sectors, to help overcome bottlenecks and market imperfections.
Although the market is considered the best system of economic coordination by liberal economists, analyses of the process of industrial transformation show that markets alone are not enough to start and sustain the process of industrial transformation. Industrial policy plays a facilitating role in industrial modernization and economic diversification in order to achieve rapid structural change (Lin, 2015; Lin & Monga, 2010).
In contemporary economies, industrial policy often translates into innovation policies that aim to improve the quality of information flows between actors and institutions, and to strengthen the innovative capacity of firms (Niosi, Bellon, Saviotti, & Crow, 2008), in particular their capacity to absorb knowledge specific to their sector of activity.
To understand the dynamics of sectoral innovation, the sectoral approach of the innovation system highlights the sectoral characteristics of knowledge, actors, networks and institutions in the innovation process (Malerba, 2009). The sectoral innovation process is embedded in an innovation system where the different actors of innovation (companies, public and private R & D centers, financial companies, administration, etc.) interact in innovation processes and maintain dynamic and systemic relationships through the flow of knowledge, finance and personnel (Laperche and Uzunidis, 2007). In this sector innovation dynamic, the role of the facilitating state is to solve the coordination problems and ensure

the outsourcing of innovation activities, filling in the market failures related to the process of innovation and systemic failure, blocking interactions between actors in an innovation system (OECD, 2010).
As such, we consider the share of Government investment into the Gross Domestic Expenditures in Research and Development (GERD) to measure the strength of national industrial policy. GERD analysis on an international basis gives 5 classes (see appendix 3):

- Serbia, Croatia and Norway all with a percentage above 43%;
- Portugal, Estonia, Spain, Poland, Greece, Romania, Slovakia and Czech Republic with a percentage between 35 and 41%;
- France, Netherlands, Lithuania, Cyprus and Finland, with a percentage between 29 and 34%;
- Luxemburg, Germany, Austria, Denmark, UK, Ireland and Sweden with a percentage between 25 and 28%;
- Bulgaria, Hungary, Slovenia, Switzerland, Belgium and Italy with a percentage between 13 and 24%;

In the frame of this report, we will consider a ranking from 1 to 5, representing a scale from the lowest to the highest level of percentage related to the weight of the government financing into the global GERD. Readers can refer to Annex 2 to find a given country's mark.

Variable 2 – National policy for sustainable development

National and territorial transport policy can be assessed through environmental, performance, and sustainable development indicators that examine transport policies from an impact perspective.
A sustainable development policy at national level leverages innovation for public transport at local level provided that national government declines measures, indicators and incentives at local level. In most countries, regulation requires any organization to present clear sustainable development indicators to inform public decisions. National government can use these indicators as instruments for negotiation between stakeholders, and local authorities go beyond sectoral approaches, question lifestyles and impulse innovative local transport policies. This negotiation may be more or less incentive going for example from the publication of a "bad students" list to financial penalties for cities which do not comply at all.
A rewarded public transport local policy should combine the three following aspects: setting up a transportation system that meets the demand for mobility, minimizing the negative impacts of transportation facilities and travel in terms of resources and pollution, minimization of the associated costs, cost of the service, as well as externalities (noise, accident, congestion, etc.).
The initiatives of local stakeholders are driven by effective national regulations and mechanisms, like the carbon tax as a negative incentive or specific funding for innovation as a positive incentive. National policy for sustainability can also be regulated through taxation on third parties like the dedicated tax chargeable to companies (a percentage of the payroll for the companies, regardless of size and with no exemptions), led in many countries to real diversity in the modes of public transportation. Also sometimes national governments stay behind local policies implementing only awareness-raising actions.
We think that the way a national government calls on local government for the deployment of a sustainable development policy is a major indicator on the local transport policy. Accordingly, this impacts the weight of regulation in the process of implementing automated driving either positively or negatively.
To support this variable, two major indicators can be extracted from the WGI[3]: 1) Government Effectiveness, which captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies, and 2) the

[3] The worldwide governance indicators - http://info.worldbank.org/governance/wgi/

Regulatory Quality, which captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. can be used.

Variable 3 - Local territories autonomy

Thinking cities outside any reference to local institutions and the state is an empirically unfounded approach. Obviously, it makes analysis easier and the territories bodies of regulation, instead of states. Recent research shows very clearly the weaknesses of this approach by insisting in particular on the strong dependence of cities in relation to the higher levels of government in terms of their institutional organization, the absence of metropolitan politicians who are becoming independent from the national political apparatuses or the difficulty of the metropolitan representatives to set up public-private partnerships structured at a metropolitan scale (Jouve, 2013).

The political dimension is more complex to understand, as well as the relationships in the multiscale decision making bodies. Local autonomy is understood as a multidimensional phenomenon, seen as both a right and a capacity. Indeed, as the legalistic approach has shown, local autonomy implies a right and decision-making powers for the management of public affairs, included in a legal framework defining the formal statutes of local governments and the legal protection arrangements of local governments. In relation to the scope of formal functional competencies is the range of services for which local governments are responsible.
Local autonomy is linked, on the one hand, to the financial resources available to local governments independently, and, on the other hand, to their administrative capacities and the opportunities they have to create, organize and maintain their political arenas independently. Local autonomy is defined as "the capacity of local governments to make decisions about the services they provide without interference from the centralized government" (Page, 1991).
We propose two methods to assess local autonomy of the analyzed territory: 1) use Keuffer's local autonomy assessment results presented in appendix 1, or, 2) use the European Commission scoring methodology presented appendix 2. We detail below the two methods.
Keuffer (2016) identified seven dimensions to measure local autonomy as follows.

