# Autonomous Vehicles from the EU perspective

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Abstract: Automated vehicles (AVs) will completely change urban mobility behavior and the structure of cities in the following years. Although the AVs development is one of the hottest topic nowadays, stakeholders are not as much engaged either in developing high-tech roads and designing new breed urban structures, or in issues deriving from different regulatory and infrastructural frameworks in the EU countries. On the one hand „low-tech" roads and traditional city structures must be changed in order to serve AVs, on the other hand AVs can help to reduce the number of conflicts and externalities caused by traditional cars in urban spaces. Thus several attempts have been made to harmonize the physical, digital and legal environment serving the development of autonomous vehicles between nations, but the frameworks for co-operation are still quite ad-hoc. The aim of this paper is to present in detail the challenges faces by urban planners and car factories and to outline the current situation of the European cooperation programmes, that focus on the development of AVs sector. We will also examine the cross-border cooperation possibilities and challenges through a case study that relates to ZalaZone test track, located in Zalaegerszeg, Hungary and representing a potential beneficiary in two INTERREG V A programmes (Slovenia-Hungary and Austria-Hungary).

## 1. INTRODUCTION of AVs R&D

According to the Innovation and Networks Executive Agency (INEA), Europe is one of the leaders of the field of R&D investment in the automotive sector, though this sector has a manufacturing output of close to 20 million vehicles and a contribution to the European GDP of 6.8%, employing over 13 million people and with a leading role in research and industrial innovation.
The Horizon 2020 research and innovation program provides great opportunity to develop automated and connected driving systems. With the rapid development of automated and connected driving systems and road infrastructure higher road safety and less pollution might be guaranteed in urban areas (1).

### *1.1 Expected advantages of AVs from the sustainability point of view*

The goal of sustainable transportation is to ensure that environment, social and economic considerations are factored into decisions affecting transportation activity (2).
Problems caused by urban mobility within cities is becoming increasingly difficult, while urban mobility greatly still relies on private cars (with diesel and gasoline) and there is only a slow shift towards more sustainable modes of urban mobility. Urban mobility accounts for 40 % of all CO2 emissions of road transport and up to 70 % of other pollutants from transport. Congestion in the EU is costs nearly EUR 100 billion, or 1 % of the EU's GDP (3).
Road traffic accidents in the Member States of the European Union claim about 25.600 lives and leave more than 1,4million people injured in 2016 (4).
The external effects of transport are continuously growing. Air pollution, the emissions of carbon oxides, smog, expropriation of areas for transport infrastructure needs, negative impact on the society, such as changes in land use and separation of residential units/built-up areas, accidents, delays are just some of the negative external effects of transport.
The new innovations of car industries and the continuously developing technology are full of promises. In the very close future autonomous vehicles will able to help drivers to avoid crashes, provides new opportunities for disabled people, will help to reduce the time spent commuting and will optimize vehicle consumption and reduce environmental pollution.
Accidents
Traffic safety and security optimists argue that, because human error contributes to 90% of crashes, autonomous vehicles will reduce crash rates and insurance costs by 90% (5).
Health effects
According to T. Litman (2019) autonomous vehicles can reduce also driver stress and boredom.
Social effects

Populations of the EU are aging, but a growing number of people living well into their 80s and maintaining active lives, this age group has specific requirements. AVs are more closely on understanding their mobility and accessibility needs (6). Autonomous vehicles can provide independent mobility also for non-drivers, including people with disabilities, adolescents, and others or who for any reason cannot or should not drive. This directly benefits those travelers, reduces chauffeuring burdens on their family members and friends, and improves their access to education and employment opportunities, increasing their economic productivity (5).

