INTERNATIONAL BENCHMARK 2020

ROAD INFRASTRUCTURE AND NEW MOBILITY

THE MAIN FINDINGS OF THE INTERNATIONAL BENCHMARK CONDUCTED IN 20 COUNTRIES

INSIGHT

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**Countries studied: United States, Canada, Mexico, Chile, Argentina, China, South Korea, Japan, Portugal, Spain, France, United Kingdom, Belgium, Netherlands, Germany, Austria, Norway, Sweden, Finland, South Africa.*

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Routes de France, the European Road Federation (ERF) and the Fédération Nationale des Travaux Publics (FNTP), in collaboration with the European Construction Industry Federation (FIEC) and the Confederation of International Contractors' Associations (CICA) launched an international benchmark in March 2019. This study covers 20 countries* around the world. It represents an overview of new mobility uses (autonomous, connected, electric, soft and active, etc.) and its impact on road infrastructure and road equipment before the global health crisis of Covid-19.

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1 - What lessons can be drawn from this global panorama of new mobility developments before the Covid-19 crisis?

In Europe, Northern countries stand out in the integration of electric mobility and have more open legislation for autonomous and connected mobility, although Europe as a whole shares the same objectives concerning urban mobility. The weight of the digital actors in mobility and transport in the United States and Asia is increasing, with different regional or national strategies. Generally speaking, road infrastructure is still little taken into account, with most of the adaptations only involving road equipment and not the road infrastructure as such.

A two-speed Europe of mobility

European countries represent half of the countries targeted in this benchmark. The comparisons show that Northern Europe is more mature in integrating new mobility than its neighbours.

This is the case for electric mobility. Norway has been the reference for several years, as has Sweden for its research on road electrification. The Netherlands also have a lead in the deployment of a recharging network. Southern Europe appears to be more dependent on grant schemes to support the sector. **Europeans need to deploy an efficient and dense charging network, a *sine qua non* condition for the development of electric mobility**. The European automotive industry sees electromobility as a strategic issue, including for freight transport and logistics. In this sense, the European Battery Alliance is a joint initiative to be welcomed and encouraged at the EU level.

The analysis is more nuanced concerning autonomous and connected mobility. The Netherlands remain the most advanced, with clear support for digitalisation of all road equipment. The Scandinavian countries, Germany and the United Kingdom have open experimental legislations on autonomous vehicles, detailed national strategies and plans and strong support from the automotive industry and start-ups. MaaS, C-ITS and mapping technologies are often quoted. Southern European countries are more cautious in this regard, having also more restrictive legislative frameworks regarding the deployment of this mobility.

Homogenous objectives and actions emerge concerning urban mobility. Europeans have the stated objectives of reducing pollution and self-driving. Large cities and governments are emphasising soft mobility and reducing the use of private cars in favour of public transport. Numerous initiatives to

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redefine urban and road space are suggested. Cities are moving towards flexible travel options through multimodal, accessible and inclusive mobility solutions. **Roads are seen as a necessary sharing space between different types of mobility, for example via dedicated lanes**.

European countries do not appear to be very quick to modify their road infrastructure, recalling the already high costs of maintaining and servicing an ageing network. For the moment, the integration of new mobility goes more through road equipment than through the road itself.

The West and the East, two distinct models

This benchmark study also covered North America and Asia. While the North-American region faces the same problems as Europe, Asia is likely to follow a different model of deployment of new mobility.

In the United States, **the GAFA (Google, Apple, Facebook, Amazon) already play a fundamental role in the development of new mobility**. They are shaking up the traditional sectors of the automobile and transport industry by their oligopolistic concentration. These multinationals address users directly through their platforms, algorithms and the data generated, by proposing an integrated global offer with new transport services or vehicles with on-board software (Waymo, Sidewalk Labs in Toronto...). These players are likely to replace the traditional players with regards to the service dimension of mobility.