1	Legal autonomy	The formal statutes of local governments and the legal protection arrangements for local governments
2	Political discretion	The general distribution of power and the effective decision-making powers assigned to local governments for the provision of services
3	Scope of delivery	The range of services for which local governments are responsible
4	Financial self-sufficiency	The financial resources available to local governments and the ability to freely decide their sources;
5	Organizational autonomy	The free organization of political arenas and administration specific to local governments
6	Non-interference	The extent of freedom left to local governments as part of the control carried out
7	Access	The degree of influence of local governments on political decisions made by higher levels of government

Table 1 - Local autonomy variables

On this basis, Keuffer (2016) designed a comparative Local Autonomy Index (LAI) and used it to measure autonomy in 39 European countries. Readers can either refer to appendix 1 to find each country's mark. The scoring of the LAI provided 5 classes[4].

1. A group consisting of the Nordic countries (Finland, Iceland, Denmark, Sweden and Norway) and some central countries (Switzerland, Germany and Poland), all with a local autonomy score of more than 69.55;
2. Countries with an LAI score in 2014 of between 60.78 and 69.55, namely Italy, Serbia, France, Bulgaria, Lithuania, Austria, the Czech Republic and Estonia;
3. Countries with an average degree of local autonomy (LAI score between 50.07 and 60.77), i.e. Portugal, Slovakia, Belgium, the Netherlands, Romania, Croatia, Luxembourg, Latvia and Spain;
4. A group of countries with an LAI score in 2014 of between 41.77 and 50.06, i.e. Hungary, Albania, Slovenia, Ukraine, Greece and the United Kingdom;
5. A group of countries where local governments enjoy a low degree of local autonomy (the score for 2014 is less than 41.76), i.e. the countries of southern Europe and those surrounding the Black Sea (Cyprus, Turkey, Georgia, Malta and Moldova) as well as Ireland.

The European Commission also proposed a methodology to measure local autonomy of a local government (Ladner, Keuffer and Baldersheim, 2015). The authors claim that "*measuring and comparing local autonomy has proven to be a difficult task. Not only are there diverging ideas about the core elements of local autonomy, there are also considerable difficulties to apply specific concepts to different countries*".
By analyzing 39 European countries from 1990 to 2014 with a network of experts on local government assessing the autonomy of local governments of their respective countries the authors identified eleven variables measured on seven dimensions and combined all data to a "Local Autonomy Index" (LAI).

Readers can refer to appendix 2 to calculate or use the methodology proposed by the European commission to calculate the LAI index for one specific region or city.
The design of the index needs a ranking from 1 to 5, representing a scale from the lowest to the highest level of local autonomy; section 2.2.2 explains how to translate the LAI given by Keuffer or the LAI resulting from EC scoring into a ROAD index score.

Variable 4 – Governance and the existence of an integrator at local level

The existence of transport and mobility policies has a positive impact for the implementation of new services as well as the existence of public service delegation.
In relation with the general abandon of Keynesian approach and the role of government, in favor of a liberal economy, most of public transport services operations have been transferred to private bodies through regular calls for tender and procurements. In some cases, public bodies still keep control of the services by guaranteeing compliance with operators (Denmark, France, Germany, Switzerland) or decide to let the market play its role (UK). The level of delegation plays an important role for the shift towards innovation.
Stability is important to ensure cohesion of projects on the long term. Generally, the transport governance is composed of an elected body and a technical body, the latter one actually ensures stability.
Besides, public transport is very often characterized by multilevel government which allows a better fit to local needs provided local operations are managed by a strong local integrator. The existence of an integrator policy organization at local level implementing local mobility policy has a direct impact on operation efficiency. In that case, the local government can fully delegate operations to the

[4] This classification is based on the Natural Thresholds algorithm (Jenks). Natural threshold classes depend on the natural pools inherent in the data. The terminals of the classes designated by this method allow to group similar values as best as possible and optimize the differences between classes

integrator and concentrate on needs anticipation and innovation deployment. But the challenge is to identify what governance arrangements would optimize policy throughout these layers in terms of value.
Governance may be held within four different contexts from the less to the more innovation fostering: 1) no real body of governance, 2) several bodies organizing public transport, 3) operations recently delegate to a local integrator, and 4) operations recently delegate to an advanced integrator, 5) operations recently delegate to an innovation oriented integrator.

2.2.2 Scoring the ROAD Index

Scoring the ROAD index aims at providing an understanding as to whether regulation will boost or limit the deployment of automated mobility , for instance: the integration of automated buses in the local public transport network that is being regulated.
The four variables we presented are analyzed for each city and their reality is weighted on a 1 to 5 scale (1 minimum and 5 maximum) (figure 3.2).
Scoring the ROAD index allows to assess the regulation framework impact on innovation of each city; the relative approach helps to establish a referential to evaluate the impact of regulation on the city readiness for mobility innovation.

Scoring the variable "National Industrial policy strength"

This variable is scored by analyzing the country's GERD according to following modalities, (a comparison between several countries is presented appendix 3)

GERD score	ROADi score	GERD score	ROADi score
0 to 20%	1	41% to 50%	4
21% to 30%	2	Over 51%	5
31% to 40%	3		

Scoring the variable "National policy for sustainable development"

This variable is scored by analyzing if and how the national government is putting pressure on local governments policy for sustainable development.

National government position	ROAD index score	National government position	ROAD index score
no national policy for sustainability	1	Medium negative or positive incentives	4
Only awareness actions with proposition for indicators	2	High negative or positive incentives negotiated within a set of indicators	5
Low negative or positive incentive	3		

Scoring the variable "Local autonomy"

We propose 2 ways for scoring this variable. One way is to look for the country's position on local autonomy proposed by Keuffer (2016); appendix 2 presents Keuffer's scores and their translation into ROAD index scores.

The other way is to score local autonomy by using the questions identified by the European Commission as assessment presented appendix 3. Answering the questionnaire brings out a score of local autonomy (LAI). LAI score ranges between 0 as minimum and 28 as maximum. LAI score is translated on the ROAD index scale from 1 to 5 according to following modalities.

