POLICY BRIEF #46

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Autonomous vehicles in urban settings.

Recommendations to encourage testing and societally beneficial deployment.

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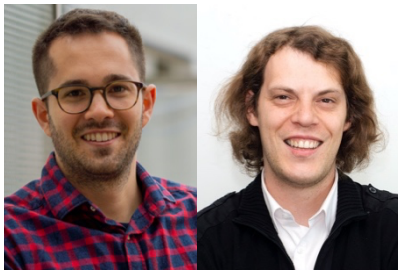
SMIT STUDIES MEDIA INNOVATION TECHNOLOGY



Autonomous vehicles in cities have been part of the smart mobility agenda for quite a while. Tests with autonomous vehicles in mixed traffic conditions are however only emerging in Belgium and still with limited scope. In this policy brief, we will tackle three key issues policymakers will need to address to support the development of autonomous vehicles from mere pilots to real services: develop a vision and a testing strategy, develop a business ecosystem, and influence the societal impact of self-driving mobility services.

Highlights
- Seven autonomous shuttle test projects have been executed in Belgium over the past three years but still with a **limited application** scenario.
- Policymakers should **develop a clear vision** on the role of autonomous vehicles in cities to stimulate further trials that cover various use cases and situations, in order to advance the technology and increase awareness by the general public.
- The timely deployment of autonomous vehicle services in Belgium will depend on having a clear business case, which involves **developing a regional business ecosystem**.
- Different factors influence the resulting societal impact of self-driving mobility services: regulators need to address the decision and recommendation systems of autonomous vehicles and MaaS platforms, and data sharing schemes as well.

1. Promises, challenges, and state-of-the-art of autonomous vehicles in Belgium

Road congestion and road safety are major mobility problems in cities. In Brussels, congestion causes commuters to lose over a hundred hours a year[1], which comes with an economic loss of about 2% of GDP[2]. Road traffic accidents and fatalities are above the EU average[3], leading to a similar economic cost[4]. Self-driving technology can be a solution to both challenges. By

[1] According to the INRIX 2019 Global Traffic Scorecard and the TomTom 2019 Traffic Index.
[2] MORA (2018). Mobiliteitsverslag 2018. Mobiliteitsraad van Vlaanderen. Available at: https://www.mobiliteitsraad.be/mora/publicatie/mobiliteitsverslag-2018
[3] UNECE (2019). Statistics of road traffic accidents in Europe and North America. Volume LV. United Nations.
[4] Wijnen, W., & Stipdonk, H. (2016). Social costs of road crashes: An international analysis. Accident Analysis & Prevention, 94, 97-106.

taking over the role of the driver and being part of a wider smart road infrastructure, autonomous cars will erase human uncooperative behaviours and errors on the road, allow for better monitoring of traffic flows, and reduce the risk of traffic accidents. The new idle time can be spent by the driver on work or leisure activities. The reduction of congestion will also have environmental benefits, such as reducing air pollution and lowering car pressure on public space by optimising parking.

Autonomous vehicles also promise to increase accessibility to mobility services for people who are not able to drive or who live in remote areas with limited public transport. For instance, they can make on-demand trips more affordable for people suffering from certain physical disabilities or visual impairments. These issues are more common among elderly citizens, and like for most of Europe, Belgium's and Flanders's populations are aging[5].

Despite these promises, the introduction of self-driving vehicles is not without its challenges. For instance, if self-driving is primarily for non-shared, private use, it could lead to an even higher volume of traffic and distances travelled. In Belgium, this number is currently high: the main mode of transport is the private car, which represents the majority of travel, both in number of trips and distance. Moreover, the average occupancy rate of cars in Belgium is just 1.21 for adults[6]. Secondly, autonomous driving will make taxi services more affordable by removing the driver, but this has the potential to induce net job losses. Thirdly, its greater convenience from freeing commuting and parking time can increase demand for car ownership in cities, hence congestion and pollution.

Towards shared and Public transport
To avoid the adverse effects of autonomous vehicles, studies point to the role of shared cars - robotaxis - and public transport, and the importance of their interdependence in future roll-out scenarios. To optimally reduce congestion and car usage, autonomous taxis should be combined with high-capacity public transport[7]. The promise within the field of public transport in cities is in the deployment of autonomous shuttles that provide last-mile solutions that connect campuses, remote neighborhoods, business parks or car parkings with major public transport hubs.