This trend can also be observed in China. The BAT (Baidu, Alibaba, Tencent), equivalent to the American GAFA, are involved in many sectors, also affecting the transport sector. Baidu is particularly involved in technologies for autonomous and connected vehicles by providing for example a car software platform with associated content (Baidu Maps) to car manufacturers. This is seen as an alternative to the software usually developed by car and equipment manufacturers and as a potential substitution for the services offered by Apple and Google. For these digital players, taking into account the road infrastructure is not a priority for the time being.

The United States gathers the main companies working on new forms of mobility in the world. However, the potential for deployment of these technologies is hampered by the **lack of harmonisation of regulations in the various states**. Each state issues its own rules on the testing of autonomous vehicles. This is also the case in Canada, which suffers from divided jurisdiction between federal agencies and the different provinces, creating fragmented road infrastructure regulations despite strong state financial support for autonomous vehicle development and testing.

This problem of governance is less acute in Asian countries. The latter are characterised by a **strong strategic and financial involvement of governments,** stimulating the industry sector. Public funding for pilot tests of autonomous vehicles is substantial. There is also strong support for the development of "Newly electrified vehicles". In China, these initiatives are openly supported by the state and integrated into planning programmes. Also, Asia dominates the world battery market for electric vehicles. Korea and Japan are also partly supporting hydrogen technology.

The studied Asian countries want to position themselves as leaders in the digital industry in general: 5G networks, AI, Smart City. The Japanese and Korean automobile industries, in cooperation with public authorities, wish to deploy a large fleet of autonomous vehicles and a road infrastructure that can accommodate level 3 and 4 autonomous vehicles within the decade.

Western countries have an old and expensively maintained road network and are moving more towards a digital strategy based on the connectivity of vehicles and road equipment. Asia is investing more in both, digital mobility technologies and road infrastructure, especially in China. The

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enactment of technical standards and norms is faster there. Europe may have to choose between American and Chinese standards in the future.

Latin America innovates in urban mobility

Urban mobility initiatives are supported by the governments of the three countries studied in Latin America (Mexico, Chile and Argentina). The objective is to offer sustainable mobility options to road users. Although major initiatives have been carried out, developments often depend and vary according to local competences. Capital cities are major references in terms of urban mobility, for example Mexico's Ecobici bike share system which is the second largest bike sharing system in North America and the fifth largest in the world. Santiago de Chile has the largest fleet of electric buses outside of China.

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2 - New mobility: Where are their main developments? Business and industrial strategies of public and private actors, geographical developments, users' acceptability.

The main issues relating to new mobility can be divided in different blocks: **the digital issue** (processing and use of personal data, cyber-security), **governance** (partnerships and degree of involvement of the public and private sectors), **the environmental issue** (reduction of GHGs, development of low-emission vehicles and modes of transport) and **the objectives pursued** (control and reduction of congestion, road safety, degree of social acceptability). Depending on the studied regions, the strategies adopted differ in scope and degree.

Europe, North America and Asia are the three continents that are most interested in new mobility services. Their development can potentially give rise to three different models in the future. Development efforts are relatively different from one continent to another. Nevertheless, new mobility is based on an **important requirement of inclusiveness and accessibility**. Therefore, **the processing and use of personal data** is one of the fundamental issues addressed, especially where data is considered indispensable to structure and improve travel.

- **In North America**, mainly in the United States and Canada, a large number of start-ups in this field are to be noted, which are sometimes supported by **massive private investments,** as it is the case with start-ups working on automatization. Sometimes however, the economic profitability of these small companies is not yet sustainable, as is the case of micro-mobility operators in urban areas (e-scooters and electric scooters).

  The federal structure of these countries also shows the **weight of certain federal states** as drivers of new mobility (California, Michigan), whether through stricter environmental legislation or protection of their industries. The link with the private sector remains very strong in these states. The main structuring elements of new mobility for certain states and cities are the reduction of traffic congestion (home/work), the reduction of GHGs and better road safety. It should be noted in this respect that federal plans exist for the development of electrical terminals.