LAI score	ROADindex score	LAI score	ROAD index score
0 to 5	1	16 to 20	4
6 to 10	2	21 to 28	5
11 to 15	3		

Scoring the variable "Governance"

This variable is scored according to the following modalities:

Governance situation	ROAD index score	Governance situation	ROAD index score
no governance body	1	advanced local integrator	4
several local bodies	2	innovation oriented local integrator	5
recent local integrator	3		

Once the four variables are assessed, we can calculate a global ROAD index whose score gives an evaluation as to whether the analysed regulatory framework represents a barrier or a facilitator for automated mobility. Figure 3.1 pictures the index scale and the meaning of the ROAD index score calculated out of 20. The 4-point scale not only provides a good stratification level, but also doesn't allow a neutral point, thereby cities will be clearly positioned in one of the two sides of the spectrum.

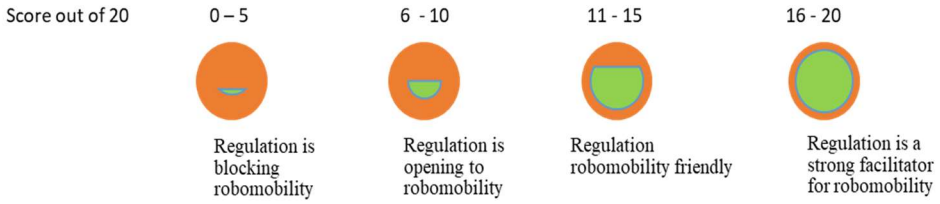


Figure 2 - The ROAD index scale (Mira-Bonnardel and Couzineau, 2021)

2.2.3 Application to Avenue demonstrator cities

In order to test the ROAD Index, we applied the analysis to four European cities: Copenhagen in Denmark, Lyon in France, Luxembourg city in Luxembourg and Geneva in Switzerland. The context of each city is briefly presented in the following sub-sections.

Copenhagen, Denmark

In the context of Denmark, the industrial policy is not very developed and has a limited impact on innovative mobility. In terms of environmental performance, Denmark is among the most exemplary countries in terms of Government Effectiveness and Regulatory Quality but it is considered that there

are medium negative or positive incentives.. In the context of Denmark, local authorities are well empowered, but road experimentations still depend on national regulation. Consequently, if the local policy for mobility and transport in Copenhagen exists, it is still limited. The approval process of automated mobility falls under the national legislative framework, making it very extensive and requiring a lot of documents and safety justification at any stage.
From January 2019, Copenhagen has an integrator policy body which should have a positive impact in order to integrate innovative mobility solutions in the city mobility plan, as additional means of transportation, and not only as experimental or extra projects.

Lyon, France

In France, local authorities can be proactive in terms of local regulations, but depend on the national government for laws and schemes. However, there is a current tendency to give more power to local authorities, as reflection of national government withdrawal in public services. The national industrial policy is strong which has an extremely positive effect on the development of automated buses. The centrality of power at the national level is very high which can have a very positive impact to give general directions either in terms of national policies and/or regulations to support and fasten automated buses deployment .
In Lyon, the local policy for mobility and transport is very strong and extends to different cities around the metropolitan area. It has a highly positive effect on automated buses projects, allowing the integration of new modes in mobility plans. The governance body, SYTRAL, has been created in 1989 which proved to have an extremely positive impact in order to integrate automated vehicles in the city mobility plan, as additional means of transportation, and not only as an experimental or extra project. The contract for the public service delegation to the PTO is renewed every 6 years: this has strong impacts on the PTO which has to comply with objectives and KPI determined by the SYTRAL.

Luxembourg city, Luxembourg

In the context of Luxembourg, local authorities depend on the national government for laws and schemes and the level of independence is good to have a positive impact on automated buses deployment (the mobility and traffic regulation is decided at the local level. Meanwhile, the number of administrative layers is very low (short administrative distance between national and local government) which can be extremely positive for cities/local governments in terms of autonomy and possible empowerment to authorize and launch experiments and projects (fast decisions and implementation) .
In Luxembourg Ville, the centrality of power at the national level is high which can have a very positive impact to give general directions either in terms of national policy and/or regulation to support and fasten automated buses deployment. In the context of Luxembourg, the national industrial policy is strong which has an extremely positive effect on the development of automated buses. In terms of environmental performance, Luxembourg is among the most exemplary countries in terms of Government Effectiveness and Regulatory Quality and it is considered that there are high negative or positive incentives.
In the city of Luxembourg, the local policy for mobility and transport is very strong. It has a highly positive effect on automated buses projects, allowing the integration of new modes in mobility plans. The Integrator policy bodies at local level exist for several years and have proven to have an extremely positive impact on the development of e-mobility and thus in the future to ease the integration of automated vehicles in the global mobility plan, as additional means of transportation, and not only as an experimental or extra project.

Geneva, Switzerland

Due to its particular confederation organization, Switzerland has a very low centrality of power at the “national” level, which can have a very negative impact to give general directions either in terms of national policies and/or regulations to support and fasten automated buses deployment The number of administrative layers is very important which could be negative for cities/local governments in terms

of autonomy and possible empowerment to authorize and launch experiments and projects. But it is to note that these layers have been given relatively high autonomy which prevents regulation pilling for example. It shortens the distance between cantons and cities for example. Thus it has a positive effect on the deployment of new systems.
In the context of Switzerland, the industrial policy is not very developed and has a limited impact on innovative mobility. Geneva is independent and therefore can decide on its own regulations and has implemented strong mobility and transport policy. In terms of environmental performance, Switzerland is among the most exemplary countries in terms of Government Effectiveness and Regulatory Quality but it is considered that there are medium negative or positive incentives. In Geneva, the existence of an integrator, allowing the long term decisions reinforce the capacity to support and fasten automated vehicles.

The ROAD© index for the four European test cities

To resume all data presented for the 4 cities we analyzed, we scored the four variables in table 3.3 hereafter; this allows us to give an overview of the ROAD© index scoring. Each variable is marked according to the city characteristics/

Cities	**Copenhagen**	**Lyon**	**Luxembourg**	**Geneva**
Variables				
Local territories autonomy	2	4	3	5
National Industrial policy strength	2	3	2	2
National sustainable development policy and local declination	5	4	5	4
Governance - Integrator policy bodies at local level	3	5	4	5
ROAD© Index per city (score out of 20)	12 	16 	14 	16 

Table 2 - The ROAD© index for the four cities (Mira-Bonnardel and Couzineau, 2021)

The four cities receive a good score proving that the regulatory framework their PTOs have to comply with is not only rather open to automated driving but can play as facilitator for the integration of automated buses into the existing network.
One of the reasons explaining why the ROAD© index is the highest for Lyon lies in the public transport governance.