Environmental effects

Autonomous vehicles will affect travel and land use development patterns; road, parking and public transit demands; traffic problems. On the one hand autonomous vehicle car-parks can decrease the need for parking space by an average of 62% and a maximum of 87%. The revitalization of space that was previously used for parking can be socially beneficial if car-parks are converted into commercial and residential land-uses (7). Hayeri et al. (2015) indicate that since lane keeping systems will guarantee that vehicles stay within their lanes, it would be possible to reduce the width standards of lanes, shoulders, clear zones, and medians. On the other hand autonomous vehicles may require higher roadway maintenance standards, such as clearer line painting and special traffic signals, than traditional vehicles, that might causes higher environmental and cost effects (8).

The value of travel time

Travel time is one of the largest costs of transportation, and travel time savings are often the primary justification for transportation infrastructure improvements. it is argued that riding in an AV will be more pleasurable than a normal car or a normal bus. During travel people will be able to work or just enjoy their time.

External Cost

Some studies stated that autonomous driving will reduce external costs including traffic congestion, energy consumption, pollution emissions, roadway and parking facility costs (9).

According to T. Litman (2019) autonomous vehicles might reduce pollution only if they will be all electric and mostly shared. If many users choose personal autonomous vehicles instead of public vehicles energy consumption and pollution emissions will increase.

The following table summarizes the expected external effects of AVs compare to traditional cars as it can be seen on **Table 1.**

**Table 1. The expected external effects of AVs compare to traditional cars**

| External effects | AVs (shared autonomous vehicles) | AVp (personal autonomous vehicles) | Traditional car |
|---|---|---|---|
| Accidents | less | less | more |
| Noise | same | same | same |
| Health effects | less | less | more |
| Social effects | less | less | more |
| Building damage | same | same | same |
| Climate impact | less | same | same |
| Environmental effects | less | same | same |
| Nature and landscape effects | less | same | same |
| Time value | less | less | more |
| Cost effects | less | less | more |

### 1.2 *Towards on AVs sustainable development*

According to T. Litman (2006) conventional planning tends to assume that transport progress is linear, consisting of newer, faster modes that displace older, slower modes as it can be seen on Figure 1. This model assumes that the older modes, such as walking, bicycle, train, bus are unimportant and automobile travel has priority over other modes of transport (10). In this case autonomous cars will have priority over all other transport modes, but then autonomous cars could not be sustainable.

***Linear transport progress:*** Walk → Bicycle → Train → Bus → Automobile → Improved (autonomous) automobiles

*Figure 1 Conventional transport planning model*

In order to stay sustainable, during AVs development a parallel model must be applied, which assumes that each mode is useful, and strives to create balanced transport systems that use each mode for what it does best. In this case AVs might have priority over traditional vehicles but each mode of transport still must have a relevance in city development as it can be seen on Figure 2.

***AVs Parallel model:*** Walk → Improved walking conditions
Bicycle → Improved cycling conditions
Train/Bus → Improved public transit service /Autonomous public transport
Automobile → Improved automobile travel conditions / Autonomous private transport

*Figure 2 Sustainable transport planning model of AVs*

## 2. EU PERSPECTIVE ON AVs

Europe accounts for 23% of global motor vehicle production. Our vision is for Europe to be a world leader for fully autonomous safe mobility. This will lead to new jobs, economic growth, less traffic congestion and new mobility solutions for the elderly and physically impaired. With the third Mobility Package, the European Commission is proposing a strategy aiming to make Europe a world leader for fully automated and connected mobility systems. The strategy looks at a new level of cooperation between road users, which could potentially bring enormous benefits for the mobility system as a whole. Transport will be safer, cleaner, cheaper and more accessible to the elderly and to people with reduced mobility. In addition, the Commission is proposing to establish a fully digital environment for information exchange in freight transport. This will cut red tape and facilitate digital information flows for logistic operations. (11) The European Commission supports the introduction and deployment of Connected and Automated Mobility (CAM) on various levels:

- Policy initiatives: developing policies, communications, roadmaps, strategies in close collaboration with stakeholders.
- DG CONNECT's role is to bring together stakeholders and countries to foster exchanges of experience, ideas and proposals;
- Development of standards at the European level;
- Co-funding of research & innovation projects (H2020), support actions and of infrastructure pilots;
- Legislation at the European level when needed. (12)