  Cities are also interested in **changing their traffic management methods**: moving from a flow of vehicles to a flow of passengers by integrating traffic lanes differently (public transport, cars, soft modes taken into account), as is the case in Sacramento.

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User acceptability is generally very low in relation to new mobility uses. This is mainly due to the current place of the private car, the geography and the supply of public transport in these countries.

The protection of personal data and their use is an issue for users, consumers and public authorities in the United States and Canada especially in the context of the rising influence of the GAFA. On the specific project "Quayside" in Toronto operated by Sidewalk Labs, a subsidiary of Alphabet, the parent company of Google, Sidewalk Labs had been forced to restrict its perimeter of intervention and data collection.

The US Congress intends to pass a federal law to regulate data management. California did not wait for this federal law by adopting its own legislation, directly inspired by the European GPDR, to provide rights for consumers and obligations for companies that collect data (California Consumer Privacy Act). The subject of cybersecurity is well identified by the US administration to standardise data carriers used for transport and mobility.

- In Asia, new mobility is developing through **a strong political will by public authorities, supported by a strong State structure and a deep interaction with national industries**. This is particularly the case in China and South Korea. This translates into an important commitment to the electric vehicle, the generalisation of connected roads, and increased accessibility for older people. Depending on the country and its car manufacturers, decarbonised vehicles continue to penetrate the market, as do recharging networks. Hydrogen fuel is still being considered as a long-term option.

  However, the processing of personal data is taken into account differently depending on the country and its governmental structure. South Korea has implemented a liberal data system. Japan has opted for open data sharing. China requires platforms hosted in its country to register to state authorities, the data being stored on Chinese territory.

  It is in Asia **that the acceptability of these new mobility is the highest**, much **higher** than in Europe or North America.

- In Europe, the Scandinavian countries and the Netherlands are **ahead of the rest of their neighbours in the integration of electric mobility**: Norway is a pioneer, the Netherlands have the most developed and densest charging network in the European Union, Sweden is investing heavily in electric road systems. **Most European countries are carrying out numerous experiments**: cooperation between Sweden and Germany in a system for recharging heavy goods vehicles by catenary, 5G tests between Germany, Luxembourg and France, cooperation for intelligent transport systems between Portugal and Spain.

  Europeans are very committed to the environmental issue, as shown by the European Green Deal proposed by the European Commission to reduce greenhouse gas emissions with ambitious targets for 2030 and 2050. This is especially impacting the transport and mobility sector.

  European car manufacturers have launched major investments in electric vehicles, following the new fleet emission standards adopted by the EU and following some pressure made by the Member States. **Partnership projects between European States and manufacturers are underway to develop and support a European industry in electric mobility, as illustrated by the European Battery Alliance**. Recharging infrastructure is developing in different ways depending on the country, but is definitely on the rise.

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Europeans are looking for common European wide technology systems and standards to **ensure their industrial and technological autonomy from** the US and China. This is particularly the case regarding autonomous and connected mobility. As elsewhere, the **objectives are to reduce congestion and improve road safety**. Furthermore, Europe is well advanced on the issue of personal data protection and processing. **The acceptability in Europe of these new mobility is on average** between North America and Asia.

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3 - Common grounds, divergences, singularities between the studied countries and the level of maturity between Europe and the rest of the world.

The West and Asian countries are quite mature concerning the development of new mobility in general. Europe is caught up in the competition for leadership in the digital industry between the American and Chinese players, for whom the development of new mobility mainly involves equipment rather than the road infrastructure itself. Europe remains more demanding on the environmental issue, integrating active and soft mobility in urban areas more rapidly. The strategic and industrial issues of electric mobility, but also connected mobility, are increasingly being addressed by the European Union since the arrival of the new Commission.

The level of maturity of each region studied differs according to its challenges.