In Europe, the number of trials with autonomous shuttles is expanding, among others due to important EU-funded projects (Avenue, CityMobile, Fabulous). Where initially the focus was on technical validation, it is now shifting to developing a real service in an urban setting (fleet management, remote control, smart information boards, etc.). As Table 1 indicates, tests with autonomous cars and shuttles in mixed traffic conditions in Belgium are gradually emerging, although deployment scenarios are still basic. Others are being announced.

Location	Partners	Scenario	Duration
Brussels Airport	De Lijn	Mixed traffic - Demonstration (no passengers) Parking	2019
Han-sur-Lesse	VIAS	Mixed traffic (500 m) - passengers Connecting Parking with entrance of Caves of Han complex	2018
Waterloo/Braine L'Alleud	VIAS	Mixed traffic (2.4 km) - passengers Monument Lion of Waterloo to farm Hougoumont	2018
Brussels	MIVB-STIB	Soft mobility modes (1.5 km) - passengers Parc of Woluwe Mixed traffic on closed site - Passengers Solvay Site	2019-2020
Brussels	Project	Mixed traffic - passengers	2019-2020

[5] According to data from Eurostat and Statistiek Vlaanderen.
[6] Derauw, S., Gelaes, S., & Pauwels, C. (2019). Enquête monitor over de mobiliteit van de Belgen. Federale Overheidsdienst: Mobiliteit en Vervoer.
[7] OECD (2015). Urban Mobility System Upgrade: How Shared Self-Driving Cars Could Change City Traffic. International Transport Forum Policy Papers, No. 6. OECD Publishing: Paris, France.

	consortium ASSUZB	Traject 1 Brussels Health Campus (400m) - on campus road: Auditoria to Student Houses Traject 2 (Brussels Health Campus (800m) - public road: Hospital Entrance - Parking - Public Transport Hub	
Gent	AZ Maria Middelares Hospital	Mixed traffic (600 meter) - passengers Entrance Hospital with bus and tram stop	2020 - 2021
Louvain-La-Neuve	TEC	Railway Station to Science Park Einstein	2021

Table 1: Overview of tests with autonomous vehicles in Belgium

Against this background of promises and challenges of autonomous vehicles and their initial tests in Belgium, this policy brief will focus on three key questions in the development of autonomous vehicles:

- How to encourage the testing of autonomous shuttles?
- How to foster deployment of autonomous vehicles in Belgium/Flanders?
- How to incentivise a positive societal impact from self-driving mobility services?

While the emergence of autonomous vehicles triggers a wider range of questions, these were the main outcomes of two projects imec-SMIT was involved in with respect to autonomous vehicles: the Flemish Smart Highway project[8] and the Brussels project Autonomous Shuttle Service for the Brussels Health Campus (ASSUZB)[9].

2. How to test autonomous vehicles

It is important for policymakers to develop **a clear vision on the role of autonomous vehicles** in cities **and** from that vision **organise or stimulate trials**. This can inform the composition of a strategic plan covering preferred usages and target audiences. The current 'Good Move' mobility plan of the Brussels Region, for example, does not mention any kind of autonomous vehicles. Nonetheless the policies in that plan that aim to develop pedestrian zones, create low-car neighbourhoods, or implement a generalised 'zone 30' are fruitful for autonomous shuttles. The policies erase the current burden for shuttles to compete with other means in terms of speed and provide suitable areas for deployment.

Especially in certain urban development projects, the potential and feasibility of autonomous shuttles as a last-mile solution should be considered from the start of the design process. In the case of Brussels, one can think, for example, in the direction of some of the 11 strategic to-be-developed neighbourhoods in the Regional Plan for Sustainable Development.

Trials should also cover various use cases and situations, ranging from the last-mile connection of a car parking to a public transport stop, to touristic purposes, to shuttle services at events. One could also consider mixed purposes, such as personnel transport during the day with transport of goods overnight. Finally, trials are not only locations of experimentation, but concrete sites where the **larger public can experience** and become aware of future mobility solutions.

[8] The Smart Highway project (2018-2020), funded by VLAIO (the Flemish Agency for Innovation and Entrepreneurship), studied different aspects to enable cooperative, connected and automated mobility (CCAM) on Flemish public roads. Within the project, imec-SMIT researchers identified the economic challenges and opportunities of autonomous vehicles based on desk research and interviews with experts from mobility-related organizations (mobility service providers, public agencies, associations and consultancies, and truck and shuttle manufacturers). Our role in the project was also to propose and validate different business models for several autonomous driving use cases.