Not surprisingly, all those four cities are hosting automated buses experimentations mainly within the European AVENUE project (https://h2020-avenue.eu) which is coherent with the good ROAD© index they have been granted with our analysis.

Copenhagen obtains the weakest ROAD© Index score due to a low local autonomy. This weakness explains why the experimentation that should occur within the framework of the AVENUE project is eventually abandoned during 2020.

The figure 3.3 helps to visualize the ROAD© Radar comparing in which way cities characteristics differently concur to the score and which variable could be leveraged to increase the score.

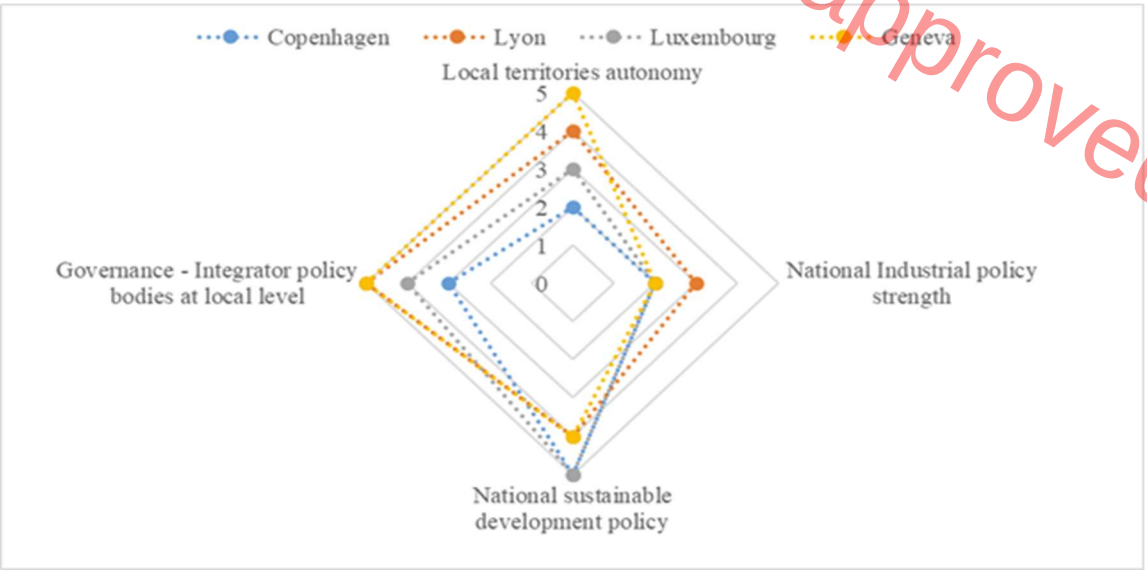


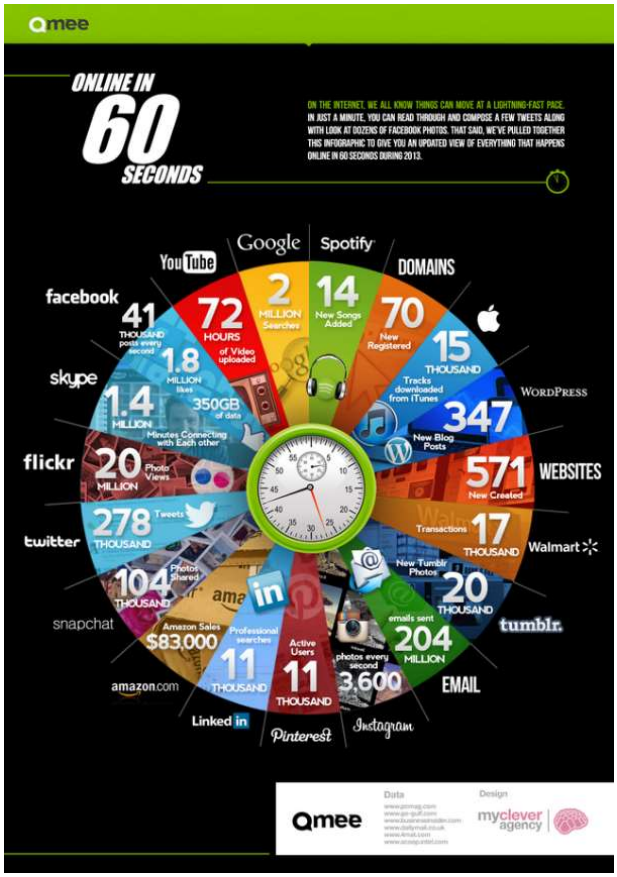
Fig 3 - Cities regulatory framework's strengths and weaknesses (Mira-Bonnardel and Couzineau, 2021)

Lyon's strength lies clearly in the existence of an integrator governance body, the centrality of power allowing a national industrial policy which surprisingly functions concurrently with a strong local policy. Lyon's main weakness lies in the thickness of the administrative layers.
On the contrary for Copenhagen regulatory barriers are due to the weakness of a local power while local policies and local independence could help to turn regulation into a facilitator.
Although well ranked, the city of Geneva lacks a national industrial policy which is due to the federalism of the country that favors local autonomy of Swiss "cantons". Regulation may be considered as facilitator mainly thanks to robust mobility policies made by local authorities. In fact, Geneva is the first city implementing a type of on demand automated service.
Luxembourg is a specific case since, due to the small size of the country, the city and the state present an overlapping perimeter that makes less relevant the analysis in terms of local autonomy and national policy.