Europe and North America face an ageing and expensively maintained road network. **The role of road infrastructure is still largely underestimated. However, maintenance is recognised as a key element to enable the deployment of new forms of mobility,** in particular through the polluter-pays or user-pays principles. The economic models for new forms of mobility and the financing of road infrastructure still raise major questions.

Today, new mobility is more likely to be achieved through digital technologies that involve road equipment more directly than the road infrastructure itself. Asia is following the same path, with much greater emphasis on these technologies. This is the case in South Korea where road equipment is being introduced in urban areas with the development of Smart Cities (open circuit), but where their substitution is considered on closed-circuit motorways for autonomous level 4 and 5 vehicles**.**

Global competition on standards, norms and development of autonomous and connected mobility is taking place between North America and Asia to hold the leadership in the digital industry. The American GAFA and their Chinese counterparts, the BATs (Baidu, Alibaba, Tencent), are shaking up and replacing the traditional players in the transport sector. On the basis of the data they collect, they can address users directly and offer them a range of mobility services that take into account all their journeys. Northern Europe and the Netherlands are notable examples of the integration of these new technologies (MaaS, ITS). Digital players do not really consider the road infrastructure for the time being.

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The issue of governance is central to the ability to adopt standards in a unified and rapid manner, and disparities exist in this regard in all the countries studied. This is the case, for example, between Canada and the United States, where interoperability of road systems and equipment is being developed in order to ensure their effectiveness and readability in both countries. This equipment designed, manufactured and used by road sector companies must be recognised by all vehicles on the road.

The picture is more balanced considering electric mobility, where a high level of maturity can be observed in all three continents. China and the United States are at the heart of the global production of electric vehicles and support this market to a large extent. Europeans, for their part, are more advanced in the evolution of mobility in urban areas, favouring active and soft mobility through a redefinition of road and urban space.

The European automotive industry is facing more stringent requirements for CO2 emissions from vehicles than anywhere else in the world (95g/km in Europe, 122g/km in Japan and China, 125g/km in the United States). In this sense, the road infrastructure sector must participate in and accompany this expected downward trend in greenhouse gas emissions from the road sector as a whole.

The decarbonisation of the road sector in Europe will become a key issue for road actors through actions on infrastructure design, changes in processes and materials used, and by examining the life cycle and resilience of infrastructure. The sector can contribute to the environmental transition through the large-scale deployment of charging infrastructure for low-emission vehicles.

Latin America is in a different position. Large cities are innovating in the field of urban mobility (self-service bicycle or electric bus fleets). Applications such as "Where Is My Transport" identify the formal and informal public transportation networks in low- and middle-income cities, considering the flexibility of uses. However, the development of electric and autonomous mobility appears to be rather limited in the short term. Road infrastructure is seen as an enabler to connect cities and regions, with a view to offer a more inclusive access to all the population and open-up rural areas.

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4 - Global overview of the role of road infrastructure in traditional transport and the development of new forms of mobility

The role of the road differs according to the regions of the world: an expensive asset whose maintenance and transformation are necessary in the West and Japan, part of a digital acceleration strategy in Korea, support for the development of connectivity in China and South America. The integration of road infrastructure into connected, autonomous and carbon-free mobility differs according to the regions of the world.

Each country agrees on the **importance of a good road network** to ensure the movement of goods and people under good conditions, guarantee safety and access to services and promote equity between territories in terms of regional planning and attractiveness.

As road transport modes are dominant in all countries, they need to find solutions to congestion issues, sustainability of road maintenance, road safety, reduction of GHG emissions, overall performance of their transport systems and financing.

This comparative study clearly shows the differences in management policies or budgetary choices from one continent to another and between the countries themselves.

- For **Latin America** (Mexico, Argentina, Chile) the subject of maintenance and rehabilitation of basic road networks is a priority.