[9] The ASSUZB research project (www.avlab.brussels) ran from 2019 to 2020, bringing together VUB and ULB researchers (SMIT, MOBI, LoUiSE) and the VUB University Hospital. SMIT was responsible for the Living Lab implementation, the creation of future use case scenarios for the campus with relevant stakeholders and the formulation of policy recommendations with regards to testing in the Brussels Capital Region. The project was funded by Innoviris, the Brussels Agency for Research and Innovation.

A city authority should play a role in supporting such trials. Besides installing proper signalisation to inform other road users about the shuttle (for example at crossroads), adaptations to the current road infrastructure (placement of certain separators/freeing up parking spots to make temporary bus stops), and road regulation will be needed (e.g., reduction of the speed limit along one public road). On public roads, where authorisations for such interventions are needed, reducing waiting times to obtain authorisations will avoid delays in testing.

For assuring a good testing process, the urban Living Lab approach used in ASSUZB turned out to be a fruitful approach. The aim was to practically implement a shuttle service on the Brussels Health Campus to gather insights on user acceptance, spatial impacts, and policy of autonomous vehicles in Brussels. It provided a method to co-create with all stakeholders the design of the trajectories within mobility challenges of the campus. This could then be tested with passengers (students, patients, hospital staff, visitors) in an iterative way. An important consideration in testing is to **pay as much attention to the experience of your passengers as to the reactions of other road users,** particularly the interactions between the shuttle, the safety operator and pedestrians, cyclists, or drivers. This allows for detection and design of good practices and traffic rules.

As for the scope of the tests, the Smart Highway analysis highlights that a remaining challenge is to convince international market leaders to collaborate on trials in the region. To attract larger scale projects — compared to the pilot autonomous shuttles projects of De Lijn and STIB — , authorities should be more proactive in approaching companies and facilitating tests. Such larger-scale tests, such as robotaxi projects with dynamic routing in complex environments, entail much larger investments, and thus are only pursued by companies focusing on valorising the service over the long term with a large market penetration.

3. How to deploy autonomous vehicles

How to proceed from testing to deployment of autonomous vehicles in Belgium? One major obstacle today is the lack of a clear business case to develop commercial autonomous vehicle solutions. Two main hurdles can be identified.

First of all, **an update in the Belgian traffic code** is needed in order to allow vehicles to be rolled out as commercial services on public roads without a human driver or operator on board. Before this happens, a prerequisite will be to amend the Vienna Convention on Road Traffic, which makes the presence of a human driver obligatory. This treaty was ratified by Belgium and is therefore binding in the country. While an amendment proposal was adopted by the United Nations Economic Commission for Europe (UNECE) and formally communicated to the contracting parties in 2021, it is not in force yet. This regulatory change is important because the financial viability of autonomous vehicles is challenged by the cost of having an employee supervising the vehicle at all times, a lesson that was also learned in the ASSUZB project.

Secondly, there is no active business ecosystem for autonomous vehicles yet in Flanders and/or Belgium. While there are some initiatives in place — such as ITS.be, that organizes events and tries to foster cooperation among local actors —, extensive cooperation around commercially-minded initiatives is still lacking. **Developing a local or regional business ecosystem** is important for three main reasons:

- to assure economic competitiveness by having businesses that generate employment and pay their taxes in the region(s);
- to have services that are more aware and aligned with the specific mobility needs and policy goals of the region(s) — simply reacting to the initiatives of foreign companies without a local footprint would be suboptimal, since their regional context (mobility patterns, culture, infrastructure, etc.) can be completely different;
- to ease cooperation between public and private players from the moment of building services, which will make it easier to anticipate the societal impacts of the technology. In addition, large corporations are more difficult to influence by policy, because of their bargaining power.

To build a regional ecosystem, more involvement by the following stakeholders is necessary:

- Vehicle manufacturers and technology companies involved in self-driving. Limiting cooperation to the local level is not enough. It is valuable that certain elements of the value chain are provided by international market leaders. As is the case for testing, it is important to incentivise these actors to implement their innovation projects in Belgium.
- Public transport operators (PTOs). Optimally, they should be involved in further road tests, and coordinate more between each other to share the insights of these tests in a more structured way. Ideally, a joint approach for testing conditions would mean that service providers do not have to negotiate with each city separately but can rely on national-level agreements. In addition, last-mile shuttle services (e.g., on a hospital campus) could be incorporated in other MaaS projects. While last-mile shuttles should not operate on conventional public transport roads, as this creates redundancy of offer and practical burdens, it is crucial that at connecting stops shuttles can make use of the PTO's infrastructure to avoid an uncomfortable change between transport modes and improve the journey experience.
- Research institutions. Besides generating acceptance among users via testing projects, universities should conduct applied research that supports entrepreneurship. This can be done by collaborating with existing local players, focusing on how they can adopt innovations beyond the project. This requires research that has a longer-term view than the common project horizon, and that considers the future competitiveness of the local economy and labour market.
- Public authorities. Besides being involved in autonomous shuttle tests and having a long-term vision of the desired future to strive toward, local and regional authorities have a role in incentivising the involvement of the other key stakeholders. Public entities can stimulate the deployment of autonomous vehicles by adapting road infrastructure and co-investing in R&D to motivate other players to explore the technology.