3 Regulatory compliance plan

A regulatory compliance plan requires the implementation of a systemic and systematic regulatory intelligence. According to Aguilar (1967), a pioneer in intelligence research, strategic intelligence is about capturing information about events and relationships taking place in the company's external environment, information whose knowledge is likely to help the management team in its strategic choices about the future of the company. This acceptance includes the concepts of the environment, information and the future. According to Pateyron (1998), it is the search for information through constant vigilance and constant monitoring of the environment for strategic purposes. In the same vein, Romagni and Wild (1998) define the concept of strategic intelligence as a careful analysis of the different facets of the environment in order to develop pro-activity and to best prepare an organization's decision-making. Strategic intelligence can, in a simplified approach, be defined as the targeted activity of acquiring, processing and disseminating external information of a strategic nature for the sustainability of the company (Lafaye, 2004). According to Kriaa-Medhaffer (2006), the vigil can be of two kinds: to know the current environment, to anticipate changes that may be relevant to the company (opportunity or threat), to prepare early enough and to be able to act at the right time and as quickly as possible. Lesca (2001) writes that strategic intelligence is the ongoing collective process by which a group of individuals proactively track down and use anticipatory information about changes

that may occur in the company's external environment in order to create business opportunities and reduce risk and uncertainty in general. Thus, scouting means to be awake, to be receptive, to be ready to detect something that could happen without knowing exactly what or where (Lesca, 2003).



Every 60 seconds,

- 70 new domains are registered.
- 571 new sites are created worldwide.
- 72 hours of videos are uploaded to YouTube.
- 278,000 tweets are posted on Twitter.
- 1.8 million likes appear on Facebook.

The implementation of regulatory intelligence rises many issues among which the following.

- Which are relevant and reliable information sources?
- How to capture weak signals
- How to assess the strength of users' expectations or fears for new mobility services?
- How to assess the strength of lobbyers?
- How to organize the monitoring of dimensioned information to listen, sort out and extract valuable information.

Keeping in mind the essential steps of the monitoring cycle allows to improve each link by gradually integrating new sources of information or new monitoring tools in order to control the entire process from information collection to upon publication (if necessary):

1. Definition of the axes of monitoring on the Internet: define the objective of the monitoring, the information sought and its limits.

2. Identification of information sources: select the keywords and / or information sources to monitor.
3. Collection and selection of information
4. Analysis and organization
5. Synthesis and perspective
6. Publication and dissemination
7. Evaluation and continuous improvement

3.1 Methods

The tools available on the web now make it possible to easily collect all “white information” (as opposed to “gray information” which is more difficult to access and requires greater technical resources and “black information” which falls under industrial espionage). It turns out that this public information alone represents tens of thousands of sources and content to monitor daily: press, blogs, social networks, opinions ...
Two approaches therefore to define the perimeter of Internet monitoring:

1. The source-based approach: select a number of relevant sources from which the publications have been monitored.
2. The keyword approach: select a set of keywords relating to the search fields.

If the sources are well defined (eg following the news of institutional actors in the field of autonomous mobility), it is sufficient to list all the targeted websites and then automate the monitoring tasks. To search for sources, it is possible to use Google News for online publications and type in keywords that match the search domain to identify those news sources.
Often, however, this simple monitoring is not sufficient as the information sought is usually not restricted to a particular website. Many tools can then allow the collection of information by keyword.

3.1.1 Search engines

Traditional search engines

Google, Bing, Yahoo, Exalead: Search engines are the number one source of information. searches can be refined using query techniques on Google:

- Word exclusion: To exclude a word from the search, place the minus sign (-) immediately before that word. (The minus sign must be preceded by a space.)
- Expression search: To search for an expression (for example, "autonomous shuttle"), use quotation marks. When you put multiple words in quotes, Google considers them as a single string of characters and only searches for documents that contain those words in the same sequence.
- Some characters are recognized by Google as expression connectors: hyphen (-), standard slash (/), period (.), Equal sign (=).
- Targeting operators: Certain character strings, or “operators”, modify Google's behavior. For example, the operator "site:" (without the quotes) limits the search to a specific site or domain (eg site: youtube.com if you are only searching for content that is not present on Youtube).

Meta-engines

Meta-engines (example: Kelseek, Mamma, Kartoo, Yippy, Dogpile, ixquick,) are web services drawing their information through several search engines to provide cross-results that can be useful for have a complete view of search engine results (in the case of a competitor search for example).

News search engines

Google News, Yahoo News, Bing News index articles from all the international press. It is therefore an important source when collecting information.

Blog Search Engines

Google Blog Search, Technorati, eBuzzing Labs allow you to search for information posted on the blogosphere.

Real-time search engines:

Twitter has 3 ways to search through its formidable database of conversations and information: 1. Through the search bar at the top of the page; 2. Through the search page accessible at https://twitter.com/search-home; 3. Through Twitter's advanced search page available at https://twitter.com/search-advanced.
The advanced search on Twitter (Advanced Search) allows you to perform searches on complex keywords or expressions in a simplified way - without having to use the operators - with the possibility of filtering by language, by hashtag, by place, by date, by profile and even by positive or negative sentiment, which can be handy for tracking user feedback on a brand or product.
To cite other real-time engines: Google Real Time, Twitter Search, Facebook Search (or OpenBook to query all of the public statuses published by Facebook users. We can also cite Social Mention and Backtype Alert to be notified by email as soon as a keyword is published in a Facebook status or to know the opinion of Internet users on a particular keyword on micro-blogging services and social networks.

Search for conversations and discussions

Google Discussions allows you to request directly and only in forums.

Document search

Google's advanced search makes it possible to refine searches in order to query only in types of documents: pdf, word, excel, PowerPoint… In addition, Google Books allows you to search among millions of books digitized around the world. SlideShare is an interesting platform for slideshows, as well as Scribd for Pdf documents and finally Flickr for images. Google Patents data basis gives an overview on technologic innovation to come.

Images and video search engines

Google Images, Yahoo Images and Bing Images offer a service dedicated to searching for images on the Internet Google Videos, Yahoo Videos, Bing Videos offer a service dedicated to searching for images on the Internet. You can also make requests directly in the main video platforms: Youtube, DailyMotion, Vimeo, Viddler, Veoh, Metacafe.