- In **North America,** the quality of the infrastructure networks has deteriorated so much (including road networks, their equipment and engineering structures) that a consensus has been reached between the Republicans, President Trump and the Democrats to adopt in the spring of 2019 a major investment programme of 2000 billion dollars over 25 years. The American Society of Civil Engineers (ASCE) in 2017 estimated that $836 billion would be needed to upgrade roads and bridges in the United States. Figures from the World Economic Forum show that the United States was spending an average of 2.4% of its GDP on infrastructure (transport, energy, water and waste treatment networks, etc.) while Europe spent an average of 5% of its GDP on the same type of infrastructure.

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- **In Europe**, many countries face an ageing road network (Germany, France, United Kingdom, Belgium) and there are significant differences in commitment. For example, the amount spent annually per kilometre of road in the years 2010 was 4 to 5 times higher in Austria, Belgium, the Netherlands, the United Kingdom than in France or Germany. In the period 2000/2014 France spent 0.99% of its GDP on transport infrastructure while Germany spent 0.59% of its GDP. The latter two countries have recently become aware of maintenance delays and have decided to increase their commitments.

- **In the Asian countries** studied, the logics differ:

    - **China** is investing massively in the creation of new road and rail infrastructure in order to create better links between many megalopolises. China is made up of more than fifty cities or agglomerations with a population of between 2 million and 32 million inhabitants. In 2017, more than 8,000 kilometres of motorways were built (there should be more than 140,000 kilometres of motorways in 2018).
    - **South Korea's** population is concentrated in high-density urban areas and is developing its interurban links.
    - **Japan** has a road network that is large for its surface area but aging. Other problems are the frequency of natural disasters and the isolation of its rural population coupled with the ageing of its population.

However, the common denominator between these three very different countries is that, wanting to take the lead in the new mobility, **they are accelerating their programmes for the digital transformation of their road infrastructure** for decarbonised, autonomous and connected mobility.

The acceleration of new forms of mobility, the race for hypermobility in all countries before the health crisis, and the diversification of uses induced by the digitalisation are further shaking up the fundamentals of transport, such as interurban network managers and urban authorities. The search for an optimisation of network operations and their transition to a multimodal approach are no longer enough.

The role of road infrastructure in the face of these new transport and mobility challenges is not introduced in the same way in the countries studied, except perhaps in **urban areas** where **active, light and shared mobility** becomes common sense, giving the authorities a lever for regulating or sharing road space.

The prospect of the autonomous vehicle is currently being tested in many countries, for contrasting uses (individual or collective shuttle-type travel). Its development depends on both:

- **Choices made by public authorities,** which refuse to have pavement standards imposed with adequate levels of services;
- **Choices of the car manufacturers** or,
- **Choices of digital players** who opt for digital information systems (5G) that give priority to interactions between vehicles rather than from vehicles to physical infrastructure.

On the American continent (Canada follows the standards imposed by the United States), American public authorities are focused on **road safety issues related** to independent driving. The upgrading of road networks is based on a patrimonial approach and accessibility rather than connectivity, except for traffic information. The choice of the industry is clearly to be able to **work without the road infrastructure**. It is expected, that the autonomous vehicle will adapt to the roadway it uses. Its integrated sensors and geolocation will have to be sufficient to ensure autonomous driving at level 4 or 5.

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The authorities in **Latin America** urgently need to maintain the existing infrastructure and to create the missing links within the region.

In Asia, China has made infrastructure connectivity a standard part of its development programmes. In Japan as in South Korea, manufacturers and the authorities are supporting infrastructure connectivity and information exchanges. **Road equipment (road markings, roadside units, cameras) are favoured over pavement equipment**. For example, a city dedicated to autonomous driving, the K-City, was created in South Korea.