## 3. RUNNING PILOT PROJECTS

Horizon 2020 EU Research and Innovation program, with its funding over 7 years (2014 to 2020) supports many projects related to autonomous vehicle development (13). Large scale of project deals with the testing of the traffic rules on open roads as well as with the technology for automated vehicles, to develop relevant rules, to increase public acceptance and to develop co-operation between the different actors. Selected examples are as follows:

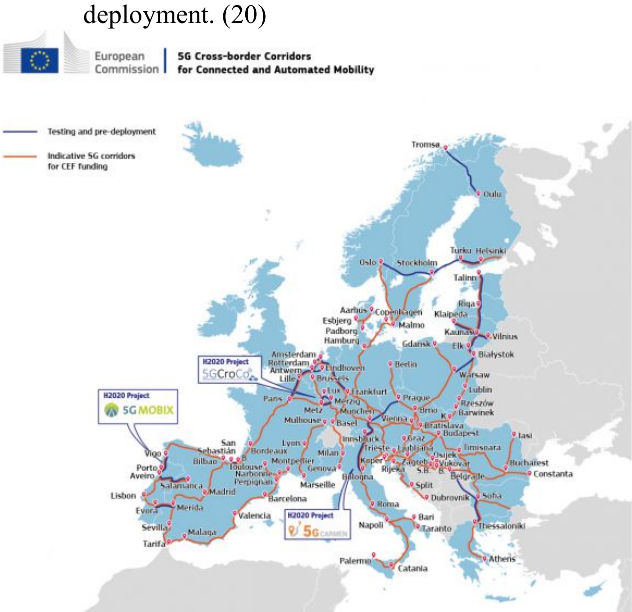
- ICT Infrastructure for Connected and Automated Road Transport - ICT4CART aims to bring together, adapt and improve technological advances from the telecommunication, automotive and IT industries to provide the ICT infrastructure to enable the transition towards road transport automation. To achieve its objectives ICT4CART, instead of working on generic solutions with questionable impact, builds on four specific high-value use cases, which will be tested under real-life conditions at project sites in Austria, Germany, Italy and at the Italian-Austrian border. (14);
- Inframix aims at preparing the road infrastructure with specific affordable adaptations and supporting it with new models and tools, to accommodate for the step-wise introduction of automated vehicles. (15);
- interACT project will be working towards the safe integration of AVs into mixed traffic environments. In order to do so, interACT will analyse todays' human-human interaction strategies, and implement and evaluate solutions for safe, cooperative, and intuitive interactions between AVs and both their on-board driver and other traffic participants. (16);
- L3Pilot tests the viability of automated driving as a safe and efficient means of transportation on public roads. It will focus on large-scale piloting of SAE Level 3 functions, with additional assessment of some Level 4 functions. The functionality of the systems will be exposed to variable conditions with 1,000 drivers and 100 cars across ten European countries, including cross-border routes. (17);
- TransAID develops and demonstrates traffic management procedures and protocols to enable smooth coexistence of automated, connected, and conventional vehicles, especially at Transition Areas. A hierarchical approach is followed where control actions are implemented at different layers including centralised traffic management, infrastructure, and vehicles. (18).

## 4. CROSSBORDER CORIDORS

The goal of the cross-border projects, which are funded by the EU is to support EU-member states in common transportation planning.
On 23 March 2017, 27 Member States plus Norway and Switzerland upon invitation of the EU Commission signed a Letter of Intent committing to work together on large scale testing and demonstrations in the area of connected and automated driving. This Letter of Intent addresses the digital aspects, such as connectivity, spectrum, data, cybersecurity, artificial intelligence etc.
The 29 signatory countries agreed to designate 5G cross-border corridors, where vehicles can physically move across borders and where the cross-border road safety, data access, data quality and liability, connectivity and digital technologies can be tested and demonstrated. The European Commission's ambition is to focus on these corridors in future EU automated driving projects in the area of digital policies, with links to cybersecurity, privacy, 5G, internet of things, data economy, free flow of data, etc. (19)
The EU supports 3 projects (running as part of the European Commission's 5G Public Private Partnership) which will set up 5G trials over more than 1000km of highway including four cross-border corridors, which will be used to help connected and automated mobility become a reality in Europe:

- 5GCroco will trial 5G technologies over highways between Metz, Merzig and Luxembourg, crossing the borders of France, Germany and Luxembourg. It will test and refine advanced 5G network technologies such as mobile edge computing and network slicing, and will test tele-operated driving, high definition maps for autonomous vehicles, and Anticipated Cooperative Collision Avoidance (ACCA).

- 5G-Carmen will conduct extensive trials across an important north-south corridor from Bologna to Munich via the Brenner Pass, spanning 600 km of roads, connecting three European regions, Bavaria (Germany), Tirol (Austria) and Trentino/South-Tyrol (Italy). It will focus on vehicle manoeuvre negotiation, infotainment, and emissions control in sensitive areas.
- 5G-Mobix will test connected and automated mobility applications along two cross-border corridors between Spain and Portugal, a short corridor between Greece and Turkey, and six national urban sites in Versailles (France), Berlin and Stuttgart (Germany), Eindhoven-Helmond (Netherlands) and Espoo (Finland). In addition to technical validation and advanced use cases, the trials will make it possible to define cooperation models and include cost/benefit analysis. They will explore new business opportunities for 5G-enabled connected and automated mobility services and provide recommendations and options for deployment. (20)




Map 1: 5G Cross border corridors (21)

## 6. URBAN PLANNING DEVELOPMENT TOOLS IN THE SERVICE OF AVs

In order to influence the spread of the autonomous vehicles in urban areas the use of large scale of urban planning tools are advised. These urban planning tools might be physical, legal or fiscal.

City planning tools such as planning of city structure, regulation of land-use, brown-field rehabilitation, assignment of development areas, planning of transport network or parking management can be done by supporting autonomous vehicles, with positive discrimination of AVs. New development areas might be accessible only by autonomous vehicles or dedicated lanes or transport networks could only use by autonomous vehicles.

Proper use of other tools such as traffic control, admission regulation, roads and bridge tolls and the favorable charges for AVs can also contribute the widespread adoption of AVs. Public parking priorities and different vehicle taxes for AVs might be also effective in the case of increase of number of AVs in urban areas.

## 5. AVs AND SMART CITIES

According to the actual term our cities will become smart cities on the next decade, so the autonomous vehicles will run in those cities (22). In the smart city's framework, there is a much stronger focus on modern technologies compared to urban sustainability frameworks. The general goal of smart city is to improve sustainability with the help of technology (23).

Several test tracks have been built around the world for modeling and analyzing self-driving cars and smart city systems. These test tracks allow to perform different levels and types of analysis as it can be seen on Figure 3. Hungary has built-up a multi-level testing environment called ZalaZone, which was designed on the demand of industrial companies (e.g.: AImotive, AVL, BME GJT, Bosch, Commsignia, Knorr-Bremse, Continental, EVOPRO, NKH, NI, SZTAKI, ThyssenKrupp Presta, TÜV Rheinland, ZF).