4. The societal impact of autonomous vehicles

One issue to consider is **regulating the artificial intelligence-based systems underlying autonomous vehicles and MaaS platforms**. The rules self-driving algorithms incorporate may be set according to different environmental and ethical aspects; therefore, these decisions will have traffic and societal impacts. There is a risk they negatively influence the mobility behaviour of people simply by the suggestions they make. For instance, if recommending an individual ride-hailing service appears more profitable than a more sustainable mode, it will be more likely the MaaS app does so. Having more private robo-taxis can lead to more kilometres ridden without passers on board and less sharing of trips, with a subsequent worse impact on congestion and energy consumption. In addition, demand-based surge pricing may affect inclusion and accessibility to transport, since certain neighbourhoods will have a higher willingness to pay and consequently attract a higher offer of mobility solutions than others. Lastly, if the algorithms of vehicles or recommendation engines are solely based on the rider's convenience, they may take or advise suboptimal routes, for instance, based only on the distance or duration of a trip, without considering other policy preferences such as traffic flow in certain neighbourhoods.

Second, another issue concerns **the sharing of data coming from autonomous vehicles**. While there are instances in which mobility data is publicly shared in Belgium, such as via the Flemish Mobilidata platform or the country's National Access Point, for some types of vehicle data there are no clear sharing rules and, for many stakeholders, no sharing systems in place. A main reason is that the owners of these data are reluctant to share it with potential competitors since they have a commercial interest in it. For public transport, car-sharing and other mobility services, having access to data from vehicles (e.g., about location, behaviour, maps, road tests, etc.), would help improve the quality of services. Further, access to data is crucial to build a local MaaS platform with multi-modal recommendation services. We argue for a hybrid approach of leaving such sharing to bilateral market agreements combined with governmental intervention that mandates the open sharing of operational data (relating to the number of passengers, number of rides, etc.) and traffic data for those self-driving services provided in public roads. The sharing of this data coming from autonomous vehicles could be done via the existing regional or national platforms. Lastly, enforcing such sharing at the regional or national level

would mean that local authorities would not need to do so separately, which limits their bargaining power and efficiency, and threatens the interoperability of data.

Finally, policymakers must **take into account the potential impact on the job market**, since the task of public transport drivers may become redundant with the advent of autonomous vehicles. The professions of bus and tram driver currently employ over 20 thousand people in Belgium. However, for the foreseeable future, especially in complex urban settings, shuttles are not expected to be able to drive themselves everywhere. During this transition period, policymakers must allow the business case of autonomous shuttles by making it affordable. As mentioned above, it is important to adapt legislation so as not to mandate an operator to be behind the wheel all the time, as soon as it is objectively proven safe. This must not imply that the driver becomes redundant, but rather that the nature of the job will adapt, freeing time for the driver to spend more effort in tasks that add societal value to citizens, for example, assisting the elderly or enforcing that people wear face masks. Regarding the longer-term impact, it will be important to avoid future labour market disruptions once full self-driving technology matures. To this end, it is important to already invest in planning to anticipate the future labour demand for these professions.

Develop a vision for autonomous vehicles and test to learn and prepare

City authorities should understand what autonomous vehicles will mean for the city and **define a vision**. As the technologies are new, testing is very important to gather necessary insights. Develop a strategy and approach to support trials, involving all actors.

Enabling the business case to incentivise deployment by market players

Policymakers can help make autonomous vehicle services financially viable by **updating traffic legislation**. Public authorities and universities can also foster the involvement of other stakeholders in a regional business ecosystem by focusing research efforts and R&D funding on incentivising that **local players** explore the technology and adopt innovations.

Ensuring a positive societal impact from self-driving technology...

by (i) regulating the algorithms of MaaS platforms and autonomous vehicles, (ii) enforcing sharing of certain data to build local multi-modal recommendation services, and (iii) adapting the nature of the public transport driver's job while planning to anticipate the long-term labour market disruptions of driverless services.

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