3.1.2 People Engines

Professional social networks such as Linkedin are important sources of information for gathering information on people or on current projects. People research can lead to the use of metasearch engines such as Pipl to monitor, for example, publications related to an individual on the Internet. Facebook with its Graph Search will also become more and more interesting to search for profiles.

This interest of a well-organised web scanning is to detect weak signals that may become strong trends and eventually regulation>.

It is possible to use curation tools such as Pocket or Scoop.it which, thanks to a button located in the navigation bar, allows you to put aside articles or media while browsing the Internet.
In the case of a watch that should lead to the creation of lists (ex: lists of projects, etc.), "bookmarking" tools such as Diigo, Delicious, or Mister Wong can be relevant because they make it possible to capitalize on information and categorize your favorites lists. Pearltrees offers a graphic representation inspired by Mind Mapping tools.

3.2 Analysis and organization

3.2.1 Automation of the scouting

One of the challenges of Internet monitoring is to be able to automate the collection of information and to channel this information into a reduced number of formats so that the processing of information is rapid.
A first solution is that of email alerts: this is an interesting choice when the day before is not intended to be shared. Google Alerts, for example, offers to search for all news containing a particular keyword or phrase and to be notified by email as soon as a new article is indexed in the engine. Backtype Alert also allows you to receive a daily, weekly or monthly email notification indicating all the social networks and sharing sites that have mentioned a search term (eg "Google" or "Marketing"). Mention also allows you to receive alerts when a word is mentioned on the Internet and social networks.
A second solution is that of RSS (Really Simple Syndication) feeds which allow the syndication of content on the Internet. Once you have identified a source of information, you can automatically collect each new article and export it to an RSS reader. This functionality makes it possible to centralize different sources at the same point and then process them without having to consult each of the sources every day.
Finally, the use of page change alerts such as Change Detection can be a way to be warned when a static site uploads a new example homepage.

3.2.2 Convert RSS to email alerts and emails to RSS feeds

The Holy Grail consists in concentrating all the information flows in the same format (email or RSS alerts) in order to be able to process them. XFruits is a very useful tool for this task by allowing to:

- Aggregate several RSS feeds
- Send an RSS feed to email
- Transform emails into RSS feeds
- Publish RSS feed in the form of web or mobile pages
- Send RSS feed to a blog
- Publish RSS feeds in Pdf form

3.2.3 Gather the results in a single tool

RSS feeds are now ready to be processed with Google Reader for example. There are, however, alternatives to Google Reader: Digg Reader, Feedly or The Old Reader allow you to organize and consult the feeds of articles as they are published on their original sites.
Feedly, for example, allows you to bring together all the RSSs from favorite sites and blogs to read them in a feed or on mobile.
Hootsuite (or TweetDeck only regarding tracking tweets on Twitter) can do the job for tracking social networks (Facebook, Twitter, Linkedin, Youtube, Google Plus, Instagram, Tumblr ...)
It is possible to annotate them, activate a follow-up on the articles to be consulted later, select the articles of interest, classify them by assigning them a tag or keyword then finally share them. The

"Sharing" functionality in turn generates (as well as the lists of feeds created) an RSS feed composed only of the selected articles. This is the strength of RSS feeds that allow content to be easily exchanged, mixed, filtered and then republished. There is nothing effectively preventing the flow of handpicked articles from being used to generate an alert sent directly to the inbox with XFruits. In case of duplicates in the lists of RSS articles, we can use Feed Informer.

3.2.4 Why legal intelligence?

The task is to consult current legal affairs on a regular basis. Any business, regardless of its field of activity, has an interest in keeping up to date with legal developments.
Legal watch allows to stay informed of draft laws, to anticipate future legislative and regulatory changes. By thinking upstream about the means of their implementation, the actor saves time.
By consulting legal news regularly, the actor can apply the rules that apply to it at the right time. It gains in legitimacy and avoids sanctions.
Setting up a legal watch system is essential to sense future trends and guide internal decision-making in a company, or even gain a competitive advantage.
Legal news does not only carry binding rules: monitoring allows to take advantage of changes that have occurred in the interests of the company.

Different texts are to be considered like the following.

1. European texts: regulations, decisions. The directives need to be transposed into national law before being applied directly to EU member states,
2. National texts: codes, laws, decrees, decrees. Circulars and technical instructions should be considered when imposed by a regulatory text,
3. Local texts: prefectural order to operate, other prefectural ordinances discussed (e.g. those relating to environmental zones), municipal by-laws, PLU, zone regulations (for certain areas of activity), building permits, internal regulations, letters from the competent authorities and containing requirements, etc.
4. The normative documents (measurement standards...) called by a regulatory text,
5. Voluntary application documents: Standards, organizational-specific repositories.

3.3 Actors identification

Regulation does not emerge by itself, it is pushed by different stakeholders according to their strategic interest. Therefore, to antcipate regulatory changes, it is very important to identify stakholders, to understand their specific influencing power and in which direction each one is about to push regulation.

3.3.1 Influencers' typology

We have identified 6 groups to be followed in order to build a Intelligence tool of autonomous mobility regulation. These groups don't share the same level of impact on autonomous mobility but have to be considered in its ecosystem.

Group A: The legislators.

No matter the level considered (local, national or European), the legislator is the one designing, deciding and implementing the regulation. He/she is the first to be followed to know the current laws and to forecast the coming ones.

Level	Body
Local level:	City Hall Metropol government PTO Transport/mobility Commission
National level	Prime Minister Office Transport/land-use/Infrastructures Ministries Senate / Chambers
European level	Commission General Directorate

Group B: The Counsellors.

This group encompasses agencies, bodies which provide decision-makers with advice. In the context of Autonomous mobility, they are standardization agencies, environment/mobility agencies. Mandated to publish reports, studies and recommendations, they have an indirect impact on the regulation, considering the final decision shall belong to the legislators.

Group C: The Politicians.