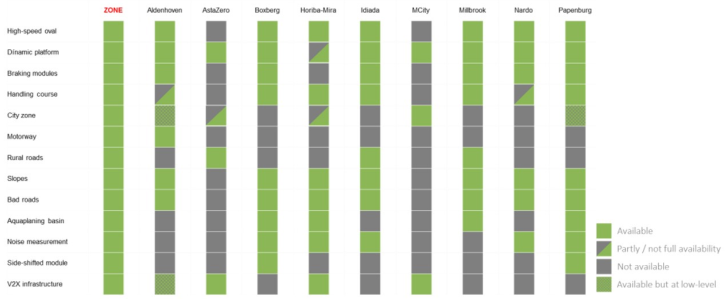



*Figure 3 Comparison of different test track modules world-wide (22)*

In the ZalaZone test track a Smart city zone is also planned as it can be seen on Figure 4. The Smart city zone is expected to be ready by 2020, which will provide an opportunity to make many tests such as AD vehicle test services, low-speed platooning at various junctions and lane layout; emergency braking in city environment with different barriers (static, moving) on high and low friction surface; crossings with low to medium friction surfaces for interactions with optional vehicle number with ABS, ATC, ESP activity; cooperative tests with vehicles, pedestrians, bikers etc.; different parking situations, parking house, valet parking, park assistant, different layouts, smart parking; intelligent logistic yard; different road construction zone scenarios in city environment, different road side objects: buildings, trees, parking cars, used road signs, fences, dust-bin etc.; changing weather conditions (24).

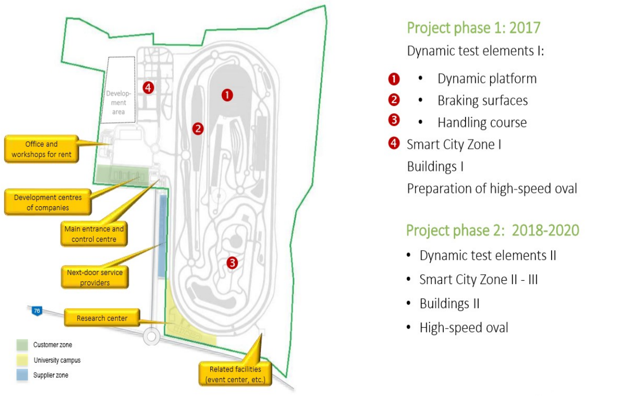



*Figure 4 Comparison of different test track modules world-wide (22)*

## 7. CROSS-BORDER COOPERATION PERSPECTIVES OF ZALAZONE

ZalaZone test track is located in Zalaegerszeg, in County Zala which is part of the programme area of two INTERREG V A Cross-border Cooperation Programmes: between Hungary and Austria, and between Hungary and Slovenia. The three countries have signed a memorandum of understanding on cross-border cooperation in developing and testing electric, integrated and autonomous vehicles in 2018, that advocates creating conditions to establish an Austrian-Hungarian-Slovenian driverless region, which facilitates the expansion of new mobile technologies and vehicles. (25) Nonetheless, the cooperation programmes do not foresee any priorities in this direction. The INTERREG V A Cross-border Cooperation Programme Austria-Hungary has a priority axes set on " Promoting sustainable transport and removing bottlenecks in key network infrastructures" and funds six projects: Smart Pannonia, CrossBorder Rail, CrossBorder Road, Rajka – Deutsch Jahrndorf, St.Margarethen-Fertőrákos, Várbalog-Halbturn. The selected operations will contribute to development of the rail and road infrastructure across the border, and to the enhancement of sustainable mobility in general, but non of them is dedicated to autonomous driving or connected issues. (26)

The INTERREG V A Cross-border Cooperation Programme Slovenia-Hungary also allows also projects related to cross-border accessibility and interoperability under the priority axis 2 "Cooperative Region", nonetheless no approved projects tackle any issues related to transport and/or connectivity. (27)

## 8. CONCLUSION

Car factories are considerably engaged to the innovation and development of autonomous vehicles for a relatively long time. However, more and more researchers deal also with the development of the urban structure and road infrastructure there is still a lot of open questions about that how AVs could be adopted in urban areas in the most effective and most sustainable way. Fortunately, the Research and Innovation program of the EU provides significant financial support for the implementation of these researches. These international projects help to harmonize the physical, digital and legal environment serving the development of autonomous vehicles between nations. On the other hand, cross-border programmes should follow the lead and set a focus on connected and automated mobility.

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