In **Europe, public authorities** are **cautious not** to be drawn into universal road standards that would be impossible to ensure on all networks. As far as the Netherlands, the United Kingdom, Germany and France are concerned, **the trend is to achieve a more balanced system** between on-board connectivity equipment and external equipment, with vehicle to vehicle (V2V) or vehicles to infrastructure (V2I) interactions, particularly in terms of safety of the autonomous vehicle. Road equipment here is also favoured.
More as a budgetary precaution than for technological reasons, public authorities are reluctant to clearly position a minimum level of service of the road infrastructure to secure autonomous mobility.

In terms of carbon-free mobility, the challenges of the massive development of the electric vehicle are correlated with the equally massive deployment of recharging stations, particularly hydrogen-powered ones. While in all the countries studied, governmental or industrial choices are acting in favour of decarbonised mobility, road infrastructure as such has not yet been adopted as an essential condition for the development of electric mobility.

Yet studies **in the United States** show that poor road maintenance increases the consumption and energy expended by the vehicle, especially heavy goods vehicles. For example, automobile equipment manufacturers such as Michelin in **France** have modelled the energy gains obtained when having a good interface between the tyre and the road surface.

However, there are interesting prospects for electric road systems. **Swedish and German manufacturers** (Scania and Siemens) are very advanced in testing pantograph or conductor rail systems on heavy goods vehicles. Tests have been initiated in Sweden and Germany. Induction technology also opens up prospects, giving road infrastructure a role in the development of electromobility. Networks or demonstrators exist in **Norway, South Korea, the United Kingdom and France.** In the latter country, building and public works groups are working with energy companies and car manufacturers to study the dynamic charging system with the transfer of parts of the energy carrier to the infrastructure.

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5 - Users' expectations on the role of road infrastructure in the studied countries

Users' expectations of road infrastructure differ from one region of the world to another: a social and connecting role between regions in Latin America and China, a vector of connectivity in Asia, a demand for assitance, regulation and safety of mobility in the West.

In all the countries studied, road users expect road infrastructure and its equipment to be **maintained and made safe** and to meet the needs of the population for their exchanges, their daily mobility, access to all services, the movement of goods or supplies and connectivity between territories. Disparities between individuals and territories remain high.

In Asia (Japan, China, South Korea) as **in Latin America** (Mexico, Argentina, Chile), expectations naturally focus on the need for equity and equal access to territories (city-centre and peri-urban relations, city-to-city links or medium-distance mobility) and on the need for security, especially in Latin America. **The social and vital role of road networks and roadways** is highlighted, without being exclusively associated with the use of private cars. It is strongly expected that the road infrastructure and its facilities will promote **intermodality** by combining all types of mobility: collective or individual, carbon or decarbonated (electromobility), active and inclusive (cycling and walking), especially in cities.

This concept finds its reality **in Asia** thanks to **infrastructure connectivity**. The road infrastructure provides services for vehicle to vehicle or vehicle to infrastructure communication, for autonomous driving, for the use of traffic data towards the user, or for the analysis of the network's state for maintenance purposes.

In North America (Canada and the United States), where the road mode is dominant for land transport, users also demand a more agile, safer, maintained infrastructure that supports different modes in urban areas: support for electromobility (charging stations) or energy supply. In this respect, they feel that **private players are shaping mobility without any real regulation,** and express the wish for better cooperation between the world of the vehthe automotive sector and the infrastructure sector. Road safety issues for autonomous driving are well identified by users.

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For all eleven countries studied in **Europe** (France, Germany, Netherlands, Norway, Finland, Sweden, Belgium, Austria, Spain, United Kingdom, Portugal) expectations converge: the aim is to **ensure a sufficient level of maintenance for the entire ageing road network**. The development of new forms of mobility in urban areas is an opportunity to redevelop public spaces and roads and to share them in a better way. Road safety remains a fundamental issue, as is the limitation of congestion and the reduction of greenhouse gas emissions generated by road transport. ITS technologies and the emergence of MaaS are well perceived as a solution for optimising transport and regulating flows. However, the contribution of the road infrastructure itself to this optimisation is not yet well identified in all countries.

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