In this group, we find political groups which can orientate votes in a way or another, once again, no matter the decision level concerned, depending on their representativity into the decision body.

Group D: The influencers.

This fashioned word represents pressure groups or lobbying interests. The influencers can be pro or anti alternative mobility.

Car as a mobility mode	Car manufacturers; energy providers; car clubs; automotive suppliers…
Urban Collective transport	Consumer associations ; Public transport association ; Environmental activists
Bicycle as a mobility mode	Consumer associations; cyclists association; car-free city associations
Pedestrian mode	Consumer associations; pedestrians association; car-free city associations

Group E: Society.

It is important to scout societal trends, opinions as they can have a direct impact on the decision-making process, mainly at the local level: to a certain extent, popularity of projects, appetite for innovative mobility, car-free spirit are influencing strategy/MAAS (phone)

Group F: The Rest of the World.

Success and failures, scandal, dramatic accidents in the rest of the world can influence the regulation in the area/country.

3.3.2 How to follow influencers?

Actors	Under watching	Sources
Group A The Legislators	- Planning - Agendas - Meetings	Institutional websites Institutional social media account (Twitter, Facebook, linkedin)
Group B The Counselors	- Past and present missions - Official reports	Institutional websites Institutional social media account (Twitter, Facebook, linkedin)
Group C The Politicians - Local level - Elected or not	- Nomination into a dedicated commission - Creation of a "think tank"	Official websites Official social media account (twitter, facebook, linkedin) Private pages or blogs Private social media account Twitch and youtube channel
Group D The influencers	- Meetings - Conferences - Workshops - reports	Official websites, pages or blogs Official social media account (twitter, facebook, linkedin) Whatsapp and facebook group
Group E Society	- Social trend in mobility	Social media (Twitter, Facebook, linkedin) Whatsapp and Facebook group
Group F The Rest of the World	- Success - Failures - New project	Sources: Traditional media Social media (Twitter, Facebook, linkedin)

3.4 Regulation timeline: past, present, future

We identified three levels of regulation based on time disposal.

a) The existing regulation: this is the easiest to find as it is set in stone and available on official websites. (follow-up)

b) The under-construction regulation: it is the one under discussion, not yet voted. It is subject to planning, meetings and various versions of the text. Those steps/processes should be monitored in the frame of the regulation scooting. Staying up to date allows to be ready, or to make the necessary adjustments, and to start the potential project as soon as possible.

c) The forthcoming regulation (expected even) : this regulation lays in the grey zones of political will, pressure power, societal trends deciphering. It requires to use more dedicated social tools and eventually to invest time into social media groups (early birds)

When will c) become b)?

It is clear that b) becomes a) when it is adopted. It is more complex to identify the switch between forthcoming an under-construction. The scouting of keywords on social media highlights idea, thought and projects. When is the social trend considered serious enough to be taken into consideration by policy makers? In other terms, when is the buzz big enough ? we can provide two kinds of answers:

1. When ideas/trends appear into traditional media, this is seen as an important step into seriousness.

2. Three tools allow to monitor virality : Graphystories allowing to identify upstream articles that have generated shares on social networks or are about to go viral ; Buzzsumo allows to monitor the most shared articles on social networks based on the keywords of interest and Socialshare allows to select the sources then either to consult the articles in order of publication or by number of shares on the Internet, which makes it possible to detect the articles in the process of buzzing.

4 Conclusion

This evolution can be described as a sequential process as described by Hansson (2020). Analyzing the two cases of regulating automated vehicles in Sweden and Norway, Hansson (2020) identified multiple regulation modes adjusted within at least 3 phases. Phase 1 illustrates the existing regulation, which is not adjusted for automated vehicles. Phase 2 is the transition phase induced by technological innovations challenging the existing regulation; during this phase, Hansson distinguished three types of co-existing regulation mode: the existing regulatory standards, self-regulation, and elements of open method of coordination. Hansson showed how both Sweden and Norway draw on existing regulations when shaping new ones and at the same time the two countries also shape new regulations based on benchmarks and learning experiences from other countries. Phase 3 leads to the consolidation of the new regulation (Hansson, 2020).

This report proposes to complementory approches to understand regulatory requirements (Hansson's phase 1), to anticipate new regulatory requirments (Hansson's phase 2) and implement relevant compliance plans (Hansson's phase 3).
The firt approach lies on the assessment of the national regulatory framework by the ROAD© index, based on the evaluation of four national variables that influence deeply the regulatory framework openness to innovation.
The second one proposes a panel of tools to implement a regulatory intelligence integrating online data as well as official position statements and unofficial moves of influencing stakeholders.

To combine efficiency and time savings, it is important to apply a methodology adapted to the actor, and to use powerful tools and to identify reliable sources of legal information.
Know the "hierarchy of standards" to assess their degree of constraint. The law - in that it includes articles of Codes, decrees, ordinances, etc. - must be respected in any event. The case law gives an indication of the tendency of judges to interpret the law, it is not binding per se but provides useful information.
Example France : It should be noted that proposals and bills are not binding until they are adopted and published at the Journal Officiel. In most cases, the binding nature of a new law is also subject to the prior enactment of an implementing decree.
At a time when every blog author has the means to improvise legal advice, it is essential to pay attention to the websites requested in the context of legal intelligence. Tip: .gouv / .gov extension sites, as government sites, offer reliable resources. Questioning the Legislation database to correct a rumor or verify the entry into force of a law on Service-Public.fr are good basic reflexes. Historical law publishers, including Dalloz and LexisNexis, broadcast equally reliable legal news. If you have a lack of hesitation about the reliability of a source, it is also important to contact the right people.

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Appendix 1-Local Autonomy Index by countries

(from Keuffer, 2016)

Country	Indice 2014	ROAD index score
Switzerland	79	5
Finland	78,85	5
Island	77,12	5
Denmark	74,49	5
Sweden	74,29	5
Germany	74,16	5
Poland	73,8	5
Norway	72,76	5
Italy	67,05	4
Serbia	66,65	4
France	65,99	4
Bulgaria	65,06	4
Lithuania	64,49	4
Austria	64,35	4
Czech republic	64,17	4
Estonia	62,95	4
Portugal	60,77	3
Slovakia	60,38	3
Belgium	60,02	3
Netherlands	59,17	3
Romania	58,46	3
Croatia	55,86	3
Luxembourg	55,64	3
Latvia	54,23	3
Spain	53,85	3
Hungaria	50,06	2
Albania	49,36	2
Slovenia	48,7	2
Ukraine	47,83	2
Greece	46,86	2
UK	46,31	2
Cyprus	41,76	1
Turkey	38,63	1
Georgia	37,88	1
Malta	37,12	1
Moldavia	35,45	1
Ireland	34,23	1

Appendix 2-Local Autonomy assessment from the EC

(from Ladner, Keuffer and Baldersheim, 2015)

Dimensions		Score	Variables
Institutional depth	The extent to which local government as formally autonomous and can choose the tasks it want to perform	0 1 2 3	Local authorities can only perform mandated tasks Local authorities can choose from a very narrow, predefined scope of tasks Local authorities are explicitly autonomous and can choose from a wide scope of predefined tasks Local authorities are free to take on any new tasks (residual competencies) not assigned to other levels of government
Policy scope	Range of functions (tasks) where local government is effectively involved in the delivery of the services (be it through their own financial resources and / or through their own staff	0 - 3	not at all; partly; fully responsible of - Education (0-0,3) - Social assistance (0-0,3) - Land-use (0-0,3) - Public transport (0-0,3) - Police (0-0,3) - Health (0-0,3) - Housing (0-0,3) - Caring functions (0-0,3) - Road infrastructure (0-0,3) - Port or airport infrastructure (0-0,3)
Effective political discretion	The extent to which local government has real influence (can decide on service aspects) over these functions	0 – 3	No, some, or real authoritative decision-making in not at all; partly; fully responsible of - Education (0-0,3) - Social assistance (0-0,3) - Land-use (0-0,3) - Public transport (0-0,3) - Police (0-0,3) - Health (0-0,3) - Housing (0-0,3) - Caring functions (0-0,3) - Road infrastructure (0-0,3) - Port or airport infrastructure (0-0,3)
Fiscal autonomy	The extent to which local government can independently tax its population	0 1 2 3 4	Local authorities do not set base and rate of any tax Local authorities set base or rate of minor taxes Local authorities set rate of one major tax (personal income, corporate, value added, property or sales tax) under restrictions stipulated by higher levels of government Local authorities set rate of one major tax (personal income, corporate, value added, property or sales tax) with few or no restrictions Local authorities set base and rate of more than one major tax (personal income, corporate, value added, property or sales tax)
Financial transfer system	The proportion of unconditional financial transfers to total financial transfers received by the local government	0 1	Conditional transfers are dominant (unconditional = 0 - 40% of total transfers) There is largely a balance between conditional and unconditional financial transfers (unconditional = 40-60%)

		2 3	Unconditional financial transfers are dominant (unconditional = 60-80%) Nearly all transfers are unconditional (unconditional = 80-100%)
Financial self-reliance	The proportion of local government revenues derived from local sources (taxes, fees, charges)	0 1 2 3	Own sources yield less than 10% of total revenues Own sources yield 10-25% of total revenues Own sources yield 25-50% of total revenues Own sources yield more than 50% of total revenues
Borrowing autonomy	The extent to which local government can borrow	0 1 2 3	Local authorities cannot borrow Local authorities may borrow under prior authorization by higher-level governments and with one or more of the following restrictions: a. golden rule (e. g. no borrowing to cover current account deficits) b. no foreign borrowing or borrowing from the regional or central bank only c. no borrowing above a ceiling, absolute level of subnational indebtedness, maximum debt-service ratio for new borrowing or debt brake mechanism d. borrowing is limited to specific purposes Local authorities may borrow without prior authorisation and under one or more of a), b), c) or d) Local authorities may borrow without restriction imposed by higher-level authorities
Organizational autonomy	The extent to which local government is free to decide about its own organization and electoral system	1 2 3	Local executives are appointed by higher-level authorities and local authorities cannot determine core elements of their political systems (electoral districts, number of seats, electoral system) Local executives are elected by the municipal council or directly by citizens Local executives are elected by the citizens or the council and the municipality may decide some elements of the electoral system Staff and local structures, local authorities: Hire their own staff (0-0,5) Choose their organizational structure (0-0.5) Fix the salary of their employees (0-0.5) Establish legal entities and municipal enterprises (0-0.5)
Score for Self-rule		**0 - 28**	**The overall self-rule enjoyed by local government in X country (the sum of all the variables above)**

Appendix 3 - GERD index

This index measures the share of Government funding in the Gross Domestic Expenditure on R&D.

$$\frac{GERD\ financed\ by\ Government\ in\ PPP\$\ (2018)}{GERD\ Total\ in\ PPP\$\ (2018)}$$

Country	GERD financed by government	Road Index score
Serbia	48%	4
Norway	47%	4
Croatia	43%	4
Portugal	41%	4
Estonia	40%	3
Spain	39%	3
Poland	38%	3
Greece	38%	3
Romania	36%	3
Slovakia	35%	3
Czech Republic	35%	3
Turkey	34%	3
France	32%	3
Netherlands	31%	3
Lithuania	31%	3
Cyprus	30%	2
Finland	29%	2
Luxembourg	28%	2
Germany	28%	2
Austria	28%	2
Denmark	27%	2
United Kingdom	25%	2
Sweden	25%	2
Bulgaria	24%	2
Switzerland	24%	2
Hungary	23%	2
Slovenia	23%	2
Belgium	20%	1
Italy	13%	1

Sources : Unesco institute for Statistics, Science, Technology and Innovation, Expenditure on R&D – GERD Total in PPP$ (2018)
Unesco institute for Statistics, Science, Technology and Innovation, Expendi-ture on R&D– GERD financed by Government in PPP$ (2018)